IMPLICIT BIAS AND STEM EDUCATION:
AN EXPLORATION OF GENDER AND RACIAL DISPARITY

by
Mary Frances Park

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Abstract

The research study presented in this dissertation was the result of an exploration of the problem of gender enrollment disparities in STEM elective courses at the high school level in an independent school in the western United States, Western Regional School (WRS; a pseudonym). A review of the literature in chapter one revealed several factors contribute to gender, as well as racial/ethnic, disparities in the enrollment of STEM courses at the high school level as well as selection of STEM majors at the university level. Those factors include but are not limited to gender inequalities as displayed in both overt and explicit biases and implicit biases, U.S. gender norms and socialization, as demonstrated by gender stereotyping, and a lack of STEM role models which may affect STEM self-efficacy and STEM self-identities. The needs assessment focused on the investigation of STEM course enrollments during a 10-12 year period along with semi-structured interviews with influential WRS community adults such as teachers, academic advisors, deans, counselors, and administrators. The key findings showed evidence that while there were no significant gender disparities in the enrollment of required STEM courses at WRS, there were significant disparities in the selection of specific STEM electives including physics-based, computer science, and advanced mathematics courses. The needs assessment informed the design of an intervention professional development (PD) program focused on implicit bias as it pertains to gender and race/ethnicity and science performance for educators and academic advisors at WRS. The intervention PD was developed around Bandura's social cognitive theory of reciprocal determinism. The researcher conducted a mixed methods convergent parallel design study to evaluate the intervention PD program. The eight-session PD program ran for a total of four synchronous and four asynchronous sessions and showed that the participants' awareness of both what implicit bias meant in general and their own level of individual biases increased. Additionally, with that increased awareness came motivation to change teaching and advising practices in the form of a call to action. These educators and academic advisors shared their plans and priorities to focus on mitigating their own implicit biases, especially as it related to their enrollment discussions with students and classroom practices. Their self-efficacy as academic advisors, on the other hand, did not appear to be significantly improved as a result of the intervention program, but it should be noted that that result may have more to do with the structure and duties of WRS academic advisors and not because of the design of this specific intervention PD program. The findings of this study suggest that the PD program could support the increased awareness of implicit bias around gender and race/ethnicity and a call to action in the broader adult community of WRS, especially all faculty and staff.

Keywords: STEM, gender, race, ethnicity, equity, implicit bias

Dissertation Advisers: Dr. Olivia Marcucci and Dr. Karen Karp

Committee Member: Dr. Margaret Mohr-Schroeder

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The student has made all necessary revisions, and we have read and approve this dissertation for submission to the Johns Hopkins Sheridan Libraries as partial fulfillment of the requirements for the Doctor of Education degree.

Dr. Olivia Marcucci	[signature]	11/2/22
Adviser	Signature	Date
Dr. Karen Karp	Karen Karp	10/31/2022
Committee Member	Signature	Date
Dr. Margaret Mohr-Schroeder	[signature]	10/31/2022
Committee Member	Signature	Date
Committee Member	Signature	Date

Dedication

This dissertation and its research are dedicated to multiple people who have inspired me and continue to do so daily. First, I would like to dedicate this work and any potential impacts it might have to my best friend and constant inspiration, Kristin Hone Brown. You were always there pushing me to be a better educator and person, and this work could not have been possible with you. I am confident you would have been right there alongside me conducting this research if you could. "I might only have one match, but I can make an explosion."

To all those students who have dreamed of being a scientist, technology specialist, engineer, or mathematician, I dedicate the findings of these research studies. May we always remember that the more voices and perspectives we have in STEM will only serve our planet in a way that ***all peoples*** *are represented in our pursuit of knowledge. Finally, to all the educators, parents, guardians, families, friends, and mentors encouraging these young students to pursue their dreams, you are vital to the support of these future scientists.*

"Don't let anyone rob you of your imagination,
your creativity, or your curiosity.
It's your place in the world; it's your life.
Go on and do all you can with it,
and make it the life you want to live."

-Dr. Mae Jemison

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Executive Summary

A gender gap in science, technology, engineering, and mathematics (STEM) in the United States manifests at all levels of education and careers. From elementary schools through universities and to the workforce, females continue to be underrepresented in STEM spaces. While women now hold approximately 50% of all available U.S. jobs, they comprise only roughly 25% of the STEM labor pool (Beede et al., 2011). Sadler et al. (2012) uncovered the disparity in high school STEM aspirations by showing a 3:1 male-to-female graduation ratio of students who intend to pursue STEM majors. If female students do not aspire to careers in STEM at the high school level, then they are less likely to seek and ultimately obtain college STEM degrees (Ackerman et al., 2013).

Problem of Practice

The well-documented gender gaps in STEM fields demonstrate a disparity in STEM interest and education throughout girls' lifespans (Beede et al., 2011; Kanny et al., 2014; Sax et al., 2017). Additionally, these well-recognized phenomena do not appear to be changing despite various efforts to narrow the gender gaps (Iskander et al., 2013; LaForce et al., 2019; Miller & Hurlock, 2017; Sadler et al., 2012; Sublett & Gottfried, 2017). Even more concerning, numerous studies show that the intersectionality of gender and race amplifies this disparity, especially for African American/Black women (Charleston et al., 2014; Johnson, 2011). There are many potential contributing factors to this gender gap, including institutional issues, societal problems (e.g., sexist attitudes towards female scientists), individual-level phenomena (e.g., unconscious habits such as lack of self-efficacy), and, finally, explicit or implicit biases around who actually does science.

The phenomenon has often been dubbed the ‘leaky’ pipeline. This pipeline has often been pointed to as the primary cause of this gap. Even so, researchers often disagree on which parts of the institutional pipeline contribute the most to the exodus of women from STEM pathways (DeWitt & Archer, 2015; Raabe et al., 2019). This dissertation focuses on the specific role that high school coursework and influential community adults have on female students’ enrollment in STEM-related courses during their high school years. Without these foundational STEM high school courses, female students cannot build the background needed to participate fully in STEM majors, diminishing their chances of working in STEM careers.

Context of Study and Salient Needs Assessment Findings

This dissertation seeks to identify the extent and potential causes of gender disparity in the enrollment of STEM elective courses in a U.S. high school. Specifically, the researcher investigated the enrollment data for students in the 11th and 12th grades at West Regional School (WRS), an independent school in the western United States. In the U.S., independent schools are not a part of a formal district and are, therefore, independently governed and formally accredited by the National Association of Independent Schools (NAIS). The total enrollment for the 2021-2022 school year is 736 students, with 102 full-time faculty members. WRS’s student body includes 25.8% students of color (WRS School Profile, n. d.). While the school has a current annual tuition fee of $32,841 per student, 28% of the students receive financial aid totaling over $4.4 million per year (WRS School Profile, n. d.; WRS Tuition and Financial Aid, n. d.). WRS had previously collected data for student course enrollment, and the researcher was able to access this secondary data for the dissertation’s needs assessment study.

The specific STEM courses evaluated in the needs assessment included all courses identified as either a graduation requirement or an elective course. The researcher expected the enrollment into the required course enrollments to exhibit the gender balance of the overall grade level. On the other hand, elective courses at WRS are entirely voluntary and depend on student interest and scheduling availability. For years, STEM teachers and academic advisors at WRS have suggested a gender imbalance in many elective courses, especially those that favor male enrollment, such as physical and technology science-based, engineering, computer science, and advanced mathematics courses.

As predicted, the needs assessment enrollment data demonstrated gender parity for all the required STEM courses except Geometry Functions. Additionally, there was no statistical difference between the proportion of female students enrolled and the males in these required courses. The needs assessment enrollment data revealed that certain elective STEM courses showed significant differences in the enrollment proportions of female to male students. Those courses included: AP Physics C: Electricity and Magnetism, AP Physics C: Mechanics, Biomechanics, Engineering Design and Build, Honors Multivariable Calculus (HMC), two computer science elective courses AP Computer Science AB, and the Independent Studies: Advanced Computer Science Topics. Additionally, these computer science courses are only accessible at the end of the computer science 'tract.' Thus, prerequisites in computer science prevent students from enrolling in either of these elective options until introductory computer science courses have been previously completed.

Semi-structured interview data from WRS faculty and staff enriched the enrollment data and proved vital in identifying potential causes for the course enrollment disparity. This interview data gave insight from the influential adults' perspective as to some reasons for enrollment differences. The most important theme from these interviews appeared to be a lack of STEM confidence and STEM identity from the female students in the courses where disparity was significant. Other important emergent themes developed included concerns about the factors students consider when selecting courses, the varied advice students receive prior to enrollment, potential implicit bias around science performance, and, finally, a dysfunctional advising system.

Themes around the pressures relating to the college admission process appeared to be the most influential driving forces for students, as stated by the interviewees. WRS faculty and staff stated that they encourage students to pursue their genuine academic passions and create well-balanced schedules during pre-enrollment discussions. These influential community adults appear to be concerned with broader societal perceptions students may have and the varied advice WRS students get from other important adults in their lives, primarily through recommendation processes. The overarching concern of these interviews was the school's role in supporting students through the enrollment process and, especially, the need to evaluate and potentially restructure the current advisory program at WRS. Many shared that they had never received any formal development programming at WRS or any other school related to their roles as academic advisors. Many interviewees felt ill-prepared for the role of academic advisor. Finally, the researcher chose to focus on actionable themes of implicit bias around gender and race/ethnicity as it pertains to science performance and educator and advisor self-efficacy as it related to advising students for the literature of potential interventions.

Theoretical Framework

In order to support this study's intervention, the researcher conducted a literature review and proposed a professional development program supported by a foundational theoretical framework. The researcher used Bandura's (1989) Social Cognitive Theory (SCT). At its most fundamental thesis, SCT suggests that learning happens in the social environment. SCT specifically focuses on how individuals' behavior is based on their own experiences and influenced by their social environment. Bandura (1989) posited that these factors involve which behaviors a person chooses to display or not. The SCT describes human functioning as the interactions between an individual's behaviors, environmental factors, and cognition (Bandura, 1989; Schunk, 1989).

Of Bandura’s (1989) Social Cognitive Theory's six essential constructs, this dissertation focuses primarily on the final one, self-efficacy. Self-efficacy is a person's confidence in their abilities to perform a behavior to be positively received. Additionally, an individual’s self-efficacy may be influenced by their capabilities, past experiences, and other social factors. SCT was the guiding framework for the intervention literature review that addressed the gender disparity in STEM education at the high school level because its constructs, especially self-efficacy, can be used to explain an individual’s behavior. The researcher was particularly interested in the self-efficacy of educators and academic advisors and how confident they felt in encouraging their students, especially girls and students of color, to pursue STEM interests.

Intervention Study

The intervention study investigated how participation in a professional development (PD) program would impact WRS educators’ and academic advisors’ awareness of their implicit biases. Additionally, self-efficacy around academic advising, specifically related to STEM course enrollments, was another focus of the PD program stemming from a potential increase in implicit bias awareness. The research intervention study explored the following five research questions:

RQ1: How did the participants complete the activities presented in the implicit bias professional development (PD) program?

RQ2: How did the participants engage with the activities in the implicit bias PD program?

RQ3: How did participation in the implicit bias PD program impact participants' awareness of their own implicit biases toward the influence of gender in science performance?

RQ4: How did participation in the implicit bias PD program impact participants' awareness of their own implicit biases toward the influence of race/ethnicity in science performance?

RQ5: How did participation in the implicit bias PD program impact the participants' self-efficacy as it relates to the academic advising of their students?

Research Design

This intervention study and evaluation used a quasi-experimental, mixed methods research design (Creswell & Plano Clark, 2018; Onwuegbuzie & Leech, 2006). The overall approach to the convergent parallel design was equal parts quantitative and qualitative data collected concurrently (Creswell & Plano Clark, 2018; Tashakkori & Teddlie, 2003). Some portions of the study incorporated an explanatory sequential design specifically related to the focus group data. Additionally, the researcher decided to implement a pre-post-intervention designed study to address the use or exclusion of a comparison group. The researcher chose a pre-post-intervention study but could not establish a control group for comparison. The pre- and post-intervention design can be conducted without a formal control group; thus, the treatment group served as its own comparison (Lochmiller & Lester, 2017). The use of both surveys and qualitative measures, such as a focus group and participant reflective journals, allowed the researcher to determine if there were external factors that could affect the outcome of the study.

Findings

The researcher designed the intervention PD program to introduce participants to the concept of implicit bias in general and specific instances of implicit bias of gender, race/ethnicity, and its effects on science performance. Specifically, the researcher was interested in focusing on participant awareness of implicit biases and their self-efficacy as it related directly to their interactions with students. FitzGerald et al. (2019) showed that implicit bias PD programs focused solely on identifying biases would fail to bring about lasting change in adults. Thus, the program was designed to incorporate opportunities to learn what implicit bias was and what, if any, individual biases participants had and also introduced strategies that can be used to mitigate the negative effect biases can have on people. Research has shown that PD programs allowing participant opportunities were considerably more effective for seeing longer-term benefits of bias reduction (Batchelor et al., 2019; Glock et al., 2013; Moss-Racusin et al., 2018).

The intervention PD program showed high levels of participant use of materials and engagement with PD activities reflected in the high attendance records, high completion rates of pre-planned intervention activities, Use surveys, and reflective journals. Specifically, Use survey results showed that participants could access all intervention PD materials. These findings suggest that participants completed the intervention PD programming at high rates as designed by the researcher prior to the intervention.

The researcher reported extremely high completion rates of Engagement surveys and personalized process plans. This demonstrated that participants were highly engaged with these components of the intervention. Additionally, participants reported feeling very engaged to highly engaged throughout the entire program. All five focus group participants suggested that they wished the intervention PD program would have run much longer than the eight sessions and that it should be a required program for all of WRS's faculty and staff.

The findings of this dissertation study showed that educators and academic advisors who participated in the implicit bias-focused professional development program experienced a significant increase in their awareness of the concept of implicit bias in general and, more specifically, as it relates to gender and race/ethnicity. The number of intervention PD program participants (N = 12) was small. Thus, the lack of a statistically significant change in overall awareness could not be detected, given the small sample size. While the quantitative data showed little statistically significant differences in all aspects of awareness from survey questions, the qualitative data, including reflective journal entries, open-ended survey questions, and the post-intervention focus group, gave the researcher a resounding answer that the intervention provided participants many opportunities for increase implicit bias awareness.

Alternatively, the study did not ultimately show that WRS educators and academic advisors had significant changes in their self efficacies as it related directly to their roles as advisors to students, especially prior to course enrollment discussions. In both the needs assessment and final intervention study, many participants pointed to a dysfunctional advising system at WRS. The researcher has concluded that while self-efficacy was an important part of the intervention, this dysfunction superseded participants' abilities to apply this specific programming to their roles as academic advisors at WRS. The participants shared that while they might not feel more confident in their roles as academic advisors, per se, they did feel an overall increase in general efficacy as it pertained to their awareness of the harmful effects unchecked implicit biases can have in their classrooms and their own lives.

Chapter 1

Literature Review on the Problem of Practice

Introduction

The gender gap in science, technology, engineering, and mathematics (STEM) in the United States manifests at all levels of education and career opportunities. From primary school through college to the workforce, females are underrepresented in STEM spaces. Beede et al.'s (2011) work shows that while women hold roughly 50% of all available U.S. jobs, they comprise roughly 25% of the STEM labor pool. Sadler et al. (2012) uncovered the disparity in high school STEM aspirations showing a 3:1 male to female graduation ratio of students who intend to pursue STEM majors. If female students are not aspiring to careers in STEM fields at the high school level, then they are less likely to pursue and ultimately obtain college STEM degrees (Ackerman et al., 2013).

In 2012, The President's Council of Advisors on Science and Technology projected the U.S. will need approximately 1 million more people trained in STEM over the next 10 years if it hopes maintain its position as a global leader in science and technology. In a 2018 report, Deloitte suggests the need for manufacturing jobs to grow by 1.96 million workers by 2028. Citing the retirement of the baby-boomer generation, the report also states there will be a shifting skill set that relies heavily on technology. They also propose a skills-gap between 2018-2028 which could leave an estimated 2.4 million jobs unfilled (Deloitte, 2018). Funk and Parker (2018) noted that overall STEM employment has grown 79% since 1990 and that, specifically, careers related to computers have seen the biggest jump with a 338% increase. Clearly the demand for qualified and trained STEM professionals is on the rise in the U.S. According to Georgetown University's Center on Education and the Workforce, college graduates who earn

STEM degrees have higher earning potential overall, specifically citing petroleum engineering majors who earn the highest annual salaries over the course of their careers, approximately $136,000 annually (Carnevale et al., 2015). Females and other underrepresented minorities do not have equal access to these high-paying STEM degrees, impacting their lifelong income and wealth development (Funk & Parker, 2018). While the potentially high earnings of STEM careers might be a consideration for many, the equal access to STEM careers by the hiring of a more diverse population of workers leads to a richer pool of problem-solvers. Allen-Ramdial and Campbell (2014) that many nations are faced with the challenge of a lack of diversity in the STEM fields, and that in order to ensure success in these field by way of promoting "increased production capacity and creativity" that will "preserve global scientific competitiveness" (Allen-Ramdial & Campbell, 2014, p. 612).

The objective of this chapter is to review the recent literature around the gender gap in STEM. First, I describe the theoretical framework used to narrow the scope of my intended research. Next, using that framework, I will discuss various contributing factors at each of the systems levels. While evidence at each level supports these numerous potential contributing factors to my problem of practice, I will focus the remainder of this dissertation on a few specific contributing factors outlined at the microsystems level that appear to be both relevant to the research context, described in Chapter 2, and also the ones that are in the sphere of influence for potential interventions. In this chapter I will be exploring just the critical factors under each system's level, with a more in-depth literature review conducted on the factors in the conceptual framework that follows.

Problem of Practice

There are well-documented gender gaps in the science, technology, engineering, and mathematics (STEM) fields at many levels (Beede et al., 2011; Kanny et al., 2014; Sax et al., 2017). Disparity in both STEM interest and education throughout girls' lifespans are a well-recognized phenomena and do not appear to be narrowing (Iskander et al., 2013; LaForce et al., 2019; Miller & Hurlock, 2017; Sadler et al., 2012; Sublett & Gottfried, 2017). Additionally, studies show that the intersectionality of gender and race amplifies disparity in STEM, especially for African American/Black women (Charleston et al., 2014; Johnson, 2011). As the literature suggests, there are many potential contributing factors for this gender gap. Some of those potential contributing factors are institutional or societal problems (e.g., sexist attitudes towards female scientists) while others are individual-level phenomena (e.g., unconscious habits such as lack of self-efficacy).

Many researchers point to a 'leaky' STEM pipeline as the primary cause for this gap, but there is some disagreement about which part of the institutional pipeline is contributing the most to the exodus of women from STEM pathways (DeWitt & Archer, 2015; Raabe et al., 2019). This dissertation focuses on the role that high school coursework and influential community adults have on the STEM pipeline. If female students are not electing to take these STEM related courses during their high school years, there is a significantly lower probability that they will pursue college STEM majors and eventually hold STEM-based careers (Ackerman et al., 2013; Moakler & Kim, 2014; Yoon & Strobel, 2017). If girls and women are missing out on these critical high school elective courses and thus not building the background needed for full participating in STEM majors, then their chances to work in the STEM fields diminishes.

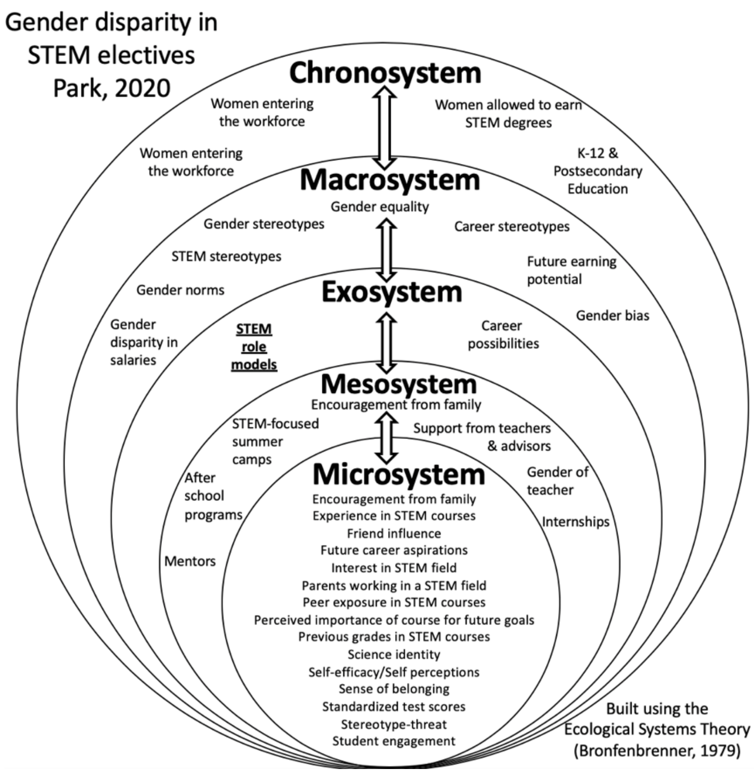
Theoretical Framework

Bronfenbrenner's (1979) developed his Ecological Systems Theory (EST) as a way to explain the various factors that directly or indirectly influence how children progress through their developmental stages. While Bronfenbrenner's work later focused on the importance of proximal processes with the Process-Person-Context-Time Model, the early version of his theory still has a strong presence and relevance in educational research. His nested EST model is depicted with various concentric circles that show the different levels of influence on the person, with the child situated at the very center of the model. For example, the outer most circle represents the chronosystem. This references factors that include changes over time. The macrosystem focuses on social and cultural values that may influence the child's development. The exosystem includes factors that are in the child's indirect environment. The mesosystem starts to focus on factors that are considered 'connections' to the subject. Finally, the microsystem encompasses all factors in the child's 'immediate environment.'

The STEM gender gap is influenced by many factors at different levels of the Ecological Systems Theory, from the factors in the chronosystem all the way down to the microsystem level. While factors such as gender norms and stereotyping are critical macrosystem-level factors, they may not be practical to address within the scope of this research. The microsystem-level, on the other hand, is full of potentially actionable contributing factors such as students' science interest, their self-efficacy, their sense of STEM-belonging, teachers' impact on any of those reasons, and, in addition, the encouragement from a student's own family. When considering why this problem of practice exists, the question of what contributing factors lead to the gender disparity in STEM elective courses away from the relatively gender-balance in required STEM courses, is imperative. The research in this dissertation will specifically focus on microsystem-level questions but can be extrapolated to understand more of the macro- and chronosystem levels concerns. In the following sections, I will introduce and explore the contributing factors at each of the levels of Bronfenbrenner's (1979) Ecological Systems Theory (Figure 1.1).

Figure 1.1

A Nested Model to Identify Potential Contributing Factors of the Gender Disparity Observed in STEM Electives at an Independent High School Level



Bronfenbrenner (1979) described five nested levels of environments that affect child development. They were described as nested as they interrelated and have influential relationships on how child develop. The microsystem is the level closes to the child. It contains the child's immediate environment such as their parents or guardians, siblings, teachers, and peers. The mesosystem is the next environment. It is defined as the interactions between the child's microsystems. For example, this might include the relationship between a child's parents and their teachers, or their siblings and their schoolmates. The exosystem are those environments in which the child is not in directly involved, but is affected by indirectly. These environments could include their parents' social circles or places or work and the mass media. The macrosystem focuses specifically on how culture and society can shape and affect a child's development. This can include factors such as socioeconomic statues, ethnicities, societal norms, and geographical locations, for example. Finally, the chronosystem describes changes that occur of an individual's lifetime that can influence development. This might include, for example, major life transitions (i.e., death of family members, divorce, moving) or historical events.

Potential Contributing Factors to Gender Disparity in Students' STEM Enrollment

Chronosystem Factors

This literature review will focus on potential causes of the gender disparity of students in STEM elective course selection starting with the chronosystem. The chronosystem encompasses factors that span both an individual's life as well as a broader historical timeline in regard to this problem of practice. A major and potential contributing factor of this problem of practice is the gender disparity in education in general. This disparity in access to higher education has contributed to the lack of females pursuing and obtaining STEM-specific college degrees. An understanding of this timeline will help to explain how women eventually started to pursue STEM-related careers but were delayed by educational access (Solomon, 1985). These factors, that have been identified in literature include women's delayed entrance into the workforce, delayed access to higher education, delayed access to STEM careers because they earned fewer STEM college majors. The continued delay of women earning STEM degrees lead to women being denied the higher earning potentials that come with those degrees.

Women Entering the Workforce

The United States has a long history of gender disparity in various career paths. Moen and Han (2001) acknowledge that prior to the Industrial Revolution, that people in the United States "may have had life plans, they did not have careers" (p. 44). The Industrial Revolution created a big shift in the workforce where employment shifted dramatically from self and family-owned operations such as farming and towards businesses that required a larger labor force. Moen and Han (2001) described this historical time of the creation of careers as new ways to carry out work. As careers defined the labor force, unpaid labor that included house and family work, was marginalized. "This bifurcation of productivity, distinguishing paid from unpaid, also became heavily gendered" (Moen & Han, 2001, p. 44). This divergence led to the societal concept of men as the 'breadwinners' and females as the 'homemakers.' While there is evidence women also entered the workforce during this time period, they often did so into careers where college degrees were not prerequisites (Solomon, 1985). Careers such as administrative assistants, nursing, retail, and primary-level teaching, for example, were the most accessible entry points for females into the workforce. Some of those careers required college degrees and some did not. It is worth noting the while nursing is a STEM career, there is a historical connection to this field being dominated by women. Solomon (1985) identified midwifery as one occupation in the United States in early 17th century as "exclusively" female. Nursing, as an extension of caregiving as well having this historical link to midwifery, made sense as a career choice for women during this time. Once women were allowed to earn university degrees, their selection of majors still appeared to be dictated by cultural expectations.

Women Earning College and STEM Degrees

Before the late 1800s, women being accepted and enrolled in universities in the U.S. was limited (Solomon, 1985). Women pursuing STEM degrees were even rarer. Because the majority of U.S. universities did not admit women until the mid-1800s, women lacked the access to advanced degrees and careers that required those degrees such as medicine, engineering, and law (U.S. News and World Report, 2009). While higher education in the U.S. began with the founding of Harvard University in 1636, Catherine Brewer became the first White women to earn a bachelor's degree from Wesleyan College in 1840 (Macon, GA), 200 years behind men's rights to earn the same degree (Farnham, 1995). In fact, prior to that, only White men were allowed to enroll in and earn college degrees. With that said, there is conflicting information, but the first Black man to earn a college degree was in the early 1820s (Slater, 1994). Elizabeth Blackwell became the first White female in the U.S. to earn a medical degree in 1849, whereas Mary Jane Patterson was the first Black women to earn a bachelor's degree in 1862 (Solomon, 1985; U.S. News and World Report, 2009). While she never officially entered the engineering workforce, Elizabeth Bragg was the first U.S. White female to earn an engineering degree in 1876 (LeBold & LeBold, 1998). By 1893, only three women in the entire United States had earned engineering degrees (LeBold & LeBold, 1998).

By the late 1970s, women in the United States surpassed men in the number of higher education degrees earned (Snyder, 1993). According to Fry (2019), gender parity for college degree-holding individuals in the U.S. workforce was achieved in early 2019. According to recent analysis of U.S. Bureau of Labor and Statistics workforce data by Pew Research Center, there are now 29.5 million women who hold at least a bachelor's degree in the U.S. workforce, outnumbering the 29.3 million college educated men (Fry, 2019). While the ability for U.S.

female students to earn college degrees lagged behind men for roughly 200 years, in the past 40 years more female students have earned bachelor degrees than males (Blau & Kahn, 2017; Michelmore & Sassler, 2016; Snyder, 1993). As a result, more women were able to enter and stay in the workforce, albeit it not necessarily without periodic interruptions for personal reasons such as family commitments (Solomon, 1985). While more women are able to enter the workforce, it is important to remember that women still lag behind men being consistent members of the workforce, with little to no career interruptions. In 2018, this disparity was still evidenced by the fact that 78.1% of college-educated males were in the workforce, while only 69.9% of college-educated females were (Fry, 2019).

Even with more females earning college degrees, the disparity in STEM degrees earned remains considerable. According to the National Center for Education Statistics (2019), currently approximately 36% of STEM degrees were acquired by female students compared to the 64% conferred to male students. This gap in degrees-earned leads directly to fewer women in STEM careers, which then leads to women missing out on earning higher salaries associated with degrees in engineering and computer sciences, for example. In a longitudinal study conducted by Hersh (2000) from 1960-1996, 130 colleges and universities from 55 different countries responded to a survey investigating the changing position of women earning engineering degrees. According to their data, the percentage of women earning engineering degrees in the United States was slowly increasing until 1985, where it started to level off through 1995 at 5.7% (Hersh, 2000). According to the National Science Foundation (2018), women made up only 15% of engineers in the United States in 2015. So, while the percentage of female engineers has risen over the decades, it appears to be making only slow progress in narrowing the gender gap.

Data collected from the National Science Foundation's Scientists and Engineering Statistical Data System from 1995-2008 included information from 61,417 full-time employed STEM workers who received their college degrees between 1970-2004 (Michelmore & Sassler, 2016). After running multivariate regression analysis, they found all fields, except computer science, showed female representation in STEM majors had increased substantially since the 1960s, with representation in the life sciences making the biggest jump. Their data also implied that conditional to earning a STEM degree, women were equally likely to work in STEM careers as their male counterparts, which contradicts other findings, with the exception of computer science, showing a decline. They also found that female computer science degree holders were actually less likely to work in computer science occupations. With a demand for more a computer-literate workforce (Zilberman & Ice, 2021), women may find themselves in the position of being left out computer science and technology-related careers if they are not earning college majors in these fields. Although women make up to roughly 50% of the life science workers (i.e. biologists, nurses, doctors), their overall share in the STEM workforce is just 20% (Funk & Parker, 2018). Michelmore and Sassler (2016) discovered that female computer science degree earners were less likely to be employed in their fields, which should be a major concern as computer science accounts for slightly more than 30% of the STEM workforce. In addition, the two fields with the fewest women in the workforce in the United States are computer science and engineering, but not necessarily globally (Hersh, 2000). This proves to be of significant concern because those fields represent approximately 75% of the STEM workforce (Michelmore & Sassler, 2016).

Wage Gaps

Concerns about wage gaps between men and women are valid considering research has shown that white women make approximately $0.85 to every $1.00 their counterparts earn, while the gap is larger for women of color (Graf et al., 2019). The Equal Pay Act signed by John F. Kennedy in 1963 was meant to prevent wage disparity between men and women, and yet approximately 60 years later women are still earning less than male counterparts for the same jobs. As a working paper by Sloane et al. (2019) suggests from roughly 1.7 million survey respondents between 2014 and 2017, it is not that women are necessarily deterred in selecting certain college majors because of the documented gender wage gap, but their research does shows that the majority of college-degree seeking women select majors associated with lower potential salaries compared to male counterparts overall.

While women are starting to close the wage gap in numerous fields, the gains are slow and much progress still needs to happen if women are to achieve equal pay for equal work. A study of 8587 young female workers born in the 1960s versus 1980s showed that the overall wage gap closed 4% points between the generations (Roche, 2017). The researchers used indicators for the wage gap such as “mean and median gender log wage differential, female to male pay ratios, and the mean female percentile in the male wage distribution” (Roche, 2017, pp. 337-338). While data suggest that the gap has narrowed, Roche (2017) suggested it might be because the older cohort left the workforce in favor of marriages and the younger cohort probably entered a “more progressive, female-friendly labor market” (p. 333). Blau and Kahn’s work (2017) addressed the gender wage gap using microdata collected from the Panel Study of Income Dynamics (PSID) of 17,819 participants from 1980 to 2010. They, too, found the gender wage gap was indeed narrowing and by 2010 conventional human capital variables, or the economic value of a worker's experience and skills, explained little of the gap, while gender differences in occupation and industry choice continued to be considerably more important factors.

While the research shows a slight narrowing of the wage gap, Xu's (2015) data showed there is a consistent pattern of disparity in pay, specifically for women in STEM careers, over a 10-year span from graduation to early career development. The research showed the factors associated with the persistent pay gap were systemic in nature (Xu, 2015). Interestingly, Blau and Kahn's (2017) research suggested that by 2010 the gap was most notable at the top of the wage distribution, indicating a glass ceiling. Potential explanations for this continued gender wage gap cited career interruptions and shorter hours worked for female workers as some of the most important contributing factors, especially in high-skilled STEM careers (Blau & Kahn, 2017). In addition, their research also pointed to gender differences in industry, gender roles, and differences in gender division in labor. Evidence from Blau & Kahn (2017) that strongly suggested that gender discrimination cannot be overlooked as a continuing factor to these lower wages for females across industries.

It is also important to note the dramatic increase of women in specific STEM professions, especially in the life science and medical fields still does not mean women are closer to narrowing the wage gap. Boulis and Jacobs (2008) noted the increase representation of women in the medical field. Most notably, they identified the dramatic rise of women enrolled in medical schools, from 11% to roughly 49%, between 1970 and 2005. They also noted that during that same relative time period that women practicing medicine increased nine-fold, from 25,000 in 1970 to 225,000 by 2002. With that said, Michelmore and Sassler (2016) found that in STEM fields with a greater representation of women (such as life and medical sciences), the gender wage gap exists and can be explained by the observed characteristics between men and women working in those fields. They defined the observed characteristic as calculated logged hourly wage for STEM occupations, annual earning totals, and number of weeks worked per year compared among gender and race. In the fields where women are concentrated the least, computer science and engineering, the wage gap persists even after they controlled for the observed characteristics.

While the gender wage gap in STEM certainly still exists, it appears to be narrower compared the overall workforce pay gap between men and women outside of STEM careers. Blau and Kahn (2017) also noted, that since 1980s there was an initial narrowing of the wage gap because of this, but since then progress has slowed and shown only a modest change. A gap in wages leads directly to a disparity in life-long earning potential. According to the 2016 Institute for Women's Policy Research report, women can lose more than $530,000 over the course of their lifetime and nearly $800,000 for college-educated women because of the gender wage gap (Hegewisch & Williams-Baron, 2017). The concern remains, if researchers have identified college major-selection as a predictor of future earning potential and data suggests college-bound women are not selecting those higher-earning potential majors as frequently as men do, then the overall gender wage gap will remain persistent. As Fry (2019) suggests, "the growing number of college-educated women in the labor force translates into greater earning potential for women overall and could eventually contribute to the narrowing of the gender wage gap."

When looking specifically at STEM careers, the engineering field is one of those areas where women may be missing out the most financially. According to Somers & Moody (2019) for their report in US News and World Report, the 10 highest paying college majors are all engineering-specific. One can clearly see how valuable not only earning an engineering degree can be, but how important the starting salaries are for life-long earning potentials that come with engineering careers. Michelmore and Sassler's (2016) data show, when women earn bachelor's degrees in engineering, they are very likely to end up holding an engineering job. Considering the median starting salaries of the engineering majors, women would be setting themselves up well in selecting any of these majors. If more women are earning college degrees than men, then it begets the question as to why the wage gap still persist. Blau and Kahn (2017) cite a few potential reasons such as the fact that women are more likely than men to experience 'disruptions' in their careers due to family commitments (e.g., childbirth, parenting, *etc*.), shorter hours worked, gender differences in workplace industries, differences in gender roles, and overall gender discrimination all must be included as potential contributing factors.

Sterling et al. (2020) suggest that while men and women have "near identical human capital at college exit," there are cultural believes that men are better suited for STEM professions compared to women that that may lead to "self-beliefs that affect pay" (p. 30303). Sterling et al. (2020) hypothesized that the gender pay gap post-college was the result of a difference in self-beliefs or self-efficacy, favoring men in STEM jobs, specifically in the engineering and computer science fields. They used data from a 3-year, longitudinal study (from 2015-2017) that included 559 individuals who completed undergraduate degrees (from 27 different U.S. universities) in either engineering or computer science. The data showed that women earned less than men, with the same degrees, in their first jobs. They also found that cultural beliefs play a role in creating gender disparities among STEM degree-holding grades that aligns with the pay gap. Sterling et al. (2020) further suggest that these personal beliefs might have "gendered effects on salaries in a number of ways" (p. 30304). Because of lower self-efficacies, women may pursue lower-paying jobs, less-competitive jobs, or jobs outside their majors compared to men who have earned them same degrees.

Macrosystem Factors

While it is important to understand the historical context of the chronosystem considering the factors related to gender disparity in STEM education, other contributing factors at various levels of Bronfenbrenner's EST model help to shed light on the many facets of the problem. The social and cultural factors of the macrosystem that are linked to gender disparity in STEM education appear to be tied to issues of gender equality, norms, socialization, and bias. These factors are very important when attempting to understand the persistence of the traditional roles and gender norms of our society.

Gender Equality

Gender equality is defined as people having equal access to opportunities and resources free from gender discrimination (Subrahmanian, 2005). Gender equality in a society is critical for both male and female student's development of their academic interests and their ultimate pursuit of that interest as it pertains to a future career. Looking at the influence of gender equality in the U.S. and its role in shaping gender norms, attitudes, and stereotypes is both meaningful and ambitious.

Gender equality is a macrosystemic factor, but it is often manifested in smaller ways: the perpetuation of negative stereotypes, the subtle biases of both teachers and students, and the combined effect of those biases on a student's STEM interest, science identity or someone who considers themselves a science person, and self-concept (Cameron et al., 2020). Both negative stereotypes and subtle biases in classrooms are factors that will be addressed at the microsystems level. Our continued inability to close this enrollment gap will only lead to fewer and fewer women entering the STEM workforce, which ultimately results in a lack of representation of diverse perspectives in global scientific problem-solving (Ellis et al., 2016; Lindsay et al., 2016).

Overt Bias

While implicit bias is a concerning potential contributing factor, it might be harder to identify it in others and even more of a challenge for individuals to recognize it in themselves. Additionally, implicit bias will be discussed further in a later section. Overt bias, as recognized in certain communications styles, other the other hand, is often considerably more noticeable. Blair et al.'s (2017) research of university-level engineering faculty found three dominant communication styles used when speaking to students. The researchers interviewed 18 faculty members employed in the engineering schools of three different U.S. universities. The results show the discourses identified were defined as gender blindness, gender acknowledgment, and gender intervention. Gender blindness is defined as a professor's assertion that gender is a non-issue in the classroom and that any perceived issues are individual differences and not gender-linked (Blair et al., 2017). Gender blindness is similar to the well-intentioned, but problematic attitude as color blindness linked to discussion of racial inequities. The authors' differential gender acknowledgement and gender intervention, saying that both recognize variation in academic performance between genders, but the former states it is not their responsibility to address gender inequities and the latter claims the promotion of gender equity as their job. Blair et al. (2017) determined that gender acknowledgement was the most commonly used communication strategy by faculty interviewed, highlighting that the professors state it is not their responsibility to promote gender equity among their students and thus continues to perpetuate systemic gender bias in the engineering departments. In research conducted by Kuchynka et al. (2018), 592 women and 163 males enrolled in STEM courses responded to surveys focused on their experiences of sexism from STEM professors. The women reported more instances of benevolent sexist behaviors (e.g., protective paternalisms and complementary gender differentiation behaviors) compared to overt, hostile sexism. Cases of benevolent sexist behaviors were linked to reported to lowering STEM major intentions for women who were already struggling with their STEM identities. Women who already had strong STEM identities reported benevolent sexism did not lower their STEM major intentions. Those cases of hostile sexist attitudes were linked to females reported lower STEM GPAs for students who were already suffering from a low STEM identity. Males were surveyed and their results confirm the females' data, that the women's perceptions were not without warrant. Cases of overt sexism, benevolent or hostile, appeared to deter female students who are already struggling with their own STEM identities.

Gender Norms and Socialization

Related to but distinct from gender equality, gender socialization is defined as the process in which children are introduced to various cultural norms and behaviors associated with their biological sex (Carter, 2014). The gender gap in the STEM fields is just another example of what can happen as a result of conscious or unconscious gender socialization, via parents or guardians early on in life and with peer groups and educational systems as children age (Reinking & Martin, 2018). Researchers believe that gender socialization might play a significant role in whether or not students will choose to pursue educational paths in the STEM fields (Reinking & Martin, 2018). If children accept these assumptions through the gender socialization process, then it could manifest itself as damaging gender stereotypes (Reinking & Martin, 2018). Beutel et al. (2018) suggest the internalization of damaging gender norms, bias, and stereotypes is one of the driving forces keeping girls and women from choosing STEM majors. Beutel et al. (2018)

collected questionnaires from 657 underclass female students from a 4-year, public university in the United States. The questionnaire focused the independent variable as conformity to feminine norms and the dependent variable was college major declaration. Their research found that cultural norms around what it means to be feminine is contributing to the "ongoing gender segregation of academic fields of study" away from STEM and towards arts, humanities, business, communication and journalism (Beutel et al., 2018, p. 113).

Gender norms are so ingrained in children at such a young age that they shape a child's interests. As noted by Reinking and Martin (2018), socialization practices manifest themselves early in children's lives. For girls, this could include talking themselves out of STEM activities, either consciously or unconsciously, they initially show a proclivity towards because they feel like those activities are not for girls. According to van der Vleuten et al. (2018) conducted research using five different waves of data collected from the Children of Immigrants Longitudinal Study in Four European Countries (CILS4EU) as well as the Dutch-specific study, Children of Immigrants Longitudinal Study in the Netherlands between the years 2011-2012 and 2014-2015. van der Vleuten et al. (2018) used information from 744 female students from 174 different classes in 100 different schools. The surveyed the girls' choice of study, STEM or not. They found that the likelihood of a female choosing to engage in STEM activities and classes decreased when they had friends with more traditional gender norms, whereas boys' academic choices appeared to be independent of friends' adherence to traditional gender norms. Beutel, et al. (2018) suggest that currently in the U.S. there is a "general conformity to feminine norms" that is linked to female students avoiding STEM and doctoral, research-track medical majors (not to be confused with practicing medical majors), in favor of humanities degrees (p. 113).

Implicit Gender Bias

Implicit gender bias in education, by peers and teachers alike, can be especially harmful when investigating the causes of gender disparity in STEM education. Greenwald and Krieger (2006) define implicit bias suggest "that actors do not always have conscious, intention control over the processes of social perception, impression formation, and judgment that motivate their actions" (p. 946). Frawley (2005) discusses the critical role teachers have in addressing and combating gender bias, even if subtle, in the classroom environments. He also suggests that teachers must personally "strive to critically analyze their own attitudes and behaviors about gender roles" (Frawley, 2005, p. 226). Hand et al. (2017) point to more underlying causes for the gender gap in STEM fields. Their research highlighted the role that subtle, yet traditional gender role stereotypes of both high school teachers and students had on individual students' confidence levels in their STEM courses. The study included 44 teachers (15 STEM faculty) and 121 students, all in the 11^{th} grade at one U.S. high school. Separate surveys were given to teachers and students that collected data on gender role bias based on their perceived masculine and feminine characteristics. The results suggest that both teachers and students (male and female) attribute more masculine qualities to scientists and more feminine qualities to the humanities. Both teachers and students also indicated they thought male students were higher STEM performers compared to their female peers.

Manifestations of implicit bias and explicit attitudes related to gender in STEM can be subtle and sometimes harmful if not appropriately addressed. In an ethnographic case study, researchers conducted 88 hours of class-time observations and student interviews to investigate the presence and effects of microaggressions in career and technical education (CTE) programs at the community college level. Data were collected from 29 different CTE class meetings at a mid-Atlantic community college (Lester et al., 2016). Interview questions were carefully crafted after researchers reviewed the results from two surveys, the Microaggression Against Women Scale, MAWS, (Owen et al., 2010) and the Racial and Ethnic Microaggression Scale, REMS (Nadal, 2011). Nine female students were interviewed for approximately one hour each following the classroom observations. The interviews revealed a culture of microaggressions maintained by the instructors' pedagogy and communication styles and the physical spaces in which classes were held. Lester et al. (2016) concluded that this type of culture perpetuates societal norms that reinforce the implicit bias that STEM and CTE are for male students.

In an intensive, year-long case study, Gonsalves (2014) collected data from 11 doctoral physics students, both male and female. She determined that in order for these doctoral students to self-identify as a physicist they needed to achieve both competence in the subject and perform physicists' behavior or ascribe to a gender-neutral personality. As Gonsalves notes, this so-called gender-neutral behavior was in essence any behaviors deemed not feminine. Francis et al. (2017) used data previously collected in the ASPIRE2 longitudinal study of U.S. students ages 14-19, which tracked their STEM interest and career aspirations. While the original study focused primarily on quantitative survey data, Francis et al. (2017) conducted 132 interviews of some of the original students surveyed along with their parents. Denigrating descriptions of female students, such as being labeled a "girly girl," appear to have negative effects on high school students' STEM aspirations (Francis et al., 2017, p. 1101). Research even suggests that potentially positive feminine attributes, such as patience and reserved personalities, were not in line with the ideals of science ability, with some teachers and students overlooking a female student's aptitude for science simply because she was too feminine and not demonstrating more masculine characteristics often attributed to scientists (Gonsalves, 2014; Francis et al., 2017).

Students enter their upperclassmen years of high school at risk of not being able to dispel the misconceptions around gender socialization because of their specific experiences with gender bias from the broader society along with subtle, implicit biases from their families, teachers, and peers. Siani and Dacin's (2018) research focused on the high school years as a timeframe when students are transitioning from required coursework to elective classes as a critical point in the STEM pipeline where female attrition takes place. They surveyed 70 11th and 12th grade high school students from the United Kingdom, male and female, as well as 70 local college students in their first and second years of university. All students who participated in the research were enrolled in at minimum one STEM course. The survey data revealed that female students cited the reason for not selecting fields of study that include computer science, physics, and engineering was because of a "masculine culture of the fields," indicating some level of gender bias (Siani & Dacin, 2018, p. 13). Only 25% of female students expressed an interest in STEM careers. Of that 25%, the authors noted the girls preferred biological subjects and had indicated considerably lower interest in chemistry, physics, engineering, and computer and information technologies.

When addressing the role implicit bias has on the gender gap in STEM course enrollment, it is crucial to recognize the part male faculty might play specifically. Sattari and Sandefur (2019) conducted research with 30 male university professors from two separate universities to explore their understanding of how gender affects STEM education. In this qualitative study, Sattari and Sandefur (2019) utilized an inductive approach and carried out semi-structured interviews with the male STEM professors from two different midwestern universities in the United States. They focused their interview questions on two main queries. First, they wanted to know if these professors viewed gender as something that mattered in shaping an individual's STEM education experience. Second, they wanted to understand the participants' views of gender equality and if they believed it personally affected them or not. Sattari and Sandefur (2019) found that the professors varied in their understanding of the challenges that women face in STEM. Most participants expressed gender-blind attitudes and argued that STEM in academia is inherently bias-free and does not impact women's access to STEM fields. However, a significant number of these professors recognized they felt privileged in their careers and were able to articulate subtle ways that gender affected men and women's opportunities differently. Sattari and Sandefur (2019) recommend further investigations into the role that male faculty members' perceptions of gender issues have on their students and their female colleagues. Some of the gender issues the authors suggest considering include the work-life balance of female colleagues and students, the challenges females often face in dealing with male-dominated environments (i.e., jobs, classrooms, laboratories, *etc.*), and finally, the implicit biases males have but might not be aware of when it comes to their female colleagues and students.

Exosystem Factors

Narrowing down from historical and societal factors to factors more closely related to the individual, the exosystem refers to adjacent contexts. These contexts could be, for example, the child's parents' coworkers or other acquaintances whose opinions and attitudes may still affect them albeit indirectly. The influence of a presence of STEM role models as well as clear descriptions of career possibilities are important factors that may have the potential for encouraging female students to remain in the STEM pipeline. A lack of both of these potential factors could be contributing to the leak in the proverbial STEM pipeline, where high school girls could be opting out of STEM coursework. In subsequent sections, the effect of STEM role models and the influence of exposure to future STEM career possibilities will be explored in detail.

STEM Role Models

The benefits of role models, in any field of study, is to show individuals that their interests are shared with at least one other person that is just like them (Starr et al., 2019). The feeling that you can accomplish something because someone who looks or acts like you has accomplished your career goals is encouraging and has the potential to help in the retention of various disciplines. On the flip side, a lack of role model exposure may lead to lowered or absent self-concept, potentially deterring individuals from pursing STEM fields. In STEM fields, research on the exposure to role models has revealed various effects.

From supportive female teachers and encouraging same-sex peers to knowledge of famous female scientists' biographies, evidence shows that exposure to STEM role models might prove to be one strategy that could help mend one of the leaks in the STEM pipeline (Levy & London, 2016; Solanki & Xu, 2018; Starr et al., 2019). Other research presents mixed or siloed results depending on specific STEM disciplines or even fleeting effects of exposure to STEM role models (Bamberger, 2014; Bettinger & Long, 2005; Stearns et al., 2016).

Studies have shown that exposure to STEM role models can have positive effects on girls' and enhance their ability to see their future selves as scientists. Starr et al. (2019) designed a virtual reality (VR) experience for 79 undergraduate females in California, half intended STEM- and half indented humanities-majors. Immediately following the VR experience where they were presented with a fictional science laboratory prompting their own future, potential STEM successes, participants were asked to fill out questionnaires. Exposure to a possible future in which they were their own role models, students were asked for their reactions to the experience. Starr et al. (2019) reported that students who were already STEM-leaning stated that the VR experience increased their feelings of STEM identification, which the humanities-leaning students reported they were even more confident they lacked STEM identities.

In a study of 1035 U.S. university students, STEM and non-STEM focused, the effect of exposure to role models that broke the traditional White, European male stereotype was conducted through an online survey (Levy & London, 2016). Participants were asked to read biographies for six fictional STEM role models, racially, ethnically, and gender diverse. After the exposure to these role models' biographies, students completed surveys that measured STEM interest, non-STEM interest, self and STEM perceived identity compatibility, academic sense of belonging and self-efficacy, educational degree intentions, and gender-specific variables of STEM identity and stereotype endorsement. Results showed, for both STEM and non-STEM focused students, exposure to non-stereotypical role models positively increased STEM interest, STEM identity, and an academic sense of belonging. There was also a positive effect on academic self-efficacy, but only for STEM students.

Female student STEM-engagement behavior was evaluated for STEM-interested undergraduates at the University of California Irvine in 2013. Solanki and Xu (2018), surveyed and observed 9,766 students during 20,209 course visits as they were enrolled in 23 various introductory STEM classes. The basis of this work was to evaluate behaviors in respect to the gender of professor, as a proxy for exposure to gender-specific STEM role models. Solanki and Xu (2018) found that courses taught by female professors narrowed the gender enrollment gaps and improved female students' engagement behaviors such as seeking help, personal self-efficacy, STEM interest, and utility value of course content. Bettinger and Long's (2005) study of 54,000 U.S. undergraduates hinted at similar results. Using a comprehensive longitudinal data set, Bettinger and Long (2005) suggest that female students' academic interests were positively affected by enrolling in female-taught introductory courses for various disciplines, but failed to find the same true for fields of study that were already universally known to be male-dominated (e.g., physics).

While some evidence shows that White women are positively affected by exposure to primarily White female role models, generally and in the microsystem as female STEM teachers, but it also raises the important issue of a lack of data for the effect of women of color as role models in STEM (Stearns et al., 2016; Van Camp et al., 2018). With so few female STEM role models' stories being told throughout history and more specifically in classrooms, many girls have not heard about all the contributions women, including women of color, have made to vital STEM discoveries. Evidence shows that Black girls can benefit from more stories told early in their academic experiences (Hambrick, 1993). In her ethnographic-based dissertation, Hambrick (1993) reported that "Black females are underrepresented in professional science and technology careers and are thereby relegated to low paying jobs and poor self-esteem. Black females lack of choosing scientific careers is cause [*sic*] by them not being expose [*sic*] to appropriate black female scientist and inventor role models during their preparatory school years" (p. 198-199). Hambrick (1993) also pointed out that schools were not offering any role models of black females for children in their curriculum, specifically in STEM areas. Hambrick's (1993) dissertation work centered around gathering, analyzing, and writing curricular biographies that emphasized and highlighted the careers and contributions of black, female inventors. Ultimately, Hambrick (1993) exhaustively searched for living black, female inventors from the 19th and 20th centuries to interview. She finally found a total of six inventors and selected three to interview based on proximity to her research institution. Hambrick's (1993) in depth interviews produced three themes. Those themes included potential reasons why these women were successful at achieving their dreams of becoming inventors during a time when being a black, female inventor seemed impossible, especially with the lack of role models. Hambrick's (1993) work resulted in themes included the reason these women pursued STEM was to preserve their "invisible dignity" (p. 202), the idea that they needed "unshouted courage" (p. 204) as black women to combat a life of racism and sexism, and, finally, the development of "quiet grace" (p. 206) to withstand all the pressures that might have forced them out of their STEM paths.

In a study with 54,000 first-year university students from 12 different U.S. universities, exposure to female professors as role models was found to increase the students' interest in STEM and major choice, most notably in mathematics and geology. In the same study, exposure to female professors had no statistically significant effect on engineering, physics, and computer science interest (Bettinger & Long 2005). Van Camp et al. (2019) investigated the use of same sex-role models on 72 female STEM majors on just two separate occasions and found that exposure negatively related to explicit stereotypes and positively related to STEM outcomes of the students' GPAs and STEM course enrollment decisions. Van Camp et al. (2019) used a method called a "reflective role model condition" which simply exposed the female STEM students to biographies of female role models (p. 656). As stated, Van Camp and colleagues (2019) measured these attitudes of explicit stereotypes by using Nosek and Banaji's (2001) Go/No-Go Association Task tests. Herrmann et al. (2016) tested an online strategy that involved a letter from a female role model encouraging 316 first-year female psychology and chemistry majors. When compared to the control group, who did not receive the encouraging letter, the exposed students had higher STEM grades and lower failing and withdrawal rates. Herrmann et al. (2016) demonstrated a lack of female role models had detrimental effects on these students, specifically as it related withdrawal from the STEM majors. Finally, Shin et al. (2016) reported that 1035 undergraduate student, who were exposed to atypical STEM role models (not White males and not individuals with overtly and obvious natural academic abilities), were shown to both dispel stereotypically ideas about who does STEM and positively impact their academic self-efficacy in STEM. Additionally, the findings showed that the exposure to these role models has a positive effect on both the STEM and non-STEM majoring undergraduates of the study as it related to their interest in STEM subjects, but only a positive effect on the academic self-efficacy of the undergraduate students pursuing STEM degrees.

Earlier in the STEM pipeline, research conducted with 60 9^{th}-grade female students from a STEM-focused high school were exposed to role models on two separate occasions. The program was dubbed an interactive role model event. The event consisted of two separate, 4-hour visits the students took to a local high-tech company to meet with scientists and tour their facilities. This interactive role model program showed a significant change in the girls' original, negative perceptions of female scientists and STEM career choices to that of positive attitudes over a relative short time (Bamberger 2014). With that said, there are some concerns that female STEM role models who embody STEM stereotypes are not necessarily helping to recruit or retain underrepresented females (especially racially/ethnically diverse women) into certain STEM majors. Cheryan et al. (2011) tested exposure of stereotypical and non-stereotypical computer science (CS) role models on 85 female undergraduate students who had not declared themselves as STEM majors. Researchers exposed these students to two different types of role models comprised of upper-level undergraduates, stereotypical and non-stereotypical computer science majors (male and female), for an hour and forty-minute interview sessions. Following the interactions, each participant completed a questionnaire that attempted to measure their perceived dissimilarities to the role model and their success beliefs if they were to pursue a computer science major. As evidenced in their study, it turns out the role model's gender had no significant effect, but rather lack of conformity to STEM stereotypes had a positive effect on females' STEM beliefs in computer science (CS) when compared to exposure to stereotypical CS role models (Cheryan et al., 2011). While the study conducted by Bamberger (2014) is hopeful, the fact that it was a small-scale study, with a relatively low participant number and mediocre methodology consisting of only two occasions of female role model exposure is not inherently contradictory to other studies. It does suggest, perhaps erroneously, that the role models must be female, whereas other suggest role model exposure is positive as long as the role model bucks conventional stereotypes regardless of gender (Cheryan et al., 2011; Shin et al., 2016).

Mesosystem Factors

The factors at the mesosystem level consist of the interactions between the different parts of a child's microsystem. From the interactions with STEM mentors, to specific STEM internships, afterschool programs, and STEM-focused summer camps, young women have a number of factors, that if present, could contribute to the support and encouragement of their pursuit of STEM learning. On the other hand, a lack of these factors could lead to females' lower STEM self-concepts. Consideration of these factors and the roles in which they might play encouraging female students to pursue STEM education is critical. While they may not necessarily represent daily reminders that microsystem factors afford students, they are indeed important to consider.

Mentors

Evidence suggests that the roles that mentors play in supporting and encouraging students to continue to pursue STEM education are important (Kricorian et al., 2020). Thus, a lack of available and supportive mentors would suggest that girls, interested in STEM subjects, might be missing out on the encouragement of these potentially valuable, influential adults. Wilson and Grigorian (2019) researched the type of mentor they dubbed ‘near peers,’ also known as college-aged mentors for high school female students. They stated that this type of mentor embodies a powerful position as they interact with female students to promote higher education in mathematics and sciences. These ‘near peers’ engaged with 306 high school students to present a dynamic, one-day mathematics workshop called MathShows. Throughout the day, high school students attended various presentations offered by college-aged students as well as mathematical professors. Wilson and Grigorian (2019) noted that “the high school students seemed to respond with more vigor to the college student presenters than to the college professors” (p. 5). Additionally, the researchers reported that even a single day of presentations involving near-peers had a significant effect on students’ math attitudes, but less of an effect on their math self-confidence, which remained largely unchanged (Wilson & Grigorian, 2019).

In a study conducted in 2019, researchers investigated the role that mentors had on the reasons why female and people of color were choosing to pursue STEM education and careers. Kricorian et al. (2020) created a quantitative survey designed to evaluate the role mentors had on encouraging the persistence of women and underrepresented minorities in different areas of the STEM pipeline (from high school to post-graduate careers). The measures included in the survey included STEM belonging, science identity, growth mindset, and the respondents’’ views on STEM participation. The study was conducted by some of the research team at MiOra, a non-profit organization whose goal is to increase the participation of women and people of color in STEM fields in the United States. The survey was emailed to MiOra members and researchers' peer contacts currently in STEM fields. Data were collected from the surveys between 2019-2020, with 48 respondents completing the entire survey (response rate was not reported by the authors). Participant demographics included 71% female, 96% participants of color, 5% high school students, 52% college enrolled students, 11% graduate or medical students, and 32% recent STEM graduates. Kricorian et al. (2020) found that by assessing the experiences and preferences of women and people of color currently participating in STEM, they could better assess the importance of the role mentors play in theses individuals' decisions to pursue and thus remain in STEM fields. They found that 68% of those surveyed knew someone currently in STEM that matched either their gender or their race/ethnicity outside their own family that served as an influential STEM role model. Additionally, most of participants attributed their persistence in STEM was linked to "meeting and being mentored in STEM by someone of their same gender and ethnicity" (Kricorian et al., 2020, p. 6). Finally, the authors recognize that it can be challenging, due to the scarcity of role models fitting this description, to find mentors in close proximity for many STEM-aspiring students. Thus, Kricorian et al. (2020) incorporated questions about the role media exposure and virtual role models could have and most reported that it "would be effective encouragement to pursue STEM" (p. 6). This last finding is encouraging for educators who might not have local mentors to pair with students based on gender and racial/ethnic profiles, as the study suggests.

It is often reported that even if the number of girls and women pursuing STEM degrees increases, the gender inequality in the STEM faculty can be another negative contributing factor related to STEM mentors (Casad et al., 2020). Research has also shown that, while in recent years, the number of women earning postgraduate STEM degrees is increasing, the number of females in university-level STEM faculty positions remains largely unchanged (Casad et al., 2020). Stevenson University, located outside of Baltimore, MD, is an exception to this case. According to a recent case study, Gorman et al. (2010) highlight the benefits of a unique university that has a full-time STEM faculty department comprised of 71% female professors and 100% female academic leadership, well beyond the national norm. The university credits this department's gender representation with its recent growth in the percentage of undergraduates pursuing STEM degrees. This study invested the "informed, innovative approach to curriculum reform, synergistic leadership and management principles" to create what the university describes as a web of mentorships (Gorman et al., 2010, p. 1). From female STEM administrators mentoring full- and part-time professors, to faculty mentoring students, upper classmen mentoring younger peers, and finally, partnering with local and national public middle and high schools to mentor both teachers and students, Stevenson University's model "demonstrated practical ways to encourage, enable, and empower more women to engage and be successful in STEM disciplines" (Gorman et al., 2010, p. 11). While Stevenson University is atypical in terms of its academic teaching and leadership demographics, it presents a compelling argument for the role female STEM mentors can play in decreasing gender disparity in STEM education.

Microsystem Factors

Factors at the microsystem level include direct contact interactions that are the closest to the developing child and include encouragement of family members, having a parent or parents who work in a STEM field, support from influential adults in the school community, stereotype threat, friend influence and peer exposure, a student's experience in required STEM courses, gender of their STEM teacher, a sense of STEM belonging, and their perception of the importance of particular STEM courses in relation to future career aspirations. There are microsystemic factors both within the school environment and outside of it. The school factors may include interactions with classmates, friends, teachers and even the teachers' gender, whereas the out of school factors include the students relationships with their parents, guardians, and siblings.

Support From Influential Community Adults

A contributing factor at the microsystem level includes the roles that influential community adults such as STEM teachers, academic advisors, grade-level deans, wellness counselors, and college counselors play in their various capacities to encourage students' interest in STEM coursework. This is distinct from the earlier conception of 'mentors' because these community adults are part of WRS students' lives every day, but do not necessarily play the role of a traditional academic mentor. Miller and Hurlock (2017) point to the support of high school counselors specifically in the encouragement of promising females to apply to and attend STEM programs in non-research-intensive universities. This case study identified and defined these students as "STEM-promising" based on whether or not they had completed at least one Advanced Placement (A. P.) STEM elective course in high school. Miller and Hurlock (2017) also acknowledged that this definition 'narrow' compared to gathering the grades study subjects received in a wider variety of high school STEM classes, but argued it was sufficient and appropriate for their research goals. Participants included what the authors dubbed as 103 STEM-promising female undergraduate freshmen enrolled in the spring of 2014 from a single, non research-intensive private suburban university in the United States. The results of the case study suggest these higher educational institutions appear to be more supportive of female STEM majors and produce more female STEM graduates. This research suggests that a lack of specific conversations by college counselors with female students might contribute to these students not seeking the right kinds of colleges that can support their desire to major in STEM fields. Miller and Hurlock (2017) state that counseling STEM-promising females into non research-intensive universities appears to result in higher numbers of STEM degrees obtained for females. In my context, college counselors play a significant role in supporting our upperclassmen as they research and eventually apply to colleges and universities. Miller and Hurlock's (2017) research seems relatively specific for both STEM-promising students and college counselors. If the counselors are not aware of this potential link, then it is reasonable to assume they are not sharing that information with their college counselees.

Science teachers and department chairs also play critical roles in the retention of females and underrepresented students in STEM courses once they have the choice to enroll in electives versus simply completing the required core classes (Gorman et al., 2010; Kendricks et al., 2013). Researchers investigated the role that specific and inclusive STEM school strategies had on students' STEM-related outcomes and academic achievements (LaForce et al., 2019). They also investigated if those results varied by student gender identity and race/ethnicity. The study included 20 inclusive STEM high schools from seven different states in the U.S. (Ohio, Texas, Washington, California, North Carolina, Tennessee, and New York) and analytic questionnaire data from 2943 high school students who were racially/ethnically and 50:50 female/male ratio. Data collection included student questionnaires measuring science intrinsic motivation, science ability belief, and interest in future STEM careers, and subsamples of student grade point averages (GPAs). Research showed that when STEM-focused high schools and their teachers were able to implement strategies such as problem-solving projects, supportive student-teacher relationships, autonomy, cognitively demanding work, interdisciplinary content, technology use, and teamwork into their curriculum, they were more successful in reducing or reversing gender and racial gaps in elective courses (LaForce et al., 2019).

Sahin et al. (2017) set out to collect information on the role that parent and teacher encouragement can have on students' STEM interest in quantitative, 4-year study. Research collected in the first year of the study (2016) included survey data from 1520 racially and ethnically diverse male and female 9th grade students who were currently attending 20 different charter high schools in Texas. Sahin et al. (2017) found that students who receive encouragement from parents and teachers as well as being supportive of their personal interests and goals in high school are more likely to pursue a STEM major than students who receive little to no support from influential adults in their lives (Sahin et al., 2017). Academic counselors often recommend male students to honors STEM courses and, despite good intentions, deans and advisors have created tracking systems that perpetuate gender inequality (Ikonen et al., 2017; Mann et al., 2015).

Teacher Gender

There appears to be some evidence, albeit not strongly conclusive, as to the gender of a student's STEM teacher and closing the gap in STEM education (Solanki & Xu, 2018; Stearns et al., 2016). Solanki and Xu (2018) conducted a quantitative study of 9,766 undergraduate students at the University of California, Irvine (male and female). In 2013, they made observations over 20,209 STEM courses over three consecutive academic quarters. Those classes included STEM courses that were all prerequisites to STEM majors. Solanki and Xu (2018) administered pre-and post-experience surveys to students enrolled in the STEM courses. Those survey items included different motivation constructs (value, utility value, and self-efficacy) and student engagement (measured by attendance, active listening to lectures, help-seeking, and class participation). Solanki and Xu (2018) found that having a female professor narrowed the gender gap for both engagement in STEM courses and overall STEM interest. Additionally, they concluded that both male and female students tended to respond positively to the instructor gender that mirrored their own.

Stearns et al. (2016) investigated the role of teacher gender on the girls STEM success as defined by the authors as students declaring and then earning STEM degrees in college. Utilizing the longitudinal North Carolina Roots data set, which the includes academic for all public-school students from 7th grade through college graduation, the authors college data for 16,300 racially, ethnically, and socioeconomically diverse college-bound students in 2004. These students hailed from 540 different middle schools and 350 high schools in North Carolina. Of that group of students, 17% of them originally declared STEM majors with 19% ultimately earning STEM degrees. Male students disproportionally earned 57% of those STEM degrees. Stearns et al. (2016) used the North Carolina Roots secondary data to compare STEM success (declaring a STEM major and earning the degree) to high school teacher demographics for these students. Their results showed that white women would more likely to both major in and graduate in STEM fields when their high schools had higher proportions of female STEM teachers irrespective of teacher race. Additionally, the data showed the female teachers (no matter their race) were not negatively affecting men's chances of majoring in STEM fields. The authors reported that the data for black women were less conclusions simply because the sample sizes of these students earning STEM degrees were too small for statistical analysis (Stearns et al., 2016). These studies suggest STEM-interested female students have reported more positive feelings when their STEM teachers are female, and specifically, Stearns et al. (2016) showed that at least white female students are more likely to pursue STEM majors if their high schools had a higher percentage of female STEM teachers, regardless of their teacher's race.

Synthesis and Significance

There are numerous, potential contributing factors from the chronosystem to microsystem levels that could provide significant insight into the gender disparity of STEM elective enrollment in independent high schools. As mentioned throughout this chapter, factors have been reviewed that include women's history with access to higher education, the workforce and the wage gap, cultural factors of gender equality, norms, bias and socialization, role model exposure, experiences with mentors and because of mentorship, interactions with influential community adults and finally, teacher gender. This chapter examined the various levels of Bronfenbrenner's (1979) Ecological Systems Theory that contribute to the gender disparity in STEM education at various portions of the pipeline. From broader societal factors, such as gender norms, to proximal factors like the role influential adults play on a child's decision to pursue their STEM interests or not, contributing factors run the gamut. For the purpose of this dissertation, the needs assessment in Chapter 2 will investigate if gender disparity in the enrollment of STEM electives is, indeed, an issue at West Regional School. Finally, the researcher will interview various influential community adults in an effort to gain more insight into the results of the enrollment data.

Chapter 2

Needs Assessment

Introduction

As the literature revealed, there are well-documented gaps in the number of male versus female students participating in the science, technology, engineering, and mathematics (STEM) fields (Beede et. al, 2011; Sax et al., 2017). From high school STEM-focused course enrollment to women earning STEM degrees and entering the workforce, the disparity is well-recognized and does not appear to be narrowing (Iskander et. al, 2013; LaForce et al., 2019; Miller & Hurlock, 2017; Sadler et al., 2012; Sublett & Gottfried, 2017).

The high school level is an intriguing place along the STEM pipeline as it is the first point in a formal academic setting where students have choice in the courses in which they plan to enroll. While there are graduation requirements at most high schools in the U.S., students are often afforded the opportunity to enroll in elective classes as well. I focused this mixed-methods needs assessment on the meso- and microsystemic factors contributing to the gender gap in STEM elective course enrollment at one independent school the United States.

Context of Study

The researcher's problem of practice primarily seeks to identify the extent and potential causes of gender disparity in the enrollment of STEM elective courses in the 11th and 12th grades in a suburban, independent high school in the western United States, West Regional School (WRS). West Regional School is the pseudonym that will be used throughout this dissertation. Independent schools, by nature, are not a part of a formal district, and are therefore independently governed, while formally accredited. West Regional School is a member of the National Association of Independent Schools (NAIS). Additionally, it is fully accredited by the

Association of Colorado Independent Schools (ACIS), which means that it is recognized as a 6th–12th grade educational program by the Colorado State Board of Education. The school has a total enrollment for the 2021-2022 school year of 736 students and 102 full-time faculty members. WRS reported their student body to be considered 25.8% racially/ethnically diverse by way of student self-identification reporting (WRS School Profile, n. d.). Even though the school has an annual tuition fee of $32,841 per student, many students receive financial aid with the school supporting approximate 28% of its students with over $4.4 million dollars per year (WRS School Profile, n. d.; WRS Tuition and Financial Aid, n. d.). All of the data on course enrollment, teacher gender, and influential adults' perceptions of how student gender identity affects enrollment along with their conceptualization of their roles in advising students was collected from West Regional High School.

The STEM courses in this needs assessment include courses that are identified as either a class that is required for graduation or an elective course. Required course enrollments are expected to exhibit gender balance of the overall grade level. Elective courses are voluntary for the students. Anecdotal evidence suggests gender imbalance in many elective courses, especially male-favoring in physical and technology science-based classes and, in recent years, female-favoring in life science-based courses.

Overall course enrollment has typically been primarily supported by the advisory program at West Regional High School. In recent years, advisors have commented that there appears to be a shift away from their in their influence and role as traditional academic advisors with regard to discussing student academic schedules and course enrollments with their advisees and towards more glorified 'babysitters.' In years past, academic advisors were able to have conversations with their advisees as they contemplated their upcoming academic schedules, including choosing courses such as electives. In recent years, though, advisors have noted change in the expectations of what the role of an advisor is without it officially being communicated to their advisors from the WRS administration. It is a contractual expectation that WRS classroom teachers also serve as academic advisors, but many of these same advisors have stated that not only does WRS not provide professional development training for academic advising, there is no formal document outlining the school's expectations for this position. Thus, many of WRS teachers and even administrators have expressed concerns that students receive wide variety of support from their advisors. Just recently, WRS's Upper School Director lamented that the school had a shortage of "good advisors" (WRS Upper School Director, personal communication). By extension that the role that these advisors play in influencing course selection, especially for elective classes, for WRS's junior and senior students is largely unknown.

Purpose of the Study of Needs Assessment

Critical and potential contributing factors that relate to my problem of practice and that were invested in Chapter 1 were laid out in Figure 1.1. These factors include gender enrollment in various STEM elective courses (Sublett & Gottfried, 2017; Tyson et al., 2007; Wang, 2013, Yoon & Strobel, 2017), the potential contribution of the STEM elective teacher's gender identity (Solanki & Xu, 2018; Stearns et al., 2016), and the influential community adults such as our STEM teachers grade-level advisors, deans, and college counselors who might play a role in encouraging students to enroll in these STEM electives (LaForce et al., 2019; Miller & Hurlock, 2017). A list of these constructs, their operational definitions, and indicators I am used in the needs assessment are described in Table 2.1.

Table 2.1

Research Summary

Construct	Operational definition	Indicator	Citation
Gender disparity	Enrollment of male and female students into different STEM electives	10-year enrollment numbers of males vs. female students in STEM elective courses	Sublett & Gottfried, 2017; Tyson et al., 2007; Wang, 2019; Yoon & Strobel, 2017
Role of teachers, advisors, deans, and college counselors	The role those influential adults play in the enrollment decisions students make with regard to STEM electives	Answers given by these influential adults in a semi-structured interview	LaForce et al., 2019; Miller & Hurlock, 2017

Recently, the College Board reported in 2018 that the number of female students who sat for the AP Computer Science A exam rose 39%. In addition, they noted that there was a 70% increase in the number of female students who completed the AP Computer Science Principles exam. The AP Computer Science Principles course is considered a more global view of computer science and more accessible to the typical high school student compared to the more traditional AP Computer Science A and AB courses. AP Computer Science A, AB, and Principals are just a few of the elective courses we offer at our school. While these national trends are encouraging, anecdotally, we have not seen these upward trends in our same elective computer science courses. According to the literature, computer science, physics, and engineering elective courses are where gender enrollment disparity has been recognized as significant (Kang et al., 2019; Master et al., 2016; Sadler et al., 2012; Sublett & Gottfried, 2017; Tyson et al., 2007; Wang, 2013). While there are reports of the physical sciences being dominated by male students, in recent years it has been identified that the life and biological sciences are tipping the scales in favor of females (Michelmore & Sassler, 2016; Yoon & Strobel, 2017). In addition to national data on the gender disparity in STEM, the enrollment of STEM elective courses at West Regional may be a replication of this national phenomenon. It, along with the extensive literature synthesis in Chapter 1, has led the researcher to conduct this current mix-methods needs assessment study intended to investigate potential contributing factors in my specific context for this gender disparity in STEM elective course enrollment. Additionally, the research intends to conduct semi-structured interviews with WRS faculty and academic advisors in an effort to gain insight into any gender enrollment disparity that might be uncovered with the quantitative course enrollment data.

A study of the constructs identified for the needs assessment have led to the development of the following research questions (RQ):

RQ1: To what extent does student enrollment in an independent high school's STEM courses, required and elective, reflect national trends in gender distribution?

RQ2: What are influential adults' perceptions of how gender identity affects enrollment of students into independent high school STEM courses?

RQ3: How do influential adults conceptualize their role in influencing the student enrollment in an independent high school's STEM courses?

Methods

A multi-methods study was designed to show if any STEM elective courses experience gender disparity in enrollment and to identify the role in which various influential adults play in advising our students as they plan their academic schedules. The quantitative data were previously collected by WRS and used to compare enrollment data in required STEM courses to elective courses. The qualitative data come from semi-structured interviews with 28 influential adults on the WRS campus. Interviews took place on zoom and lasted between 30 and 45 minutes. Following the interviews conclusions, they were transcribed. These interviews were conducted to glean a better understanding of the effects of student gender on elective enrollment and to conceptualize the roles these adults played in supporting student enrollment. Permission for this needs assessment has been given by WRS's Head of School, who is the official IRB contact for this context.

Participants

This study's population includes two different groups from an independent high school located in a suburb just miles from a larger urban city in the western United States. The first group includes students who have enrolled in STEM courses, both required for graduation as well as elective courses. This secondary data were previously harvested by my context's Science and Information and Technology Departments. This enrollment data specifically focused on students in the 9^{th}-12^{th} grades. The second group includes what I have defined as influential community adults. These adults include STEM and non-STEM teachers, academic advisors, grade-level deans, and other school administrators in the context at WRS. Because WRS is a small, independent school, like the majority of NAIS schools many faculty and staff wear a variety of metaphorical hats. Teachers are primarily expected to also fulfill the role of academic advisors. At WRS, other staff members, including admissions officers, instructional staff, and athletic administers (non-teaching staff) may also be tapped to be academic advisors. Grade-level deans, college counselors, and academic-focused administrators (akin to public school principal and vice principal positions) often serve as informal academic advisors, giving students academic advice, such as course enrollment, without the formal title.

As previously stated, the influential adults in our community include advisors who are also current teachers (STEM and non-STEM), grade-level deans, college counselors, department chairs, and other administrators. The term influential community adult is operationalized here as any WRS faculty or staff member that has interactions with students where conversations around course enrollment, or future enrollment plans, are possible or highly likely. Many of these influential community adults play various roles at WRS, from teachers, to advisors, to counselors, and deans. For example, a student's current advisor could also be their current, former, or future STEM teacher. Some teachers may serve as a student's advisor but never as their teacher. At WRS, the majority of grade-level deans also teach at least one course. That means deans might also wear various hats in terms of the roles in which they play in advising students about course enrollment. Most of these influential community adults have shared, anecdotally, that from their role as an advisor is often as a sounding board for their students, in the early the second semester, prior to course enrollment.

Measures

As shown in Table 2.1, the construct of gender disparity is operationalized as the varied enrollment of male and female students into STEM courses, specifically the elective courses. This will be measured by using WRS's enrollment data for STEM courses from 2008-2018. The construct of teacher's gender identity is defined as how a teacher identifies their own gender. This will be measured using the same enrollment data set from 2008-2018 from WRS. This quantitative data will be analyzed based on a comparison of the proportions female to male students enrolled in each of the STEM courses over a 10-year period using a standard score (or Z-score). WRS has an overall student population of 50:50 female-to-male ratio. It is expected that enrollment into required STEM courses will mirror the overall student population of equal proportions of 50:50. Thus, using a comparison of the proportions of female to male students enrolled in both the required and elective STEM courses and analyzed using standard score statistical analysis (Z-scores), should indicate which STEM courses have disproportionate gender enrollments.

Finally, the role of teachers, advisors, deans, and college counselors has been operationalized as the role that these influential adults play in the enrollment decisions students make with regard to STEM elective courses. This will be measured by the answers given by these influential adults in the semi-structured interviews. Because the researcher has experience as both a STEM teacher and academic advisor in WRS and is familiar with the context, she chose to use a priori codes as the basis for theme development from these semi-structured interviews. According to Lochmiller and Lester (2017), "the key assumption of an a priori code is that you, as a practitioner scholar, have carefully read and reviewed the exiting literature and formulated an understanding of practice based on that literature" (p. 175).

Enrollment Data

To address research questions one and two, I used 10 years' worth of existing data, from 2008-2018, previously collected by this high school's science department. The enrollment data were approved by the WRS site IRB and were deidentified by the science department prior to my request for access to it. My IRB checklist was also approved by my advisors and my Research Methods professor. I was officially approved to proceed with data collection by the Johns Hopkins University Homewood Campus's Institutional Review Board on April 14, 2020.

These data include the total student enrollment numbers into all STEM courses, required and elective, as well as the gender identity of the STEM teachers. The data contain total STEM enrollment information from 13390 students (which includes the science, mathematics, and computer science departments).

Semi-structured Interviews

To address research questions three and four, semi-structured interviews were conducted with 28 influential community adults from this independent high school in the spring of 2020

(Appendix A). According to Kvale (1996), interviews are a powerful information-gathering tool that a researcher uses to study "people's understanding of the meaning in their lived world" (p. 105). The semi-structured interviews were conducted via Zoom as we were unable to meet in person by a state mandated stay-at-home-order as a result of the 2020 coronavirus pandemic. Audio-only recordings were made during these semi-structured interviews in order to accurately collect interviewees' answers. In addition, I took hand-written notes, asked only my semi-structured interview questions, and did not provide any personal commentary.

Procedures

Participant Selection Process

All participants were read a pre-interview consent script in order to obtain verbal consent prior to the start of their online interviews (Appendix B). Those influential adults included all current WRS employees. An email was sent in early March, 2020 to the entire WRS high school's faculty and non-teaching educational staff (including deans, counselors, college counselors, and academic administrators), which included roughly 70 faculty and staff. Of those who were emailed, all respondents were scheduled for an interview (30), and of those scheduled 28 were able to make and complete the interviews by May of 2020, for an approximately 40% response rate. The 28 individuals were assigned unique pseudonyms and included 12 STEM and eight non-STEM teachers but who were all academic advisors, three department chairs, and five other administrators including grade-level deans, college counselors, and other administrators. To be clear, all the teachers who were interviewed both teach and hold the formal role as academic advisor, while the others interviewed (department chairs, grade-level deans, college counselors, etc.) do not hold the formal title of academic advisors, but definitely have regular conversations with students about their academic plans for WRS and beyond. These adults are considered influential because they are the people who students are encouraged to consult prior to selecting classes in which they plan to enroll in for the upcoming academic terms. In addition to parents and peers, our community directs students to engage in conversations with these adults specifically, as they are assumed to have the most experience with advising students.

Data Collection

The enrollment data were deidentified by an outside party of all information including the elimination of names of students and teachers, their ID numbers, and email addresses prior to their receipt. In addition, the enrollment numbers were analyzed along with the teachers' gender identity. Data were analyzed in terms of total enrollment proportions by gender in elective STEM courses similar to data collected by Yoon and Strobel (2017) and analyzed using the Excel software program. Because some courses, both required and elective, were taught by specific teachers based on their specializations or the course was either replaced with another course or phased out, some enrollment data does not show 10 years' worth of enrollment numbers. The total number of years the enrollment data includes is represented in Tables 2.2-2.4.

Data Analysis

The existing enrollment data were arranged by and included the following variables: course name, year taught, the number of students broken down by gender, and the gender identification of the course instructor. Graphs showing proportion of female enrollment were created using Microsoft Excel. The means and standard deviations were calculated in order to determine the Z-scores. As previously stated, the construct of gender disparity was assessed using the enrollment of male and female students into different STEM electives compared to enrollment of required STEM courses all students in this context are expected to be enrolled in.

The audio files of the semi-structured interviews were originally recorded using the Zoom application and then subsequently transcribed using the Otter AI Software. Once transcribed, I listened to each interview and checked for Otter AI's accuracy; any discrepancy in the transcript was corrected immediately. I coded the interviewees' responses using a mixture of a priori and emergent coding, identified themes across interviews, and looked for links between those themes, and tried to identify emerging patterns (Lochmiller & Lester, 2017). All 28 interviews that were coded included responses from STEM teachers, non-STEM teachers (all teachers are also academic advisors), department chairs, grade-level deans, college counselors, and one administrator. My role as a classroom teacher on our campus did not put me in a position of power over any potential participants. Each interview started with my informing the interviewees that their participation in the interviews was completely voluntary and anonymous and that they may opt-out at any time via the interview consent script (Appendix B). As stated above, the semi-structure interview questions were developed to address research questions three and four. Interviews lasted roughly 30-45 minutes. Finally, audio files were transcribed into word documents using the Otter AI software program. Accuracy of the Otter AI program was confirmed by a comparison of the audio files with the program-generated transcript. I corrected any transcription errors on the document if and when there were discovered.

Findings

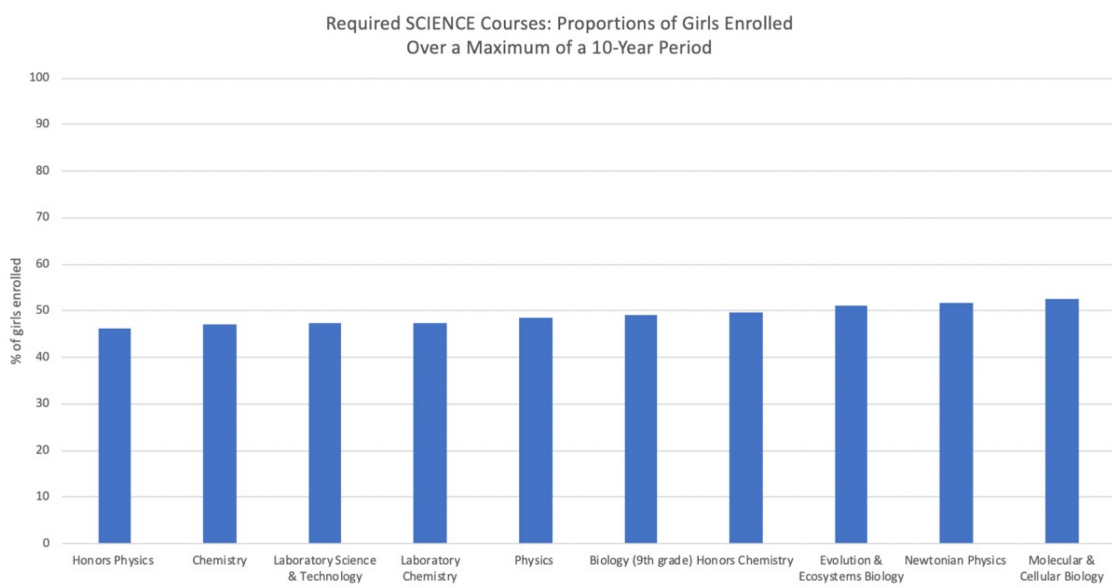
Research question one asked to what extent does student enrollment in an independent high school's STEM courses, both required and elective, reflect national trends in gender distribution. Data were collected and analyzed for all required and elective STEM courses at WRS. Independent study courses were excluded from the analysis due to concerns about reliability of the data.

Required Science Courses

Figure 2.1 shows the enrollment in required science classes including various Biology classes (Biology for 9th grade, Evolution and Ecosystems Biology, and Molecular and Cellular Biology), the three levels of Chemistry (Laboratory, General or Honors), the three levels of Physics (Newtonian, General, or Honors).

Figure 2.1

Proportion of Girls Enrolled in Required Science Courses at West Regional High School Over a Maximum of a 10-Year Period



None of the required science courses had statistically significant disparity in the proportion of female versus male students enrolled, which mirrored the school's 50:50 gender balance (Table 2.2).

Table 2.2

Science Department Enrollment Data

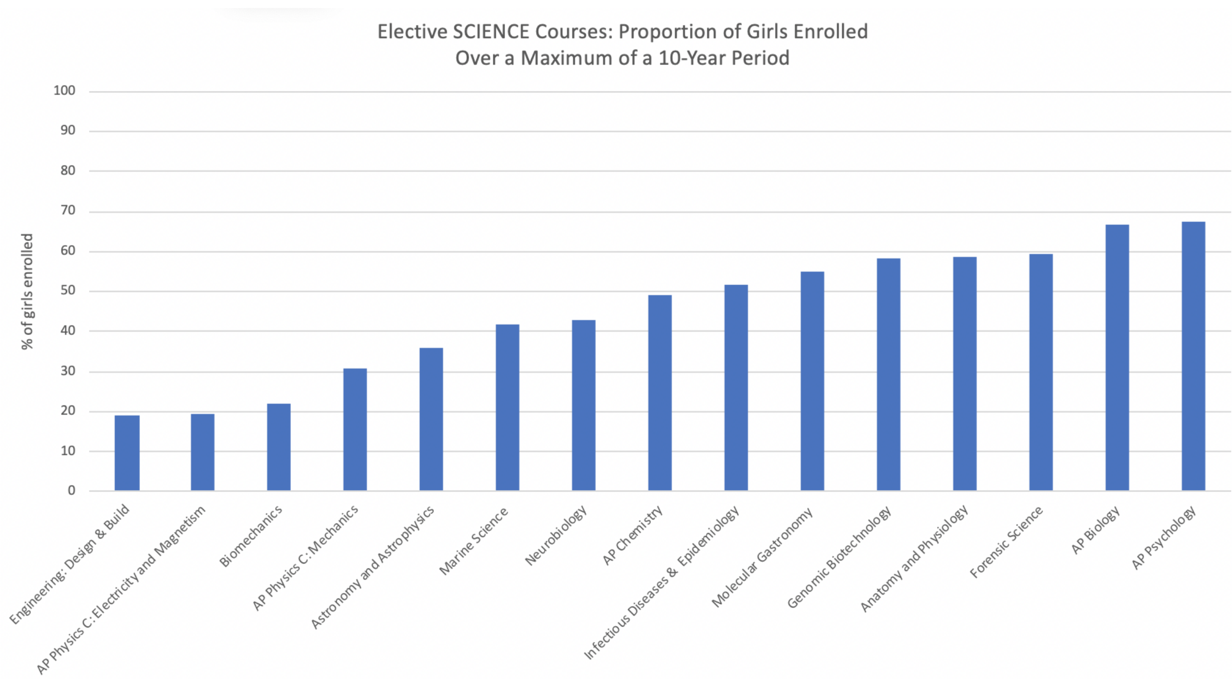
Course name	Required or Elective	% of females enrolled	# of years of data	Z-score
Biology (9th)	Required	49.23	7	-0.26
Chemistry	Required	47.07	10	-0.37
Evolution & Ecosystems Biology	Required	51.02	2	0.10
Honors Chemistry	Required	47.71	10	-0.33
Honors Physics	Required	46.34	10	-0.46
Laboratory Chemistry	Required	47.44	7	-0.28
Lab Science & Tech	Required	47.44	7	-0.28
Molecular & Cellular Biology	Required	52.59	6	0.37
Newtonian Physics	Required	51.64	6	0.14
Physics	Required	48.59	10	-0.18
Anatomy & Physiology	Elective	58.82	4	0.29
AP Biology	Elective	66.67	4	1.67
AP Chemistry	Elective	49.02	10	-0.12
AP Physics C: E & M	Elective	19.35	4	-3.83
AP Physics C: Mechanics	Elective	30.67	10	-2.42
AP Psychology	Elective	67.32	6	1.44
Astronomy & Astrophysics	Elective	36.11	2	-1.07
Biomechanics	Elective	21.88	2	-9.37
Engineering Design & Build	Elective	19.23	4	-2.80
Forensic Science	Elective	59.26	4	1.85
Genomic Biotechnology	Elective	58.13	8	0.48
Infectious Disease & Epidemiology	Elective	51.65	2	0.09
Marine Science	Elective	41.67	6	-1.04
Molecular Gastronomy	Elective	55.00	2	0.27
Neurobiology	Elective	42.86	2	0.00*

Elective Science Courses

Figure 2.2 shows the enrollment of the elective science classes that include all of the elective science department courses. Those classes include AP Biology, AP Chemistry, AP Physics C: Electricity and Magnetism, AP Physics C: Mechanics, AP Psychology, Astronomy and Astrophysics, Biomechanics, Engineering: Design and Build, Forensic Science, Genomic Biotechnology, Infectious Disease and Epidemiology, Marine Science, Molecular Gastronomy, and Neurobiology.

Figure 2.2

Proportion of Girls Enrolled in Elective Science Courses at West Regional High School Over a Maximum of a 10-Year Period



Four out of the 14 science electives demonstrated a statistically significant gender enrollment disparity when comparing the proportions of female to male students, with females underrepresented in all four (Table 2.2). AP Physics C: Electricity and Magnetism had a p-value < 0.01 (Z-score = -3.83). AP Physics C: Mechanics had a p-value < 0.05 (Z-score = -2.42).

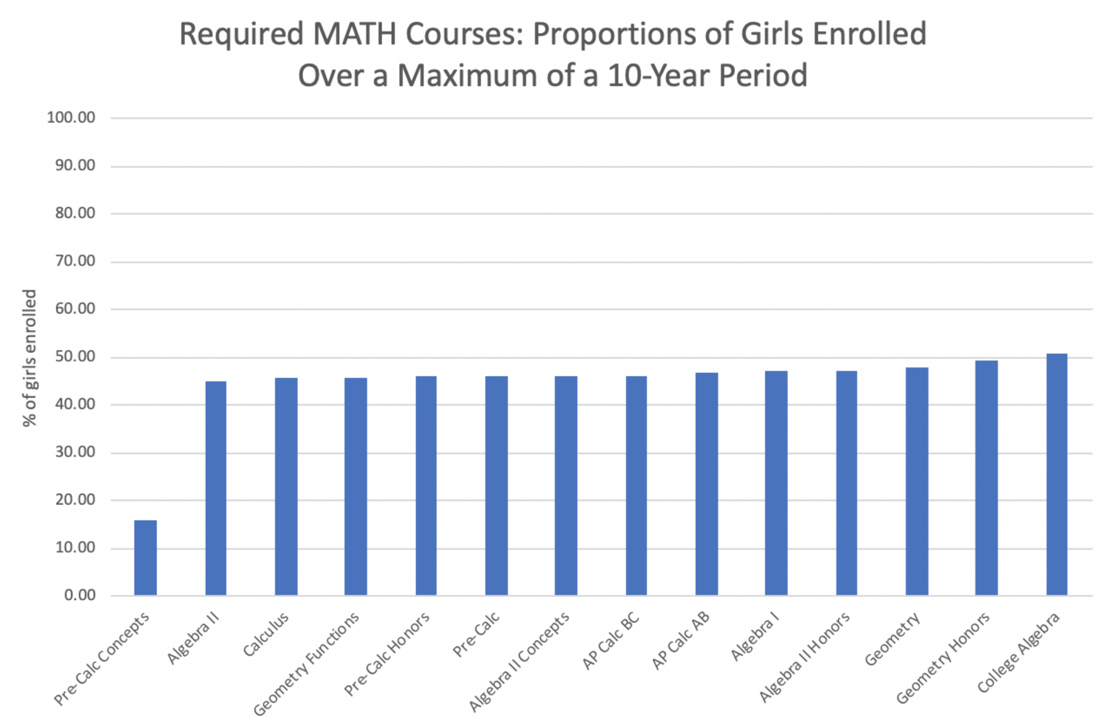
Biomechanics had a p-value < 0.001 (Z-score = -9.37). Finally, Engineering Design and Build had a p-value < 0.01 (Z score = -2.80).

Required Mathematics Courses

Figure 2.3 shows the enrollment of the required math classes that include all of the required math department courses. Those classes include Algebra I, one of three levels of Algebra II (Concepts, General, and Honors), AP Calculus A, AP Calculus AB, Calculus, College Algebra, one of three levels of Geometry (Functions, General, and Honors), and one of three levels of (Concepts, General, and Honors).

Figure 2.3

Proportion of Girls Enrolled in Required Math Courses at West Regional High School Over a Maximum of a 10-Year Period



None of the required math classes, with the exception of one, showed statistically significant evidence for gender disparity in enrollment of female versus male students (Table 2.3).

Table 2.3

Math Department Enrollment Data

Course name	Required or Elective	% of females enrolled	# of years of data	Z-score
Algebra I	Required	47.03	10	-0.03
Algebra II	Required	44.86	10	-0.86
Algebra II Concepts	Required	46.22	10	-0.29
Algebra II Honors	Required	47.34	10	-0.38
AP Calculus AB	Required	46.76	10	-0.22
AP Calculus BC	Required	46.26	10	-0.34
Calculus	Required	45.56	10	-0.63
College Algebra	Required	50.68	8	0.08
Geometry	Required	47.94	10	-0.34
Geometry Functions	Required	45.65	2	-14.5
Geometry Honors	Required	49.43	10	-0.06
Pre-Calculus	Required	46.17	10	-0.96
Pre-Calculus Concepts	Required	15.79	2	-0.96
Pre-Calculus Honors	Required	46.10	10	-0.32
AP Statistics	Elective	43.62	10	-0.91
Functions, Stats, & Trig	Elective	48.24	3	-0.25
Honors Multivariable Calc.	Elective	27.27	5	-2.27
Probability & Stats	Elective	49.22	6	-0.08
Sports, Stats, & Data Analysis	Elective	54.55	2	1.52

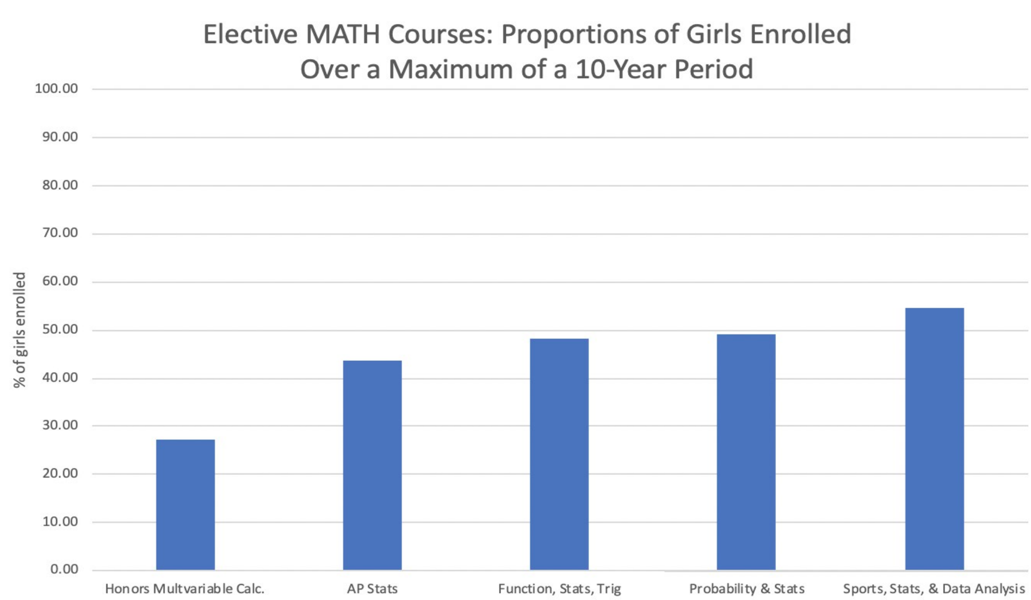
Geometry Functions is the only course that show statistically significant gender disparity in the enrollment of female students. It has been confirmed that this specific course is relatively new at WRS. In fact, the p-value < 0.001 (Z-score = -14.5) was calculated based on just two years' worth of enrollment data. There are different levels of these required courses. Recently, the WRS mathematics department decided that the geometry-level needed an additional, more remedial course. Thus, Geometry Functions was added as one of options students can be enrolled in for their required geometry course.

Elective Math Courses

Figure 2.4 shows the enrollment of the elective math classes that include all of the elective math department courses. Those classes include AP Statistics, Functions, Statistics, and Trigonometry, Honors Multivariable Calculus, Probability and Statistics, and Sports, Statistics, and Data Analysis.

Figure 2.4

Proportion of Girls Enrolled in Elective Math Courses at West Regional High School Over a Maximum of a 10-Year Period



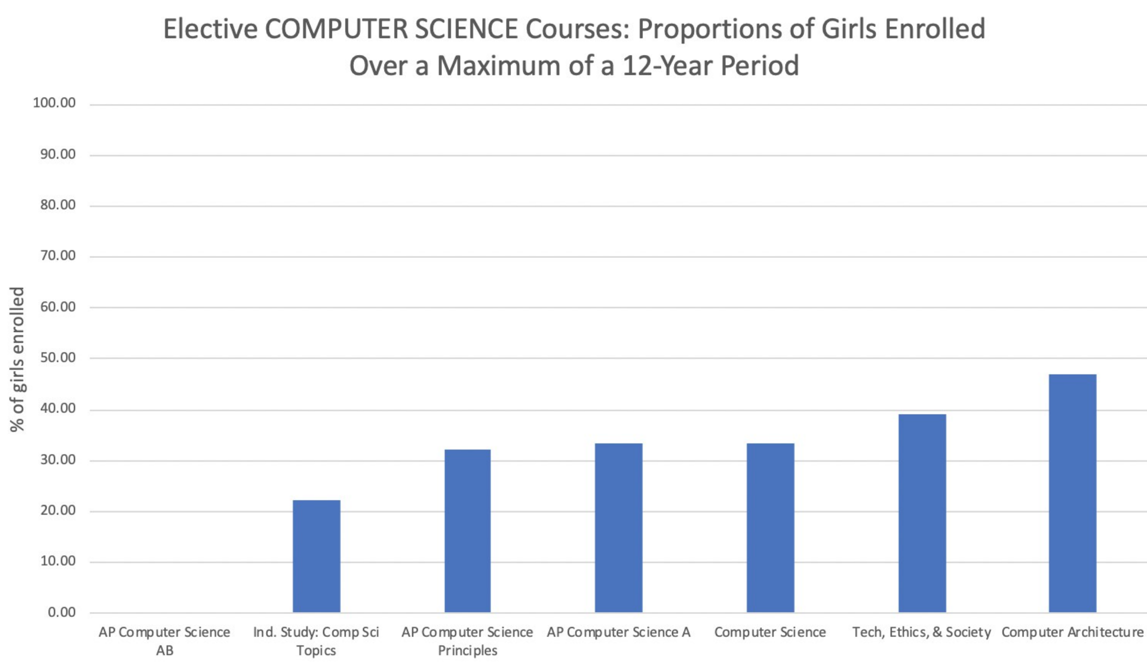
None of the elective math classes, with the exception of one, showed any statistically significant evidence for gender disparity in enrollment of female versus male students (Table 2.3). Honors Multivariable Calculus was the only course that show statistically significant gender disparity in the enrollment of female students. The p-value was calculated as $p < 0.05$ (Z-score = -2.27).

Elective Computer Science Courses

Figure 2.5 shows the enrollment of the elective computer science classes that include all of the computer science department courses. There are no computer science graduation requirements at West Regional High School. Those elective classes include AP Computer Science A, AP Computer Science AB, AP Computer Science Principles, Computer Architecture, Independent Studies (various computer science topics), and Technology, Ethics, and Society.

Figure 2.5

Proportion of Girls Enrolled in Elective Computer Science Courses at West Regional High School Over a Maximum of a 10-Year Period



Of the seven computer science elective courses offered at West Regional High School, two courses demonstrated statistically significant gender enrollment disparity (Table 2.4).

Table 2.4

Computer Science Department Enrollment Data

Course name	Required or Elective	% of females enrolled	# of years of data	Z-score
AP Computer Science A	Elective	33.33	7	-1.85
AP Computer Science AB	Elective	0.00	2	-8.33
AP Computer Science Principles	Elective	32.14	3	-1.79
Computer Architecture	Elective	47.06	2	-0.21
Computer Science	Elective	33.33	7	-0.88
Ind. Study: CS Topics	Elective	22.11	11	-2.07
Tech, Ethics, & Society	Elective	39.02	5	-0.33

AP Computer Science AB had a p-value < 0.001 (Z-score = -8.33) and the Independent Studies: Computer Science Topics elective, with a p-value < 0.05 (Z-score = -2.07).

Research questions two and three were addressed using the qualitative data collected during the semi-structured interviews. Research question two asked what the WRS's influential adults (teachers, academic advisors, deans, college counselors, and other administrators) perceptions of how gender identity affects enrollment of students into independent high school STEM courses. Research question three asked how do those same influential adults conceptualize their role in influencing the student enrollment in an independent high school's STEM course. The interviews produced a number of emergent themes across the various types of influential adults. The themes were developed from the a priori codes the researcher had developed based on previous literature searches prior to the semi-structured interviews. Codes were then compiled into categories, which were then carefully developed into themes after extensive coding. The researcher hand-coded the interviews and organized codes into a spreadsheet in order to create the categories. The following emergent themes were developed as a result this qualitative process. Those themes included the roles these adults play at WRS, adult perceptions of student considerations for course enrollment, factors that adults consider when giving enrollment advice, situations when they would encourage or discourage a student from enrolling in a STEM elective, the other adults they encourage students to discuss enrollment with, students that are easier and harder to recruit into STEM, the concerns they have around the varied enrollment advice the students receive, and finally, their "magic wand" wishes for structured STEM enrollment advising.

Influential Community Adult Roles

For those faculty and staff who have been teaching in our context for at least five years, there was a resounding theme that the role of advisor has drastically changed, shifting significantly away from the more hands-on advisory role to what one teacher, Ada, even dubbed "more like a babysitter." Another teacher, Stephen, stated that the West Regional advisory system was "fundamentally broken," while non-STEM teacher Jane said the "general, overall academic advising program was super flawed." Another non-STEM teacher, Sylvia, lamented that the "advisor role has been greatly diminished" and she feels as if she "has most enrollment conversations from the teacher perspective" as compared to academic advisor. Those who acknowledged their positions included academic advisor, in addition to teacher, all stated that they have received zero formal training as academic advisors and believe that might be contributing to the varied advice they give to their students. Finally, STEM teacher Joycelyn specifically acknowledged “there has been no training in regard to the different sequences for the various courses” in terms of all the STEM required and elective courses.

Factors Student Consider for Enrollment. 28 out of 28 interviewees mentioned that they believe that students make their enrollment decisions based on what will make their academic transcripts more appealing to college admissions departments or perceived importance of a rigorous transcript. The prevailing theme of “college prep choice” was prominent in the interviews. WRS administrator, Carl, said after students consider their graduation requirements, the select courses on "what they think they need to get into a name-brand, high quality college." STEM teacher, Neil, says not only do the students want to represent themselves to colleges, they focus on “the honors- and AP-level courses for GPA bumps.”

Interviewees also consistently mentioned that younger students, those in the 9th and 10th grades, often sought advice that was focused on overall long-term planning (entire high school career), while later in 10th grade and into 11th grade, students were focused specifically on what they believe colleges would want to see on their transcripts. This theme of "college prep choices” showed up in numerous responses appeared to be tied to perceptions of courses into which students enrolled. These courses ranged from the various levels a student might be recommended to for required courses and also courses in which they elected to take, such as a “fun elective” versus an AP-level course. Carl specifically pointed out that he believes students “often enroll in APs because of college perceptions” and “that some students choose classes based on interest like pre-med-, engineering-, CS-minded students.” Dean Mary-Claire pointed out that there was a distinction in the selection of higher-level courses and that students were selecting classes in which “they think they will be successful with regard to their GPAs.” Alfred exclaimed that students are thinking about how their transcripts will look for college admissions “all the time!”

Students' own "genuine interest as a secondary factor" was identified by many interviewees as potentially influencing course selection after "college prep choices" appearance for colleges. Twelve adults mentioned that they believe students would select a course based on genuine interest. According to the adults interviewed, they believed that the secondary factors that students consider are dependent on what year in high school the students are when they consider their enrollment options. One of those teachers, Lynn, said it did not happen, though, until she had rising seniors, quoting one "I am finally getting to take the courses I'm really interested in taking!"

Interviewees were asked to ranked what factors they believed students considered when making decisions about course enrollment. There was some disagreement about which was ranked third and fourth, but peer influence and community pressure seem to be more equally referenced, whereas feelings about the specific class (i.e. workload and/or feelings around the teacher) trailed those as primary student considerations. Nine adults mentioned, in some capacity, that students will consider if a friend is taking the class or if a friend has recommended the class. Ten adults identified community pressure or "chatter," as Sylvia called it, as a potential influential factor. Three non-STEM teachers cited parents as the specific sources of community pressure. Grace said that students might select the course to "please their parents." Albert noted that advisees often say they are enrolling in a course because it is "what my parents want me to take." Finally, Dorothy noted the "influence of parents and their expectations for the students" as a factor for student enrollment decisions. They suggest that friend influence might have been more important to underclassmen where as personal interests are more important for upperclassmen.

Only three of the 28 influential adults referenced the elective teacher as a reason a student might elect to take (or not take) a course. Even the reasons the adults cited for this potential cause vary. STEM teacher Lynn said her advisees consider "which teacher is teaching the elective course to see if they are fun and if they like the teacher." STEM teacher George mentioned his students often ask which teachers are the most "fun" and "who is an easy grader." Finally, Mae, another STEM teacher said her advisees consider "teacher-student compatibility" when deciding between available electives. No influential adult brought up teacher gender identity as a reason their students were selecting elective courses. The fact that WRS is a small independent school leaves very few options for which teachers teach the various electives. Often, students do not have a choice as to which teacher they will have.

Finally, a few of the influential adults mentioned that students consider the weight of their entire academic schedule along with extracurricular commitments prior to enrollment. Non-STEM teacher Alexander mentioned that he thinks his "students also seem to be balancing an academic resume." STEM teacher Iréne, noted that she saw some "students being reflective and selecting classes based on their own passions and academic schedules, but also suggested that it "isn't common." Finally, in the past three years (2019-2022), WRS has recently reduced the maximum number of courses a student can enroll in per semester, from seven down to six. This decision was made by WRS administration in an effort to reduce nightly homework loads and address student wellness.

Factors Considered by Adults for Recommendations

The most influential factors that the adults who were interviewed considered when they were recommending classes to students included some very strong links to each other as educators. Themes included adults wanting their students to follow their passions and genuine interest and enroll in courses in which they found real enjoyment of the subject matter rather than what they think would appeal to colleges and adults wanting their students to consider their entire schedule in an attempt to maintain that coveted school-life balance. The adults all emphasized in some way that a passion was critical for a student to have when pursuing a specific enrollment decision. Of the 28 adults interviewed, 18 specifically mentioned that a student's 'genuine interest' in or 'passion for' a subject was a high priority for them when recommending enrollment into classes. Shirley, a STEM teacher, said that "student interest should be the number one factor considered" when discussing elective enrollment. College counselor Alice asks students to "complete self-reflections" as a way to get at students' true passions and future aspirations. Non-STEM department chair Alfred tells advisees to "enroll in what you love."

In a close second to interest, 15 adults said the specifically consider their students' overall wellness when discussing enrollment. They specifically point to a balance in the students' schedules. The majority of adults pointed to students' wellbeing as a top priority for their students, stating that they wanted to advise students to make decisions that resulted in a happy, healthy school year. Neil, STEM teacher, said he "prioritizes balance for [his] advisees' schedules so they won't be overwhelmed during the school year." Non-STEM teacher Grace notes that she "reminds students to be well-rounded in their course-selections." Non-STEM teacher Alexander recounted numerous conversations with students who wanted to load up their academic plates and said he often urged students to consider if "the juice was worth the squeeze."

Other adults noted encouraging students to select classes in which they think is the 'best fit' for a student and yielding to or given primary consideration to a student's teacher placement recommendation (based on class performance and often diagnostic test scores). Seven adults all cited academic "fit" when recommending a course for their students. Non-STEM teacher Sylvia said she specifically considers "where they will be most successful" when weighing regular, honors, or advanced placement courses. While six adults specifically referenced a teacher placement recommendation or performance on a diagnostic test, responses here were less enthusiastic. In fact, one STEM department chair, Isaac, said that he actively ignores the placement recommendations when having one-on-one discussions with students saying that "I don't believe this is the best indicator" of how a student will eventually perform in a course.

Lastly, five adults specifically pointed to the fact that they would gladly encourage students who demonstrate a combination of a high work ethic along with genuine interest in taking courses that will truly challenge them, even if they were not officially recommended for a course. STEM teacher Mae said she has no problem with students wanting to take a difficult course if they are able to "rise to the challenge and are eager for the complexities of the course and is willing and okay with earning lower grades in order to be challenged."

Encouragement/Discouragement Into STEM

The questions around encouragement or discouragement into STEM electives provided surprisingly similar answers across the 28 interviewees. The majority of the adults had stories of encouragement of a student into a STEM elective because they were aware of a student's high level of genuine interest in a particular STEM field. Joycelyn, a STEM teacher, noted that she has encouraged students to "double up in some STEM classes" senior year because of their future STEM aspirations. Academic Dean Charles commented that he "believes STEM is pretty darn popular" and that it is "easy to recommend students into STEM classes." College counselor Alice stated that she "has encouraged students to double up in STEM because there are more electives in the science department and if students love STEM they should take it" but she also admitted to sticking "to the recommendations from the teachers or specific department."

Many had stories of specifically encouraging female students to enroll in STEM electives. STEM teacher Joycelyn recently "encouraged a 9th grader who was really interested after her first computer science class and she encouraged her to keep going." Non-STEM teacher Stephen recalled that "a senior last year was really passionate about STEM but wondered if she should diversify, but I encouraged her to take STEM electives because I knew her passion." Administrator Carl told me that he had "discovered a female student's STEM interest and allowed her to modify her graduation requirements in order for her to participate in a new program and take computer science, robotics, and technical theater electives." STEM teacher Mae recalled that she had "just recently encouraged a female student to enroll in a computer science class because she knew this student would love this specific class as she loves to problem solve."

In addition, seven teachers noted that they personally did not need to recommend students into STEM classes as they were already inclined to enroll. Non-STEM teacher Dorothy said that she has "never had to encourage students to take STEM courses because she thinks they already know what they want" and stated that she thinks we "are pretty much a STEM school already." College counselor Rachel was frank, "honestly, I don't really need to push students to take STEM because it seems to be the norm that our students take STEM courses whether it is an elective or not."

On the other side of encouragement, most adults seemed to be unsettled with the word "discourage," but when they answered that sometimes they might "discourage" a student from taking a STEM elective it was not because they did not think a student should take a particular

STEM elective. The discouragement came in the form of probing a student's true intentions for taking a particular STEM elective. These adults said the only reason they would discourage enrollment into a STEM course was if they knew the student's passion laid elsewhere, that students believed their college acceptance depended on it, or they were taking the course for the wrong reasons. Nine adults mentioned specific reasons for discouraging enrollment based specifically on the fact they thought student course selection was based on the wrong reasons. Non-STEM teacher Albert recounts that he "always asks advisees why they are taking STEM over art electives." He notes that "roughly 90% of their answers include comments like 'because I think it'll look good for colleges.'" He also notes students tell him they feel "pressure from out of school college counselors, parents, and some school staff and other advisors."

Other reasons cited for discouragement was simply the level (i.e. honors and AP courses versus general) at which the student was reaching might not be in their best interests for overall success and enjoyment of the course. Nine teachers cited concerns over a student challenging their teacher recommendations and the "fit" of different classes. STEM teacher Dian mentioned that her "most frequent conversations are around placements into physics classes as students move up from chemistry." She said, "it is all focused on fit for a student regarding honors versus general physics" and that she "never dissuades non-AP STEM electives." Another STEM teacher, Lynn, described a conversation with a recent student who she "discouraged away from honors and to general chemistry because it wasn't the right fit." Finally, another STEM teacher, Katherine, pointed to conversations around "students wanting to take honors but who were recommended for general" are her most frequent "dissuading" conversations. She also mentioned "talking to students at length about fit."

Finally, eight adults expressed concerns over balance in a student's schedule and how it might affect their experience and wellbeing. Jane, a non-STEM teacher, said she does "not specifically discouraged students from taking STEM courses, but rather tries to encourage them to take an art or language course over a second STEM course" in favor of a "well-rounded schedule." She said she "discourages doubling up" in STEM. Neil, a STEM teacher, said he "would only do this if students had too rigorous of a schedule and if they really told him they had interest elsewhere." STEM teacher Louis recalled "a recent rising senior who was attempting to load up their schedule with too many STEM classes" and he was concerned they would not experience a "diverse academic experience."

Additional Advice From Community Adults

When asked if there were any other adults the interviewees encouraged their students to speak with prior to enrollment was meant to capture a bigger picture of who students might turn to when seeking enrollment advice. The majority of the answers included an advisees' parents or family members, the current teacher of the course they were considering enrollment, their grade-level deans but only there was concern around their overall schedule, and college counselors; specifically, when a question arose regarding perceived importance of a class for college admission. Non-STEM teacher Dorothy said she suggests her advisees "talk to the future elective teachers of the courses they are interested in" as she "believes teachers have their own expertise" and would have "better insight." Sylvia, a non-STEM teacher, encourages students to "stick to the teacher recommendations over parent opinions." STEM teacher Mae even suggested that "sometimes talking to parents and friends about course enrollment is counterproductive."

College counselor Alice raised specific concerns around the role of both the advisors and grade-level deans. She actually "encourages students to talk with the future elective teacher as advisors are not formally trained at West Regional High School and it is unclear what the role of dean truly entails." Other adults echoed similar concerns around the dean position. Non-STEM teacher Jane recalled that very recently a dean told her "'it isn't your job to advise' which seemed very odd considering I am an advisor."

Students Who Seek Advice

Adults frequently described the same type of student who regularly seeks enrollment advice. 12 adults specifically described these students as the highly motivated, academically-driven students, those who are either concerned about recommendations they received holding them back from what they want to take or students who really trust the adult and are honestly seeking their advice. Dean Charles identified the "high-achieving students who are overbooked" are ones that frequently "seek guidance" from him. College counselor Alice names "top-tier students, the ones who are always doing a lot and asking if their schedules are too much" frequent her office. STEM department chair Charles echoes the comments by pointing out "top-tier students who are academically driven" coming in to discuss placement, but perhaps need "a little more work, but also want the challenge, but also might be trying to take on too much." STEM teacher Mae said she always sees 'the eager beaver, the over-achieving type of student who wants the "A" in class."

In addition, five adults mentioned that they had students come for advice that knew them from a previous course or another on-campus role they hold (i.e. coach, advisor, club sponsor). Non-STEM teacher Alexander mentions "students who [I am] close with because of the debate team often ask for advice annually prior to course enrollments." Administrator Carl cited "students who are particularly interested in West Regional's Innovation Scholars Program[1]" are the ones he sees annually.

Three adults specifically noted that girls tended to seek advice more than their male students. Dean Mary-Claire said she "talks with more boys than girls" and that "girls seem more organized overall." STEM teacher Dian has noticed "female students from her core science course" overwhelmingly seek her enrollment advice every year.

Recruitment and Retention of Students

Answers to the questions of which students are easier or harder to recruit and then retain in STEM classes was informative. One interviewee stated, 'the kids who already knew they love science' and those students who had incredibly positive experiences in their core required courses are the easiest to recruit and retain in STEM classes. Many shared experiences of students who were enrolled in STEM courses and they already knew what they loved to study. They shared those students often described themselves as 'being a science kid' or 'a math kid.' Interview questions around the recruitment into and retainment of students into STEM is directly tied to my problem of practice and has the ability to give insight, beyond the numbers, of gender disparity in the enrollment of STEM electives. On the other hand, many gave reasons for 'losing' students to other subjects such as their gender, race and ethnicity, concern around being stereotyped, and students that either lacked confidence to continue in STEM or did not want to work hard in subjects they believed require significant amounts of effort.

Adults mentioned that students were easier to recruit and retain in the STEM departments were because of two main, emergent themes: the students already identified themselves as

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[1] WRS's Innovations Scholar program is described as an optional independent study program for interested students to continue investigating their academic passions beyond the classroom (WRS Innovation Scholars Program, n. d.).

'STEM kids' or they did not previously have that confidence or passion but they had such a positive experience in their core courses that they found success and wanted to continue the study. Specifically, 13 adults stated a previous interest in STEM as the most important indicator a student would be encouraged to enroll in electives. STEM department chair Isaac said the students who are the easiest to recruit and then retain are the "stereotypical geeks who seem to be open to ideas." He noted that there is an "interesting dynamic at our school where being smart is 'cool' and that the "robotics students are easiest" because they self-identify quickly as "science kids." STEM teacher Ada said those students were primarily "top-tier" and "already loved science." STEM teacher Katherine pointed to her students she called "STEM obsessed." While STEM teacher George was even more specific saying it was the "overconfident boy" who always wanted to enroll in physics electives. STEM teacher Louis said overwhelmingly it is the "baseline 10th grade boy who loves video games and whose parents encourage them to study computer science."

Other adults describe students that find success in their core STEM courses, discover a new interest, but these comments were fewer in number compared to a previous declaration of love for STEM subjects. College counselor Rachel said that the "top-tier students" who are her "highest flyers" are easiest to recruit. STEM department chair Marie says it is often the student "who is discovering they really can do math." While this is encouraging, the majority of the adults interviewed emphasized a previous love of STEM to be the indicator of ease to enroll in elective courses.

Adults also mentioned a number of themes for students who they were not able to either recruit or retain in STEM elective courses. Emergent themes include concerns about not being able to recruit diverse students based on gender (specifically girls) and race/ethnicity. Eight different adults mentioned girls and/or students of color were sometimes the harder groups to recruit and retain. STEM department chair Isaac noted that "physics doesn't seem to see the numbers of female students" like other subjects. STEM teacher Joycelyn mentioned that "shy, touchy-feely girls who have trouble putting themselves out there" are some of hardest students for her to convince to enroll in STEM electives. Mae, another STEM teacher, echoed similar feelings saying that "female students with confidence issues" are the hardest to encourage into STEM. George, STEM teacher, stated that "girls in honors physics that did well but lacked confidence to go on to AP" and that "numerically AP Physics has a gender disparity problem." STEM department chair, Marie, said, for her, are the hardest to recruit are the "giddy, perky girl who thinks good enough is good enough." Finally, STEM teacher Iréne noted that "9th grade girls and students of color are the hardest" to encourage to enroll in future STEM electives.

Other adults pointed to students who they assumed felt more of the social pressure to not stick with subjects like computer science because it 'wasn't cool.' Two teachers specifically commented on the fact that they cannot seem to encourage certain, socially-affluent students were not as interested in enrolling in STEM electives. Non-STEM teacher pointed to the "lax bros" as the hardest group to encourage. On the flip side, STEM teacher Henrietta said that they "were able to recruit students because their friends were already into robotics," for example, and "they wanted to be with their peers."

Nine adults mentioned slight variations on the reason that they struggle to recruit students into STEM electives around the idea that students have preconceived notions of what it means to be a STEM student or the work it takes to be a STEM student. STEM teacher Neil said that "some AP classes are harder to recruit simply because of preconceived notions of rigor." STEM teacher Joycelyn said that she believes students view STEM electives with a "fixed mindset" and cannot imagine themselves in those courses based on experience in their “core classes.” Finally, STEM teacher Ada points to students that “find core classes challenge, especially the girls, and they don’t feel like they were successful in those classes.” She went on to say that she believes their “curiosity was squashed by experience.”

Varied Advice Concerns

All of the adults expressed some level of concerns about the varied advice students received prior to making their enrollment decisions. The concerns include varied advice from parents, grade-level deans, advisors, pressures external to West Regional High School, teachers and department chairs, and only minorly their own peers.

Over 11 adults directly cited concerns around the advice given by students’ own parents or guardians. The majority of the adults stated that they did not believe the poor advice was intentional, but rather it came from an uninformed or outdated perspective. Administrator Carl said he regularly has parents in his office discussing course enrollment that say to him "we know what you say to everyone else, but...” what about our child. He mentioned that comments like this are common and he believes they come from a place of “love” and “wanting the best for their child.” Grade-level dean Mary-Claire recalled similar meetings with families and said while she believes there is good intent, but “parents really aren't helping.” Non-STEM teacher Stephen says that his biggest concern is around “deans and parents saying how important math and science classes are compared to art, history, or language courses.”

The combined concerns around on-campus adults that include the grade-level deans and the academic advisors actually overshadowed concerns around parental influence. Dean and advisor concerns were expressed by 18 of the 28 adults interviewed. STEM teacher Joycelyn stated that she “would like grade-level deans to be more informed as advice givers” and that she was “frustrated with their supermarket comments” and is “concerned that advisors just talk to students about their own personal experiences.” Non-STEM teacher Sylvia said that the “dean is often the final say” in terms of students’ schedules and she “thinks that is a problem.” STEM teacher Dian recounted conversations with students who have confided in her that they are “being told by deans they shouldn't take a STEM class because it would be too hard or too much work.” Comments around the role of academic advisors felt different than comments regarding the grade-level deans. Most adults mentioned the fact that while they believed advisors were not giving the best advice all the time that they did not believe was completely their faults. College counselor Alice concurred that it is “not the fault of advisors, but there's a lack of training for them.” She continued that “for most faculty it feels as if the advisory role is more of an add on or a chore.” She said that many advisors are “talking more about the college process than they should as they don't really know especially with regard to course recommendations.” She suggested that there needs to be “more training for deans and advisors” and that enrollment discussions “should include the college counseling team.”

Concerns were also expressed by eight adults specifically around external influences and opinions from private college counselors, college admissions offices, and even societal perceptions and giving recommendations to students based on their own perceptions of the college process instead of a true understanding or consultation with experts in our context.
One concern was around the misconceptions of what a particular class entailed because of what peers said, or uninformed teachers from different departments, talking about what they thought a particular classed covered. STEM teacher Ada recounted student “concerns from their public-school friends talking about the important of AP classes.” STEM teacher George believes that there is a “broader societal norm and messaging that physics is for boys.” Finally, non-STEM

teacher Albert acknowledged the fact that there is “so much information is available in terms of college guides and internet sources, quality or not,” that might influence our students.

Ideal STEM Advising

My final interview question focused on a wish list of sorts. I asked the interviewees, if they could wave a magic wand, how would STEM advising be designed in our context. Two main themes emerged: a complete restructuring of the entire West Regional High School advisory program along with concerns regarding enrollment decisions seemingly linked to graduation requirements and the college admission process.

Overwhelming interviewees said that our advisory system felt fundamentally broken. Of the 28 adults interviewed, 24 emphasized the advisory program was not working as is and that if they could wave their magic wands and fix STEM advising then they might as well fix the entire program. Non-STEM teacher Stephen agrees and says we have a “broken advisory system” and have for years. STEM teachers Rosalind and Mae and college counselor Alice all said that the enrollment process takes and needs “more time” and “space.” STEM department chair Marie said she “wants more knowledgeable advisors giving advice” to our students pre-enrollment. Finally, STEM teacher Joycelyn said she “would love to have the administration create an advisory training program for the teachers.”

They said they wished there was time and space for students to explore what they found enjoyable about the learning process. One teacher even suggested a day set aside for sophomores and juniors so they could actually visit different STEM electives in what seemed like a mini course audit experience. Another teacher suggested having a discipline-specific panel available to answer students’ questions around elective courses well in advance of enrollment deadlines. What is ultimately becoming clear from these interviews, though, is that adults at West Regional feel somewhat disorganized and that important discussions around enrollment, among other things, are not getting the time and attention they deserve at the detriment of the students. Many adults said their ideal program for advising would be to remove college admissions from all discussions. Almost all of the adults said, they wanted advising as a whole to be a broader discussion of a student's genuine interests and academic passions. STEM department chair Isaac told me that he wished that enrollment conversations could be "be devoid of GPA and college admissions influence." He said he wants students to "take what they are interested in and rather than staying 'I need to take these AP classes' for this college or that one." He summarized that "the motivational part of enrollment needs to be changed." STEM teacher Mae agreed with him saying she "would love to take college admissions and student transcripts out of the conversations."

Summary and Conclusions

In conclusion, the quantitative enrollment data showed, as expected, gender parity for the all the required math and science courses with the exception of Geometry Functions. Overall, there was no statistical difference between the proportion of female students enrolled compared to the males in required courses. While the Geometry Functions demonstrated a statistically significant gender disparity in the enrollment proportions, it should be noted that compared to the majority of classes with up to 10 years of enrollment data, this class has only run for two years and is considered the most remedial level in geometry.

The problem of practice predicted gender disparity to be the greatest in physical science courses, highest levels of mathematics, and computer science. Enrollment data showed that AP Physics C: Electricity and Magnetism, AP Physics C: Mechanics, Biomechanics, and Engineering Design and Build all had Z scores that showed significant differences in the enrollment proportions of female to male students. The only math elective that had a statistically significant Z score was Honors Multivariable Calculus (HMC). This course also happens to be the highest level of in-person math electives that can be taken at West Regional High School. Finally, two computer science elective courses showed statistically significant Z scores for enrollment proportions, favoring male students. Those electives were AP Computer Science AB and the Independent Study: Computer Science Topics. It should be pointed out that both of these courses are only accessible at the end of the computer science 'tract.' Pre-requisites keep students from enrolling in either of these elective options until introductory computer science courses have been previously completed.

The qualitative data not only served to enrich the enrollment data, but it also was vital to help identify potential reasons and causes for the extreme disparity in the courses described above. The interviews with the influential community adults covered a broad spectrum of adults that WRS students are encouraged to speak with regarding their academic enrollment plans. While the quantitative data show which courses had statistically significant gender disparity in the enrollment proportions of female to male students, the qualitative data gave insight from the influential adults' perspective as to some of the reasons as to why it is occurring. The biggest theme from these interviews seems to be a lack of STEM confidence and, perhaps, STEM identity, from the female students in the courses where disparity has been measured. In addition to the major implications of how student gender plays a role in the disparity of STEM enrollment at WRS, the other important, emergent themes of the semi-structured interviews included concerns about the factors students consider when selecting courses, the varied advice students receive prior to enrollment from people on and off campus, and finally a clear breakdown in the advising and dean programs.

Themes around the pressures, internal and external, of the college process appear to be one of the most influential driving forces for students. Faculty and staff, on the other hand, tend to encourage students to consider their genuine academic passions and create well-balanced schedules in their pre-enrollment conversations. Adult are concerned about broader societal perceptions students may have as well as the varied advice West Regional students get from parents, advisors, deans, and teachers, especially through recommendation processes. One thing rang clear, the adults spoke of the school's role in supporting students in the enrollment process and recognized the need to evaluate and restructure the advisory program overall, not just as it related to STEM support. Many advisors acknowledged that they had never received any formal development programming, at WRS or any other school. Because the job is implied in the title, advisors at WRS felt as if they were flying blind, so to speak, as they worked to support their students on a wide range of topics.

At this time, a potential intervention point seems to be revealing itself. In addition to the 28 semi-structured interviews in this needs assessment, a recent all faculty survey conducted by WRS's administrative team revealed that both high school and middle school teachers are very concerned with the quality of the advising program. Specifically, advisors stated that they are concerned with a lack of clarity in what is required of faculty who hold the position along with the complete lack of training for advisory program as a whole. With regard to my specific problem of practice, perhaps a better system for advising our students, including a gender interventionist approach, along with other potential contributing factors yet to be fully uncovered, will lay the ground work for narrowing the gender gap in the enrollment of various STEM electives at our independent high school level. The next chapter will consist of a literature review of potential intervention strategies for narrowing, or eliminating, the enrollment gap in the courses described above.

Chapter 3

Intervention Literature Review

Introduction

The current problem of practice facing WRS is the gender disparity in students' enrollment of STEM electives. West Regional School, an NAIS-accredited, rigorous college preparatory, independent school is comprised of 6^{th} through 12th-grade students. The middle school grades are relatively rigid in their course offerings, with elective classes available to students as extracurricular activities rather than academic credit. Graduation requirements constrain the enrollment process for the high school students at WRS. Students in the ninth and tenth grades are very limited in the elective courses they can schedule.

Comparatively, juniors and seniors have considerably more academic elective options. Once in the 9^{th} grade, all students are assigned academic advisors. Throughout their high school career, students consult both their advisors and grade-level deans for course enrollment advice. Elective classes are presented to the entire student body during an annual assembly in February. Students then must enroll in their courses by the second week of March. Prior to the enrollment deadline, students and their families meet with their assigned academic advisors to discuss their current coursework and future enrollment plans.

According to the Head of School, during the 2020 state of school address, a recent culture survey of faculty indicated that most academic advisors felt ill-prepared to execute their advisory duties (Head of School, personal communication, 2020, January 8). They cited WRS's lack of a formal advisor training program. Many advisors noted the lack of training as detrimental to student enrollment discussions. Because of this, students often seek out additional course enrollment advice from trusted teachers, department chairs, or their fellow peers. While students report, in conversations with teachers, that they enjoy their advisors' support, they also state confusion and uncertainty around the overall enrollment process. Students need and deserve proper academic advising. In addition, the WRS advisors report wanting the very best for their students. A clearer, more streamlined process for disseminating elective course information and fielding student queries is needed if WRS effectively addresses gender disparities in the enrollment of the STEM elective courses. By having academic advisors and STEM teachers formally trained through a diversity, equity, and inclusion lens, WRS could close the gender disparity enrollment gap.

Themes were identified from the needs assessment that revealed that the college process's internal and external pressures appear to be among the most influential driving forces for WRS's high school students. On the other hand, faculty and staff encourage students to consider their genuine academic passions and create well-balanced schedules in their pre-enrollment conversations. These influential community adults are concerned about the broader societal perceptions WRS students may have to face, specifically the pressures that students might feel about getting into the 'right college.' Additionally, the academic advisors worry about the varied advice their students receive from parents, peers, deans, and teachers, especially through the course recommendation processes. One theme rang clear. The adults spoke of the school's role in supporting students in the enrollment process. They recognized the need to evaluate and restructure the advisory program overall, not just related to STEM support. Many academic advisors acknowledged that they had never received any formal training at WRS or any other teacher preparation programs as to how to be an academic advisor to high school students. Because the job is implied in the title, academic advisors at WRS felt as if they were flying blind, so to speak, as they worked to support their students on a wide range of topics.

Finally, as it relates directly to the gender disparity in the STEM electives, the influential community adults were acutely aware of the gender gap. While many stated they have been attempting to encourage promising female students into STEM courses and to follow their science passions, many (who are not STEM teachers) did not clearly understand the STEM electives offered at WRS. They stated they continued to feel ill-prepared to fully support these young women and their STEM interests.

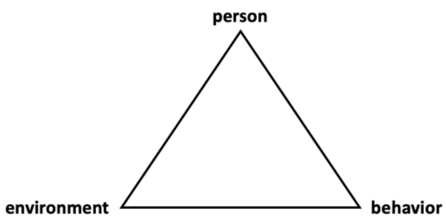
Before outlining the proposed intervention, this chapter presents a literature review of advising-related interventions that focus on some of the most accessible contributing factors to the gender disparity in enrollment of STEM electives at WRS.

Theoretical Framework: Social Cognitive Theory

To properly address potential interventions for improving the advising program and eventually diminishing STEM course enrollment problems at WRS, the literature review and proposed intervention are supported by a foundational theoretical framework. Bandura's (1989) Social Cognitive Theory (SCT), at its most fundamental thesis, suggests that learning happens in the social environment. SCT considers how individuals' behavior is based on their life experiences and the influence of their social environment. Bandura (1989) suggests that these factors play a critical role in a person's behaviors and why they display specific actions and not others. He also describes human functioning as the interactions between an individual's behaviors, environmental factors, and cognition, as shown in Figure 3.1 below (Bandura, 1989; Schunk, 1989).

Figure 3.1

Relationship of Behavior, Environmental Variables, Cognitions, and Personal Factors



Note. Adapted from Schunk, 1989

Social Cognitive Theory has six essential constructs used to explain an individual's behavior. They include reciprocal determinism, behavioral capability, observational learning, reinforcements, expectations, and finally, self-efficacy (Bandura, 1989). The final, last construct added, self-efficacy, was included as the theory evolved from previous iterations (Bandura, 1971). First, reciprocal determinism, the foundation of SCT, is defined as the mutual influence of the individual's cognitive processes, their environment, and the individuals' behavior. Second, behavioral capability refers to a person's ability to carry out specific actions based on their prior knowledge and developed skills. Third, observational learning is learning that results from watching the behaviors of others and then repeating them. Bandura (1989) describes the repeating of behaviors as modeling. Fourth, reinforcement suggests that a person is more likely to continue a behavior if they receive positive reactions and discontinue behaviors because of negative responses. Fifth, expectations are what an individual considers when deciding to behave a certain way. One anticipates the reactions to a particular behavior based on previous experiences that include the responses to their past behaviors. These expectations can determine whether or not an individual will engage in certain behaviors. Finally, self-efficacy is defined as a person's confidence in their abilities to perform a behavior to be positively received. A person's self-efficacy is influenced by their capabilities, past experiences, and other social factors of their environment. Social Cognitive Theory is used as the guiding framework for the following literature review of interventions that address the gender disparity in STEM education at the high school level because its constructs, especially self-efficacy, can be used to explain an individual's behavior.

Intervention Literature Synthesis

To understand and address the gender disparity in the enrollment of STEM electives at WRS, this chapter reviews potential interventions into the following factors: implicit biases in the STEM classrooms and in academic advising, the role that influential community adults play in students' enrollment decisions, and finally, the STEM identities and sense of STEM self-belonging for female students. This paper will examine various interventions for each of the above contributing factors. These interventions will be investigated using Bandura's (1989) Social Cognitive Theory as the theoretical, guiding framework.

Interventions Addressing Implicit Bias in STEM Education

Implicit bias is defined by Staats (2015) as "attitudes and stereotypes that affect our understanding, actions, and decisions in an unconscious manner" (p. 29). One reason educators must understand implicit bias is that most neuroscientists agree that a majority of our behavior-based decisions occur outside our conscious awareness (Staats, 2015). While implicit biases do not automatically affect all of our behaviors, they often act like mental shortcuts to save time in human's decision-making processes. Even the most well-intentioned individuals are at risk of exhibiting behaviors influenced by these implicit biases. These behaviors can "produce inequitable outcomes for different groups" (Staats, 2015, p. 30). Identifying and addressing harmful implicit biases should be of the utmost importance to educators, considering those biases could have unintended yet harmful effects on their students.

According to Holroyd et al. (2017), the most problematic implicit biases target social groups, such as religious, ethnic, racial, and gender groups. Luckily, individuals can learn to intervene on their own behaviors once they recognize they have implicitly biases thoughts and those thoughts can negatively influence their behaviors. The question of who is responsible for addressing that specific type of biased behavior is complicated, though. If a person is not aware of their own implicit biases, it is impossible to attempt to change them without knowing how? to test for them in the first place. It would make sense for the administrators to guide their faculty in implicit bias identification and training to serve their student populations better in traditional educational settings (Gino and Coffman, 2021).

Implicit bias can manifest itself in a number of instances in educational systems. At the university classroom level, Lester et al. (2016) highlighted the harmful effects of implicit biases of professors in microaggressive behaviors such as communication styles and decisions made in the physical spaces where learning takes place. Further supporting this finding, Charlesworth and Banaji (2019) conducted a study that included 4.4 million peoples' Implicit Association Test (IAT) (Greenwald et al., 1998) results collected over a 13-year period. Their findings contradicted previous assertions that implicit attitudes are resistant to change because they are inherently part of our unconscious awareness (Charlesworth & Banaji, 2019). Their research used data previously collected through implicit association tests by the Project Implicit website (Project Implicit, n. d.). They specifically found evidence that people can change their implicit biases over time for three particular attitudes (i.e., sexual orientation, race, and skin tones). While the change in these biases might be gradual, it can also be durable and move toward a decrease in overall prejudiced attitudes (Charlesworth & Banaji, 2019). The authors addressed possible limitations of the study that include concerns of generalizability and the cause of change, specifically cited by the authors include “low overall bias, high implicit-explicit correlation, and high societal priority” (Charlesworth & Banaji, 2019, p. 191). Charlesworth and Banaji (2019) addressed those potential limitations with their methodology and state confidence in the study's "contribution for generating and testing novel predictions about the patterns of long-term population-level implicit and explicit attitude change" (p. 191). Thus, as Staats (2015) suggests, testing implicit bias is just the first step to eventually addressing and changing one's unconscious, potentially harmful attitudes. The following will look at research that ranges from simply bias testing educators to intentional professional development programs for educators to support changes in their implicit and explicit negative attitudes.

Unconscious Bias Testing and Resources for Teachers and Academic Advisors

An essential first step in addressing one's own implicit biases is to become aware of them (Staats, 2015). According to Staats' review of prominent implicit bias research (2015), people can reprogram their mental associations and actively align their unconscious biases with their explicit beliefs. It takes work, though. Once teachers are aware that they have these biases, they can work to prevent them from influencing their interactions with students. Staats (2015) suggests additional personal efforts must follow implicit bias testing such as (1) intergroup contact, (2) exposure to counter-stereotypical examples, and (3) educators exhibiting self-regulated and careful decision making. First, intergroup contact includes events that allow for meaningful engagement with others who have identities different from your own. These events help people to create new associations and break down existing implicit biases. Second, if teachers can expose themselves and their students to counter-stereotypical examples of successful scientists, then they have the potential to start to change widely held stereotypes in STEM. Finally, if teachers can take time to respond to their students and carefully process their thinking, thus shifting to conscious thought, they have the potential to minimize their unconscious biases (Staats, 2015). As Staats (2015) states, there can be "real-life implications of implicit biases," and they "can create invisible barriers to opportunity and achievement for some students" (p. 33). Staats (2015) suggests that identifying one’s own implicit biases is step one for addressing these biases in the classrooms and in academic advising conversations. Steps two and three involve going beyond the identification of biases. As outline in the following sections, an argument for the use of Harvard’s IATs as a tool for implicit bias identification will be presented. Next, de-biasing strategies and essential component of implicit bias professional development programs will be investigated. A proposed intervention will include, not only implicit association tests for participants, but also de-biasing strategies presented in a thoughtfully constructed intervention professional development program.

Implicit Bias Testing. Implicit bias training has had varied success when conducted in professional development programs. Jackson et al. (2014) investigated the impact a brief diversity training session had on the implicit biases and explicit attitudes of 234 U.S. professors from four different midwestern universities. Jackson et al. (2014) administered a series of quantitative measures in order to determine if specific implicit bias training could improve the attitudes people have toward women in STEM. Using Nosek and Banaji's (2001) Go/No-Go Association Task (GNAT) instead of the commonly used IAT measure, Jackson et al. (2014) found that the personal implicit associations about women in STEM changed only for male participants, not for females. The female participants had already reported more positive associations in the pre-training test. Additionally, the pre-test and post-tests showed that male participants were more likely to endorse harmful or negative stereotypes about women in STEM, which did not change with the diversity training. They concluded that the brief diversity training improved implicit associations about women in STEM, but more work needed to be done to improve overall attitudes and stereotypes. Jackson et al. (2014) acknowledge the potential limitation of using a paper-based (rather than computer-based) bias testing is that it has binary results with no record of timing. Computer-based tests have the ability to record the time it takes for participants to make their choices, which can imply hesitation. While Bar-Anan and Nosek (2014) suggest computer-based testing provides for stronger convergence among various implicit bias tests, Teachman and Brownell's (2001) research demonstrates predictive validity for paper-based tests.

Any proposed intervention to address the gender disparity in STEM elective enrollment at WRS would need to be explicitly designed to support high school students. Implicit biases focused on the STEM interests of young adults need to be prioritized when investigating how influential teachers' biases might affect WRS's STEM-promising females. To further examine implicit bias and explicit gender stereotypes in STEM, Fleming et al. (2020) utilized both the Adult- and Child-Implicit Relational Assessment Procedure tests (IRAP). Similar to the Implicit Association Tests (IAT) and Go/No-Go Tests (GNAT), the IRAP test is a computer-based association test. This study employed two versions of the test, one making the connection for science to adults (male or female) and one making the connections to children (male or female). Thirty-three university-aged students' implicit biases were tested using both the Adult-IRAP and Child-IRAP tests using pictorial stimuli. Their explicit attitudes were measured using the Career Suitability Rating Scale, which utilizes an 11-point Likert scale system to measure career suitability for males and females in 12 different careers (six STEM and six non-STEM). While both tests showed significant stereotyping of males as scientists (or a bias for males as scientists), only the adult tests demonstrated a negative bias of men in the arts (Fleming et al., 2020). The researchers noted that the gender of the participants did not affect the results of either test. They also reported that while there was a STEM bias in favor of males, it was more robust in the adult test, implying that implicit bias becomes more pronounced and intractable with age.

A more nuanced investigation of the social cognitive perspective concerning implicit gender-domain stereotypes was conducted by Smeding et al. (2016). The researchers carried out a combination of four empirical studies and computational modeling, using approximately 90 U.S. university undergraduate students (STEM and non-STEM majors). In one of their experiments, they simulated "students" using computer and robotic technology. In these experiments, they replaced the traditional keyboard with a mouse and trackpad to investigate minute sensorimotor movements as test-takers made their selections (Smeding et al., 2016). This methodological adjustment allowed the researchers to note the variations of hesitancy among student selections. The limitation of traditional implicit association tests (IAT) is that researchers can only collect information based on the binary nature of the test when using a keyboard versus using a mouse and trackpad. The hesitancy in selection for the IAT tests still demonstrates implicit bias, but only for one measure, the timing component. On the other hand, the mouse-tracking system allowed them to follow the movement of the respondent's choice, a combination of implicit bias and sensorimotor movements. The four individual studies' results support the assumptions that an individual's position in the test (male/female, STEM/non-STEM) and what they have learned through socialization matters, but so does the nuanced sensorimotor data (Smeding et al., 2016). Additionally, one of the experiments demonstrated the influence that early stereotyping can have on the decision-making process as it relates to the IATs. Their findings were also consistent with previous gender-domain studies, in which males are positively associated with STEM fields.

When considering an intervention for implicit bias training at WRS, the researcher needs to also consider the depth of the intervention. Clark and Zygmunt (2014) caution against the use of IATs as the sole intervention training tool for implicit bias professional development. While IATs can bring awareness of one's implicit bias to light, interventions that do not present participants ways to mitigate the harmful effects of those implicit biases fall short. In a qualitative study of 302 early childhood and elementary school teachers (293 female, 278 White, 8 Black, 2 Hispanic, and 5 multicultural), Clark and Zygmunt (2014) reported the impressions these educators had after enrolling in an online diversity course. The course consisted of each participant completing two IATs, one for race and one for skin tone. Participants were then asked to engage in discussion boards and report their reactions to the IAT results. The researchers coded the entries and determined that the participants' reactions to the IAT results fell into one of five categories. Teachers reported one of the following overall reactions: disregard, disbelief, acceptance, discomfort, or distress (Clark & Zygmunt 2014). The majority of the participants' discussion posts reported disregard or disbelief (75%), while only a smaller portion acknowledged acceptance, discomfort, or distress. Based on those results, Clark and Zygmunt (2014) caution the use of the IATs as a stand-alone professional development tool for educators when they consider the impact implicit biases can have on their students.

De-Biasing Strategies. While the act of increasing awareness of one's own biases is an important first step in implicit bias training, it is important to note it is only the first step (Staats, 2015). Harrison-Bernard et al. (2020) conducted a study that included 55 university-level faculty and staff, each of whom attended a 3-hour diversity, equity, inclusion, and implicit bias in academia workshop. Participants engaged in various activities in the 3-hour workshop including "didactic presentation, videos, teaching modules, an active-learning activity of matching vocabulary words, brainstorming and discussions" (p. 288). Active discussion among participants (large and small groups) was encouraged by the facilitators as was the reflection by each participant following various portions of the program. Using retrospective pre- and post-surveys, they found that the intervention's first objective was achieved. The workshop used a stepwise approach to implicit bias training. Their first goal was to educate participants on common terminology that should be used when focused on inclusive spaces, such as classrooms. Harrison-Bernard et al. (2020) were quick to report an important limitation of these results. They acknowledged that 38% of attendees reported that this intervention was not their first exposure to diversity training. They also acknowledged that the intervention along with the specific workshop tools, allowed them to report that participants also met their second study objective, for attendees to take their implicit bias information and learn the impact it can have on students. Additionally, researchers found that participants had gained information as to how creating more inclusive environments is critical when supporting university students from diverse backgrounds (Harrison-Bernard et al. (2020). Additional limitations for generalizability were reported by the researchers. They stated that the workshops focused primarily on race and ethnicity training and, to a significantly lesser extent, other important components of diversity such as gender, age, religion, and socioeconomic status. Finally, while Harrison-Bernard et al. (2020) noted the strength of retrospective pre-/post-survey tools, the use of these quantitative data measures did not allow the researchers to determine how the knowledge participants gained during the workshops lead to the changes in behaviors they were reporting on the surveys.

Implicit Bias Professional Development Programs. Building an effective intervention for implicit biasing training for educators appears to be another critical step for addressing and mitigating the negative effects these biases can have on students. Lai et al. (2014) undertook a massive comparative investigation of 17 different implicit bias interventions. The study began with various research teams submitting different interventions that had been tested an average of 3.7 times, including a total participant number of 17,021. All participants were non-Black U.S. citizens that were registered on the Project Implicit website (Project Implicit, n. d.). The researchers found that eight of the 17 implicit bias interventions were effective at reducing participants' preferences for Whites compared to Blacks. Lai et al. (2014) noted that interventions that provided participants with programs that included counter-stereotypical exemplars provided specific strategies for mitigating biases and used evaluative conditioning techniques proved to be most successful. A counter-stereotypical exemplar is simply an image, video, or depiction of a person performing a job or duty that is sees as contrary to the roles that gender norms dictate they typically perform. The researchers also stated the other nine interventions were ineffective. They also noted interventions that felt inauthentic for participants, particularly ones that focused primarily on participants being asked to engage in others' perspectives, asked them to consider egalitarian values, or ones that attempted to induce positive emotions were especially ineffective. Lai et al. (2014) acknowledge that while the comparison yields important findings, the research is limited because it allows for comparative inferences for studies conducted under specific experimental contexts and conditions. In other words, they are concerned their studies are so specific, it might be difficult to compare another study's findings to their unless the methods and participants mirror their study's methods and participants. They caution that a simple change in procedures or the selection process or demographics of the participants could alter the overall effectiveness of each particular intervention they deemed effective.

Given enough time and resources, a more comprehensive approach to the implicit bias training of educators might prove to be the most effective mitigating strategy. van Langen (2015) reported the findings of a study funded by the Dutch government and conducted in conjunction with a non-profit organization, the Dutch National Expert Organization on Girls/Women and Science/Technology (VHTO). The goal of this massive program was to fund, oversee, and evaluate a series of policies and programs aimed at increasing the participation of girls and women in STEM at various levels. While the entire study is admirable in its goals, certain aspects are particularly relevant, including raising the awareness of gender biases and stereotyping in influential community adults (e.g., parents, teachers, school officials) via a professional development program. This portion of the study included participants from 55 different high schools and 73 pre-vocational schools. The educators participated in a combined total of 220 workshop sessions. While the authors did not state the exact number of teachers who attended these workshops, they estimated that between and impressive 10% and 20% of all Dutch secondary schools participated in at least one workshop. The various workshops offered specifically to the educators included the "training of teachers, student advisors and school guidance counsellors with respect to gender awareness and stereotypes involving gender and STEM but also appealing STEM education options for girls and women" (van Langen, 2015, p. 30). The results were collected post-educator professional development program and measured the growing proportion of girls and women participating in STEM at their respective levels (van Langen, 2015). The self-reported strength of the overall approach is that the researchers and supporting organization, VHTO, conducted interventions from the primary school level through the STEM labor market. They also recognized that only schools interested in participating had educators participating in the interventions, thus influencing the motivations of those who were participating in the specific intervention workshops.

In a theoretical proposal, Lin et al. (2008) suggested for anti-bias teacher education training to be successful, an intervention must include involving more than just program facilitators in an intervention's development, but also the very stakeholders who will benefit from this type of professional development. Lin et al. (2008) recommended inviting parents and guardians into the discussions for the development of teacher education programs, having teachers conduct home visits for their students, engaging intervention participants in reflective writing and role play as a critical part of intervention work, and finally, incorporating service-learning. As the authors suggest, these strategies should be used as a jumping-off point for any researcher developing and intending to implement an anti-bias curriculum into teacher training programs. The researchers suggest that a vital cornerstone of anti-bias training is when the professional development program contains the reflective process of participants, especially as they determine how effective each strategy of that training is to both themselves and their students. For example, if a professional development program is to use IAT tests to increase participants' awareness of their own implicit biases, then Lin et al. (2008) suggest that the participants not only take the IATs, but spend time critically reflecting on their own personal results. Finally, they state that educators must pay particular attention to how much they, as an individual, might have changed in their attitudes, beliefs, or practices following anti-bias training.

Professional Development Focused on Fostering Gender Equity in the Classroom

Research has shown that the identification of implicit biases and measurement of explicit attitudes is the first step schools should take if they are to address disparities within their schools, such as gender or racial/ethnic disparities of STEM elective enrollment courses at WRS. Various de-biasing professional development programs are investigated to assess the risks and benefits of engaging in this type of intervention at WRS.

In order for change to happen, one must recognize that process of change is highly variable for individuals (Guskey, 1991). In a reflective article, Guskey states that even as institutions implement new practices and policies, it is still up to the individuals (e. g., teachers, advisors, deans, *etc*.) to carry out the work. Guskey (1991) focuses his work on the five key components of effective professional development. They include designing a program that recognizes that change is an individual process, the program itself should be smaller in scale while maintaining larger goals, work should be conducted in teams, has procedures for personalized feedback based on participant results, and finally, provide both continued support and follow-up to the program’s work. He suggests that in order to truly support individual change, programs must consider the embedded structures that influence each participants' actions and choices as well as their motivation for change. He recommends programs can be successful as long as the researchers think big but start small (Guskey, 1991). He encourages the creation of professional development activities to be practical and align and educator training with what is possible in specific contexts. For successful training, individuals should work in teams as "discomfort that accompanies change" and that programs that include opportunities for personal reflection and feedback yield longer-term effects.

Utilizing these recommendations for successful implementation of professional development programs, Zozakiewicz and Rodriguez (2007) executed an intervention project entitled Maxima, whose goal was to create "inquiry-based, gender-inclusive, and culturally relevant learning environments" (p. 397). The researchers grounded their program in sociotransformative constructivism as their theoretical framework. They aimed to create and study an intervention focused on three guiding concepts for their teacher training program. Those concepts included being responsive and theoretically explicit, providing ongoing and on-site support, and introducing reflexive approaches to collaboration. While the entire intervention was created as a 3-year long professional development (PD) project, this specific article reports on year-one findings. The project was conducted by trained university professors and with a local school district in the Southwest of the United States. Twenty teachers from the participating district were selected from a pool of educators because they taught 4th through 6th-grade students in mathematics and science with a primarily Latino/Latina student population. The participants included nine Latinas, one Latino, one African American female, and nine Anglo female teachers, and three student teachers (race/ethnic and gender not reported) (Zozakiewicz & Rodriguez, 2007). This qualitative study included three interviews from each of the 20 educators, after a 2-week summer institute training program, and again as a follow up at the end of the fall semester and at the end of the school year. The training program was designed in collaboration with the participants and was "focused on meeting their academic and professional needs" (Zozakiewicz & Rodriguez, 2007, p. 405). Week one of the summer institute was focused on the integration of general science and learning technologies and the second week was focused more deliberately on integrating specific science, mathematics, engineering, and learning technologies into the educators' curriculums. Beyond the summer institutes, the Maxima teachers participated in monthly meetings designed specifically to discuss their progress and concerns with their new curriculum. Additionally, each year, one of these monthly meetings was reserved as a day-long workshop to cover content requested by the participating teachers in order to address their specific instructional needs. A focus group was held for the students of participating teachers at the beginning and end of the school year. Artifacts were also collected, and they included materials such as ongoing surveys, transcripts, videos, and researchers' field notes. Researchers conducted an ethnographic approach to data analysis and concluded that data from the first year of the program yielded positive results (Zozakiewicz & Rodriguez, 2007). They reported that teachers were responding positively to the training and were already changing their practices to support student engagement and learning.

Intervention Addressing the Role of Influential Community Adults as Academic Advisors

As the needs assessment showed, WRS's high school students interact with and consult numerous the influential community adults (teachers, academic advisors, deans, counselors) as they contemplate and make enrollment decisions. These adults include their academic advisors, teachers, grade-level deans, and other community members within the administrative team. While students are formally assigned academic advisors at the start of high school, many adults can influence the students' decisions around STEM elective course enrollment and potentially their STEM identities and feelings of STEM-belonging (Sutton & Sankar, 2011). As the research shows, even the most well-intentioned people can exhibit behaviors based on implicit biases (Staats, 2015; Whitford & Emerson, 2018). It is crucial to understand how these community adults' own implicit biases might specifically impact the students' STEM enrollment decisions.

Professional Development for Academic Advisors, Deans, Teachers, and College Counselors

In an effort to support both the influential community adults and the students, professional development programs exist that can help reveal implicit biases around gender and teach participants how to mitigate the adverse effects of those biases on their students. Towery (2007) points out how critical relationships are between teachers and students. She also states that it is in those relationships where teachers can become vital allies in a school's effort to achieve gender equity in the classrooms and the community at large. Towery (2007) analyzed data collected from a three-year, in-service professional development program focused on raising teachers' awareness of and response to the gender inequities in their schools. The in-service program was implemented in two Boston-area high schools and included 71 teachers, both male and female. This study was conducted as a process evaluation of the implementation of the Gender Equity in Model Sites (GEMS) initiative (McIntosh, 2004-2005) of the Seeking Educational Equity and Diversity (SEED) Project (The National SEED Project, n. d.). The GEMS initiative portion of this 3-year long professional development program intended to change school culture around gender to create a more equitable community culture embedded in the curriculum, school climate, and microclimates (McIntosh, 2004-2005). The GEMS program included monthly, on campus, 3-hour PD seminars for teachers, staff, and parents/guardians. Professional development for each session was determined to be site-specific based on the communities needs and included specific GEMS programming such as videos, trips, speakers, gender-based activities, all facilitated by SEED-trained leaders. In this self-described mixed methods study, the author only presented her qualitative data. The biggest limitation of the study includes that the data are limited to one U.S. city and from just two high schools and no quantitative data were collected even though 71 teachers participated in the study. The author also states that the goal of the study was to understand teacher perspective and “not seek to demonstrate actual or observable changes in behavior” (Towery, 2007, p. 7). She conducted one-on-one, semi-structured interviews with 36 teachers post-intervention, which lasted approximately 60 minutes. The research aimed to assess the teachers' awareness of and responses to gender inequities after participating in the professional development program. Towery (2007) found the program to be quite successful and reported that teachers who completed the PD had made significant progress in their thinking around gender inequities but also struggled with how to deal with their own gender biases and that of their school.

In order to develop any successful professional development program, one must identify all key components of the potential program. For example, the creation of a professional development program that allows the school's influential advisors and teachers to identify their own implicit biases is just the start to a successful intervention around addressing implicit bias. Ramsey et al. (2013) used a case survey method to assess 170 professional development programs' successes and weaknesses focused on gender equity in schools. These empirical studies included both quantitative- and qualitative-focused research studies. Ramsey et al. (2013) selected studies that included research on various PD's effect on girls' achievement to ethnographic papers focused on both school and community interventions. Their coding scheme focused on the development of common themes across the various PD studies. Themes that emerged from the comparisons included the PD content, how projects were implemented, student-specific activities, and the sustainability of the implementations themselves (Ramsey et al., 2013). They found that professional development programs that included all four themes were twice as likely to center gender equity issues and creating more welcoming environments in teachers' classrooms rather than merely increasing teacher awareness of equity issues and three times as likely to engage students in classroom equity practices (Ramsey et al., 2013). Finally, they suggest implementing multicultural education as a starting place to develop successful PD programs aimed at gender equity in order to capture a broader perspective of self. The authors highlighted the portion of their intervention that participants found to be self-relevant. They noted that it allowed the PD “message to sink in more deeply” (Ramsey et al., 2013, p. 392). Additionally, they encouraged any future interventions that mirror this work to activate participants' sense of self, specifically those STEM experiences of their own that relate to female STEM role models and peers. Ramsey et al. (2013) recognize that their findings were testing for the short-term effects of the intervention and acknowledge that without testing for long-term effects, they do not have the entire picture of the intervention's impact and, potential, long-lasting changes for the participants.

The second study followed a gender awareness professional development program in rural Pakistan. Halai (2011) conducted 12 PD workshops that focused specifically on mathematical tasks, engagement of mathematical learners, and finally, emerging issues related to gender differences in problem-solving. The program had two primary goals: improving teachers' mathematical pedagogy and raising gender awareness among high school mathematics teachers. Halai (2011) concluded that after the professional development training, and despite the overall community's desire to increase gender equality in the classrooms, teacher appeared to be unmoved or even more conservative in their attitudes. They found that these teachers treated their students unequally in their mathematics classrooms. In addition, their lowered expectations of the girls affected the female students' confidence and self-image as successful mathematics students. Thus, she reported that this particular professional development program showed no evidence that teachers experienced a shift in their gender perspectives and concluded that there must be more significant social and cultural issues influencing their resistance to the program. The author was very explicit when explaining that while the professional development program was well research and implemented, the broader societal context of the rural Pakistani community created a paradoxical situation. They stated that where "parents and community value education beyond primary school for girls" the "teachers, head teachers and the district education officials believe that equality in access to schools for boys and girls was equivalent to gender equity" (Halai, 2011, p. 48). The author also stated that the teachers and educational system believed firmly that by allowing female students to participate in education beyond the primary school years was 'good enough' and that the potential for the PD to raise gender awareness could not solely be guaranteed without considering "the broader social and cultural context of the teachers' lives so that those underlying generative features which impede change…become central with potential for a fuller realization of the goals of gender equity as an integral element of social justice in education quality" (Halai, 2011, p. 49).

The training of academic advisors to work closely with students as they make enrollment decisions is one potential intervention that could positively affect WRS students directly. Both Gordon (2019) and Lee (2018) stress the need to train these academic advisors at the university level as critical for the support of all students. Gordon (2019) has been discussing ongoing advisor training since 1984, additionally stating it is imperative as student demographics change as well as curricular opportunities of individual universities. Beyond simply having discussions with students about choices of study and course enrollment, Gordon (2019) states that academic advisors are a source of support as students consider their immediate academic choices but also their future goals and potential career paths. Lee (2018) adds that academic advisor training needs to include the use and implementation of uses critical race theory in order for advisors to be actively aware of and "maintain a consciousness of the ways race and racism influence not only the experiences of students of color but also their relationships with academic professionals" (p. 77). Considering that WRS has an increasingly diverse student population in both gender and race/ethnicity, advisors who have profession development focused on anti-bias strategies related to gender, race/ethnicity, and their intersectionality, could be better suited to support students' short and long term academic goals, as described by Gordon (2019).

STEM-Specific Training for Academic Advisors and Educators

While researchers have been able to uncover many potential contributing factors to women's attrition from the proverbial STEM pipeline, a surprisingly low number of empirical studies have been done on existing professional development programs that are aimed at addressing these specific factors. Moss-Racusin et al. (2014) conducted an extensive literature review, and they found zero double-blind, randomized controlled trials of interventions targeting gender bias in STEM. Sithole et al. (2017) took a narrative literature review approach to investigate the factors that students face as they attempt to navigate their STEM educational journeys. They point to institutional, personal, and other factors as essential areas for female students' intervention and support. They suggest that institutional factors such as academic advising as being a "pivotal process for a student's education and career" (Sithole et al., 2017, p. 49). One intervention strategy they recommend is professional development and support for STEM educators. Battey et al. (2007) suggest that while there are numerous professional development programs for educators, there has been very little attention given to programs that address gender equity in STEM education specifically. In a review of 170 professional development projects, they state that most programs lack the critical elements needed to promote and implement gender equity in science classrooms (Battey et al., 2007).

While few empirical studies explicitly focused on addressing gender equity in STEM classrooms, others have suggested key elements to be considered when designing such programs. Killpack and Melón (2016) recommend educators must be allowed to engage in meaningful professional development and personal reflections to support their students fully and that particular attention is paid to the role those individual educators play in supporting girls in science. They point out the consistent, daily interactions STEM educators have with their students give those educators the opportunities and responsibilities to support and retain a diverse student group in the sciences. Killpack and Melón (2016) state that PD programs must be designed to ensure that educators are aware of the privilege gap between themselves and their students, acknowledge and confront their own implicit biases, and do whatever was necessary to mitigate stereotype threats in their classrooms. One way Killpack and Melón (2016) suggest educators become more aware of their privileges is to consider the intersectional nature of both our and our students' identities. Including Crenshaw's (1991) definition of intersectional and beyond, this awareness can help us to see the connection between a person's privilege and their feeling of sense of belonging and, potentially, their persistence in STEM. Killpack and Melón (2016) recommend gather data about their students (i.e., in survey form) to learn more about any structural barriers or situations that could impede their ability to learn and perform to the best of their abilities in the classroom. They urge STEM professors to include the important, but often overlooked contributions of underrepresented STEM individuals or groups. With regard to implicit biases, Killpack and Melón (2016) recommend that PD programs include implicit bias tests, such as IATs, followed up with lessons on how to "use personal cognitive practices, such as actively identifying and negating stereotypical thought, affirming counter-stereotypes, or priming our minds to think differently and creatively in the face of stereotypes, to reduce our negative unconscious evaluations of people belonging to stereotyped groups" (p. 5). In an effort to mitigate stereotype threats, teachers can provide students opportunities for self-affirmation, such as alternative assessments. Finally, Killpack and Melón (2016) urge educators to embrace a growth mind-set for both themselves and their students with respect to intelligence and STEM ability.

As previously mentioned, interventions that address STEM educators' implicit biases are the first step of any successful program. Ideally, though, professional development programs that present ways for educators to change those biases and mitigate their effects on girls in STEM education should be the ultimate goal. Carnes et al. (2012) presented an intervention specifically designed to address implicit bias around gender equity in university-level STEM educators. The researchers held two separate 2.5-hour Bias Literacy Workshop programs with 180 STEM faculty at two different midwestern universities. The Bias Literacy Workshop components were designed around four main outcome goals for participants, 1) awareness of implicit bias and a motivation to act to change negative behaviors associated with those biases, 2) increasing self-efficacy with the ability to use anti-bias behaviors, 3) being able to envision a link between the actions one has and their desired outcomes, and finally, 4) a deliberate practice and commitment to improve gender equity in their academic departments and personal lives (Carnes et al., 2012). The Bias Literacy Workshop had multiple components including participants completing Harvard's IATs for gender and leadership, engaging gender-focused case studies, facilitator-led presentations on effective and ineffective de-biasing techniques, and, finally, participants writing a commitment to continue their own efforts to improve gender equity, at the university and in their lives. Follow-up interviews were conducted with 12 male and 12 female participants four to six months post-intervention. Carnes et al. (2012) found that most participants reported feeling that the program was "very useful" for their continued work in STEM educational settings. Additionally, 68% indicated they now had increased knowledge of the workshop's content, 87% felt they received workshop materials they intended to use for their personal growth, and 75% demonstrated that they were now aware of their own biases and were able to articulate plans to change their behaviors because of the training (Carnes et al., 2012).

Additional research includes descriptions of continued success with professional development programs that target the educators' personal biases first and then follow up with specific action plans to help individuals mitigate negative behaviors associated with those biases. Moss-Racusin et al. (2016) investigated a particular type of professional development workshop entitled 'Scientific Diversity.' They utilized several sessions of the National Academies Summer Institute for Undergraduate Education meetings to conduct this 120-minute intervention. They selected 126 white male and white female life science educators. They purposefully chose white educators because they were concerned that Black, Indigenous and People of Color (BIPOC) participants might minimize the results of the white professors' implicit bias tests. This is an important point to note, as the results of this study are all based on the fact that all participants are white, life science educators, which makes the findings more challenging to generalize to the broader STEM community and beyond. The Scientific Diversity workshop was designed to take a scientific approach to a diversity intervention. When the authors stated that the workshop was designed to take a scientific approach, they meant it was designed using peer-reviewed, evidence-based strategies with the specific intention of improving "STEM faculty's awareness of diversity issues, gender bias, and readiness to take action on diversity issues (Moss-Racusin et al., 2016, p. 3). The researchers insisted that successful gender-bias interventions must have the following essential design elements. Interventions must be based on theory and empirical evidence. The approach fostered active learning by the participants, and the solutions must be presented as a shared goal and responsibility of both individuals and groups, finally that there will be a rigorous evaluation of the intervention to test its efficacy (Moss-Racusin et al., 2016). Participants were given pre-intervention and post-intervention questionnaires, both two weeks prior and two weeks post-workshop. Moss-Racusin et al. (2016) found that after attending the

Scientific Diversity workshop, participants reported more awareness of their own biases, that they were expressing less gender bias after the PD, and that they were more willing and eager to engage in behaviors that helped them to reduce their own gender biases.

Some gender-biases and STEM-specific professional development programs have demonstrated how bias awareness encourage potentially longer-term impacts. One issue of potential concern is providing quality PD material to achieve both immediate and long-term changes for these influential community adults. Moss-Racusin et al. (2018) took what they learned from the aforementioned successful workshop and developed an easily accessible and free intervention program entitled Video Interventions for Diversity in STEM (VIDS). The VIDS professional development intervention was created by an interdisciplinary group of STEM researchers and filmmakers. They made two sets of videos, narratives, and expert interviews. The two distinct video styles were used in this intervention and focused on the compelling stories of personal narratives and the straightforward facts of interviews. They also created a third option, which was simply a combination of the two formats. The study's goal was to scale up this type of intervention and test its ability to target STEM gender bias with multiple audiences. Specifically, Moss-Racusin et al. (2018) wanted to determine if the use of VIDS could reduce personal gender bias, increase overall gender bias awareness, improve attitudes about girls and women in STEM, and promote behaviors that support movement towards gender parity in STEM education. Both versions of VIDS include six five-minute videos that cover the same information. Moss-Racusin et al. (2018) recruited 450 adult participants (ages 18-68) through the crowdsourcing site Mechanical Turk to take one of five experimental professional development VIDS courses. They included narrative only, interview only, hybrid, video control, or intervention control. Utilizing pre-intervention and post-intervention surveys, the authors found that the VIDS intervention (interview, narrative, and hybrid videos) was able to successfully reduce participants' own gender bias, increase overall gender bias awareness and positive attitudes about women in STEM, and confirm participants' intentions to engage in behaviors that will promote gender parity in STEM in their own contexts.

Professional development that focuses on gender bias training has shown that it effectively increases participants' gender bias awareness. However, there are some concerns about a potential yet unintended effect of gender bias training, leading to people thinking that implicit bias is immutable (Hennes et al., 2018). In an attempt to test the VIDS intervention strategy (Moss-Racusin et al., 2018) and show participants that implicit bias can be changed, Hennes et al. (2018) added a program entitled UNITE to the VIDS intervention. The UNITE module was added by Hennes et al. (2018) to the VIDS intervention program in direct response to concern that the program might harm self-efficacy by creating a fixed mindset that implicit biases are stable and, therefore cannot be changed. The UNITE module adds empirical information for intervention participants about gender bias in work environments. The UNITE module "provides specific detailed scientific and anecdotal evidence, based on mindset theory, that gender bias is not fixed, culminating in a step-by step guide for promoting gender equity using empirically based strategies" (Hennes et al., 2018, p. 791). The acronym UNITE stands for the strategies the module promotes: "Underscore effective diversity training, Notice and correct for your implicit biases, Include inclusive pictures and language, Take time to mentor your fellow employees, Emphasize that employees can and will improve" (Hennes et al., 2018, p. 792). Using the VIDS intervention combined with the UNITE module, two separate experiments were run. Experiment one included 343 individuals (ages 20-70) recruited from the crowdsourcing site Mechanical Turk. Participants viewed the hybrid PD videos from the VIDS strategy. They followed up the video sessions with the UNITE presentation. The second experiment mirrored the first with the exception of the participants. The researchers specifically recruited science faculty. These participants included 149 male and female STEM educators (68% women) who completed the same program, the VIDS and UNITE presentations. Hennes et al. (2018) replicated the Moss-Racusin et al. (2018) VIDS program findings. The program improved the awareness of gender bias and appeared to reduce sexism in the workplace. For experiment one, Hennes et al. (2018) reported that the UNITE presentation had no discernible evidence that it improved the VIDS program's effectiveness for general public participants. Interestingly, the second experiment, the combination of the VIDS and UNITE programs, appeared to be the most successful for improving overall gender-specific attitudes and a willingness to reduce the harmful effects of gender bias for the STEM faculty.

The support of female students pursuing STEM educational pathways is not simply limited to classroom teachers and university professors. Academic advisors fill a critical role in the support of STEM-promising girls and women. Clark et al. (2016) conducted research to highlight the important role academic advisors play in the persistence of female STEM graduate students. They choose this population specifically as it represents yet another point of attrition, the graduate level, for females from the STEM pipeline, one where they believe students are making decisions about their future careers. This study represented the potential success for interventions that target academic advisors as they can act as important buffers against the attrition of women from the STEM pipeline. The study included a subset of data collected from a larger longitudinal study of STEM graduate students. Participants included 332 racially diverse, male and female doctoral students, all U. S. citizens, pursuing degrees in both social sciences and STEM disciplines. Quantitative data were collected via online student surveys to measure the students' perceived advisor support, their gender-STEM identity, their perception of STEM importance, STEM self-efficacies, and their sense of belonging. Clark et al. (2016) found that female graduate students who perceived support from their academic advisors predicted higher levels of gender-STEM identity for female graduate students only, while males' gender-STEM identity remained unchanged. Additionally, higher levels of gender-STEM identity predicted a greater perception of the importance of STEM for females but not males. Finally, higher STEM importance was shown to predict greater levels of STEM self-efficacy again for female students, but not males. The researchers found that the indication of STEM importance predicted a higher sense of belonging for both female and male graduate students. While the findings indicate the predictability of perceived advisor support on important factors for the persistence of females in STEM, such as STEM-identity and STEM self-efficacy, the finders were limited because the use of quantitative-only survey tools did not allow for the incorporation of participants' voice.

STEM-specific academic support and programming have the ability to increase STEM self-identity and self-efficacy in female students (Clark et al., 2016). While research suggests that the demand for a well-trained, diverse STEM workforce is only increasing, one cannot ignore the long road ahead for increasing diversity in STEM fields and the need to investigate the intersectionality of gender, race/ethnicity and STEM persistence (Fry et al., 2021). Coleman (2020) conducted a study that focused on using the motivations of Black and Latinx students to drive the creation of an intervention program dubbed the D-STEM Equity Model in order to support and encourage the diversification of the STEM education to career pipeline. The actionable portions of the D-STEM Equity Model educators can play a very active role in fall under the category of STEM motivation. The study lays out a five-step approach to increasing diversity in STEM, specifically the representation of Black and Latinx students. Those steps include early STEM exposure (starting as soon as pre-kindergarten), upgrading course curriculum to be culturally responsive, having regular conversations on race in an effort to break negative stigmas and for Black and Latinx students to become role models for others, to create personalized assessments and evaluations for Black and Latinx students and instill a growth mindset around STEM education, and finally create opportunities for STEM leadership development for Black and Latinx students. The first portion of the study collected qualitative data from students directly. Coleman (2020) gathered participant stories related to the intersection of race and STEM experiences in small group discussions from 281 Black and Latinx students. The researcher reported that the themes most important to the creation of the D-STEM Model came from those student-centered focus group discussions. Students shared motivating factors such as an obligation to their respective racial community to break negative stigmas and counter societal stereotypes, recognition that STEM education can lead to careers in STEM as a progressive field, real-life applications, tackle the world's biggest problems, and finally, real enjoyment of STEM subjects. The incorporation of student voice into the creation of the D-STEM Model is innovative and truly reflects the motivations of the student participants. Research is currently ongoing based on this current publication (Coleman, 2020).

Many researchers emphasize the need to collect the perspective and voices of underrepresented students in STEM fields prior to creating intervention programs and professional development training (Coleman, 2020; Comeaux et al., 2017). Comeaux et al. (2017) conducted a qualitative study of NCAA Division-I athlete STEM graduates and their undergraduate experiences with university adults, including academic advisors, their peers, including other athletes, STEM and non-STEM faculty, and coaches. Comeaux et al. (2017) conducted in-depth semi-structured interviews with 17 former Division I athletes (6 female and

11 male; 13 Black, 2 White, and 2 Latino) who all graduated with STEM-specific undergraduate degrees. The researchers asked questions around the topics of students' goals, their frequency and quality of STEM-related activities they participated in, their experiences as it related to their STEM persistence, and finally, their experiences with various university community members. Researchers found four major themes across the interviews. Those themes included female aggression in STEM versus male acceptance. Female students felt, in order to gain respect from professors and peers, they needed to be more aggressive and assertive in STEM classrooms, while males felt generally more accepted as STEM majors. Both male and female student-athletes commented that professors were shocked and surprised at their high academic performance, especially for males. Additionally, both males and females stated they often participated in perpetuating stereotypes that negatively affected other student-athletes even though they were aware of the harm it could inflict. Finally, while they were not asked directly by the interviewers, some of the participants noted that their racial identities played a role in their perceived experiences on campus as STEM-majoring student-athletes. Comeaux et al. (2017) utilized member-checking as a tool to ensure the trustworthiness of the qualitative data collected.

Summary of Intervention Literature

This literature review introduced interventions focused on implicit bias in STEM education and the role influential community adults have as academic advisors for high school students. Before gender bias mitigating interventions are introduced into West Regional School, influential adults must identify their own biases, especially those related to gender stereotypes in STEM education and STEM careers. The use of implicit bias tests such as the Implicit Association Test (Greenwald et al., 1998) and Implicit Relational Assessment Procedure test (Barnes-Holmes et al., 2006) are useful, quick, and easy tools that collect information from intervention participants before and after gender bias focused professional development programs.

Once influential community adults have an awareness of their own implicit biases, other professional development programs can show participants how they can work to change their biases, moderate their behaviors so the biases do not harm interactions with students, improve their attitudes around gender stereotyping in STEM, and encourage behaviors to mitigate or eliminate gender bias in advising conversation and in the classrooms. Professional development intervention programs such as the Scientific Diversity workshops (Moss-Racusin et al., 2016), VIDS programs (Moss-Racusin et al., 2018), and UNITE training (Hennes et al., 2018) have the potential to accomplish long-lasting changes for these influential adults, both personally and? for their school communities. Subsequent revisions of this intervention literature review will investigate programming and interventions that address female students' STEM identities and their sense of STEM belonging. These three factors, implicit bias, the role of influential community adults, and female students' STEM identities and sense of STEM belonging, are critical and accessible entry points for starting to increase gender parity in the enrollment of STEM electives at WRS.

Proposed Intervention at West Regional School

The data collected during the needs assessment along with the literature review revealed a few promising interventions. The most promising of proposed interventions includes a professional development program that WRS targets at influential community adults, including teachers, academic advisors, deans, counselors, *etc.*. The proposed intervention includes eight 90-minute sessions of professional development (PD), both synchronous and asynchronous programming. This program will include specific programming that covers three distinct areas of implicit bias: gender, race, and the intersectionality of the two.

In the first phase of the PD program (synchronous session 1), STEM educators and academic advisors will be introduced to the concept of implicit bias in general. They will complete a short pre-test survey focused on prior knowledge related specifically to implicit bias (e.g., gender, race, and intersectionality). They will participate in an Implicit Association Test (IAT) utilizing the sensorimotor tracking method described by Smeding et al. (2016). Data collected in this manner has the ability to reveal extremely subtle implicit biases over the simplified binary choice that using keyboards can give (Smeding et al., 2016). Additionally, prior to the IATs and following their completion during the first phase and throughout the entire intervention, participants will be completing reflective journal entries (LaBelle & Belknap, 2016). These journals will provide substantial qualitative data for both the process and outcome evaluations of the study.

The second phase of the PD training program (synchronous sessions 2-3) will include various activities focused on increasing the participants' awareness of the effect their implicit biases (gender, race, and, finally, their intersectionality) has on students, especially female and racially/ethnically diverse students. For example, following the initial IAT test session, academic advisors and STEM teachers will participate in the 30-minute VIDS program (Moss-Racusin et al., 2018), followed by the UNITE presentation (Hennes et al., 2018). Other intervention materials will be focused on gender bias, racial bias, and the intersectionality of gender and bias. Subsequent revisions of this chapter will include specific details of those intervention activities.

Finally, the final phase will be conducted during the final PD session (synchronous session 4). Participants will take another IAT test to determine if implicit biases have changed due to the intervention. They will complete their reflective journals and take a short post-test survey. Finally, in an effort to capture participant voice and conduct a truly mixed methods evaluation, participants will be asked to engage in a post-intervention focus group to determine their experiences with the intervention program.

The ultimate proximal goals of this intervention study are 1) an increased identification of participants' own implicit biases, 2) increase participants' awareness of the effect implicit biases have on female and racially/ethnically diverse students in academic-based and classroom-based conversations, 3) increase participants' self-efficacy as it pertains to the academic advising of female students of all racial backgrounds, and finally a 4) creation of personalized process plans for participants that helps them to align their explicit attitudes with their behaviors to reduce or mitigate their implicit biases. The distal goal of this dissertation work is to increase the potential for gender and racial/ethnic parity in the enrollment of STEM elective courses at WRS.

Chapter 4

Intervention Procedure and Program Evaluation Methodology

Introduction

The intervention literature review suggests that even fully-trained academic advisors have implicit biases that could be harming and discouraging female and underrepresented students of color from choosing to enroll in STEM elective courses (Jackson et al., 2014). Interventions that are focused on implicit bias identification only often fail to bring about lasting change in adults (FitzGerald et al., 2019). The use of implicit bias identification paired with specific professional development programs focused on mitigating the negative effect of those biases have been found to be considerably more effective (Batchelor et al., 2019; Glock & Kovacs, 2013; Moss-Racusin et al., 2018). The intervention addressed advisor and teacher training related directly to uncovering any implicit biases they might have and learn how those biases may affect how they engage with students as they consider enrollment in STEM electives. Ultimately, the intervention had two goals. One, that it provided the opportunity for participants to identify their implicit biases around gender and race/ethnicity, as they are associated with science, using Implicit Association Tests (Project Implicit, n. d.). Second, it would allow participants to see how those biases affect underrepresented students in relation to academic advising, and, hopefully, to increase the alignment of their explicit attitudes and behaviors to reduce or mitigate negative effects. This intervention was evaluated by following research questions. The first two questions are focused on the process of the intervention, while the last three questions are focused on the outcomes of the intervention.

Research Question 1. How did the participants complete the activities presented in the implicit bias professional development (PD) program?

Research Question 2. How did the participants engage with the activities in the implicit bias PD program?

Research Question 3. How did participation in the implicit bias PD program impact participants' awareness of their own implicit biases toward the influence of gender in science performance?

Research Question 4. How did participation in the implicit bias PD program impact participants' awareness of their own implicit biases toward the influence of race/ethnicity in science performance?

Research Question 5. How did participation in the implicit bias PD program impact the participants' self-efficacy as it relates to the academic advising of their students?

A theory of treatment (Figure 4.1) was developed for this intervention program to investigate these specific research questions. Research has shown that the unexamined biases of influential adults in academic settings may have negative effects on the retention and persistence of diverse students in STEM education (Killpack & Melón, 2016). Students interact daily with various influential adults at WRS including academic advisors and STEM teachers. It stands to reason that advisors and STEM faculty should have both the opportunity and commitment to identify their own implicit biases for the sake of their students (Staats, 2016). In addition, those educators should engage in professional development that helps them learn how to align their explicit attitudes around gender and race/ethnicity with the mitigation or reduction of any identified implicit biases (Staats, 2016). As Figure 4.1 shows, the intervention directly targeted these influential community adults while indirectly supporting all students, and especially STEM-promising female and underrepresented students of color (Killpack & Melón, 2016).

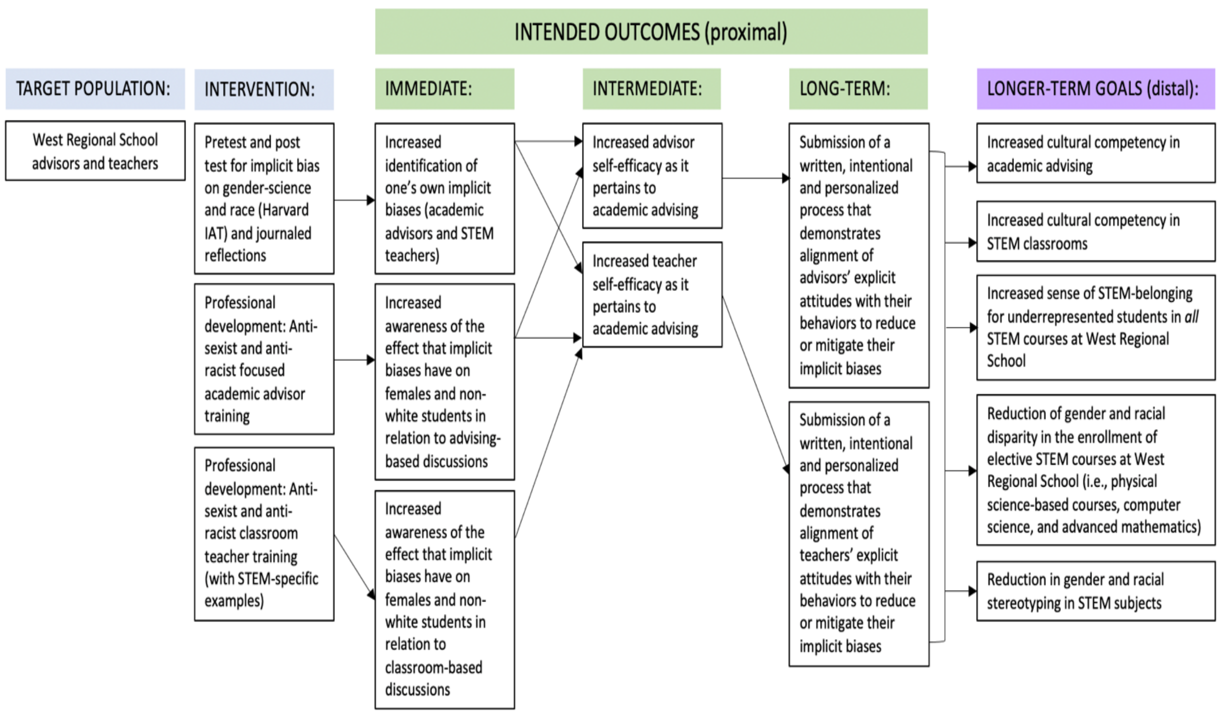
The theory of treatment model (Figure 4.1) shows the Harvard's Implicit Association Tests specifically for "race" and "gender-science" was administered to the participants' pre- and post-professional development (PD) sessions (Greenwald et al., 1998; Project Implicit, n. d.). Research has found that people have the ability to change their implicit biases over time once they are aware of them (Charlesworth & Banaji, 2019). Figure 4.1 also shows the professional development interventions included gender- and racial/ethnic-specific implicit bias awareness program activities with the introduction of context-specific mitigation strategies (Moss-Racusin et al., 2018; Sparks, 2020). The PD for academic advisors also included gender and racial/ethnic-specific sessions (Gordon, 2019; McDonald, 2019) while the PD for STEM teachers also included specific training as it relates to in-class instruction (Moss-Racusin et al., 2016; Moss-Racusin et al., 2018; Sparks, 2020).

The intervention had several intended, proximal outcomes. These outcomes were measured and evaluated in stages following the interventions themselves. Figure 4.1 shows the immediate outcome was the result of intervention participants' IAT test results. Once these tests were completed, the results had the potential to provide awareness of the academic advisors' and STEM teachers' own implicit biases related to race/ethnicity and gender (Charlesworth & Banaji, 2019). The intermediate outcomes of increasing the adults' awareness of the effect of those implicit biases when advising and teaching female and underrepresented students of color along with an increase in personal self-efficacy as it relates to academic advising was measured through reflective journals collected throughout the PD sessions and a focus group that followed the conclusion of the PD program (Killpack & Melón, 2016). Finally, the long-term outcomes included the alignment of participants' explicit attitudes on gender and race/ethnicity to their classroom behavior while also being aware of the need to reduce or mitigate their implicit biases

(Harrison-Bernard et al., 2020). Finally, a longer-term goal, not addressed in this intervention study, would be the reduction of gender and racial stereotyping in STEM course materials through the use of increased cultural competency and curricular changes that reflect a more diverse representation of scientists (Killpack & Melón, 2016; Moss-Racusin et al., 2016; Reinking & Martin, 2018).

Figure 4.1

Theory of Treatment



Research Design

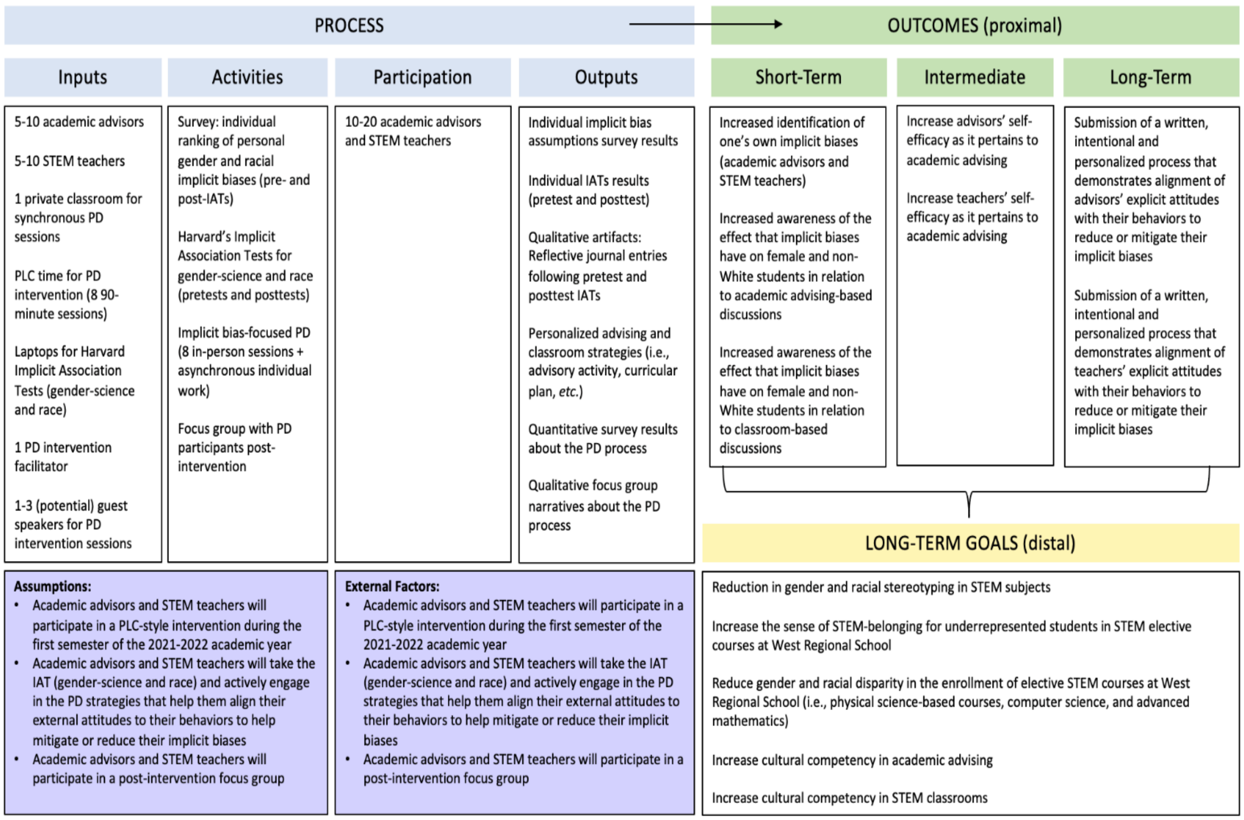
Much like medical conditions, contemporary educational problems are complex and often lack obvious or simple solutions. Researchers often choose mixed methods approaches because their contemporary problems "do not fit neatly in a purely qualitative or purely quantitative methodology" (Lochmiller & Lester, 2017, p. 212). The use of the mixed methods research paradigm is ideal for investigating educational problems when solutions are expected to be comprehensive, efficient, and affordable. The researcher's intervention used a quasi-experimental design to address the complex problem facing many educational institutions, the role that faculty's implicit biases have on the enrollment of underrepresented students into elective STEM courses. Simply using a singular evaluation method of the intervention outcomes could cause the researcher to misinterpret the results (Creswell & Plano Clark, 2018; Johnson & Onwuegbuzie, 2004). Using both quantitative and qualitative data will provide a more comprehensive evaluation of the professional development intervention program.

This evaluation used a quasi-experimental, mixed methods research design (Creswell & Plano Clark, 2018; Onwuegbuzie & Leech, 2006). The overall approach to the convergent parallel design was equal parts quantitative and qualitative data (QUAN+QUAL) collected concurrently (Creswell & Plano Clark, 2018; Tashakkori & Teddlie, 2003). Additionally, some portions of the study incorporated an explanatory sequential design (QUAN→qual), specifically as it related to the focus group data outlined in the outcome data collection matrix (Table 4.2). Tashakkori and Teddlie (2003) formally linked pragmatism and mixed methods research designs, stating that the research questions are of the utmost importance above either method. This mixed methods approach mirrored the pragmatic paradigm, which emphasizes using the methods and processes best suited to answer each research question.

The logic model (Figure 4.2) outlined both the process of the intervention and the expected outcomes. The process includes the inputs, activities, participants, and outputs to be collected for analysis. The intervention was an implicit bias professional development (PD) program for academic advisors and teachers at WRS. The PD program included eight 90-minute sessions focused on defining and identifying implicit biases of gender and race/ethnicity and introducing methods to mitigate the negative effects of those biases. Four sessions were conducted synchronously and four sessions were conducted asynchronously. The outcomes described include short-term, intermediate, and long-term. The short-term outcomes were focused on increasing the awareness of the participants' implicit biases and the potential effects those biases can have on students, in advising conversations and in the classroom. The intermediate outcomes included increasing advisor and teacher self-efficacy as it pertained to the academic advising of their students. Finally, long-term outcomes included a written, intentional and personalized process plan for each participant that demonstrated an alignment of their explicit attitudes with their behaviors to reduce or mitigate their implicit biases around gender and race/ethnicity. While this logic model includes longer-term goals, they were distal to this specific intervention and represent the ultimate, albeit it distal, desired results.

Figure 4.2

Logic Model



Process Evaluation

Process evaluations allow researchers to focus on the implementation of proposed interventions rather than outcomes alone. By evaluating various aspects of implementation fidelity, evaluators can make logical connections between program inputs and activities to outputs and, eventually, program outcomes (Baranowski & Stables, 2000). This type of evaluation allows researchers to investigate the internal components of an intervention and draw logical conclusions about their role in the success or failure of a program (Baranowski & Stables, 2000; Zhang et al., 2011). Stufflebeam's (2003) Context, Input, Process, Product (CIPP) Evaluation Model provides a framework for process evaluations. This model, and improvement science in general, are grounded in the concept of learning-by-doing (Stufflebeam, 2003; Zhang et al., 2011). By focusing on the core concepts of context, input, process, and product evaluation (CIPP), evaluators can measure an intervention's implementation fidelity. While many aspects of program implementation can be measured, this study focused specifically on the three aspects captured by the aforementioned process evaluation questions: reach, use, and exposure. Additionally, the process evaluation was conducted using a mixed methods approach to ensure increased validity through quantitative data collection, as well as qualitative data, in the form of participant voice (Johnson & Onwuegbuzie, 2004). The process evaluation was focused on research questions one and two and is laid out in Table 4.1.

Table 4.1

Process Evaluation Indicator Matrix

Process evaluation question	Process evaluation indicator(s)	Measurement	Data source(s)	Data collection tool	Data analysis	Frequency
RQ1: How did the participants complete the activities presented in the implicit bias PD program?	Reach (Baranowski & Stables, 2000): Number of intervention PD participants	Total number of academic advisors and/or STEM teachers who registered for and participated in intervention PD sessions	PD participants (academic advisors and STEM teachers)	Attendance records for the intervention PD sessions indicating school role (e.g., advisor and/or STEM teacher)	Descriptive statistics for the advisors and/or teachers in the intervention PD groups	Measured at each of the four synchronous intervention PD sessions
RQ1: How did the participants complete the activities presented in the implicit bias PD program?	Use (Baranowski & Stables, 2000): Intervention PD session activities	Total number of pre- and post-intervention Implicit Association Tests (IATs) completed, surveys completed, and personal, reflective journals submitted	PD participants (academic advisors and STEM teachers)	Harvard IATs PD participants' surveys PD participants' personal, reflective journals	Descriptive statistics for IAT tests and multiple-choice survey data; qualitative coding and themes for personal reflective journal entries	IAT tests will be conducted twice: during the first and last intervention PD sessions Short surveys will be conducted four times following each synchronous intervention PD sessions Personal, reflective journals will be submitted throughout the PD sessions after the completion of the gender-focused session (session 2), race/ethnicity session (session 3), and intersectionality session (session 4)
RQ2: How did the participants engage with the activities in the implicit bias PD program?	Exposure (Baranowski & Stables, 2000): Engagement with presented intervention PD materials	Surveys following the intervention PD sessions focused on engagement with presented materials Completion of a written, personalized process plan Participant focus group	PD participants (academic advisors and STEM teachers)	PD participants' survey results PD participants' written, personalized process plans Post-intervention focus group with PD participants	Inferential statistics for quantitative, multiple-choice survey questions; qualitative coding and themes for open-ended survey questions and post-intervention focus group	Surveys given after each synchronous intervention PD sessions 1-4 (four in total) Participants will submit one personalized process plan for either their advisory programs or their STEM classrooms Participant focus group to be conducted following the culmination of the intervention PD sessions

Outcome Evaluation

The researcher has outlined the role the mixed methods paradigm that was used in the outcome data collection (see Table 4.2) along with the interrupted time-series design where the treated group served as its own comparison group (Henry, 2010). In order to implement this longitudinal design, pre-intervention and post-interventions measures were used when evaluating all three outcome-focused questions. Research question one is more quantitative-leading with qualitative components (QUAN+qual), where results converged during analysis (Creswell & Plano Clark, 2018). Research question two is quantitative-leading but reflects the explanatory sequential design as quantitative data were collected first with the qualitative component of a focus group that followed the intervention and helped explain the quantitative data (QUAN→qual; Creswell & Plano Clark, 2018). Research questions three, four, and five are qualitative-leading with supportive quantitative components (QUAL+quan), that also converged during analysis (Creswell & Plano Clark, 2018).

Table 4.2

Outcome Data Collection Matrix

Outcome evaluation question	Construct	Data source(s)	Data collection tool(s)	Data analysis	Frequency
RQ3: How did participation in the implicit bias PD program impact the participants' awareness of their own implicit biases toward the influence of gender in science performance?	Awareness	QUAN: Participants' pre- and post-IAT implicit bias survey responses (adapted from Gonzales et al., 2014; Okorie-Awé et al., 2021) Qual: Pre- and post-implicit bias PD sessions reflective journal entries (adapted from Gonzales et al., 2021)	QUAN: Participants' pre- and post-intervention implicit bias awareness survey Qual: Pre- and post-reflective journal	QUAN: Descriptive statistics and t-tests Qual: Coding by themes	QUAN: 2 (pre- and post-IAT tests) Qual: 3 (pre- and post-implicit bias PD sessions)
RQ4: How did participation in the implicit bias PD program impact participants' awareness of their own implicit biases toward the influence of race/ethnicity in science performance?	Awareness	QUAN: Participants' pre- and post-IAT implicit bias survey responses (adapted from Gonzales et al., 2014; Okorie-Awé et al., 2021) Qual: Pre- and post-implicit bias PD sessions reflective journal entries (adapted from Gonzales et al., 2021)	QUAN: Participants' pre- and post-intervention implicit bias awareness survey Qual: Pre- and post-reflective journal	QUAN: Descriptive statistics and T-tests Qual: Coding by themes	QUAN: 2 (pre- and post-IAT tests) Qual: 3 (pre- and post-implicit bias PD sessions)
RQ5: How did participation in the implicit bias PD program impact the participants' self-efficacy as it relates to the academic advising of their students?	Self-efficacy	QUAN: Participants pre- and post-intervention survey responses (adapted from Bodenhorn & Skaggs, 2005) Qual: Participants verbal answers in a post-intervention focus group	QUAN: Pre- and post-intervention self-efficacy survey Qual: Post-intervention focus group	QUAN: Descriptive statistics and T-tests Qual: Coding by themes	QUAN: 2 (pre- and post-intervention) Qual: 1 (post-intervention)

Method

The intervention for this study focused specifically on a professional development (PD) program that introduced the concept of implicit bias, provided opportunities for participants to become aware of their own implicit biases, and, finally, offered strategies to participants to learn to both manage their biases and change their behaviors and their self-efficacy around academic advising. The PD program consisted of eight 90-minute sessions held twice a month at WRS. The study's researcher will serve as the program facilitator for all synchronous sessions to be held at WRS. As previously stated, four of these sessions were held in-person while the other four sessions consisted of asynchronous work. The participants' asynchronous work consisted of various activities such as completing readings and videos, individual implicit bias activities, and the testing any ideas they had in their own personal work settings (i.e., advising discussions or classroom activities). Finally, following the PD program, a focus group was held for a smaller subset of participants of the PD program. The following sections provide a full description of the participants of the intervention, the instrumentation used, the procedures, the specific intervention components, and the data analysis of the research study.

Context for Intervention Study

The population of this intervention study included both academic advisors and classroom teachers at WRS, a National Association of Independent Schools (NAIS)-accredited independent school located in the western United States. WRS serves students in the 6th through 12th grades. This small, independent school currently employs approximately 85 full-time teachers, roughly 60 teaching high school classes and 30 teaching middle school classes (approximately five faculty members teach classes in both grade-level divisions). The middle school grades enroll approximately 80 students per grade-level, whereas the high school has roughly 130 students in each grade. The school boasts an 8:1 student-faculty ratio, with an average class size of 16 students. The school reports between 22%-40% students of color across all the grade-level classes. Additionally, approximately 28% of the students receive annual financial aid for tuition fees. The campus is located in a suburban area approximately 10 miles from a major metropolitan city. Enrolled students travel to WRS from the surrounding metropolitan area and suburbs. The school will celebrate its 100th year at the end of the 2021-2022 school year.

WRS's mission states that they are "dedicated to providing an education exemplified by excellence in scholarship and character" (West Regional School, n. d., para. 4). WRS takes pride in both the required and elective courses they offer their students. In addition to the numerous academic electives, students are also provided independent learning opportunities through student-led extracurricular clubs, independent study classes, and access to courses offered by the Global Online Academy (GOA, n. d.). Considering the vast array of elective courses available to students, WRS's academic advisors need to be knowledgeable about these various academic opportunities. At present, there is no formal advisor training program. Most teachers and some non-teaching staff are expected to perform advisor duties without a clear description of the role. Students will not receive the best enrollment advice possible from influential school community adults as they plan their course schedules if academic advisors and teachers are not formally trained in academic advising. While students have access to a curriculum guide, STEM elective courses are only briefly described there, and students typically seek specific details from their academic advisors or STEM teachers. The classes students enroll in during high school can help identify future career interests, especially as they directly pertain to intended college majors (Trusty, 2011).

Participants of Intervention Study

The professional development (PD) program enrolled participants that included WRS academic advisors and teachers. The researcher selected a purposeful sampling strategy called, convenience sampling. Convenience sampling has been cited as beneficial as it is often able to save the researcher time, money, and effort (Patton, 1990). WRS requires all faculty and staff to enroll in yearly professional learning communities (PLC). The PLCs that are offered at WRS cover a wide variety of topics that participants can choose from, including but not limited to professional development workshops, personal growth seminars, and required learning experiences. This intervention fell under the umbrella of a required PLC format, where enrollment into the specific intervention was determined by the individual participants and not the researcher. The PD program was comprised of eight individual PLC meeting sessions, lasting 90-minutes each, four synchronous and four asynchronous. Participants enrolled in the PD program were allow to choose to participate, or not, in the researcher's data collection plan while still participating in all the PD activities. Based on WRS's COVID-protocols, there was no limit for participant enrollment. The synchronous PD sessions were able to be held in person, on the WRS campus, and only the room capacity limited the number of participants. The largest classroom at WRS had the capacity to hold 60 participants, thus the PD was capped at a participant number of 60. While the researcher had ideally wanted to enrolled high school academic advisors and teachers, middle school advisors and teachers were also welcomed to participate. In the end, 13 WRS teachers and/or academic advisors enrolled in the PD. One participant was able to complete the first PD session, but ultimately had to drop out of the program due to personal medical reasons. Findings reported in chapter five will include data from the 12 participants who completed the entire PD program unless otherwise noted. The self-reported gender and race/ethnicities descriptors of the participants included 53.8% male, 46.2% female, 76.9% White faculty and/or academic advisors, and 23.1% faculty and/or academic advisors of color. The gender breakdown of participants (53.8% male and 46.2% female) is compared to the overall gender breakdown of the faculty and staff at WRS, including teachers and academic advisors (43.7% male, 56.3% female). Additionally, the racial/ethnic breakdown of the participants (76.9% White faculty/staff and 23.1% faculty/staff of color) is compared to the overall race/ethnicity breakdown of the faculty and staff at WRS, including teachers and academic advisors (81.5% White faculty/staff and 18.5% faculty/staff of color). Participants in the study had an average number of 19.5 years of teaching (Mdn = 16 years, SD = 10.25 years). They had an average number of 12.45 years serving as academic advisors (Mdn = 10 years, SD = 8.65 years). This demographic data were self-reported by the study's participants in both pre and post implicit bias awareness surveys (Appendix G) and self-efficacy surveys (Appendix H).

Measures of Instrumentation

The measures for data collection utilized both quantitative and qualitative data collection. Additionally, these measures were used for both the process and outcome evaluations. The measures for addressing research question one included the attendance records for the PD program sessions, the number of completed Harvard IATs for gender-science and race, researcher-developed PD use surveys (Appendix D), the number of completed PD participation reflective journals adapted from Gonzales et al. (2021) and Okorie-Awé et al. (2021) (Appendix E). The measures used to address research question two include researcher-developed PD engagement surveys (Appendix F), participant reflective journal entries responding to specific engagement questions, the number of completed PD participants' written, personalized process plans, and results from the post-intervention focus group data. Measures for addressing research questions three and four included participants' pre- and post-IAT implicit bias awareness survey responses adapted from Gonzales et al. (2014) and Okorie-Awé et al. (2021) (Appendix G) and the specific PD participation reflective journals responding to specific awareness questions adapted from Gonzales et al. (2021) (Appendix E). Finally, the measures for addressing research question five included the participants' pre- and post-PD self-efficacy survey responses adapted from Bodenhorn and Skaggs, 2005 (Appendix H) and the participants' verbal answers in a post-intervention focus group as it relates specifically to self-efficacy, adapted from Gallavan (2011) (Appendix I). The following sections describe the instruments and/or tools used for data collection during both the process and outcome evaluations. A summary of the measures for both the process and outcome evaluations are listed in the data collection plan at the end of this section (Table 4.3).

PD Session Attendance Records

Attendance records were kept for each of the four synchronous PD program sessions as well as for the focus group that followed the sessions. The attendance records for all participants were used to address research question one and serve as an important indicator of the extent to which the WRS academic advisors and/or teachers participated in the PD sessions and focus group.

Harvard's IATs: Gender-Science and Race Tests

PD participants took two of the Harvard implicit association tests (IAT) for examination of participant awareness of their own implicit biases for both the gender-science and race tests (Project Implicit, n. d.). The gender-science implicit association test looks to reveal any implicit biases or stereotypes that associates science with males more frequently that it does with females (Project Implicit, n. d.; Nosek et al., 2009). The IAT test for race looks to reveal biases and prejudices associated with race (predominately White versus non-White) (Project Implicit, n. d.). The researcher did not use the actual results of each participants' tests, but rather recorded whether or not each participant completed each test, one of gender-science and the other for race. The purpose of collecting the number of IATs completed was to address research question one and ensure that participants completed an activity that could lead to informing them of the existence of any implicit biases they might have related to gender and race/ethnicity. The completion of these IAT tests before the PD programming begins, during PD session one, and at the end of the intervention program, during synchronous session four, were intended to be used as one self-reflection tool focusing specifically on the awareness of the participants' own implicit biases. The number of completed IATs during synchronous sessions one and four indicated to the researcher the extent that the participants completed this specific activity presented in the PD intervention program. The number of completed IATs per participant were used to address research question one and determine the extent that the participants were able to complete the IAT portion of PD activities presented in synchronous sessions one and four.

PD Use Surveys

The researcher-developed PD use surveys to address research question one and determine how many of the PD's activities participants were able to complete in each of the PD program's four synchronous sessions. (Appendix D). These surveys were given to the participants at the close of each of the four synchronous PD intervention sessions. The PD use survey was indented to evaluate the fidelity of implementation in initial use. The questions included queries such as the duration of time spent in the PD session, the amount of presented materials they listened to or viewed, and finally, the amount of materials they were able to access on the learning management platform, Canvas. The questions presented the participants a range of options to which they reported their use of each of the sessions' presented materials.

PD Participants' Personal, Reflective Journal Entries

The participants were asked to complete a total of five reflective journal entries with specific prompts throughout the four PD intervention sessions (Appendix E). The prompts for these personal, reflective journals were adapted from Gonzalez et al. (2021) for the IAT-specific prompts and researcher-developed for the PD session-specific prompts. The reflective journal responses were analyzed for both the process and outcome evaluations. For the process evaluation specifically, only the number of completed reflective journals per participant were collected for process evaluation portion. This number allowed the researcher to also address research question one and determine the extent that the participants were able to complete the reflective journaling activity portion of the PD program sessions.

The content of these specific reflective journals was used for the outcome evaluation. As noted, the reflective journal entry prompts were slightly modified by the researcher using questions designed by Gonzales et al. (2021). The specific changes made to the reflective journal prompts included the acknowledgement of the two specific IATs tests participants took, the gender-science and race tests, and the removal of healthcare workers and substitution of academic advisors/teachers. Two of the reflective journal entries had time-specific prompts, specifically prompts to be completed during session one and four of the synchronous PD sessions. These two reflective journals were completed during sessions one and four and were conducted immediately before participants complete the Harvard IATs for gender-science and race. The first prompt was answered before the IATs are taken. Participants then answered the second prompt immediately following the completion of the IATs. The purpose of this two-prompt reflective journal was it identify any immediate changes in the awareness of a participant's implicit bias immediately after seeing the results of their IATs. Additionally, participants completed reflective journals following the specific implicit bias training sessions for gender, race, and their intersectionality at the end of sessions two, three, and four (Appendix E). These reflective journal entries served as additional data for the researcher as she addressed research question four to determine if the PD intervention program increased participant awareness of their own implicit biases.

PD Engagement Surveys

PD program participants completed short surveys at the end of each of the four synchronous sessions to assess how they engaged with each session's materials (Appendix F). The researcher relied on previous studies for a definition of engagement. Dixson (2015) defined engagement as "the extent to which students actively engage by thinking, talking, and interacting with the content of a course, the other students in the course, and the instructor" (p. 2). She elaborated by saying, "engagement involves students using time and energy to learn materials and skills, demonstrating that learning, interacting in a meaningful way with others in the class (enough so that those people become "real"), and becoming at least somewhat emotionally involved with their learning (i.e., getting excited about an idea, enjoying the learning and/or interaction)" (Dixson, 2015, p. 4). Finally, Kuh's (2003) definition of engagement as "the time and energy students devote to educationally sound activities" (p. 25) led to the development of the National Survey of Student Engagement (NSSE).

The survey questions combined both multiple-choice style questions and open-ended questions developed by the researcher. The four multiple-choice style questions used a 7-point Likert scale and asked participants to indicated their level of engagement with each of the PD session's four main topics: introduction to implicit bias, implicit bias and gender, implicit bias and race/ethnicity, and finally, implicit bias and intersectionality (gender and race/ethnicity). Finally, the four open-ended questions provided the participants an opportunity to give specific feedback as to any part of the program they considered to be most engaging for them specifically. Answers to these survey questions directly addressed research question two and gave the researcher a more detailed understanding of which portions of the sessions the advisors and/or teachers engaged with the most during the PD sessions.

PD Participants' Written, Personalized Process Plans

The PD program not only introduced the participants to the concept of implicit bias as it pertains to gender, race/ethnicity, and their intersectionality, it also intended to demonstrate the potentially negative impacts those implicit biases can have on their students, and introduced mitigating strategies they may use in their own contexts. Participants were asked to develop their own written, personalized process plans (example of a process plan in Appendix J from a fictional participant). Those plans included ways that the individual participants plan to take what they have learned during the PD sessions and apply it to their own advisory or classroom work. Specifically, they were asked to consider how they will apply their knowledge and awareness of their own implicit biases to determine ways to mitigate those biases as they provide STEM course enrollment advice to their students. While each participant was asked to complete their own personalized process plan, this process evaluation measure was designed specifically to determine whether or not the participant has engaged in this PD-specific activity. Devine et al. (2012) demonstrated a reduction of implicit bias in intervention participants using a combination of an increased awareness of their biases, lessons on the negative effects of biases, and practical applications of strategies to reduce biases. Thus, the act of developing a personalized written process plans for implicit bias mitigation is an important part of the ultimate reduction in the negative effects of implicit bias. Thus, the researcher recorded of the number of completed personalized process plans for the PD participants. The number of completed plans addressed research question two, how the advisors and teachers engaged with PD sessions and activities around mitigation of the negative effects of implicit bias.

Post-PD Program Focus Group

Finally, following the conclusion of the PD program sessions, the researcher offered one focus group for PD participants. Advisors and teachers who completed all of the PD program's sessions were asked to participant in a post-intervention focus group. The intention of the focus group was to gather both process and outcome evaluation data. The process evaluation data collected during the focus group included specific questions of participants and their experiences with regard specifically to research question two and their engagement with the PD sessions (Appendix I).

Regarding the outcome evaluation data, specific questions were developed by the researcher over the course of the intervention program. Questions included specific prompts around how the advisors and teachers felt their self-efficacies changed throughout the intervention program. The intention of this focus group was to add voice to their pre- and post-PD program self-efficacy survey results. Specific focus group questions were cited and further developed and finally added to Appendix I. A list of the focus group questions can be found at the end of this dissertation (Appendix I).

Participants' Implicit Bias Awareness Survey Responses

Participants completed an implicit bias awareness survey pre- PD program and another implicit bias awareness survey post- PD program adapted from Gonzales et al. (2014) and

Okorie-Awé et al. (2021) (Appendix G). The comparison of these surveys was intended to address research question four, and thus measure if there was an increase in participant awareness of their own implicit biases as they pertain to gender and race. The only changes the researcher made from the original surveys (Gonzales et al., 2014; Okorie-Awé et al., 2021) to the current version (Appendix G) was to change the language from healthcare workers to academic advisors and teachers and medical field to educational.

Participants' Pre- and Post-PD Training Intervention Self-Efficacy Survey Responses

Participants completed pre-and post-intervention surveys for self-efficacy as it related directly to academic advising (Appendix H). The quantitative-only survey was adapted as a subset of the original questions from a self-efficacy survey from Bodenhorn and Skaggs (2005). Questions specific to self-efficacy as it pertained to the required duties of an academic advisor were included. Additionally, only minor changes were made to the original survey questions/prompts; specifically, the words academic advisors replaced teachers and the specific context of WRS was included for participant clarification. The pre- and post-intervention surveys provided data to address research question five which intends to determine the extent to which participants' self-efficacy increased as it relates specifically to academic advising.

Table 4.3

Data Collection Plan

Measure	Process/ Outcome	Quantitative/ Qualitative	Timeline	Participant
Attendance records	Process	Quantitative	May 2022	WRS PD participants
Harvard IATs (gender-science & race)	Process	Quantitative	May 2022	WRS PD participants
PD use surveys	Process	Quantitative	May 2022	WRS PD participants
Participant reflective journals	Process & Outcome	Qualitative	May 2022-June 2022	WRS PD participants
PD engagement surveys	Process	Quantitative & Qualitative	May 2022	WRS PD participants
PD personalized process plans	Process	Quantitative (# completed or not completed	May/June 2022	WRS PD participants
Post-intervention focus group	Process & Outcome	Qualitative	Late May 2022	WRS PD participants
Implicit bias awareness survey	Outcome	Quantitative	May 2022	WRS PD participants
Self-efficacy survey	Outcome	Quantitative	May 2022	WRS PD participants

Procedure

The intervention professional development program was structured to first, allow participants to become aware of their own implicit biases as they relate to gender, race, and the intersectionality of the two, but also ways in which participants could learn to both manage their biases and work to change their behaviors to mitigate the harmful effects implicit biases can have during conversations with students. This section provides an overview of the professional development program for implicit bias training of academic advisors and teachers at WRS. The section includes a description of participant recruitment, the outline of the content and activities of the professional development program, and the plan for both data collection and data analysis.

Participants' Recruitment

WRS requires all faculty and staff to enroll in various professional development programs hosted on campus in the form of professional learning communities (PLC). These PLCs typically meet once a month for a 90-minute session. WRS requires faculty and staff to participate in eight PLC sessions over the course of an academic school year. Depending on the school's calendar of events, these meetings can be scheduled for twice a month, as long as PLC facilitators schedule a total of eight sessions a school year. This specific implicit bias intervention program was offered as one of the PLC programs faculty and staff were required to attend in the 2021-2022 school year.

Because WRS requires all full-time faculty and staff participation in PLCs, this specific intervention PD was offered under the list of all PLCs approved for the 2021-2022 school year. Academic advisors and teachers self-enroll in each PLC. Titles and facilitators are listed on the school's Google form but individuals make their own enrollment selections. Because the participation in PLCs at WRS are compulsory, any faculty and staff who chose to enroll in this professional development program were not automatically enrolled in the study. Academic advisors and teachers who also wanted to participate in the data-collection portion of this specific professional development program needed to sign consent forms and approve the use of their data for research purposes. Academic advisors and teachers enrolled in the professional development program who wished not to participate in the data collection were still be allowed to continue to participate in the program's implicit bias PD program.

Participants included any WRS academic advisor and/or teacher. In order to have enough participants in intervention PD program, the researcher decided to open the session for both middle and high school participants. During a pre-session meeting the researcher answered any questions future participants had related to the intervention PD program and the corresponding study and then collected informed consent forms. There was no limit on the number of participants by WRS's covid-protocols if the sessions were to be conducted virtually for the 2021-2022 PLC sessions. In May of 2022, WRS covid-protocols allowed for unlimited participant numbers and in-person sessions, but a cap of 60 participants was upheld for the on-campus, synchronous sessions due to room capacity limitations.

Intervention Professional Development Program

The implicit bias professional development program for academic advisors and teachers occurred during eight 90-minute sessions, four synchronous and four asynchronous sessions. There was also be a pre-session meeting held for all participants in order to complete their informed consent forms, listen to a description of the program and the related data-collecting portions of the study, and to complete pre-intervention materials (such as surveys and reflective journal entries). The intervention was split up into four topic areas. The first synchronous session was the introduction to implicit bias. Synchronous session two focused on implicit bias as it pertains specifically to gender. Synchronous session three focused on the implicit bias of race/ethnicity. Synchronous session four will delve into implicit biases and the intersectionality of gender and race/ethnicity. Finally, sessions two through four also focused on reviewing the various mitigating strategies for implicit. Following the intervention, participants were asked to join a post-intervention 90-minute focus group. The focus group was conducted in-person in alignment with WRS and JHU covid-protocols during May of 2022.

Intervention Synchronous Session 1: An Introduction to Implicit Bias

At the start of every PD intervention session, participants checked in by initialing an attendance sheet. During this first session, participants were introduced to and asked to take the Harvard Implicit Association tests (IATs) for gender-science and race (Project Implicit, n. d.). They also responded to reflective journal prompts before and immediately after completing the IATs (Appendix E). Participants then engaged in activities that introduced them to and continued to define what implicit bias means. They learned ways in which implicit bias shows up in the world, WRS school overall, and in the interactions they have with their advisees and students. For example, the PD program used the New York Times series "Who, Me? Biased?" series throughout all four of the synchronous sessions and allowed the participants to discuss and reflect on the different terms they learned through the intervention, specifically "implicit bias." (New York Times, 2016). Participants were prompted to create their own identity maps during the session, and for homework, if they chose to continue their maps beyond the session. Identity maps allowed participants to reflect on the various aspects of their own identities, especially as they related to what is important to themselves and what they deemed as seen or important to others (Kleinrock, 2021). An example of an identity map can be found in Appendix C. These maps were used by the participants for activities and reflection throughout the sessions, but never collected by the researcher for analysis, only completion. The participants were asked what they learned from this activity (and others) in their reflective journal prompts (Appendix E). TED Talks, specifically about what implicit biases are and what we can do about them, were shown to participants during this session as well. Links to all PD materials were made available for participants in the learning management program, Canvas. This list of materials and resources were made available only to PD program participants.

Intervention Synchronous Session 2: An Introduction to Implicit Bias and Gender

Session two focused on implicit bias as it pertains to gender. This session presented examples of the intersection of gender and STEM, with special attention paid to how implicit bias can be especially detrimental to our female students as they seek enrollment advice. The session included viewing specific materials developed to expose participants to the narratives of various STEM females, both successful and those who faced barriers to success. For example, the free, online-accessible Video Interventions for Diversity in STEM (VIDS) developed and tested by Moss-Racusin et al. (2018) was used by the researcher (VIDS, n. d.). A combination of the narrative and expert interview videos was shown. Reflective journal entries were completed by participants at the end of the asynchronous session, so they had the opportunity to reflect on the specific portions of the gender-focused implicit bias sessions (Appendix E).

Intervention Synchronous Sessions 3: An Introduction to Implicit Bias and Race/Ethnicity

Session three focused specifically on implicit bias as it pertains to race/ethnicity. An introduction to the four levels of oppressions, ideological, institutional, interpersonal, and internalized was presented to participants. Anti-racist and educational-specific activities and videos were used during this specific session. Reflective journal entries were completed by participants at the end of the asynchronous session, so they had the opportunity to reflect on the specific portions of the race/ethnicity-focused implicit bias training sessions (Appendix E).

Intervention Synchronous Session 4: An Introduction to Implicit Bias and the Intersectionality of Race/Ethnicity and Gender

The concept of intersectionality, as it relates to the overlapping effects of gender and race/ethnicity that can lead to discrimination and disadvantage, was explored during session four (Crenshaw, 1991). During this session participants delved into the nuanced nature of intersectionality and acknowledge how complex the definition of intersectionality is and the role it plays in the lives of their students. Activities and videos were presented during these sessions, including but not limited to the creation of the previously described identity maps. Identity maps provided an opportunity for participants to identify their own various identities. These identity maps were be collected by the researcher for analysis, but rather were used as a PD learning tool for the participants. Reflective journal entries were completed by participants after the end of synchronous session four, so they had the opportunity to reflect on the specific portions of the intersectionality-focused implicit bias training sessions (Appendix E).

Intervention Session 4: Next Steps for Implicit Bias Training

The final PD session also allowed the researcher revisit the IATs with the participants. As they did in session one, participants responded to reflective journal prompts before and immediately after completing the IATs (Appendix E). Activities presented during this final PD session pulled together the different sessions' topics into a cohesive narrative. Additionally, during this session, the researcher introduced the use of mindfulness as a tool for participants to consider using as they worked to integrate lessons learning during the intervention into their own practices (Owen, 2020). Specific activities included how to integrate newly learned strategies for managing and combating biases into conversations advisors have with students, especially related to course enrollment discussions, and teacher-student conversations in classrooms. Intervention surveys and reflective journals were completed after this final session and a date was set for the final, post-intervention focus group.

Data Collection

Both quantitative and qualitative data were collected throughout the entire study. The detailed plan for this data collection is outlined in Table 4.4.

Table 4.4

Data Analysis Plan

Research question	Data	Collection timeline	Analysis
RQ1: How did the participants complete the activities presented in the implicit bias professional development (PD) program?	Attendance records	May 2022	Descriptive statistics
	# of completed Harvard IATs	May 2022	Descriptive statistics
	PD use surveys	May 2022	Descriptive statistics
	# of completed personal reflective journals	May 2022-June 2022	Descriptive statistics
RQ2: How did the participants engage with the activities in the implicit bias PD program?	PD engagement surveys	May 2022	Descriptive statistics
	# of completed personalized process plans	May/June 2022	Descriptive statistics
	Post-intervention focus group transcripts	May 2022	Inductive thematic coding
RQ3: How did participation in the implicit bias PD program impact participants' awareness of their own implicit biases toward the influence of gender in science performance?	Implicit bias awareness survey	May 2022	Descriptive statistics
	Personal reflective journals	May 2022-June 2022	Inductive thematic coding
RQ4: How did participation in the implicit bias PD program impact participants' awareness of their own implicit biases towards the influence of race/ethnicity in science performance?	Implicit bias awareness survey	May 2022	Descriptive statistics
	Personal reflective journals	May 2022-June 2022	Inductive thematic coding
RQ5: How did participation in the implicit bias PD program impact the participants' self-efficacy as it relates to the academic advising of their students?	Self-efficacy survey	May 2022	Descriptive statistics
	Post-intervention focus group transcripts	May 2022	Inductive thematic coding

Attendance Records. Attendance records were kept by the researcher and all participants signed in at the beginning of each PD session. These records were used to determine the extent to which the advisors and/or teachers participated in the PD-intervention sessions.

Reflection on Results of The Harvard IATs (Gender-Science and Race). Each participant was provided the opportunity to take a total of four Harvard IATs throughout the PD-intervention program (Project Implicit, n. d.). During synchronous sessions one and four, participants took the gender-science and race IATs. Each IAT test took participants approximately 5 minutes to complete. Each participant took a screen shot of their IAT results and put the image in their personalized Google document entitled "Reflective Journal: IATs" (within a personalized folder). The only people to who had access to these personalized folders included the individual participant and the researcher. The number of IATs each participant completed was recorded by the researcher once all reflective journal entries are completed.

Participant Use Surveys. At the end of each of the four synchronous PD-intervention sessions, participants took a quick, 3-question multiple choice survey about their use of session materials (Appendix D). The survey was produced using Google Forms and administered after each PD-intervention session was completed.

Participant Reflective Journals. Participants completed the reflective journals for implicit bias during synchronous sessions one through four (Appendix E). Prompts for sessions one and four were answered before and after the participants took the IATs. Prompts for two, three, and four will took place after the session materials have been presented. Blank implicit bias reflective journals were created by the researcher and personalized for each study participant. They were created in the form of a Google document entitled "Reflective Journal: IATs" (within the participant's personalized folder). These reflective journal entries were written in following each PD session listed, but participants were asked to not return to previously completed entries once the next PD sessions had begun.

Participant Engagement Surveys. At the end of each of the four synchronous PD-intervention sessions, participants took a 4-question multiple choice and 4-open-ended question survey about their engagement with the PD session's materials (Appendix F). The survey was produced using Google Forms and administered after each synchronous PD-intervention session closed.

PD Personalized Process Plans. Personalized process plans were submitted to the researcher at the end of the PD-intervention sessions, but were also accepted by the researcher all the way through the end of the study (after the focus group). The researcher used the number of completed personalized process plans to determine the total engagement the participants had with this specific portion of the PD-intervention program. The specific contents of the personalized process plans were not evaluated, but focus group questions asked if any participants have intentions to enact their plans in their advising and/or teaching capacities. Participants were allowed to complete written personalized process plans or digital representations of their process plan using applications such as Storyboard That (example in Appendix J).

Post-Intervention Focus Group. A post-intervention focus group was held following the conclusion of the PD-intervention training sessions. The focus group met for 90-minutes and the researcher asked the participants questions about their PD-intervention experiences (Appendix H). Ultimately, the focus group was comprised of a smaller sub-set of PD participants, five in total. The focus group was voice-recorded and transcribed by the researcher.

Implicit Bias Awareness Survey. The pre- and post-implicit bias intervention surveys were given twice during the study, once prior to the start of the PD-intervention in session one and once following the end of the training during session four (Appendix G). The measure was a 13-question multiple choice survey that was sent to the participants via a Google Form.

Self-Efficacy Survey. The pre- and post-self-efficacy surveys was given twice during the study, once prior to the start of the PD-intervention in synchronous session one and once following the end of the professional learning experience during synchronous session four (Appendix H). The measure was a 10-question multiple choice survey that was sent to the participants via a Google Form. The survey took participants approximately 5-10 minutes to complete.

Data Analysis

Process and outcome data analysis included descriptive and inferential statistics (if possible, based on total participant numbers) as well as inductive thematic coding.

Quantitative Data Analysis. Google forms were used to collect data for use surveys, engagement surveys, pre- and post-tests for the IAT survey responses, and the self-efficacy survey responses. Descriptive statistics were used to calculate the results of the number of participants who consented to participate in the study, the number of sessions the participants completed, and the results of the initial use and exposure surveys. Descriptive statistics and inferential statistics, specifically t-tests, were used to investigate the difference in means between the pre- and post-tests for the IAT survey responses, the pre- and post-tests for self-efficacy survey responses, and the pre- and post-tests for cultural competence assessments. SPSS was used to analyze all statistical data.

Qualitative Data Analysis. The qualitative data collected throughout the intervention and during the post-intervention focus group included the open-ended survey questions for the engagement and implicit bias awareness surveys, the reflective journal entries for the implicit bias PD program sessions entries, and finally, the focus group transcript. The majority of the data analysis began at the start of the PD intervention program and continued through its duration. Implicit bias training reflective journal entries were submitted to the researcher as early as May 2022. Additionally, open-ended engagement survey responses were collected at the end of each PD intervention session. The researcher implemented descriptive coding, using Otter AI software, in order to develop categories and then themes for the implicit bias-training and the reflective journal entries (Lochmiller & Lester, 2017). The open-ended engagement survey responses were analyzed using in-vivo codes in order to capture the participants own words as it related to their own specific engagement with components of the PD intervention program, specifically. The researcher conducted an audit trail of all qualitative coding decisions in order to maintain transparency and researcher credibility (Creswell & Miller, 2000; Lochmiller & Lester, 2017).

Strengths and Limitations of Design

Quasi-Experimental Design

Shadish et al. (2002) note the benefits of a quasi-experimental design to increase external validity because the design includes real-world situations rather than laboratory-based experiments. They acknowledge that a well-designed quasi-experimental study, compared to other non-random studies, allows for the identification and control of confounding variables. A final benefit includes the removal of ethical concerns of RCTs, excluding anyone not selected for treatment. Limitations include the non-random assignment of participants into the treatment or control groups. As a result, internal validity could be lowered because of the lack of randomized group assignments, as it can be challenging to identify all the confounding variables.

The biggest concern the researcher had about selecting the quasi-experimental design was the non-random selection of participants. It is assumed that WRS advisors and/or STEM teachers who volunteer to participate in the intervention program described in the logic model (Figure 4.2) may already be participating in their own education related to implicit bias or, at a minimum, have a desire to do so. In order to assess confounding variables such as previous experience with implicit bias training or testing, Leviton and Lipsey (2007) suggest the "straightforward approach" of pre- and post-testing variables of interest (p. 47). As shown in the outcome data collection matrix (Table 4.2), the researcher conducted pre- and post-test and intervention data collection measures for all three constructs, awareness, self-efficacy, and engagement. By including these measurements, the researcher has the potential ability to include potential covariates and increase statistical power.

While a randomized control trial design is often deemed preferable, given the timeframe and participant pool at WRS, the researcher was not able to conduct this level of evaluation design. WRS is an independent school. This means it is not a part of any public school district, and its governance comes from within. There are no formal sister schools with which the researcher was able to partner with in order to increase sample size without complicating the internal review board process. Thus, the researcher's decision to conduct a quasi-experimental design study seemed the most appropriate given the aforementioned reasons. Finally, a convergent parallel mixed methods approach with an interrupted time-series design was chosen for this evaluation study. All three guiding design choices are explained in the following sections as they relate directly to the context of WRS.

Mixed Methods Paradigm: Convergent Parallel Design

The decision to conduct a convergent parallel mixed methods study was intentional. There are considerable strengths for single-method studies conducted for educational problems, such as statistical power of quantitative research and thick descriptions for qualitative studies (Lochmiller & Lester, 2017). The researcher recognized the power a mixed methods design can have on the evaluation of complex, educational intervention studies. Additionally, the inclusion of the logic model (Figure 4.2) that outlines the flow of the intervention to include both process outputs and intervention outcomes was purposeful. Cooksy et al. (2001) state that the use of a mixed methods paradigm along with a solid logic model has the potential to enrich the data collected. The use of a well-developed logic model allows the researcher to specify the relationship between the treatment and outcomes, thus removing the vague, black box (Leviton & Lipsey, 2007; Onwuegbuzie & Leech, 2006). Finally, the use of a logic model to rule out alternate explanations for the results obtained and, in turn, reduced threats to internal validity (Leviton & Lipsey, 2007).

There are also multiple strengths and weaknesses researchers must address when selecting a mixed methods design. According to Johnson and Onwuegbuzie (2004), strengths include but are not limited to the combined benefits of both quantitative and qualitative data. Qualitative data can shed light and meaning on quantitative results. Statistical data can be used to predict qualitative themes. The combination of both methods allows researchers to address broader research questions that cannot be confined to a singular method (Johnson & Onwuegbuzie, 2004; Tashakkori & Teddlie, 2003). Additionally, they suggest that stronger evidence can be gleaned from the convergence and collaboration of mixed methods data (Johnson & Onwuegbuzie 2004). Limitations include the challenge that collecting two different types of data can have on a researcher. If that person, or people, are not well-versed in both methods, the results might not be as strong or run the risk of being misinterpreted. Finally, combining methods into a single study can be more time-consuming and expensive for the researcher. With that said, according to Johnson et al. (2007), the mixed method paradigm can "provide the most informative, complete, balanced, and useful research results" (p. 129).

The mixed methods design allows researchers to approach complex problems from multiple perspectives, holistically, while emphasizing the benefits of quantitative and qualitative methodologies and attempting to minimized the limitations of each (Creswell & Plano Clark, 2018; Johnson & Onwuegbuzie, 2004). Advantages of the mixed methods design include greater confidence in the study's findings (Dixon-Woods et al., 2004), the dual approach can make up for weaknesses compared to single approaches (Bryman, 2008; Lochmiller & Lester, 2017), and, finally, results including both quantitative and qualitative data provide potentially more comprehensive findings and explanations (O'Cathain & Thomas, 2006).

The researcher believes that the strengths of the convergent parallel design far outweigh the limitations. According to Creswell and Plano Clark (2018), the convergent parallel design is efficient as it allows the researcher to collect the data concurrently and thus saves time. There is a higher probability for participants to complete both types of data if it is happening concurrently. Another potential issue with the convergent parallel design is the different numbers of sample sizes for each type of data, quantitative and qualitative. By collecting both quantitative and qualitative data before, during, and following the intervention, the researcher hoped to increase the alignment between the sample sizes. Finally, this design allowed for the inclusion of participant voice and the reporting of statistical trends (Creswell & Plano Clark, 2018). Given the detailed outcome data collection plan (Table 4.2), the researcher planned to utilize survey results, focus group data, and reflective journals to capture both types of data, thus strengthening the findings.

Pre- Post-Intervention Design

In order to address the use or exclusion of a comparison group, the researcher decided to implement a pre- post-intervention designed study. Ideally, one way to strengthen quasi-experimental designs is to include a comparison group (Shadish et al., 2002). The researcher chose a pre- post-intervention study, but was not able to establish a control group for comparison. The pre- and post-intervention design can be conducted without a formal control group. The design involves assessing participants before they partake in the intervention, and then again following the conclusion of the intervention program (Lochmiller & Lester, 2017). According to Lochmiller and Lester (2017), the benefits of a pre- post-intervention study are that it is often convenient and affordable. Additionally, it is relatively simple and can be quickly implemented. Finally, it can provide a reasonable estimation of participants' post-intervention changes. Limitations of this type of study cannot be overlooked. Pre- and post-intervention studies without a formal control group can show only short-term changes made. They also cannot account for pre-existing trends. Finally, they cannot fully account for the possibility that other factors, occurring at the same time as the intervention, were not having an impact on post-intervention findings (Lochmiller & Lester, 2017). Thus, it could make ruling out other explanations troublesome for the researcher. With these strength and limitations considered, should the intervention prove to be successful, WRS administrators are interested in making the implicit bias training program mandatory for all academic advisors and educators. The most basic implementation of a pre- and post-intervention study without a formal control group is that it uses the treatment group as its own comparison. The use of both surveys and qualitative measures (focus group and reflective journals) allowed the researcher to determine if there were external factors that could affect the outcome variables (Table 4.2). For example, if participants were engaging in implicit bias professional development programs or workshops outside of the intervention itself, that could have had an effect on outcome measures. The researcher included survey questions about the participants' previous and current work as it related to the intervention in an effort to mitigate those potential confounding variables.

Considering the context of WRS, an independent school, and the number of intervention participants, the researcher concluded that a large sample size was not feasible to support an RCT design, but was able to support a pre- and post-intervention design (Lochmiller & Lester, 2017). The maximum number of participants for the 2021-2022 school year was approximately 85 academic advisors and/or STEM teachers. This number included both high school and middle school faculty. A similar study of the impact an implicit bias intervention had on educators reported robust effect sizes for measures related to participants' awareness of prejudice ($d = 0.74$) and stereotype ($d = 0.86$) (Hanover Research, 2019). Another implicit bias study for health care workers reported an effect size of $d = 0.34$ (Hall et al., 2015). After conducting an a priori power analysis using G*Power, the researcher concluded in order to achieve effect sizes similar to the Hanover Research results, at least $N = 23$ and preferably $N = 30$ would be required. Using the effect sizes from Hall and colleagues' (2015) study implied a need for an $N = 137$. Depending on which effect size is used for comparison, the researcher was not able to achieve a comparable participant number at WRS. In the end, participation in this intervention was maxed out at 13 participants, with a reliable number of 12 throughout the entire PD. With that said, a simple way for the researcher to increase the power of the study would be to include more participants, such as WRS middle school academic advisors and/or STEM teachers (Leviton & Lipsey, 2007;

Shadish et al., 2002). In the end, though, the researcher was not able to achieve a comparison group of the same size. Thus, the researcher opted to not use a comparison group and employed the above strategies to increase internal validity and guard against potential threats.

Conclusion

The purpose of this mixed methods intervention study was to investigate the impact the implicit bias PD program had for WRS academic advisors and/or teachers enrolled. Specifically, it was designed to determine if these influential adults (WRS advisors and teachers) were able to experience a change in their awareness of their own personal biases and a change in their self-efficacy as it related to their roles as teachers and/or academic advisors throughout the intervention program. This chapter provided an overview of the process and outcome evaluation plans as well as the intervention's research design, method, participants, and data collection and analysis plans. The use of the process evaluation in conjunction with the outcome evaluation allowed the researcher to avoid the pitfalls of a black box study (Leviton & Lipsey, 2007). Additionally, the collection of data from both quantitative and qualitative data sources had the potential to provide a deeper understanding of the results of this mixed methods study (Johnson & Onwuegbuzie, 2004). Chapter five presents the findings of the process and outcome evaluation of this PD-intervention study.

Chapter 5

Findings and Discussion

Introduction

The purpose of this final chapter is to present the findings and conclusions from the intervention professional development program focused on implicit bias. Specifically, both the results of this study's process and outcome evaluations will be presented in the following sections. This intervention study was primarily focused on how participation in an implicit bias professional development impacted WRS faculty and staff around the awareness of their own implicit biases towards the influence of gender and race/ethnicity and their self-efficacy in academic advising in science performance. Participation in the study was the result of a subset of WRS faculty and staff self-enrolling into the required professional learning communities' (PLC) program. This specific study used the required and allotted meeting times for WRS's PLCs to conduct the synchronous sessions. Additionally, participants of the study also completed asynchronous work outside of the in-person sessions held at WRS.

The combination of both process and outcome evaluations has allowed the researcher to measure the project implementation of this specific professional development program. The use of both types of evaluation provides the researcher with data to evaluate the adherence to the intervention plan and ensure the validity of the study as well as the interpenetration of the findings (Baranowski & Stables, 2000; Stufflebeam, 2003; Zhang, et al., 2011). Rossi et al. (2019) describe the importance of both process and outcome evaluations on research studies. They describe the process evaluation as an examination of what a program or intervention actually is, whereas an outcome evaluation is the systematic documentation of the key aspects of an intervention program. The process evaluation allows the researcher to review the activities, participants, and consistency of implementation of an intervention program. The outcome evaluation allows the researcher to review and interpret the performance of an intervention program in terms of the end results.

This specific intervention program was designed both to impact participants' awareness of their own implicit biases as it related to the influence of gender and race/ethnicity in science performance and to impact participants' self-efficacy as it related directly to advising their students on enrollment decisions. In order to achieve these proximal goals or intended outcomes, the researcher used the theory of treatment (Figure 4.1) to describe the path in which there was potential to affect both participant awareness and efficacy with the longer-term, or distal, goals of a reduction in overall implicit biased behaviors as it relates to gender and race/ethnicity in the context of advising students in the classroom and with regard to STEM elective enrollment decisions. By implementing a theory of treatment plan, the researcher was attempting to get out of the black box and describe the process through which this specific intervention was expected to have on the participants (Leviton & Lipsey, 2007). Additionally, by providing participants opportunities to investigate their own potential implicit biases and as well as show examples of the negative effects these biases can have on their students, the study aimed to impact participants' understanding of their own implicit biases and increase their self-efficacy around advising their students, especially their female students and students of color. According to Jackson et al. (2014), even fully-trained academic advisors exhibit implicit biases that can harm and discourage their female and underrepresented students as they consider enrollment into STEM courses. An intervention focused solely on identifying one's implicit biases often fails to bring about the lasting changes needed for educators and advisors to have lasting effects (FitzGerald et al., 2019). Rather, pairing implicit bias identification programming with specific professional development activities that focus on mitigating the negative effects of bias have been found to be considerably more effective professional development strategies (Batchelor et al., 2019; Glock et al., 2013; Moss-Racusin et al., 2018). Thus, the researcher designed an intervention program focused not only on implicit bias awareness, but specific examples of the harmful effects that a failure to identify and learn from those biases have on students, generally as well as in specific cases as it relates to STEM curriculum and course enrollment.

Process of Implementation

The intervention professional development program took place between May 4, 2022 and May 26, 2022. The program facilitator, who is also the study's researcher, met with the teachers and academic advisors (n=13) weekly for synchronous sessions. The researcher also provided activities, readings, videos, and reflective journaling work for asynchronous sessions between the in-person programming. The four synchronous sessions lasted for 90 minutes per session, with a total of six hours of in-person professional development. Each of the four asynchronous sessions included a minimum of 90 minutes of work, ranging from personal activities, readings, videos, survey responses, and reflective journaling. This resulted in an additional six hours of PD for each participant. Thus, the overall time spent for each participant in the program was a minimum of 12 hours. Finally, following the conclusion of the implicit bias program, a smaller subset of participants attended a 90-minute focus group conducted by the researcher.

The program began with participants taking two pre-PD surveys, one for awareness of implicit bias and the other for self-efficacy. Once the synchronous sessions began, participants engaged in activities, small group discussions, watched videos, and reflected on the topics of implicit bias in general, implicit bias and gender, implicit bias and race/ethnicity, and finally, the intersectionality of race/ethnicity and gender. The overarching umbrella for these sessions was focused on how these topics can affect teachers and/or academic advisors, specifically at WRS. Short surveys collected data on session attendance, how much of the PD material the participants viewed and accessed through Canvas, and the level of engagement they had with the sessions' programming.

Throughout the sessions, participants were also asked to consider their own classrooms and homerooms (for their advisory groups). They used reflective journals after the sessions to focus their thoughts on each of the session's topics. They were also asked to create and submit a personalized process plan following the completion of the professional development programming and activities. This personalized process plan was created to allow participants to set specific goals for themselves following this program so they could start to align their actions with their explicit beliefs and use specific tactics or strategies for mitigating the implicit biases they have become aware of following this PD. Participants were also asked to complete post-PD surveys for awareness of implicit bias and self-efficacy.

Findings

Completion of Intervention Professional Development Activities (RQ1)

The first research question focused specifically on the process evaluation portion of the study. It asked how the participants complete the activities presented in the implicit bias professional development (PD) program. The researcher used attendance records, the number of completed Harvard Implicit Association Tests (IATs), synchronous session "Use" surveys completed, and the number of reflective journals in order to determine how the participants completed the activities in the professional development intervention program. The subsequent paragraphs will describe the findings of each of these measurements of how the participants completed said activities.

Quantitative Findings for RQ1

The researcher used a number of different tools to determine how participants completed the PD activities. As the quantitative data in subsequent paragraphs will show, participants were extremely successful with their abilities to both access and complete PD activities, especially when those activities were presented during the in-person sessions. The researcher used data from attendances records, IAT tests, PD Use surveys, and completion of reflective journals as measures of how participants completed the intervention's PD activities.

Attendance Records. The professional development program included four synchronous sessions focused on defining implicit bias and presenting real-world examples, defining implicit bias as it relates gender issues, race/ethnicity issues, and defining what intersectionality is and its role in implicit bias. Attendance records were taken at the start of each synchronous session as well as confirmed with a question in the "Use" survey (Appendix D). It is important to acknowledge that while 13 participants started the program, one participant had to drop out after the first synchronous and asynchronous sessions due to illness. This is noted throughout this chapter as the difference in participant number from 13, for synchronous session one, to 12 for synchronous sessions two, three, and four. Attendance records and survey data show that for sessions one, two, and three, there were perfect attendance records with the chance for participants to attend 100% of the sessions (Table 5.1). Session four had a lower attendance of eight out of 12 participants in attendance or 66.7%. Two of the four missing participants were attending previously scheduled WRS-sponsored events in which their position as educators were required, one missed due to a conflicting family event, and the other one was absent due to illness. It will be reported in the participant engagement section for research question two that even though there were absences for the final session, some of those participants were able to access and complete that session's activities.

Table 5.1

Attendance Records for Implicit Bias PD Synchronous Sessions

Pd session number	# attended	% of participants in attendance
1 (*n* = 13)	13*	100%
2 (*n* = 12)	12	100%
3 (*n* = 12)	12	100%
4 (*n* = 12)	8	66.7%

Note. *Participant #13 withdrew from the study after Session 1 due to health reasons.

Completion of Harvard Implicit Association Tests. Participants were asked to complete the Harvard Implicit Association Tests (IATs) for gender-science and race as the first activity in synchronous session one and at the end of synchronous session four. The number of completed IATs for synchronous session one was 13 out of the 13 participants for the gender-science and race IATs, or 100% completion (Table 5.2). The number of completed IATs for synchronous session four was 10 out of the 12 participants for the gender-science and race IATs, or 83.3% completion (Table 5.2). It is important to note that 10 participants completed both IATs for synchronous session four even though only eight were able to attend that fourth session. That means that two of the participants who missed that session were able to access and complete the two IATs following the directions they had access to on the Canvas platform.

Table 5.2

Number of Harvard Implicit Association Tests (IATs) Completed During the PD Sessions

PD session number	# of Science-Gender IATs completed	% of Science-Gender IATs completed	# of Race IATs completed	% of Race IATs completed
1 (*n* = 13)	13*	100%	13*	100%
4 (*n* = 12)	10	83.3%	10	83.3%

Note. *One participant dropped out of the study after Session 1 due to health reasons.

PD Use Surveys. Participants were asked to complete the PD Use surveys after each synchronous session (Appendix D). There was a 100% completion rate for all surveys following all four synchronous sessions (Table 5.3). The Use survey included three questions. First, the participants were asked the extent to which they attended the session, specifically, did they attend the entire session, part of the session, or did they fail to attend the session. Next participants reported the extent to which they listened or viewed the materials presented during the session. Finally, participants reported the extent to which they were able to access the session's materials and resources on the Canvas platform. This final question was able to capture the extent to which participants could access the PD materials regardless if they were able to attend the synchronous sessions or not. For sessions one through three, 100% of the participants attended the synchronous session, listened or view the materials presented during that session, and were able to access the session's materials on Canvas. Additionally, 100% of the participants reported they were able to access all the sessions' materials on Canvas. Finally, only eight of the 12 participants, or 66.7%, were able to attend the fourth synchronous session due to the previously stated reasons, though the participants all reported they were able to listen or view the materials present during the session. The researcher believes that the four participants who did not attend this synchronous session might have mistakenly mis-read this survey question as "listened or viewed" and failed to read the part of the question stating "during the session." Other data (such as IAT completion data) suggested that even though some participants were absent for this final synchronous session, they completed the activities and materials of the session, just asynchronously. The final question provided evidence that all participants, or 100%, were able to access these materials on Canvas.

Table 5.3

Completed USE Surveys From Synchronous PD Sessions

PD session number	# of USE surveys completed	% of USE surveys completed
1 (*n* = 13)	13*	100%
2 (*n* = 12)	12	100%
3 (*n* = 12)	12	100%
4 (*n* = 12)	12	100%

Note. *Participant #13 withdrew from the study after Session 1 due to health reasons.

Completed Reflective Journals. Participants were asked to complete reflective journals following three synchronous sessions, sessions two-four. The reflective journal prompts asked participants to reflect specifically on their current definition of implicit bias, their reactions to the materials presented in the specific session, their feelings around the experiences they had during that specific session, and finally an inquiry into any outside implicit bias learning opportunities they might be doing in addition to this intervention program (Appendix E). Regarding research question one's goals, all participants had access to these reflective journal prompts through the Canvas platform. During session two, 10 out of the 12 participants, or 83.3%, completed the reflective journal prompts focused on implicit bias and gender issues (Table 5.4). For session three, nine out of 12 participants, or 75%, completed the reflective journal prompts focused on implicit bias and race/ethnicity issues (Table 5.4). Finally, following session four, 11 out of 12 participants, or 91.7%, completed the implicit bias and intersectionality reflective journal prompts (Table 5.4). These findings show that there was a high percentage of use and completion of reflective journals throughout the intervention PD program by the participants.

Table 5.4

Number of Reflective Journals Completed During the PD Sessions

PD session number	# of RJs completed	% of RJs completed
2	10/12	83.3%
3	9/12	75.0%
4	11/12	91.7%

Research question one's focus on how the participants completed the activities presented in the intervention PD program was answered with the use of multiple different data points. From attendance records, completed IATs and reflective journals, to PD Use surveys, the participants showed they were not only able to highly attend the synchronous sessions, but also access and complete activities from the asynchronous portions of the intervention PD program. The intervention facilitator built into the Canvas program, access to all the asynchronous materials, a "mark as done" feature that served as an indicator of completed readings and videos. Even with the lower attendance for the final PD synchronous session (Table 5.1), other indicators such as completion of IATs (Table 5.2) and reflective journals (Table 5.4) show more participants were able to understand, access, and complete PD activities on their own even if they were absent from that synchronous session.

Engagement With Intervention Professional Development Activities (RQ2)

The second research question also focused specifically on the process evaluation portion of the study. The researcher aimed to determine how participants engaged with the activities in the implicit bias PD program. The researcher used synchronous session "Engagement" surveys, the number of completed personalized process plans, and post-intervention focus group data to determine how the participants' engagement with the activities, materials, and readings in both the synchronous and asynchronous session of the intervention PD program. The subsequent paragraphs will describe the findings of each of these measurements of how the participants engaged with said activities.

Quantitative Findings for RQ2

The researcher used a survey to collect quantitative data in order to investigate how the PD participants engaged with the activities of the implicit bias program. The Engagement survey results yielded positive engagement responses from all participants across all four synchronous PD sessions. The results of the Engagement surveys will be explained in the subsequent paragraphs and will be coupled with qualitative data to show high levels of engagement with the PD's activities throughout the intervention program.

Engagement Survey Results. The Engagement survey was given to participants following each of the four synchronous sessions (Appendix F). In each survey participants were asked just two questions. First, using a Likert 7-point scale survey, the researcher asked participants to describe their level of engagement with the session's topic and activities. Aggregate data were compiled for the number of responses for each of the seven options across all four surveys (Figure 5.1). The aggregate data showed that participants were engaged (moderately to highly) across all four sessions.

The researcher recoded the survey answer options for analysis. Broken down by session, participant engagement was measured using the researcher-assigned values to each Likert-scale option: -3 for highly disengaged, -2 for very disengaged, -1 for moderately disengaged, 0 for neutral, 1 for moderately engaged, 2 for very engaged, and 3 for highly engaged. Means, medians, and standard deviations were calculated for each of the four engagement surveys and are reported here (Table 5.5). For the first synchronous session, focused on an introduction to implicit bias, participants' mean engagement was calculated to be 2.54 (Mdn = 3.00, SD = 0.66). For the second synchronous session, focused on implicit bias and gender, the participants' mean engagement was calculated to be 2.67 (Mdn = 3.00, SD = 0.49). For the third synchronous session, implicit bias and race/ethnicity, participants' mean was engagement was 2.83 (Mdn = 3.00, SD = 0.39). Finally, for the fourth synchronous session, implicit bias and intersectionality, the mean was calculated to be 2.33 (Mdn = 3.00, SD = 0.89). It should be noted that while session four had the highest number of individual responses of "moderately engaged" responses, the open-ended survey question allowed multiple participants to address why they selected this option. Specifically, one participant stated:

> I only put 'moderately engaged' because unfortunately I was unable to attend the session and was only able to read and watch the material. But both the [Valerie Alexander] TED Talk and the articles were ***POWERFUL*** in teaching us (and me) how naive we can be, even when we aren't trying to be!

Using both aggregate and by-session quantitative engagement survey results, it is safe to say that participants were engaged with the materials and activities provided by the PD intervention.

Figure 5.1

PD Engagement Survey's Aggregate Quantitative Results

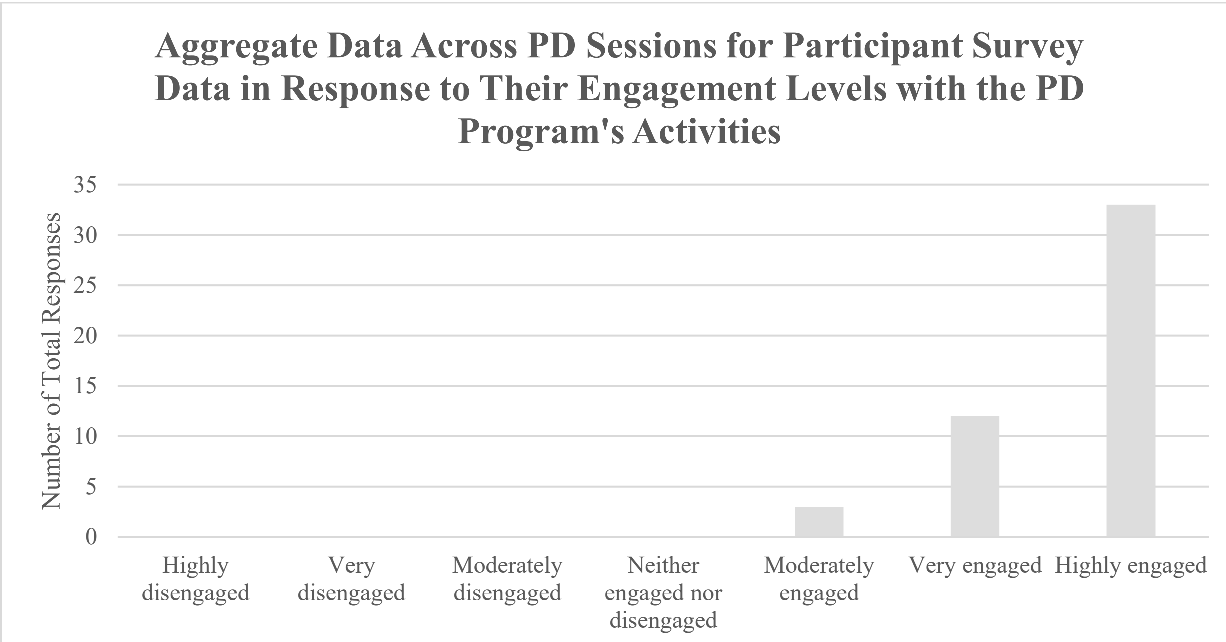


Table 5.5

PD Engagement Survey's Results for Participant Engagement Levels Throughout PD Sessions

PD session number	PD session topic	*M*	*Mdn*	*SD*
1	Implicit Bias	2.54	3.00	0.66
2	Implicit Bias & Gender	2.67	3.00	0.49
3	Implicit Bias & Race/Ethnicity	2.83	3.00	0.39
4	Implicit Bias & Intersectionality	2.33	3.00	0.89

The data showed that participants were, across the sessions, moderately to highly engaged with the intervention PD program's activities. In fact, survey data suggests that participants were very to highly engaged with the activities through the intervention program (Figure 5.1). In order to determine which aspects and activities participants were particularly engaged with, the researcher used the open-ended Engagement survey questions and post-intervention focus group to enhance the engagement findings.

Qualitative Findings for RQ2

In addition to the data provided by the engagement survey's first question, participants were also asked to explain components of the PD sessions that they would describe as captivating their engagement levels the most and why. The researcher used an inductive thematic coding approach for the open-ended engagement survey question. Themes were generated from all four of the sessions combined. While each session focused on various types of implicit bias (gender, race/ethnicity, and the intersectionality of the two), participants experienced the cumulative building of knowledge through the different topics throughout the entire PD program. Emergent themes that were developed from this data include perspective-taking opportunities, opportunities for reflection, and increased awareness in the form of a call to action. Each theme will be discussed below and includes participant voice as well.

Additionally, participants also pointed to specific activities or aspects of the design of the intervention PD program that engaged them while also strengthening their general efficacy. Multiple participants noted they appreciated that this PD program was not a singular event. One said that they thought "one of the most efficacious things about this was the frequency. That it wasn't one and done. Even between our sessions when I was reading or watching those videos…it was just on my mind all the time, which is what we need…constant reminders to be thoughtful, to be aware." Others echoed their agreement with "Yeah," "absolutely," and "I second that!" Someone else shared that "it was good to kind of have this awakening moment watching a video or doing this activity, being able to talk about it with other people, but then also kind of in the down time between meetings getting to ruminate and think about it a little bit and reflect." They mentioned appreciating the time to process the information and "apply it to the readings and the journal entries" and that it helped to maintain their "high engagement" levels. It should be noted that typically, WRS's diversity, equity, and inclusion team is allotted one official all-school PD day per calendar year. Participants also said they really loved WRS's DEI PD days, but lamented that it "a lot all at once" and them by the time they "actually have time to digest and think about it, it's over and then there's no follow up" or "no context." Participants shared that they often come away from those types of PD feeling like they are "on my own…and then I lose steam and momentum with it." One said "spray and pray one-day PD programs aren't enough." The pointed to the fact that this intervention was not just one day of deep, meaning work for them. The specifically stated that they believed PD programs would be more effective at WRS if they could "be very regular, even more regular than our PLCs." Another said they "would have liked more time with this [specific] PD program" as well.

Aspects of the PD program that a few participants shared that they felt like were the least engaging were the Harvard IATs. One participant said they did not understand the percentages the IATs gave them at the end of the tests and how to interpret it. Another said that "all the IATs tests did was either make me feel bad about myself or reinforce what I already thought I knew." They went on to say that knowing their results did not necessarily change how they behaved "by any means" rather it allowed them to say to themselves "wow, I gotta pay more attention to this." Another participant said that it was not so much about the IATs specifically, but rather the entire process saying that "part of the whole learning experience as much as the actual results of the test" was what was engaging to them. Others, again, nodded in agreement and commented "yeah" and "yup, it's the whole experience" and not just the IAT itself. Finally, one participant mused that it was "more about the *concept* of the test and how it applies to our everyday life than it is about the actual test." These specific activities engaged the participants in ways that allowed them to reflect and take in the concepts of implicit bias as designed by the intervention program.

Perspective-Taking Opportunities. Participants mentioned the engaging use and selection of the videos and articles that allowed them to see similar life situations from another's perspective, specifically from women, women of color, and all persons of color. One participant stated, "I particularly enjoyed the Starbucks training video and the [Baratunde Thurston] TED Talk. I found them engaging, And I always enjoy hearing peoples' perspectives and experiences." Another participant mentioned:

> The [Baratunde Thurston] TED Talk at the end was excellent and really had an impact on me. Just seeing/hearing accounts of the experiences people of color go through each day has me feeling a whole host of emotions. It definitely pisses me off, and I want to make sure I do not add to that struggle in any way.

Finally, another participant said, "The [Kimberlé Crenshaw] TED Talk about black women who were murdered by the police was impactful. I felt some guilt about my lack of knowledge but also some motivation to learn more." At least seven of the 12 participants noted, on more than one occasion, the usefulness of and opportunities with the videos and articles presented during the sessions to allow them to take a different perspective on the impacts that implicit biases can have on others.

Opportunities for Reflection. Participants remarked that both the synchronous and asynchronous sessions created multiple opportunities for deep and personal reflection. Some of those opportunities for reflection included time to debrief activities or videos together in small groups, while other opportunities recognized were ones of self-reflection. Specific activities and materials were pointed to as catalysts for these opportunities of reflection such as the IATs, games and activities, and videos, specifically many of the TED Talks.

Many participants shared with the researcher that while they were familiar with the Harvard IATs, they personally had not taken any themselves and thus never reflected on the experience. One participant stated that they had, "never taken an IAT before, and I found the test itself engaging even if the results were about what I expected them to be." Another described that they appreciated that the final session had them take the same IATs a second time. They said that, "returning to what we did at the start [re: the IATs] was a nice way to wrap up everything that we'd been working on and discussing all PD. I was super interested in seeing my IAT results. I also really appreciated the chance to reflect after seeing the results."

Participants often mentioned the different games and activities they were asked to take part in during the synchronous sessions as highly engaging and opportunities for various types of reflection. One study participant noted that, "Though somewhat predictable, the Tag Game [session 2] was still interesting to reflect upon." The Tag Game was a quick activity that involved minimal directions from the facilitator, but has been dubbed as a "a-ha" implicit bias activity designed to create a moment of acute awareness followed up by opportunities for discussion and reflection (Appendix K). Commenting on the same activity, a different participant mentioned that they kept "going over the game/activity again and again. So much to unpack and layers upon layers to sift through." Another participant said of the Tag Game that:

> The most fun/interesting part for me was to go through the grouping exercise, analyze our feelings/behaviors, and then breaking down the implied metaphors. It was active, there was puzzle-solving involved, and there was true revelation upon your pointing out that you had not instructed us to group ourselves according to anything related to the tags.

Finally, one participant mentioned, at the end of the entire PD program, that they "loved the interactive games and activities we did. The jelly bean activity and the Buffalo'ed card game (Appendix K) really makes you think about implicit biases." While these activities might have been quick exercises during the PD program, participant reflections show that they did, indeed, engage and prompt thoughtful reflections.

Finally, many participants mentioned that the many videos allowed them opportunities to reflect in the moment, but also between PD sessions. One participant pointed to a video shown during the implicit bias and gender session, specifically. They said that, "The [Janet Crawford] TED Talk was excellent and I found myself mentally creating a checklist of things I want to pay attention to in my classroom for the rest of the year in regards to gender bias." In response to a different series of videos, another participant said that:

> It allowed me to see and reflect on how our socialization has affected how we view individuals. It also showed me that it is all connected, and if we treat an underrepresented person differently, it cycles to others in a negative way. We also need to try to undo our socialization of biases.

The use of videos allowed the researcher to engage participants in a different way than the games and activities because it brought in various perspectives, voices, and examples of people affected by implicit biases.

Increased Awareness With a Call to Action. Participants mentioned, time and time again that the PD's activities, articles, and videos allowed them to engage in a way that increased their own awareness of what implicit biases are, how they show up in relation to gender, race/ethnicity, and the intersectionality of the two, and the potential harm they can do to people, including their own students. This level of engagement often led participants to discuss ways in which they felt personally called to action. These calls to action will be discussed with specific examples in subsequent sections. With regard to participant engagement, may cited the PD program's activities allow them to engagement in various forms of personal learning such as the opportunities to learn more about their own biases, figure out different strategies they could use to mitigate harm to their students from these biases, and continue the important work around implicit bias in general. One participant said, "To be honest, I've never thought too much about my implicit biases, but taking time to do so feels productive with respect to self-improvement and becoming more of the person I want to be. And that's what helps keep me engaged." While this statement represents evidence of a specific outcome for this participant, it also points directly to the portions of the intervention that engaged them personally, and that is the time given by the researcher's intervention design to reflect and work on their implicit biases. Another stated, "Just the sheer fact that that whole PD session was personal and affects me and how I think...I was absolutely engaged throughout the whole time so that I could learn more about myself!" Finally, one participant noted their appreciation for all the videos in the sessions and that "Each of the videos presented had easy application to personal experience and action steps for improvement." These examples support the value of the PD program's video, article, and activity selections as contributions to the participants' reported high level of engagement throughout the intervention (Figure 5.1).

Personalized Process Plans. Participants of the study were told at the beginning of the implicit bias PD program of a culminating activity they would complete and submit following the final synchronous session. This personalized process plan (PPP) would not be analyzed for the personal content, but rather be used as another indicator of engagement in the PD program. Ideally, participants would take what they learned about implicit bias, in general, and their own personal implicit biases and make a plan specific to them, their classrooms, and/or their academic advising role (Appendix J). Personalized process plans could be submitted in a purely written form, video format, or even in an infographic-style submission as seen in the example PPP (Appendix J). All participants in this specific study opted for written submissions. Additionally, 11 out of 12 participants, or 91.7%, completed a PPP (Table 5.6). Study participants were allowed to submit these PPPs following the completion of the final synchronous session in order to provide ample time for self-reflection.

Table 5.6

Completed Personalized Process Plans at the Conclusion

Timeline	# of PPP completed	% of PPP completed
Post-PD program	11/12	91.7%

Post Professional Development Program Focus Group. Following the final synchronous session, a smaller subset of five PD program participants joined the researcher for a post-intervention focus group. Following the completion of the intervention professional development program, the researcher asked participants if they would be willing to participate in a 90-minute focus group. A smaller subset of participants volunteered themselves to participant based on their availability. Ultimately, five participants met with the researcher; two Caucasian males and three Caucasian females. The researcher-developed questions were designed to address the study's questions around engagement and self-efficacy (Appendix I). In order to add data to research question two, the researcher used inductive thematic coding for the first two questions of the focus group session, which were specifically designed to ask participants about their engagement throughout the PD program (Appendix I). When participants were asked directly if the PD program engaged them as it related to implicit biases around gender, race/ethnicity, and their intersectionality there was a resounding “Yes!” from all the participants. That was followed up by one of the participants declaring “Unanimous!” The second question asked participants to describe specific activities that they felt were particularly engaging (meaning, they felt highly involved in the activities). Unlike their first answer, the researcher was able to code the qualitative data their responses provided. A single theme emerged related to participant engagement and was focused on increased awareness of implicit biases.

Increased Awareness. Participants shared various examples of the PD program’s components that engaged them including, but not limited to the activities, games, videos, conversations, and opportunities for reflection. Specifically, a number of participants mentioned engaging videos. One participant said, “I liked all the activities first off. But the ones that made me think about myself and my own implicit bias and really made me think about my own classroom and my interactions with other people—those are the ones that stood out to me.” This participant also pointed out the nuanced nature of engagement with the videos. They stated that “I wouldn’t necessarily say that a video itself isn’t all that engaging however that video you showed about, the one with interviews with people of color describing what it was like leaving their homes every day and how they have to behave on the train, hearing the perspectives of real individuals, it just made me think about it again…I’m so fricking privileged.” Another participant chimed in to agree, “The ones that gave concrete examples—you wouldn’t even be aware of otherwise.” A third participant added, “Like the things we take for granted.”

Others mentioned the smaller activities, such as the IATs and games or activities, as opportunities that increased awareness of implicit biases in an engaging way, creating ‘ah-ha’ moments. One participant shared, “playing the card game and listing your friends were also ways to just take stock of the way you go about your daily life and get a little perspective that I would not have done on my own." Another participant stated this awareness in the moment after taking an IAT by saying "those activities where we were doing what appeared to be mindless activities were really kind of like 'oh crap' moments that I really thought about later." When participants were asked to reflect on the most engaging components of the intervention PD program, they continued to highlight the most impactful ones, especially those that allowed them to have these 'a-ha' moments of increased awareness.

Awareness of Gender-Based Implicit Bias (RQ3)

The third research question focused specifically on the outcome evaluation portion of the study. It asked, how participation in the implicit bias PD program impact the participants' awareness of their own implicit biases towards the influence of gender in science performance. The researcher used pre- and post-PD program implicit bias surveys, pre- and post-IAT reflective journals, as well as PD program gender-specific session reflective journals to address the question as to how participants awareness of implicit bias may have been impacted by their work in the intervention. The subsequent paragraphs will describe the findings from analyzing each of these measurements of how the participants' awareness was impacted.

Quantitative Findings for RQ3

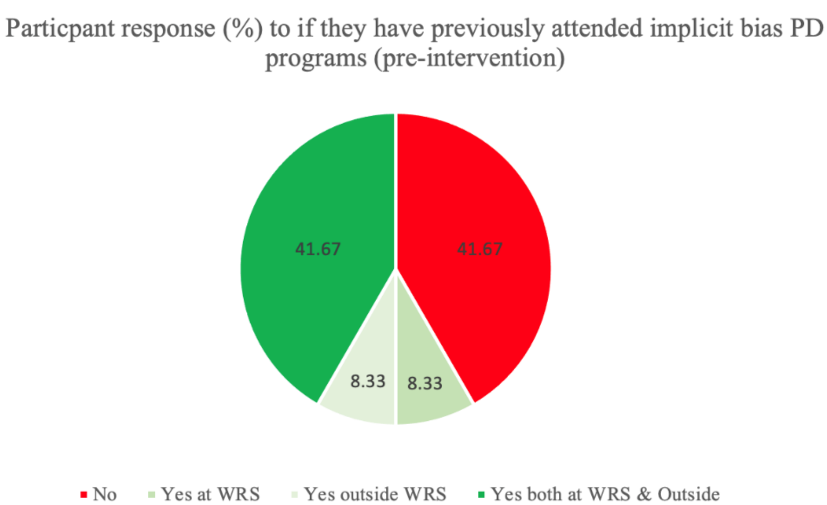
Participants were asked to complete an Implicit Bias survey prior to starting the intervention PD program and then again at the commencement of the sessions. The intention of these survey results was to determine if there was a change in participant awareness of their own implicit biases around gender and race/ethnicity as it related to science performance. Furthermore, the researcher wanted to investigate the impact that the implicit bias-focused intervention program had on the participants awareness of these implicit biases in relation to their roles as educators and/or academic advisors.

Implicit Bias Survey. Participants in the PD program were given a pre- and post-intervention survey that focused on their awareness of implicit biases (Appendix E).

One of the implicit bias awareness survey questions asked PD participants if they had previously attended professional development programs or seminars about implicit bias. Participants were able to select from four answers including no, yes at WRS, yes outside of WRS, and yes both at WRS and outside of WRS. In the pre-implicit bias survey, 58.3% of the participants reported that they had previously attended some sort of implicit bias PD program whereas 41.7% reported having receiving no such programs (Figure 5.2). Inferential statistics were not conducted on these data points as there was no change between the overall affirmative and dissenting responses from the pre- and post-surveys.

Figure 5.2

PD Participant Response to Whether They Have Attended Other Implicit Bias PD Programs (Pre-PD Survey)



Implicit Bias Awareness Survey Data. The first question participants were asked on the pre- and post-implicit bias survey was whether or not they were familiar with the concept of implicit bias. The researcher used a numerical scale for the participants' options. The scale was 0

= not familiar at all (have never heard of implicit bias), 1 = slightly familiar (have heard of it but don't know what it means), 2 = somewhat familiar (I have a general understanding of the term), and 3 = extremely familiar (I have extensive knowledge on implicit bias). Participant pre-implicit bias survey results' mean was 2.08 and the post-implicit bias survey results' mean was 2.33 (Table 5.7). A paired t-test was conducted and the differences in pre- and post-survey means was determined to be not significant ($t(11) = -1.9$, $P = 0.8$), meaning there was no statistical difference in the participants familiarity with the concept of implicit bias as a result of the PD program based on quantitative survey results, but based on descriptive statistics participants were familiar with the overall concept of implicit bias both before and after completing the PD program.

The second through seventh questions from the pre- and post-implicit bias survey used a 5-point Likert scale. It asked for participants to select one of the following based on their agreement with each of the statements and the researcher assigned the following values: -2 = strongly disagree, -1 = disagree, 0 = neither agree nor disagree, 1 = agree, and 2 = strongly agree. For the first statement, "I have a preference for White people on the implicit bias association test (IAT)," participants had a mean pre-survey value of 0.17 and 0.08 for the post-survey (Table 5.7). A paired t-test was conducted for the difference of means was found to have no statistically significant difference ($t(11) = 0.2$, $P = 0.8$) for participants pre- and post-PD program; meaning that their slight agreement with the statement did not change over the course of the implicit bias PD program.

For the next statement, "I believe the IAT is invalid," participants had mean pre-survey and post-survey values of -0.58 ($t(11) = 0.0$, $P = 1.0$) (Table 5.7), showing slight disagreement with the statement. Additionally, a paired t-test was conducted for the difference in means and showed that there was no significant difference found ($P > 0.05$) for participants pre- and post-PD program. This meant that their slight disagreement with the statement did not change over the course of the implicit bias program.

For the statement, “Gender disparities do not exist in the U.S. educational system,” participants had a mean pre-survey value of -1.58 and mean post-survey value of -1.67 ($t(11) = 0.6$, $P = 0.6$) (Table 5.7), showing disagreement with the statement. Additionally, a paired t-test was conducted for the difference in means and showed that there was no significance difference found ($P > 0.05$) for participants pre- and post-PD program. This meant that their disagreement with the statement did not change over the course of the implicit bias program.

For the statement, “Advisors/teachers treat all students the same, no matter what ‘group’ they belong to at WRS,” participants had a mean pre-survey values of -0.75 and mean post-survey value of -1.08 ($t(11) = 2.3$, $P = 0.04$) (Table 5.7), showing disagreement with the statement. Additionally, a paired t-test was conducted for the difference in means and showed that there was a statistically significant difference found ($P < 0.05$) for participants pre- and post-PD program. This meant that their disagreement with the statement changed over the course of the implicit bias program, in the direction of greater disagreement with the statement. This indicates that the participants’ awareness of students being treated differently by advisors and teachers at WRS increased over the course of the PD program.

For the statement, “WRS is fair and equitable, and provides ‘blinded’ education” participants had mean pre-survey and post-survey values of -0.83 ($t(11) = 0.0$, $P = 1.0$) (Table 5.7), showing disagreement with the statement. Additionally, a paired t-test was conducted for the difference in means and showed that there was no significant difference found ($P > 0.05$) for participants pre- and post-PD program. This meant that their disagreement with the statement did not change over the course of the implicit bias program.

For survey questions eight through ten in Table 5.7, participants were asked to share the level at which they observed what each statement was describing at WRS. The researcher used a 5-point Likert scale and asked for participants to select one of the following based on their own personal observations for each of the statements. The researcher assigned the following values to those options: 0 = never, 1 = seldom, 2 = sometimes, 3 = frequently, and 4 = always. For the first statement in this line of survey items, participants were asked to state their observations for the following, “At WRS, I have personally observed teachers who treat students differently based on race, ethnicity, gender, or other similar factors.” For this statement, participants had a mean pre-survey values of 1.58 and mean post-survey value of 1.25 ($t(11) = 1.8$, $P = 0.1$) (Table 5.7), showing that there is a mean value between the anchors of ‘seldom’ and ‘sometimes’ with the statement. Additionally, a paired t-test was conducted for the difference in means and showed that there was no significant difference found ($P < 0.05$) for participants pre- and post-PD program. This meant that overall, their observation level with regard to the statement did not change over the course of the implicit bias program. The researcher believes, based on comments from at least three participants during the focus group, that this reveals that for these participants, they were previously aware that some WRS faculty and staff are not treating students equally, quiet possibly as a result of implicit biases.

The second statement in this section of the survey was “At WRS, I have personally observed advisors who treat students differently based on race, ethnicity, gender, or other similar factors.” For this statement, participants had a mean pre-survey values of 1.42 and mean post-survey value of 1.08 ($t(11) = 1.8$, $P = 0.1$) (Table 5.7), showing that there is a mean value between 'seldom' and 'sometimes' with the statement. Additionally, a paired t-test was conducted for the difference in means and showed that there was no significant difference found ($P < 0.05$) for participants pre- and post-PD program. This meant that overall, their observation level with regard to the statement did not change over the course of the implicit bias program.

The final statement in this section of the survey was "At WRS, I have personally observed non-teaching school adults (deans, administers, counselors, *etc.*) who treat students differently based on race, ethnicity, gender, or other similar factors." For this statement, participants had a mean pre-survey value of 1.67 and mean post-survey value of 1.42 ($t(11) = 1.4$, $P = 0.2$; Table 5.7), showing that there is a mean value between 'seldom' and 'sometimes' with the statement, closer to "sometimes" compared to the two previous statements. Additionally, a paired t-test was conducted for the difference in means and showed that there was no significant difference found ($P < 0.05$) for participants pre- and post-PD program. This meant that overall, their observation level with regard to the statement did not change over the course of the implicit bias program.

These three final statement items of the survey were brought up in the final focus group, following the synchronous sessions of the PD program and will be discussed in detail in this section. It should be noted here briefly that the participants felt that the non-teaching school adults were observed to exhibit this type of negative or biased treatment more often than teachers and advisors.

Table 5.7

Pre- and Post-Implicit Bias Survey Results

Implicit Bias Survey question	*M* (Pretest)	*Mdn* (Pretest)	*SD* (Pretest)	*M* (Posttest)	*Mdn* (Posttest)	*SD* (Posttest)	*T*-test t(11)
1. Are you familiar with implicit bias?	2.08	2.00	0.29	2.33	2.00	0.49	-1.9
2. I have a preference for White people on the implicit association test (IAT).	0.17	0.00	0.83	0.08	0.50	1.31	0.2
3. I believe the IAT is invalid.	-0.58	-0.50	0.67	-0.58	-1.00	0.51	0
4. Racial disparities do not exist in the US educational system.	-1.92	-2.00	0.29	-1.92	-2.00	0.29	N/A (No change)
5. Gender disparities do not exist in the US educational system.	-1.58	-2.00	0.51	-1.67	-2.00	0.49	0.6
6. Advisors/teachers treat all students the same, no matter what "group" they belong to at WRS.	-0.75	-1.00	0.62	-1.08	-1.00	0.51	2.3*
7. WRS is a fair and equitable and provides "blinded" education.	-0.83	-1.00	0.72	-0.83	-1.00	0.39	0
8. At WRS, I have personally observed teachers who treat students differently based on race, ethnicity, gender, or other similar factors?	1.58	2.00	0.51	1.25	1.00	0.62	1.8
9. At WRS, I have personally observed academic advisors who treat students differently based on race, ethnicity, gender, or other similar factors?	1.42	1.50	0.67	1.08	1.00	0.79	1.8
10. At WRS, I have personally observed non-teaching school adults (deans, administration, counselors, etc.) who treat students differently based on race, ethnicity, gender, or other similar factors?	1.67	2.00	0.49	1.42	1.00	0.79	1.4

Note. *$p < .05$

Open-Ended Implicit Bias Awareness Survey Data. Participants of the intervention were asked two post-PD program implicit bias awareness questions, one a 'yes' or 'no' question and one an open-ended question asking participants to provide specific examples of an increased knowledge of implicit bias might be incorporated into their work with students in the classroom or with academic advising (Appendix G). The first question, asking participants directly if the PD program increased their knowledge of implicit bias, 12 out of 12 selected 'yes' or 100%. The open-ended question provided insight into how those participants planned to use this increased awareness of implicit bias in their classrooms. There were generalized responses to this question, but also a few very specific responses from the participants. One participant mused that the PD program "helped me understand what it is and where it is in my life without me realizing it. Now, that I have more awareness I see it more often in daily life, which has helped me to adjust my actions." Another participant contemplated, "I wonder what subtle behaviors I may have while I'm in my class that show a bias for or against my students based on their characteristics. This does feel like awareness is the first important step though I haven't quite determined what my next step would be." Finally, one participant said that they appreciated "even just general acknowledgment and consistent challenging of that bias helps in curbing it."

Specific comments were shared as to how this new, increased awareness of implicit bias could be used to change how the participants teach and advise. One participant shared their new goal of a "continual task to try to slow down and evaluate interactions and decisions while trying to better consider perspectives other than my own." Another STEM educator said they planned to "increase the representation of voices I use as examples in my classes, and to be very intentional about how I show people 'doing science.'" Another said they planned on using a "random 'warm calling' on pairs of students to avoid bias in calling on students. And, self-auditing personal recommendations for [AP STEM] course by gender, race, and ethnicity." Warm calling is the practice of posing a question to the entire class and then letting students practice their answers to that question in small groups or pairs before being called on randomly by the teacher. Another participant shared that they had previously "done an audit of my grades based on race and gender for a span of five years." This same educator stated, "it's time to do another. I realize that I need to do a better job of supporting students who are underperforming." One participant exclaimed that they "already have! *Yay!* I have had discussions, and used certain role-playing examples taken from our course, to teach my [students] about implicit bias." Another shared plans to help them "review my engagement strategies and find patterns in who I engage with in class to make sure that I am better serving a wide variety of students." Finally, one participant shared that they plan to "incorporate a wider range of voices in the materials read, used, and discussed to their courses. And, I want to regularly ask students individually if they personally connect with the work we are doing and respond to feedback accordingly."

Implicit Bias Awareness Reflective Journal Data. Participants were asked to reflect on their experiences with both the IATs for gender and race/ethnicity and their experiences in the specific PD sessions given specific prompts (Appendix E). The researcher used an inductive coding in order to develop emergent themes from these reflective journal responses. Themes were developed using both the reflective journal entries participants were asked to complete for both the IAT tests as well as the session-specific reflective journals (Appendix E). The researcher developed two emergent themes relevant to research question 3: heighted awareness to implicit bias (Figure 5.3) and a call to action to attempt to mitigate the negative and harmful effects of those biases in the classroom and advising (Figure 5.4).

Heightened Awareness of Implicit Bias. Using the participants' responses from the pre- and post-IAT and session-specific reflective journals, the researcher developed the theme of a heightened awareness of implicit bias, specifically addressing research question three, an awareness of implicit bias as it pertains to gender issues (Appendix E). The theme was developed by the researcher through inductive, in-vivo codes from the participants' reflective journal entries (Figure 5.3). Repeatedly, participants mentioned their awareness of the existence of implicit bias in general as well as implicit bias specific to gender, but they also reflected on the fact that this PD program allowed them to elevate their thinking around the concept of gender implicit bias. One participant shared that their "awareness is much greater than before starting this PLC. Awareness is key to growth in many areas, and hopefully, this awareness becomes something even bigger for our community." Another acknowledged that while they had "been thinking about these ideas for a few years now" that "this PLC definitely gave me a clearer sense of my implicit bias against women in science through taking the gender and science IAT." Someone else wrote that their "awareness has definitely become much greater than it was before. As before this I didn't think about this much (and likely acted in ways that were biased without realizing it)." Another participant reflected that "I still have implicit bias. It doesn't mean I'm not a good person, it just means that I need to make a continued effort to challenge my bias on a daily basis in everyday situations." Finally, one participant shared that they believe that "trainings like this PLC are essential and should be part of everyone's life!" While many of these comments suggest the role this intervention played on increasing their awareness of their own implicit biases, they also indicated that a specific focus on the types of biases, in this case gender, was particularly important to help focus the impact of this specific intervention and its session topics.

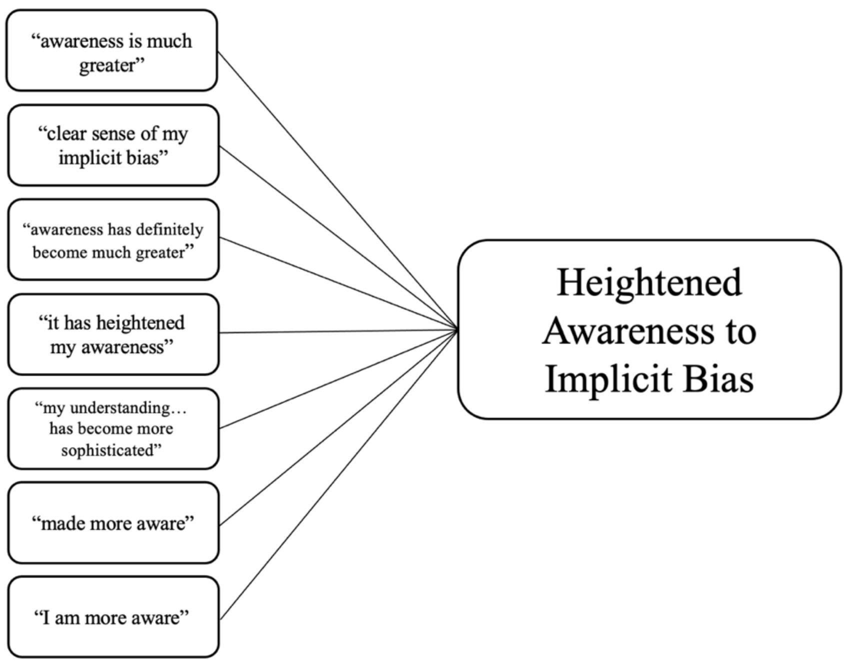
Multiple participants credited the IAT gender-science test as a tool that helped to solidify what they already suspected in regard to their own gender implicit biases. Another shared their reaction to the results of the gender-science IAT emphasizing their feelings in written form by saying, “I truly feel like I am *NOT* a biased person; however, the way the questions on the test were asked, and the thought process behind my answers, I can see here the ***IMPLICIT*** part of the bias comes in.”

Reflecting on the gender-specific sessions, other participants shared that materials, activities, readings, and videos helped them to dig deeper into the concept of gender bias. One participant said that they were “not aware that there were so many ongoing and completed studies of gender-specific implicit biases. That being said, I am not surprised by the findings, as I have been an advocate for women in many supposed ‘male’ areas of athletics and academics.” A different participant reflected that “it's impossible to take this [PD program] without feeling that you have some semblance of implicit bias; sort of like having guilt! That being said, it has heightened my awareness tremendously by reading the studies and really having it soak in.” Two other participants discussed the effect of watching the *New York Times*’s mini-film entitled *High Heels, Violins, and a Warning* (Reshamwala, 2016). One said, “I certainly found the orchestra tryouts interesting. The ‘click’ of the high-heels seems like such a subtle thing but it set the tone for the performance evaluators.” Another said that they specifically recalled “the example of the men and women auditioning for classical music positions, and how the intervention to mitigate bias required not just a screen between the performer and the evaluators, but also required that everyone take off their shoes so the evaluators couldn't hear the click of high heels. Fascinating how subtle the cues can be that illicit bias.” Another participant noted that it was not that they were just now learning about gender bias, but rather their thinking had become more nuanced and heightened. They shared, “I don't think the idea of gender bias, especially gender bias in STEM, feels new to me. If anything, this may be one of the first forms of bias that I have become familiar with. I think overall and over the course of many years, my understanding of various forms of bias has become more sophisticated." One male participant shared how shocked he was at how recently his female STEM colleagues had been experiences gender biases, saying coworker had "started working at [redacted university] in 1987... that's crazy that this stuff was all happening so recently?!?!?" Finally, another participant said that they had "been aware of this as a problem, and I have seen manifestations of it before, so I had a foundation that has made the examples less surprising. I do appreciate that I am being made more aware of them, having this underlined and reinforced, than in the past. I hope that this will help me to diffuse some of the power of my own implicit biases going forward." As demonstrated by their responses, many participants noted that during this intervention they learned how nuanced and subtle implicit bias as it relates specifically to gender-issues can be.

One really interesting side to this theme comes from a few female participants in the PD program. They provide a perspective from one side of gender bias issues that their male counterpoints did not share in their journals. One female participant shared that she thinks "because I have spent so much time thinking about and reading about these topics, I wasn't overly surprised by any examples we saw. The one study that stands out is the one that showed how attitudes changed (or didn't) after a year of being separated from the implicit bias training." Another female participant stated that she thought it was "interesting to confirm (through the IATs) that I don't have implicit biases based on gender in STEM. I've always thought this because I grew up in a household of strong female scientists, but it's been interesting to confirm it." She also said that even though her IAT score revealed she did not have gender-science bias against females, she did "think it's been really important and interesting to think about it in different contexts. It's often now on the front of my mind when I evaluate situations and I think that is good no matter what!" Finally, another female participant said that "even though I have been doing a lot of self-work around implicit bias, have read countless articles and books, and think about and challenge my own biases often....*I still have implicit biases!*"

Figure 5.3

Quotations Supporting the In-Vivo Codes to the "Heightened Awareness to Implicit Bias" Theme for Gender



A Call to Action. Using the participants' responses from the pre- and post-IAT and session-specific reflective journals, the researcher developed the theme of a call to action in order for participants to deal with the increased awareness of their own implicit biases as well as the potentially harmful effects they can have on those around them, especially their students. The researcher developed this theme through inductive, in-vivo codes from the participants' reflective journal entries (Figure 5.4). Six of the 12 participants specifically mentioned multiple times that that their responses to an increased knowledge of implicit bias and gender issues made them feel compelled to act in ways to mitigate the harmful effects of those biases. Some of their responses called for personal actions and others mentioned how they could bring in those around them into the conversation about gender-specific implicit bias.

All the PD participants described how the gender-specific implicit bias work affected them personally. The researcher used the reflective journal prompts to ask them to reflect on their reactions to the examples of gender-specific implicit biases from the PD session and to discuss how their awareness of their own implicit biases changed or evolved over the course of the PD program (Appendix E). One participant said that, “obviously, this course impacted me to always be thinking about bias and how I can be better about inclusivity, respect, and care for others.” Another wrote that they are “working on recognizing my biases so I am more aware when they pop up. I hope to redirect the socialization of these biases by creating more meaningful relationships.” Another pointed to one of the articles participants were asked to read. They said, “I was intrigued by the one article’s assertion that naming implicit bias and bringing it to our attention can solve it. That seems sensible to me: just like a bad habit, if we are made aware of the unconscious, we can marshal our efforts against it to make change." This same participant said they would like to continue to work on dealing with their implicit biases. They mused, “it might also be useful to schedule in some ‘implicit bias booster shots’ of articles or reading at regular intervals in order to refresh and revive my awareness.” Not only were participants acknowledging their increased awareness of these biases, they were also suggesting that in order to maintain their awareness they needed to continue to engage with the concepts of implicit biases on a regular basis

The reflective journals allowed the participants to deeply consider how this session affected their thinking. One of the participants shared:

> Having the issue put into the foreground like this has made me more likely to question my assumptions and to be more deliberate about approaching a student or situation with an open mind. It does become part of my planning process and my self-questioning process when interacting with students, which I think is valuable. Having the cover pulled back and taking time to think about it in the PLC has made it easier for me to incorporate these habits into my own practice.

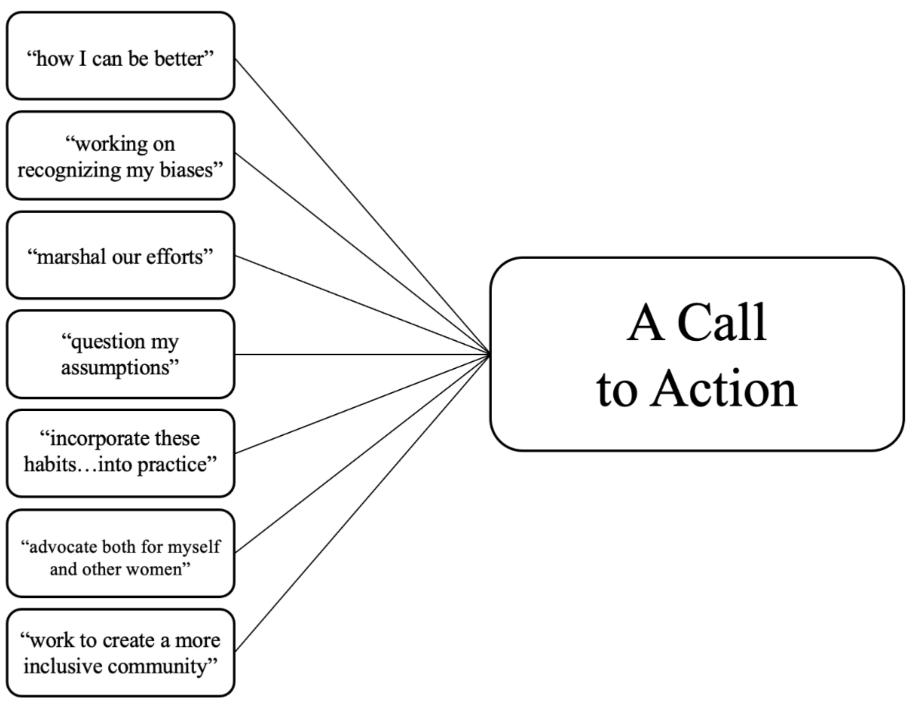
Another acknowledged that they have “always been aware” that her upbringing played a role in the way she viewed herself and others, but that she was “finally taking the time to shove those views beneath a lens and really examine them has felt good from a personal development standpoint.” Another shared plans for how they want to mitigate their biases. They said that they “continue to try to be more conscious of the thoughts that I have and why I might be having them, and (as I’ve always done) I continue to advocate both for myself and other women/minorities in my classes and field.” Another acknowledged that they realized that it was going to “revisit these ideas [gender specific implicit bias] regularly to keep them in the front of everyone's minds.” These responses also suggest that having the opportunity to reflect on the lessons learned in the intervention was another critical component contributing to their increased awareness.

There were also responses that indicated by incorporating both an inward-looking call to personal action and an outward desire to include others in the action participants would like to take to mitigate or reduce implicit biases. One participant acknowledge that they felt “surprised that I get annoyed at the bias that we read/watched but I shouldn't be. I know it is there.” They did not just stop there; this person went on to say that “rather than being annoyed I'm ready to find ways to help reverse the bias. Maybe just in myself and my family by educating ourselves more. Maybe these small acts will then continue with the interactions of my children. That might be a grand idea, but at least it brings out awareness and that is important." Another STEM educator shared that they were not actually surprised to learn about the gender biases shown in the PD session give they were in the STEM field for years. They did say that it was "still rough to spend time discussing about/hearing about at length. It's the sort of thing that feels so fixed in our society, and I feel like I don't really have any good solutions to it. With that in mind, I think it's important to consciously surround oneself with people who also care about this and are actively working to eliminate their biases, and (as a teacher) also work to create a more inclusive community and space in order to better level these biases for younger folk." Another participant shared that they were "having more discussions about implicit bias outside of this PLC. I find myself talking about it with my husband and kids more as well as my neighbors when" they get together to socialize. Finally, another shared they had been doing their own "outside reading of the scientific literature around the implicit association test and its uses." Additionally, they noted that they "assign stories of people in science from under-represented backgrounds to my classes and read those stories myself. Sometimes I facilitate discussions in [my classes] about those scientists. I also teach a unit on under-represented people in science in [class]."

Finally, participants also spoke specifically about calling others to the work of increasing awareness and working to reduce the harmful effects of gender-specific implicit bias. One educator said that he has been "encouraging [my students], as well as my wife and daughter, to embrace what they love without worrying about the bias that may exist—whether it is sports-related, in the classroom, or in the workplace." One participant said they did not feel as if they had "serious gender-based biases. But I see them out there." They shared a story about witnessing others' "blatant" gender biases and lamented not speaking up at the time, but vowing to do so the next time it occurred. Finally, another participant wrote about how they want to approach and reach out to others "who automatically get defensive and or feel attacked when asked to think about or challenge their own implicit bias." They inquired "how do we get people to see that implicit bias does not equal bad person? How to encourage people to be curious and to question their own thoughts/beliefs while not feeling ashamed?" These statements show that not only are the participants acknowledging their own or others' gender biases, they want to take this work a step further and work to reduce their harmful effects.

Figure 5.4

Relationship of In-Vivo Codes to the "A Call to Action" Theme for Gender



Awareness of Racially/Ethnically-Based Implicit Bias (RQ4)

The fourth research question also focused specifically on the outcome evaluation portion of the study. It asked how participation in the implicit bias PD program impacts the participants' awareness of their own implicit biases about race/ethnicity in science performance. The researcher used pre- and post-PD program implicit bias surveys, pre- and post-IAT reflective journals, as well as PD program race/ethnicity-specific session reflective journals to address the question as to how participants' awareness of implicit bias may have been impacted by their work in the intervention. The subsequent paragraphs will describe the findings of each of how the participants' awareness of their implicit biases towards the influence of race/ethnicity in science performance was impacted.

Implicit Bias Awareness Survey

The participants in the PD program were given the same pre- and post-intervention survey that focused on their awareness of implicit biases (Appendix E) that was used to for research question three. Because the majority of the questions were used to answer both research questions three and four, a more concise description of the findings will be reported here with the exception of the race/ethnicity specific questions. Finally, the researcher will also summarize the findings from the one open-ended survey question from the post-intervention survey below.

Implicit Bias Awareness Survey Data. Most of the relevant questions were reviewing for research question 3, with the exception of one. For the statement, "Racial disparities do not exist in the US educational system," participants had both mean pre- and post-survey values of -1.92 (Table 5.7), showing disagreement with the statement (Mdn = 2.00 and SD = 0.29). Because both the pre- and post-survey values were identical, a paired t-test was not conducted because there was no change in participants' responses post-PD experience. This meant that their disagreement with the statement did not change over the course of the implicit bias program.

Implicit Bias Awareness Open-Ended Survey Questions. The majority of these responses were described in the previous section for research question three's findings. Many of the participants noted their intentions of combining their increased awareness of both gender and racial/ethnic biases in how they were planning to address those issues in their classrooms. Specifically, one participant was deeply reflective and specific in their response regarding race/ethnicity. They shared:

> For me, a lot of this work is about awareness. Reminding myself to slow down, take the perspective of other people, ask questions of myself to challenge my thoughts/biases, educating myself on successful black people and their contributions as well as women in science (and incorporating that information into my classroom to share the knowledge and make connections to make science more human (so kids see the link between science and society!). I'd also love to expand my network (professional and friendships) to live in more diverse circles, be exposed to a broader range of people and ideas and backgrounds, and develop more lived knowledge from experiences and interactions rather than just reading/learning about black culture and only famous people of color.

Participants shared a resounding "yes" to the question of whether or not this program increased their knowledge of implicit bias. Additionally, the participants were able to apply concepts from the race/ethnicity-specific portion of the PD sessions to point to as evidence of specific increased awareness around race/ethic-specific biases.

Implicit Bias Awareness Reflective Journal Data. The PD participants were asked to reflect on their experiences with both the IATs for gender and race/ethnicity and their experiences in the PD sessions given specific prompts (Appendix E). This section will address the overall awareness of implicit bias as well as the specific responses to implicit bias and race/ethnicity in order to address research question four. The researcher developed three emergent themes from the reflective journal data, a continued acknowledgement of implicit bias, a heightened awareness of implicit bias, and a call to action.

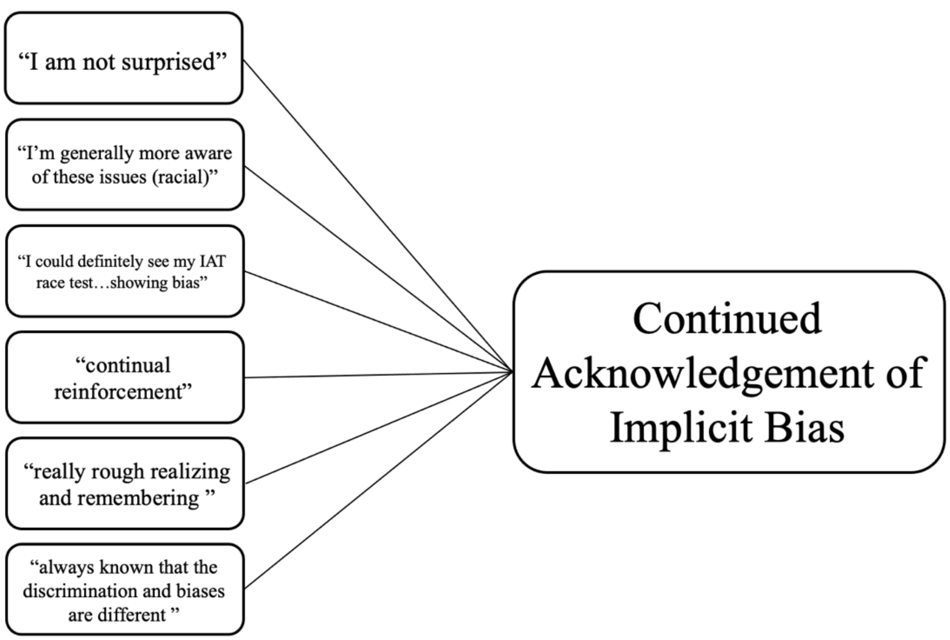
Continued Acknowledgement of Implicit Bias. Using both IAT reflective journal entries and session-specific journal entries, the researcher developed the theme of a continued acknowledgement of implicit bias as it pertains to race/ethnicity (Figure 5.5). Unlike the reflective journal entries for implicit bias and gender, the researcher noted that many participants acknowledged that racial/ethnic implicit biases exists and that many of them were previously aware of their own specific racial/ethnic biases to some degree. This theme differs from a heightened awareness because participants shared that they had a greater previous awareness of their racial/ethnic biases compared to their gender biases. One participant even mentioned that, "regarding race, I'm not in love with the results from my IAT but I am also not surprised." Another participant explicitly stated, ahead of the IAT tests, that they "could definitely see my IAT race test showing implicit bias about diversity in STEM." One participant noted the pain associated with discussing bias and shared that "It's always really rough realizing and remembering the differences between my own life and others. And I definitely think race is one instance where these differences become so clear to me." Many participants shared with the researcher, outside of the PD sessions, that they also believed that racial/ethnic biases appeared to be a bigger priority for the WRS community as a whole over gender-specific issues around bias. This continued acknowledgement of implicit bias as it pertains to race/ethnicity in the intervention program hints to what many appear to be what faculty and staff are experiencing in the broader WRS community.

One participant acknowledged and discussed their own identity as it related directly to the work done during the race/ethnicity-specific PD session. They stated that "my race is something that's always been a big part of who I am and how I identify—especially in more recent years. That said, I have always known that the discrimination and biases I face as an (…)

are very different than those felt and experienced by Black people in the US." Finally, another pointed out that they felt as if the race/ethnicity-focused PD session was "the most useful session for" them. They subtly acknowledged their previous experience with racial/ethnic biases and pointed to a perceived strength of the intervention, "I also appreciate the continual reinforcement that anti-bias training is an ongoing/always thing—Not a one-time thing." These reflections also remind the researcher that there is nuance in implicit bias work as it pertains to race/ethnicity and that continued work is necessary for a sustained change in awareness and, potentially, behavior associated with these biases.

Figure 5.5

Relationship of In-Vivo Codes to the "Continued Acknowledgement of Implicit Bias" Theme for Race/Ethnicity



Heightened Awareness of Implicit Bias. Using the participants' responses from the pre- and post-IAT and session-specific reflective journals, the researcher developed the theme of a heightened awareness of implicit bias, specifically addressing research question four, an awareness of implicit bias as it pertains to racial/ethnic issues (Appendix E). The theme was developed by the researcher through inductive, in-vivo codes from the participants' reflective journal entries (Figure 5.6). Compared to the awareness around gender biases, participants seemed more willing to share their acknowledgement of racial/ethnic biases, especially as it related to the work many were committed to doing outside of this intervention program. With that said, they also mentioned how this program, its activities and media materials, helped them elevate their thinking around the concept of implicit bias and race/ethnicity, the urgency of what this meant to them as educators (teachers and advisors), but also as human beings in general.

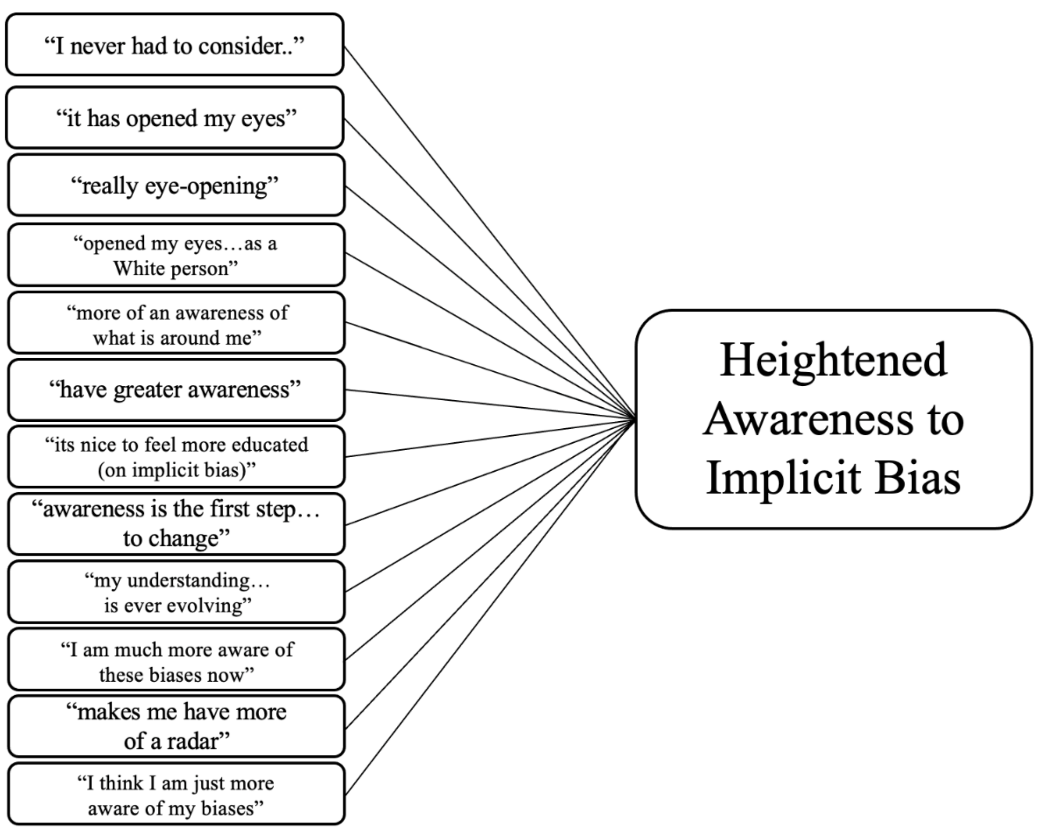
Some participants pointed to specific activities or media materials to reflect on how their awareness of racial/ethnic biases were something they want and need to be centered in their lives. One noted that a short clip from the televisions show *The Office* was quite "'cringy'...but so true probably for so many people!" (Quotation referencing The Office, 2008). The participant shared their "ah-ha" moment in their journal. "It confirms the notion in your mind that all dolls are...white. And we just unconsciously accept that!" One commented on a "particularly memorable" video shown by Starbucks to their employees (Now This, 2018). This participant reflected, "some of the participants describing their experiences felt particularly impactful because they were describing many considerations they make every day when entering a store *etc*., that I have never had to consider." One participant said that the race/ethnicity session was "really eye-opening" for them. They pointed to the Baratunde Thurston TED Talk and shared that they thought the speaker "was amazing and opened my eyes to how we have to reframe the way we think and restructure the sentence. I need to watch that again and more people should watch this to have a greater awareness." These examples reinforce the powerful nature of perspective-taking in the intervention activities of the PD program.

Other participants said they appreciated the varied examples, not pointing to one specific activity, reading, or video. One spoke generally saying, “the more examples I see, the more likely I can make connections in the future when the concepts of implicit bias are out of the context of this DEI-focused PLC, but happening around me.” Another stated that just enrolling in this intervention helps to elevate the important of implicit bias in their daily lives. They said that they left feeling “more of an awareness of what is around me, and what is always taken for granted.” Another concurred, saying, “I think I am just more aware of my biases and the tools I have at my disposal to confront them. Again, I also appreciate the reminder that I need to be forever thinking about them!” Another participant acknowledged the impact of the intervention on their thinking saying, “even as a person of color myself, I definitely grew up with biases against other groups of people, and although it’s something I’ve always been aware of, I’ve never taken concrete steps past that to truly combat those biases. I think I’m much more aware of these biases now and better understand where they come from.” Participants acknowledged the need and desire to continue their own work as an extension of what they were learning and taking away from the intervention PD program.

As previously stated, many reflected on the fact that while racial/ethnic implicit biases were something that had been on their personal radars for some time, the reminders and interactions provided by this intervention heightened their thinking about how different folks experience these biases. One participant shared that they “hope this has helped me be a better teacher but ultimately a better person.” They noted that “this awareness is the first step to being able to change things from a personal level.” Another stated that “in general, my reaction was one of gradual, incremental increasing knowledge about a topic I have thought a fair bit about.” One participant felt that “from an educational standpoint, it's nice to feel more educated on the term ‘implicit bias’ itself so that I better understand the larger societal conversation we are all participating in.” Another also said that while they have “previous knowledge of implicit bias and have been doing work for several years around this topic” they felt like their “understanding or connection to the work is ever evolving.” They stated that they felt like “each video I watch or every discussion I have changes the nuance of my understanding of it or how I reflect in my or life or how I interact or think about it.” Finally, one participant was quite blunt stating that the intervention “has opened my eyes to the fact that there are a lot of things I don't need to worry about as a white person. As a woman, I have my own set of fears or struggles, but a Black person has so many that I will never have to even think about.”

Figure 5.6

Relationship of In-Vivo Codes to the “Heightened Awareness of Implicit Bias” Theme for Race/Ethnicity



A Call to Action. As in research question three, the researcher used the participants' responses from the pre- and post-IAT and session-specific reflective journals, the researcher developed the theme of a call to action. As the above themes show, the participants have both previous and current awareness of both the existence of and potentially harmful effects racial/ethnic biases can have on their students and society in general. They also mentioned, in many ways, that their responses to an increased knowledge of implicit bias and racial/ethnic issues have made them want to act in ways to mitigate the harmful effects of those biases. One interesting observation the researcher had was that the reflections participants had with regard to their action steps for racial/ethnic implicit biases was they included exclusively 'I statements' compared to the gender-specific reflections which had both personal and global calls to action. In other words, they seemed to easily connect with the sense of urgency for their personal responsibilities with regard to any implicit biases around race/ethnicity. When it came the gender-specific implicit biases, some definitely recognized they might hold those types of biases, but many seemed to attribute gender inequalities and biases to the broader society's problem and not necessarily a problem they themselves were perpetuating.

The participants were both deeply reflective of this shared theme of a call to action for both the gender and racial/ethnic implicit bias topics. The researcher also noted that participants seemed to share even more specific actions they were already or wanting to take in their journals. Some of the actions were broad while others were quite specific in their applications. Some even went as far as sharing they had prioritized racial/ethnic biases over gender biases. One STEM educator stated that, believing they had a handle on gender biases, they were "pretty focused on racial implicit biases at the moment. I have diversified my social media and I regularly seek out stories by and about POCs as I try to integrate them into my curriculum. I'm generally more aware of these issues and thinking about them as I design activities for my classes."

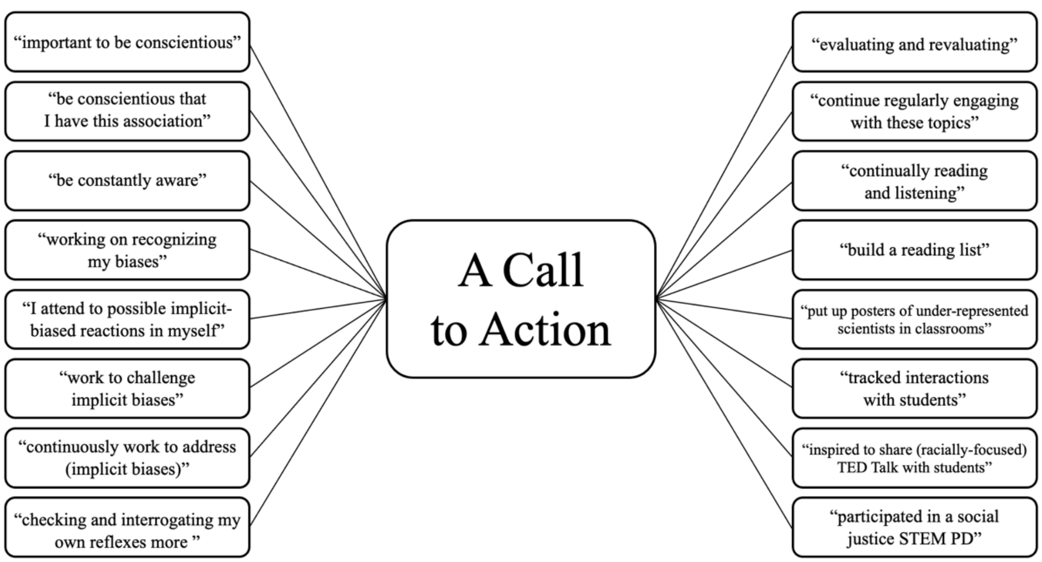
Generally speaking, many participants shared how they would like to center this new, heightened awareness of their implicit and work to act differently as a result. As stated above, some of those actions were describe in the broad sense, while others were quite specific. More generalized actions include states that are focused on how the participant plans to be **"**be conscientious" that they have certain implicit associations and "constantly aware of how it is impacting my [their] interactions with students," as one participant shared. Another echoed those sentiments by writing that they "don't question in any way the need to be aware of our implicit biases in all things that we do. I think this is especially important in the classroom and in how we interact with students." Another said that the awareness of these specific biases brought forth from the IATs and the intervention activities and conversations have made them "have more of a 'radar' in regards to actions and words of others, as well as myself. One participant mentioned that they are working on recognizing my biases so I am more aware when they pop up." These comments acknowledge a need to use the heightened awareness they have for potential, future events. Another shared that they had been focusing on their classroom actions as a result of participation in the intervention program saying, "I find that I attend to possible implicit biased reactions in myself during my classroom interactions more so now than before the PLC." One participant cited a specific [Verna Myers] TED Talk shown during the race/ethnicity-specific session stating that it was a "great reminder of how to work to challenge implicit biases" (Myers, 2014). They went on to say that the PD work has "has me re-energized to keep working with my own kids at home; including them in conversations and even challenging them to ask questions about their own thoughts/comments/questions."

Others centered their call to action on deep personal reflection and opportunities for introspection. One participant said that because of the intervention program, they have been "definitely checking and interrogating my own reflexes more, thinking about what I immediately think about other drivers based off of identity markers, the feelings I see when walking my dog at night and encountering a passerby, and how I might be responding according to stereotypes and bad assumptions. I am not always impressed with my implicit biases, but it has been valuable to reflect on them." Another said that they have recognized that there is a nuanced difference between the experiences of some people of color. This participant shared their race/ethnicity and then stated their experience "versus being Black in America really are two very different experiences, and it always makes me evaluate/re-evaluate the ways in which I'm much more privileged than others." Finally, this participant shared in their reflective journal following the race/ethnicity-specific session that they "started thinking a bit more about this since our last session, and I think one of the best solutions for me is to simply continue regularly engaging with these topics. Staying informed as to what's currently happening both in the U.S. and around the world, and reminding myself that my biases exist so as to continuously work to address them, *etc*."

As mentioned above, many participants shared that even after the first few PD sessions that they started to make changes in their behaviors, some were quite specific about what they were choosing to do. One participant was so moved by a [Baratunde Thurston] TED Talk (Thurston, 2018), that they showed it to their students as they realized it paired nicely with their current unit. The participant exclaimed, "our [students] loved the video, and it spurred a wonderful conversation about race and biases!" Many participants shared that they have been doing a lot of "reading and podcast listening" or hoping to build "a reading list to work on this summer." Another shared that they had just "participated in a PD about social justice in science recently." One participant mentioned that they start to use "randomness to 'warm call' on pairs to avoid bias." They also shared that they because tracking their "interactions this year with students when I pulled individuals aside to recommend them for the next advanced course in [the subject]." That same educator also mentioned that they had "students put up posters of under-represented scientists in the classroom." Finally, one educator stated that they "have some work to do in terms of expanding both my friend group, and my cultural awareness."

Figure 5.7

Relationship of In-Vivo Codes to the "A Call to Action" Theme for Race/Ethnicity



Self-Efficacy as It Pertains to Academic Advising (RQ5)

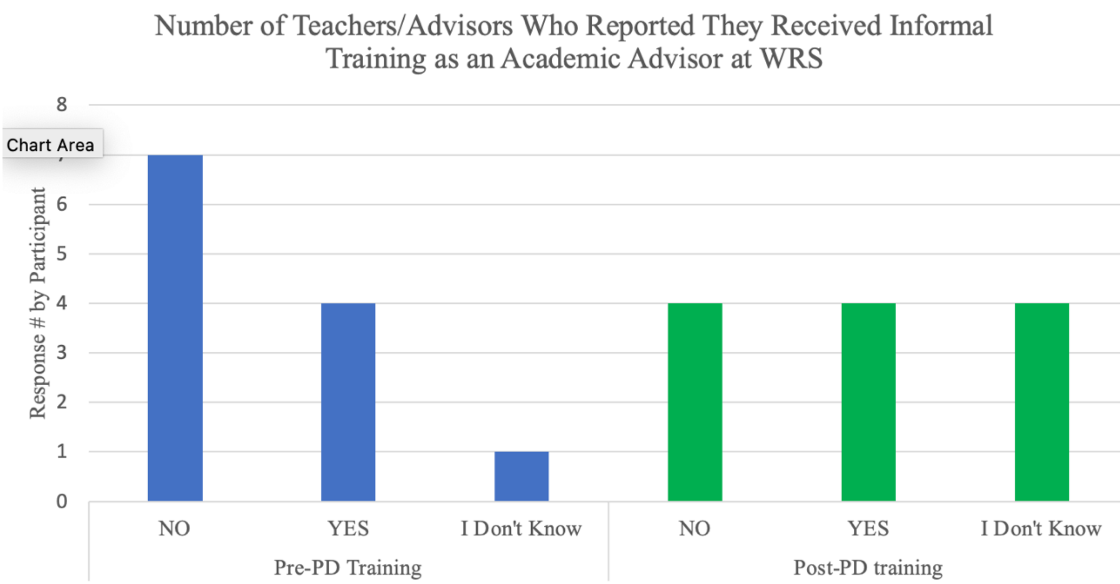
The fifth and final research question also focused specifically on the outcome evaluation portion of the study. It asked how participation in the implicit bias PD program impacted the participants' self-efficacy as it related to the academic advising of students. The researcher used pre- and post-PD program self-efficacy surveys and the post-intervention focus group to address the question as to how participants' advising self-efficacy may have been impacted by their work in the intervention. The subsequent paragraphs will describe the findings of each of these measurements.

Self-Efficacy Survey

Participants were given a self-efficacy survey before the PD program began and another following the final synchronous session (Appendix H). Both the pre- and post-self-efficacy surveys showed that 100% of the participants have not been formally trained as academic advisors before or during the PD program. Additionally, participants were asked, pre- and post-PD program, if they had been informally trained as academic advisors (Figure 5.8). Of the 12 participants surveyed before the PD program began, seven reported they had not received any informal advisor training at WRS, four said they had, and one said they did not know. Participants were not given a description by the researcher as to what constituted informal advisor training at WRS, but rather left that to each participant to define what informal training meant to them. It is important to note that WRS does not currently have an in-house advisor training program. Any formal training advisors would have received would have been outside of the WRS context.

Figure 5.8

Number of Faculty who Reported They had Received Informal Training as an Academic Advisor at WRS



Participants were asked directly if they felt confidence in their daily roles as academic advisors at WRS (Appendix H). They were asked to respond to their level of agreements with two separate statements. The questions from the pre- and post-self-efficacy survey used a 5-point Likert scale. The researcher assigned the following values: -2 = strongly disagree, -1 = disagree, 0 = neither agree nor disagree, 1 = agree, and 2 = strongly agree. For the first statement, "I am confident in my daily/weekly abilities to perform the duties of a WRS academic advisor," participants had a mean pre-survey value of 0.33 (Mdn = 0.00, SD = 0.89) and 0.08 (Mdn = 0.00, SD = 1.00) for the post-survey (Table 5.8). A paired t-test showed no difference of means ($t(11) = 0.9$, P = 0.4) for participants pre- and post-PD program; meaning that their slight agreement with the statement did not change over the course of the PD program.

The second statement, "I am confident in my daily/weekly abilities to give enrollment advice to my advisees at WRS in my role as their academic advisor," participants had a mean pre-survey value of 0.08 (Mdn = 0.00, SD = 0.90) and 0.33 (Mdn = 0.50, SD = 0.98) for the post-survey (Table 5.8). A paired t-test showed no difference of means ($t(11) = -0.7$, P = 0.5) for participants pre- and post-PD program; meaning that their slight agreement with the statement did not change over the course of the PD program.

Table 5.8

Pre- and Post-Self-Efficacy Survey Results

Self-Efficacy Survey statement	*M* (Pretest)	*Mdn* (Pretest)	*SD* (Pretest)	*M* (Posttest)	*Mdn* (Posttest)	*SD* (Posttest)	*T*-Test *t*(11)
1. I am confident in my daily/weekly abilities to perform the duties of a WRS academic advisor.	0.33	0.00	0.89	0.08	0.00	1.00	0.9
2. I am confident in my daily/weekly abilities to give enrollment advice to my advisees at WRS in my role as their academic advisor.	0.08	0.00	0.90	0.33	0.50	0.98	-0.7

*p < .05

Post-Intervention Focus Group

This section will address the overall response to the focus group questions pertaining to self-efficacy as well as the specific responses their experiences in the PD program in order to address research question five. The researcher developed a single emergent theme from the focus group questions for self-efficacy as simply efficacy. Additionally, it is important to recognize the researcher's development of an important, inductive theme, of advising system dysfunction. This theme was developed as a result of casual comments made by participants throughout the intervention program as well as repeated comments made by all five focus group participants. As stated explicitly these participants, the theme of advising system dysfunction truly over ran their ability to apply what they were learning in the intervention specifically to their role as academic advisors. Thus, it was difficult for the researcher to truly account for changes participants might have that relates directly to their self-efficacy as academic advisors. Finally, the inclusion of these findings in relation to the theme of advising system dysfunction allowed the researcher to share the participants' priorities with how they chose to apply what they learned from the intervention PD program, rather than simply force an inaccurate narrative of the findings for research question five.

As stated in the quantitative data above, the PD participants were asked to share their feelings around self-efficacy as it relates to their role as academic advisors at WRS in a post-intervention focus group with specific prompts (Appendix I). (Figure 5.9).

Efficacy. The five participants of the post-intervention PD program were asked four specific self-efficacy questions during the focus group (Appendix I). While focus group questions around participant awareness of implicit bias, in general, garnered a resounding "YES" from participants, the topic of participants' self-efficacy as it pertained to their role and duties as academic advisors at WRS was not so apparent. In fact, participants were more hesitant to agree with the notion that their self-efficacy was impacted by the participation in this PD program.

The focus group participants were first asked if they felt that participation in the PD program changed their self-efficacy around advising at WRS and if so, could they elaborate that point. One participant was quite straightforward in saying that they did not "know if I really thought about my role as an advisor in this at all" during the PD sessions. Another said it was more about how they approached their participation in the PD sessions and shared that "this might be just how I was thinking about it when I was in there, but I think I had more 'Ah-has' about my classroom than I did about advising. There were definitely things like in my action plan like I have things in there I am gonna do in my classroom but maybe not specifically around advising." They shared specifically how they approached the PD program and found, potentially, what they learned would be more applicable in their STEM classrooms. Another participant opened the door to why that might be the case, but was extremely hesitant at first saying "umm…never mind, you're recording this." The researcher assured the participant that their participation in the focus group, and their responses, would be anonymous. This participant went on to say that their responses to this specific prompt was potentially altered because they felt like their "current role as an advisor" at WRS feels "ill-defined" that that was "part of the reason why I have a hard time thinking about how this could help my advising." This comment was met with repeated "yeah, yeah," "this," and "I agree" statements from all the other focus group participants. Another participant shared that as a former, but not current advisor, that they "never really thought of the difference between teaching and advising" and that they considered them "kind of the same." They also said that the "separation between advisor and teacher" for them "never even really crossed my mind." They shared that they would "frame my mind" the same no matter which role they might be playing. Many others in the room agreed, showing that their general efficacy as educators might be higher, but when asked specifically about advising, they had lower self-efficacies in that specific role due to unclear or poor defined expectations of the role from the WRS administration.

The second question posed to the focus group asked participants if they believed that their work in the PD program had them feeling more confident in their conversations with advisees around course enrollment, and if so, could they provide examples. One more veteran STEM teacher posed their frustration by asking what appeared to be a rhetorical question, "what is the role of the advisor???" This caused others to nod in agreement. One said, going to back what another participant had mentioned previously, "I do have advisees that I will kind of help with course enrollment, but I still feel like the bulk of course enrollment-like conversations have been with the dean and happen with their teachers and others first." Like "parents" another participant offered. The first participant agreed and also shared "because conferences are so late." Meaning, the academic conferences advisors have with students prior to course enrollment have been scheduled for the same week, if not day, in which course registration is due for students; leaving little to no time for advisor-advisee conversations. Another blatantly said that "so if the role of the advisor was more advising, then yeah, I do think this [PD program] would help me navigate those conversations." They went on to say that "but I don't feel like I have those conversations very often with advisees. I have them with students, right," citing specific conversations with STEM students and enrollment discussions.

The researcher interjected a clarifying question to the focus group participants asking if their roles as advisors were more in-line with what one thinks as a traditional academic advisor to be, then perhaps would the PD program be more beneficial for them. Participants reacted in the affirmative. One said, "I would say and again, this isn't so much about your training but rather if the role of the advisor was more clearly defined by the school in terms of…I don't think the way the current system is set up" puts the advisors at the top who students seek enrollment advice from at WRS. This comment was met with non-verbal agreement around the focus group room and mirrors much of what was stated in the chapter two needs assessment findings. It appears that the role of the academic advisor at WRS is not seen by the community as a true academic advisor, but perhaps more as a homeroom teacher or, as one participant put it bluntly, a "glorified babysitter."

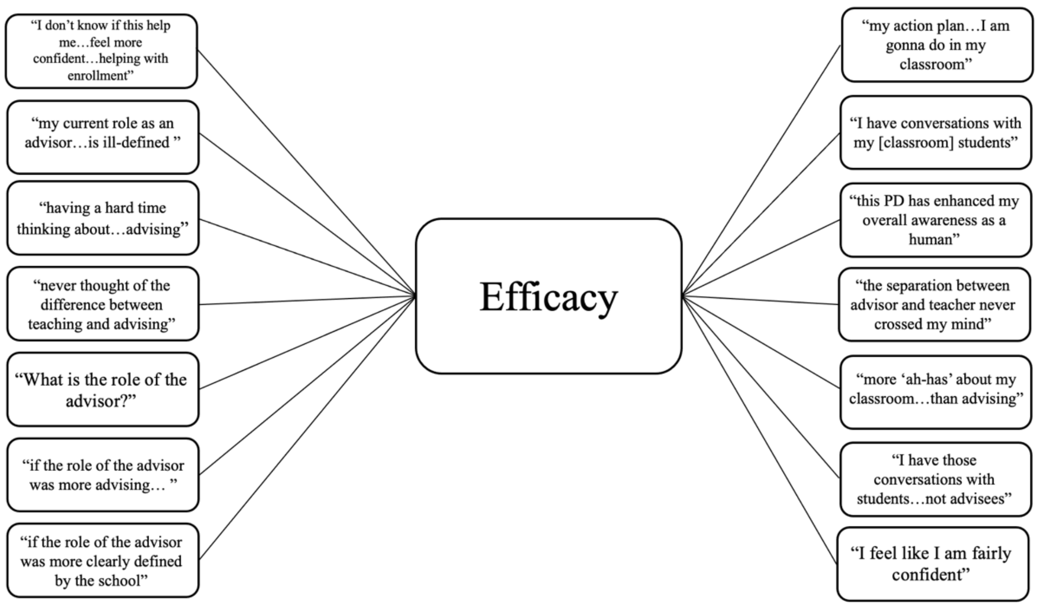
Finally, focus group participants were asked to share what aspects of the PD program they believed were most and least helpful as it pertained to increasing their self-efficacies. Many participants spoke of what they were taking away from the intervention as the most helpful aspects. One participant said that they did not know if they would "categorize that it's helping me as a teacher or an advisor" but they felt like the "PD has enhanced my overall awareness as a human." They went on to say that the program benefitted them by simply "having a greater awareness" and that has "helped me think about the things I say, that I do, the thoughts I have and the judgements I probably have" and that "the awareness is just incredible." This shows that while this participant might not have approached the PD program thinking myopically, just about advising, they are applying their new awareness to their overall efficacy around the concept of implicit bias.

Other participants shared their overall feelings from the PD program as the most helpful to them in terms of increasing their general efficacy. One said that they though the "biggest thing is just yet another reminder (immediate) to not go with my initial response, to slow down." Four others agreed by responding "yeah, and pausing" or simply nodded in agreement. Another said they planned to "try to broaden my perspective and draw on ideas that there may be different issues for different folks. And I think that's my life's work." Others even mentioned that they are "fairly confident" that they "don't have a bias in terms of guiding or assuming one kid is going to follow" a specific academic path. This is another example of general efficacy in terms of personal biases that they might apply to their classrooms or advising conversations.

With regard to overall self-efficacy as it relates to the academic advising of their students, the PD program seems to not have had the impact the researcher was intending. Specifically, the researcher had designed the intervention program to acknowledge both the roles these influential community adults play at WRS, teacher and academic advisor. The way the PD program participants seemed to approach the intervention appears to be more holistic. An important indicator of this findings is something that became clear during the focus group. The participants shared with the researcher that they felt they personally have been doing the important work around WRS's DEI goals. They noted that their participation in this PD program was just another piece of this important work overall, but not necessarily specific to their roles as academic advisors. Additionally, the concerns they expressed were for others in the community. Participants said what could improve the PD program is "getting people who don't sign up for it to take it. Another said, "yeah, yeah…I was gonna say, having people who aren't in this room to take it." Another mentioned the implicit bias survey specifically sharing that they were "doing one of the surveys and I noticed that, when it was asking about awareness and it started out with teachers, and then advisors, and then it went to administration, my perception was," that "you could graph it" another jumped in and used their arm to indicate a downward trend. The first participant said yes, a "definitely downward graph. That those folks who are assigning us [teachers and advisors] to do a lot of the work are the ones who need to do a lot more work."

Figure 5.9

Relationship of In-Vivo Codes to the "Efficacy" Theme for the Post-Intervention Focus Group Questions Around Self-Efficacy



Discussion

Completion of Intervention Professional Development Activities (RQ1)

A critical method for addressing the validity of a research study and its findings is to ensure the fidelity of implementation (Stufflebeam, 2003). This intervention used a series of methods to safeguard the implementation of the PD program. The researcher used attendance records, Use surveys, and completion records of specific PD activities, such as the Harvard IATs and reflective journals, to ensure that the planned intervention was presented as described in chapter four. Additionally, the researcher adhered to the pre-established number of synchronous and asynchronous sessions, which further helps to provide a relationship between the PD program and its intended outcomes for the study's participants.

The intervention PD program was designed to introduce participants to the concept of implicit bias in general and specific instances of implicit bias as it pertains to gender, race/ethnicity, and the intersectionality of the two and its effects on science performance. FitzGerald et al. (2019) showed that implicit bias PD programs focused solely on identification of biases would fail to bring about lasting change in adults. Thus, the program was designed to incorporate opportunities to both learn what implicit bias was, what, if any, individual biases participants had, but also introduce strategies that can be used to mitigate the negative effect the biases can have on people. Research has shown that PD programs that allow for those types of participant opportunities were considerably more effective for seeing longer-term benefits of bias reduction (Batchelor et al., 2019; Glock et al., 2013; Moss-Racusin et al., 2018).

Findings from the intervention PD program show that in addition to high attendances records, participants also had high completion rates of pre-planned intervention activities such as the Harvard IATs for gender-science and race, Use surveys, and reflective journals. Even when not all participants were not able to attend the final synchronous session, Use survey results showed that they were still able to access all intervention PD session materials as well as complete the associated activities as if they had been present. These findings suggest that participants were completing the intervention PD programming at high rates as designed by the researcher prior to the intervention.

Engagement With Intervention Professional Development Activities (RQ2)

While research question one addressed the use of the intervention PD program's materials and activities, research question two set out to determine how participants engaged with them. The high completion rates of both the Engagement surveys and the personalized process plans showed that participants were engaged with these components of the intervention. Additionally, participants reported feeling very engaged to highly engaged throughout the entire program, including both the synchronous and asynchronous sessions. One participant noted that they had selected ‘moderately engaged’ on their survey for the final synchronous session only because they were not able to attend the session in person and completed the program’s activities on their own. They lamented the potential engagement of their peers around the session’s topics as their reason for selecting ‘moderately engaged.”

Participants also shared that the topics that were most engaging throughout the intervention PD program centered around three themes, the ability to experience the perspectives of others, to have opportunities for reflection, and to experience an increased awareness of their biases that lead them to a call to personal action. Participants even suggested during the focus group that they wished the intervention PD program would have run much longer than the eight sessions and that it should be a required program for all of WRS’s faculty and staff. Many compared the length of this specific intervention PD program to the typical one-day PD programs at WRS as a reason why they felt more engaged. Many stated the length gave them the opportunities to reflect with their peers, but also time between the synchronous sessions to reflect on their own.

Awareness of Gender- and Racially/Ethnically-Based Implicit Biases (RQ3 & RQ4)

Research questions three and four focused specifically on how participants’ awareness of implicit bias changed throughout the intervention PD program as it pertained to both gender and race/ethnicity and their influence on science performance. Implicit bias awareness surveys and reflective journals were used to collect information as to how the participants’ awareness changed from the beginning of the PD program. Survey data showed that participants appeared to be familiar and aware that implicit bias, both gender-based and racially/ethnically-based, was something that WRS was not immune to, but also did not show significant change in that awareness over the course of the intervention. With that said, the number of intervention PD program participants (N = 12) was small, thus a change in awareness might not be able to be detected given the small sample size. Analyzing the qualitative data, in the form of reflective journals, allowed the researcher to incorporate participant voice and hear directly from the teachers and academic advisors themselves. Survey results showed that all participants stated their implicit bias knowledge had increased as a result of participation in the intervention study. Specifically, the participants felt that both the gender and race/ethnicity sessions lead to both a heightened awareness of implicit bias and a call to action to reduce the potential, negative effects that implicit bias can have on students, especially female students and students of color.

One interesting finding was the theme of acknowledgement of implicit bias as it pertained to race/ethnicity, but not gender. The findings suggest that the participants were previously aware that they might have implicit bias around the concept of race/ethnicity or they expected their IAT results to show they had that bias. Many participants, though, did not believe they exhibited any, or very little, gender-specific biases before completing the IATs or other PD program activities from the gender-specific sessions. This has led the researcher to conclude that the participants exhibited a heightened awareness of the importance of taking stock of their own implicit biases, especially since many did not believe they might have gender-based biases prior to completing the Harvard IATs.

Self-Efficacy as It Pertains to Academic Advising (RQ5)

The findings of whether or not the educators' self-efficacy was impacted by their participation in the intervention PD program was less clear compared to their awareness of implicit bias. Both the quantitative and qualitative data show that while the participants all agreed their awareness of implicit bias had increased as a result of the intervention, they were less confident that their self-efficacy, as it pertained to their role as WRS academic advisors, had been impacted. Specifically, they noted, especially during the post-intervention focus group, that while they had relative general efficacy in their roles as educators, their lower self-efficacy around their roles as academic advisors had more to do with the unclear expectations of that specific position. Many had shared that because WRS lacks any formal development of academic advisors, that they had not centered their learning and attention during the PD program to apply to that specific role. Many participants cited that their increased awareness and knowledge of implicit bias, gained from the intervention, would help them to be better educators, but had not specifically thought about how it would affect their role as advisors since they felt their roles had been changing over the years and they had less of an impact on their advisees' academic choices. Finally, multiple participants noted that if WRS truly created opportunities for academic advisors to have a more formalized advising role that they could see benefits of this specific intervention for those advisor-student interactions.

Implications of the Study's Findings

First and foremost, this dissertation's study has shown that WRS is not immune from the attrition of girls from specific STEM subjects as demonstrated in the needs assessment findings. Additionally, it is important to acknowledge that both the needs assessment and intervention study has shown that WRS faculty who serve as academic advisors feel as if that specific role is ill-defined as it stands currently. Many believe that academic advisors do not have the opportunities to help support and encourage girls and underrepresented students to pursue their STEM interests in meaningful ways. While the participants in the intervention study acknowledged the valuable opportunity the PD program provided them, they noted the need for more programs that could offer similar experiences. Specifically, the intervention study has shown that many WRS faculty and staff are asking for more opportunities for in-house professional development focused on the support of students by way of continued implicit bias work. Many participants commented on their desire to continue their own personal growth and deep reflection into gender and racial/ethnic biases, but also expand that work to include other areas of bias, such as socioeconomic status and LGBTQ+ biases. Multiple educators also shared that they would appreciate if WRS administration would reexamine the role of academic advisors. Specifically, many stated the need for a more formalized program that would include an advisor handbook, carefully arranged calendar schedules to allow for true academic counseling prior to course enrollments, and mandatory academic advisor development programs, especially for newly hired educators.

As it pertains to implicit biases, participants of the study also shared that having an extended PD program, such as the intervention program, was highly beneficial for them. They noted that while WRS has brought in some amazing facilitators over the years, that having single-day PD sessions did not afford participants the time for deep and meaningful reflections or the opportunities to put into practice all the things they had learned in those workshops or PD programs. One even mentioned that the “spray and pray” in-service days were just that. They got faculty and staff excited and motivated to make meaning changes, but ended as quickly as they started and were ultimately either forgotten or pushed the bottom of many participants ‘to do’ lists.

Finally, this dissertation study has given the researcher a starting point for further research opportunities at WRS. The participants of the program shared, during the post-intervention focus group, that they believe all faculty and staff should participant in mandatory PD programs focused on implicit bias. Additionally, future research could include exit interviews and surveys of graduating students or young alumni and their experiences at WRS as they pertain to the role faculty and staff played on their support as they pursued STEM elective courses, and potentially, the pursuit of STEM majors and, eventually, careers.

Strengths and Limitations of Study

It is imperative to acknowledge that with every research study, there comes both strengths and limitations. While the design of the intervention study was methodically strong, based on a solid literature review of implicit bias intervention studies, there were ultimate threats to the validity of the study's findings. The most important threat to the validity of this study's findings was the sample size of the PD program. The researcher had opened the intervention to the entire faculty and academic advisors at WRS, but ultimately only had 12 participants fully complete the PD program. As a result of a small sample size, the researcher was limited in the type of statistical analysis of the quantitative data to make any specific inferences (Creswell & Plano-Clark, 2018). Thus, the researcher relied on both descriptive and simple inferential statistics for the quantitative data and blended the qualitative data of the 12 participants in both the PD program itself and the post-intervention focus group. As a result, the quantitative data should be interpreted cautiously considering the small sample size of the intervention and in conjunction with the themes developed from the qualitative data when looking holistically at the study's overall findings.

The researcher chose this mixed methods approach to this intervention study because the contemporary problems of attrition of girls from STEM electives at WRS does not " fit neatly in a purely qualitative or purely quantitative methodology" (Lochmiller & Lester, 2017, p. 212). The use of this mixed methods research paradigm represents a strength of the study's design as it is ideal for investigating educational problems such as this. The researcher's use of this quasi-experimental design to address the complex problem of the role that faculty's implicit biases may have on the enrollment of underrepresented students into elective STEM courses was deliberate and intentional. If the researcher would have chosen a singular evaluation method of the intervention outcomes, that could have caused the researcher to misinterpret the results (Creswell & Plano Clark, 2018; Johnson & Onwuegbuzie, 2004). The use of both quantitative and qualitative data has provided a more comprehensive evaluation of this specific intervention PD program.

Finally, another limitation of the overall study was the length of time in which the participants spent in the intervention PD program. Many of the participants stated they appreciated the time spent in both synchronous and asynchronous sessions compared to typical WRS teacher preparation programming around DEI (diversity, equity, and inclusion) topics, eight 90-minute sessions over a matter of weeks are seen as just scratching the surface of what quality and meaningful professional development programs need to encompass. According to Jovanova-Mitkovska (2010) meaningful and effective professional development should include "daily professional and personal growth teacher" and is "a long, continuous process that starts from the beginning of preparation for the profession and continue until the end of life" (p. 2925). Ideally, this specific intervention PD program would have been offered over an entire academic school year, providing some space between the sessions for more personal reflection, but due to some constraints of covid-19 protocols and the PLC format at WRS, the study was offered over a shortened timeframe.

Another strength of the researcher's design was the acknowledgement of her role in the dissertation study. In a study that focused on the implicit biases of gender, race/ethnicity, and the intersectionality of the two, it is vital to consider the researcher's positionality. From the creation of the intervention program itself, to the analysis of the qualitative data, a researcher's positionality must be stated in order to increase the trustworthiness of the findings and conclusions of the study (Milner, 2007). An important reason for this is to "bring to researchers' awareness and consciousness known (seen), unknown (unseen), and unanticipated (unforeseen) issues, perspectives, epistemologies, and positions" (Milner, 2007, p. 394). For these stated reasons, the researcher felt the need to include a positionality statement in order to strengthen the findings of this intervention study.

Researcher's Positionality Statement

It is important to acknowledge that the researcher is both a STEM educator and academic advisor at WRS. For this intervention program, she not only served as the primary researcher, but she also developed and facilitated the sessions in the PD program. In addition, she has been teaching and advising at WRS for the past 16 years. That means that while she does know the context well, she, too, may have experienced similar feelings to her colleagues with regard their concerns around the need for a formal advisor training program for WRS. While she does not hold a position of power over any of the study's participants, it is important to acknowledge that many are her colleagues in WRS's Science Department or have advised alongside her for years.

The researcher has been committed to anti-racist and anti-sexist educational and personal practices for the past 27 years. She is a member of WRS's formal DEI (diversity, equity, and inclusion) team. With that said, she acknowledges her position as a cis-gendered, straight white female comes with innate biases. In order to address these very real concerns, she felt it important to make certain that her voice did not dominate the program's activities, videos, or readings. Those activities and materials were deliberately selected to include voices of the people who most often experience the negative effects of unchecked biases. She felt strongly about developing a program that centered the voices of those most impacted by implicit bias, while simultaneously acknowledging the fact that she, too, possess implicit biases of her own. She held herself to the same group norms as the PD participants (Appendix L), and even timed how much of the PD program time was used sharing her voice over the voices selected in activities, videos, and readings, making sure hers was significantly less than others. Lastly, the researcher kept a journal of reflexivity throughout the intervention study and during the analysis of findings. This practice afforded the researcher an opportunity to better understand the research questions of the intervention program, the data as it was being collected, and the researcher process itself (Watt, 2007). It also allowed the researcher to "reflect about themselves in relation to others and to acknowledge the multiple roles, identities, and positions that researchers and research participants bring to the research process" (Milner, 2007, p. 394). The reflexivity journal allowed the researcher to bring those multiple roles into focus for both the progress of the intervention program and the analysis and interpretation of the findings.

When focusing on issues of gender and race/ethnicity, it is important to use intervention materials that push participants to have courageous conversations, demonstrate various perspectives, and elevate the voices of those who traditionally and often are left out (Singleton & Linton, 2006). In this intervention, the researcher was very deliberate in her decision as to whose voices she brought into the program. Specifically, she chose to include activities created by women, gender non-binary folks, and people of color, TED Talks, and other videos to elevate others' experiences, and create opportunities for both deep, personal reflection and courageous conversations with other participants of the program. Finally, at the start of each synchronous session, the facilitator reminded participants of the established norms for safe and meaningful interactions, based on Singleton and Linton's (2006) courageous conversations model (pp. 58-65), but also adjusted to fit the context of WRS (Appendix L). These norms helped to focus the participants on their own experiences and share with one another in a way that elevated respect for the working being done in the synchronous sessions. The researcher acknowledged that, in her role as program facilitator, she was responsible for maintaining the norms, though she noted that she never once has to correct participants' behavior for any violations. The researcher noted that WRS has recently been working towards a culture that upholds norms such as those presented to PD participants (Appendix L). Finally, the researcher also hypothesized that these specific participants were already quite familiar with the established norms because of previous DEI-focused work, both at WRS and outside of the school, considering that the participants self-selected into this specific PD program.

Recommendations for Future Research at WRS

The findings of this research suggest numerous potential future research studies. The most obvious of all would be a school-wide implicit bias PD program that would include all of WRS's teachers and academic advisors, but also non-teaching staff. This could serve as an expanded evaluation of WRS, considering this current study was limited to just 12 teachers and academic advisors. There are obvious and urgent reasons why faculty would benefit from this type of intervention study, specifically their close working relationships with students and their ability to impact students' science performances. Additionally, other non-teaching staff have interactions with students that could affect science performance, perhaps not always directly but potentially indirectly. Those WRS staff could include counselors, deans, college counselors, and librarians, to name just a few. The researcher notes that, if this PD program were to be conducted on a larger scale at WRS, then she would assign a specific person to be responsible for norm adherence throughout the duration of the program. In order for academic institutions to move beyond compliance to fully embracing diversity, equity, and inclusions, schools must determine and adhere to community norms that create an inclusive environment that promotes learning for all (Williams et al., 2005). Additionally, the researcher is considering adding an amendment to her original IRB application to reconsent the 12 participants so she can use their personalized process plans as qualitative data for a deeper dive into how they plan to make changes to classroom or advising behaviors as a result of participating in this PD program.

Finally, research studies that investigate the role that implicit bias among their own peers would be of high interest to the researcher considering that students spend the majority of their time at school with their classmates. Those interactions could very well influence whether or not students choose to persist in their STEM education at the elective level.

This dissertation's needs assessment focused on STEM course enrollment and gender, comparing required to elective course enrollment. Another potential area of research would be to investigate disparities in the enrollment of AP and honors level courses for both gender and race/ethnicity at the high school level. Additionally, perhaps a study could be designed to track science-preference and science-interests in WRS students as early as the middle school grades through high school graduation.

One important point brought up during the post-intervention focus group was the development of a 'part two' of sorts for this intervention PD program. A participant suggested that in recent years there has been a high-value placed on diversity, equity, and inclusion (DEI) initiatives at WRS, but that it appears to be hyper-focused on racial/ethnic-based topics. While that is obviously important, they suggested that WRS needs to work on issues facing LGBTQ+ folks even more so, as they believe there is lower awareness of these topics among the faculty and staff.

Finally, both the needs assessment and the intervention study reveal that there is a sense of frustration from the faculty that the advising program at WRS is in desperate need of an evaluation, and, potentially, a formalization process. At minimum, the participants shared their desire for a more formalized description of the role academic advisors have at WRS, including a list of their duties and responsibilities. One focus group participant even suggested the creation of an advisor handbook, as to better inform advisors of their official role. The results of both the needs assessment and the intervention's focus group, specifically, suggest that while WRS teachers feel confident in their role as educators, they feel less confident in their roles as academic advisors. The researcher suggests further investigations into the role that academic advisors currently play at WRS and the support students receive (or not) from advisors as to strength the role they could play for students, especially underrepresented STEM students.

Conclusions

There are significant and well-documented gender gaps in STEM fields at many levels (Beede et al., 2011; Kanny et al., 2014; Sax et al., 2017). The disparity has been noted in both STEM interest and formal STEM education for girls and underrepresented students. It is a well-recognized phenomena and does not appear to improving, nationally and at WRS (Iskander et al., 2013; LaForce et al., 2019; Miller & Hurlock, 2017; Sadler et al., 2012; Sublett & Gottfried, 2017). As investigated in the literature review of chapter 1, studies have shown that the intersectionality of gender and race simply amplifies this disparity, especially for African American/Black women (Charleston et al., 2014; Johnson, 2011). While this specific dissertation study is not focused the specifics of intersectionality, it is an incredibly important for research to investigate the impact of the intersectionality of gender and race in STEM areas such as high school elective enrollment, major selection at the university level, or representation in STEM careers.

As many researchers have noted, the attrition of students from the STEM pipeline is one of the primary causes of this gap (Boedeker et al., 2015; Xu, 2008; Xu, 2017). This dissertation has focused on the role that high school STEM elective coursework and influential community adults can have on the attrition of students from the STEM pipeline. Specifically, the intervention PD program focused on the potential and harmful effects that implicit biases, as they pertain to gender and race/ethnicity and science performance, can have on students as they consider course enrollment.

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Appendix A

Semi-Structured Interview Questions

Semi-structured interview questions for influential adults regarding student enrollment decisions:

- Can you explain the role you play in supporting students during their course enrollment decisions? Can you give me an example of a recent experience when students ask for your advice about enrollment?
    - How frequently do you feel like students solicit your advice/expertise/opinions regarding course enrollment?
- In your experience, what factors do you think students consider when they are making decisions regarding classes which they plan to enroll in for the following term? Can you give me any examples from recent student conversations?
- How do you make the decisions for the recommendations you give to students? Could you identify and explain the three biggest factors you consider?
- Can you describe a situation when you encouraged a student to enroll in (a) STEM course(s)?
- Can you describe a situation when you felt you needed to discourage a student's desire to enroll in (a) STEM course(s)?
- Can you tell me some ways that you have encouraged students to also discuss enrollment with other adults, either on campus or off?
- Do you find that you are getting one type of student that that consistently seeks enrollment advice and if so, can you please describe that type of student?
- Can you describe a classic student that you struggle to recruit in your field?
- Can you describe a classic student that you find that is easy/easier to recruit in your field?

- What kinds of concerns do you have about the varied advice or input students receive in regard to the courses in which they enroll in throughout their high school experience? Can you give a specific example of a time when you were concerned?
- If you could wave a magic wand, how would STEM advising be structured at our school? Or, if you prefer, academic advising in general?

Appendix B

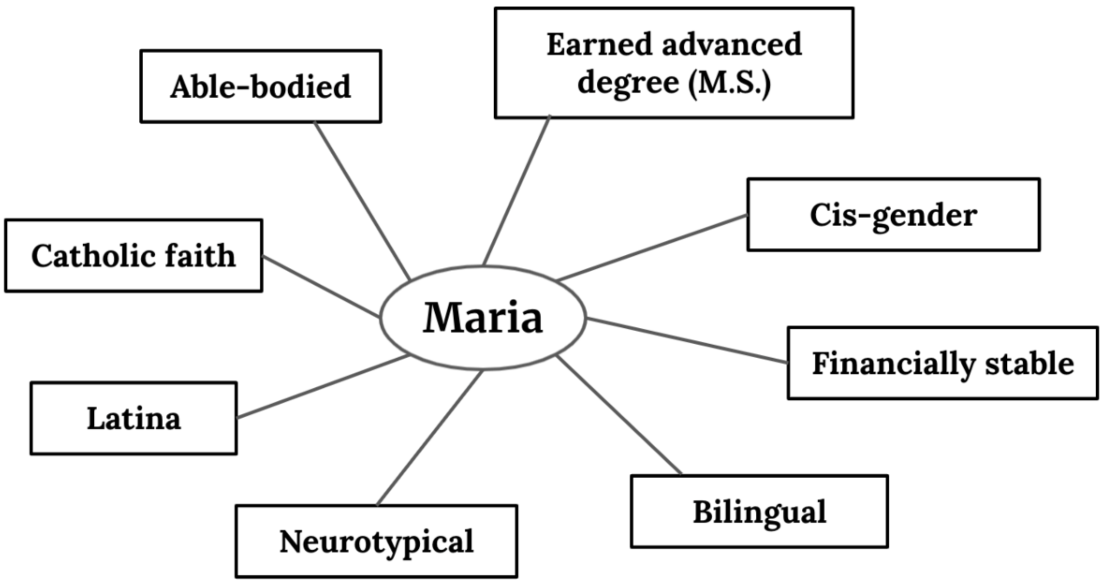
Interview Consent Script

I would like to thank you for being willing to participate in the interview aspect of my study. This research has been approved by the Johns Hopkins University Homewood Campus's Internal Review Board as well as the West Regional High School. As you might already know, my study seeks to understand the gender disparity in the enrollment of STEM elective courses at the independent high school level. Our interview today will last approximately 30 minutes. Your participation today is completely voluntary, so if there are any questions you do not want to answer that is perfectly okay. In addition, your answers and identity are 100% anonymous. Answers from your interview will be recorded with your permission, but will only be viewed by me and will be stored only on my password-protected laptop. The recording will consist of an audio file only. Are you okay with me recording our conversation today? In addition, I will take notes of our conversation, but they are also completely anonymous. Please let me know if at any point during our interview you want me to turn off the recording or keep something you said 'off the record.' Before we begin the interview, do you have any questions? [Discuss questions]. If any questions arise at any point during the interview please do not hesitate to stop me and ask.

Appendix C

Example of an Identity Map

Example of an identity map (based on a fictional PD participant):



Appendix D

PD Use Survey Questions

1. For today's PD, I attended:

A. The entire session.
B. More than half of the session.
C. Half of the session.
D. Less than half of the session.
E. I did not attend today's PD session.

2. For today's PD session, I listened to or viewed the materials presented during the session:

A. I was able to listen to or view all the materials presented in today's session.
B. I was able to listen to or view more than half of the materials presented in today's session.
C. I was able to listen to or view half of the materials presented in today's session.
D. I was able to listen to or view less than half of materials presented in today's session.
E. I was not able to listen to or view any of the materials presented in today's session, as I was not present.
F. I did not attend today's PD session; therefore, I did not listen to or view any of the materials presented today.

3. For today's PD session, I was ***able to access*** the materials presented during the session **or** on Canvas:

A. I was able to access all the materials presented in today's session.
B. I was able to access more than half the materials presented in today's session.
C. I was able to access half the materials presented in today's session.
D. I was able to access less than half the materials presented in today's session.
E. I was not able to access any of the materials in today's session even though I was present.
F. I did not attend today's PD session and I did not access any of the materials presented today (through Canvas or any other means).

Appendix E

Reflective Journal Prompts

Reflective Journal Entry #1 (Session 1):

Prompt A: Pre-Implicit Bias Test (adapted from Gonzalez et al., 2021)

*The IAT is an interesting tool to help educators become more aware of their own unconscious assumptions and beliefs. Prior to taking the IAT for gender-science and for race, discuss what results you **expect** to see after you complete the 1) gender-science IAT test, and the 2) race IAT test.*

Prompt B: Post-Implicit Bias Test (adapted from Gonzalez et al., 2021)

The IAT is an interesting tool to help educators become more aware of their own unconscious assumptions and believes. Take the IAT for gender-science and for race. Take a screenshot of your results and past them into your google doc entitled "Reflective Journal 1" located in your personalized Google folder. Discuss your reaction to your results compared to what you expected your results to be. Include in your journal how you think your results might have an impact on your work as an academic advisor/teacher.

Reflective Journal Entry #2 (Session 2): Implicit Bias Testing Post Gender-Specific PD Sessions (researcher-developed):

1. *Today, I define implicit bias as…*
2. *Reflect on your reactions to seeing examples of gender-specific implicit biases in the PD session's materials (i.e. videos, activities, and/or readings).*

3. *Reflecting on your experiences with these gender-specific training sessions, how has your awareness of your own implicit biases changed or evolved?*
4. *Describe any work that you are doing related to implicit bias* ***outside*** *of these training sessions.*

Reflective Journal Entry #3 (Session 3): Implicit Bias Testing Post Race/Ethnic-Specific PD Sessions (researcher-developed):

1. *Today, I define implicit bias as…*
2. *Reflect on your reactions to seeing examples of race/ethnic-specific implicit biases in the PD session's materials (i.e. videos, activities, and/or readings).*
3. *Reflecting on your experiences with these race-specific training sessions, how has your awareness of your own implicit biases changed or evolved?*
4. *Describe any work that you are doing related to implicit bias* ***outside*** *of these training sessions.*

Reflective Journal Entry #4 (Session 4): Implicit Bias Testing Post Completion of the Intersectionality-Specific PD Sessions (researcher-developed):

1. *Today, I define implicit bias as…*
2. *Reflect on your reactions to seeing examples of intersectionality (gender and race/ethnic)-specific implicit biases in the PD session's materials (i.e. videos, activities, and/or readings).*
3. *Reflecting on your experiences with these intersectionality-specific training sessions, how has your awareness of your own implicit biases changed or evolved?*
4. *Describe any work that you are doing related to implicit bias* ***outside*** *of these training sessions.*

Reflective Journal Entry #5 (Session 4):

<u>Prompt A</u>: Pre-Implicit Bias Test (adapted from Gonzalez et al., 2021)

The IAT is an interesting tool to help educators become more aware of their own unconscious assumptions and believes. Prior to taking the IAT for gender-science and for race. Discuss what results you ***<u>expect</u>*** *to see after you complete the 1) gender-science IAT test, and the 2) race IAT test.*

<u>Prompt B</u>: Post-Implicit Bias Test (adapted from Gonzalez et al., 2021)

The IAT is an interesting tool to help educators become more aware of their own unconscious assumptions and believes. Take the IAT for gender-science and for race. Take a screenshot of your results and past them into your google doc entitled "Reflective Journal 1" located in your personalized Google folder. Discussion your reaction to your results compared to what you expected your results to be. Include in your journal how you think your results might have an impact on your work as an academic advisor/teacher.

Appendix F

PD Engagement Survey Questions

Multiple-choice Survey Questions (researcher-developed):

1. Regarding the PD session topic, Introduction to Implicit Bias, I would describe my overall engagement level as:
   A. Highly engaged
   B. Very engaged
   C. Moderately engaged
   D. Neutral
   E. Moderately disengaged
   F. Very disengaged
   G. Highly disengaged

2. Regarding the PD session topic, Introduction to Implicit Bias and Gender, I would describe my overall engagement level as:
   A. Highly engaged
   B. Very engaged
   C. Moderately engaged
   D. Neutral
   E. Moderately disengaged
   F. Very disengaged
   G. Highly disengaged

3. Regarding the PD session topic, Introduction to Implicit Bias and Race, I would describe my overall engagement level as:
   A. Highly engaged
   B. Very engaged
   C. Moderately engaged
   D. Neutral
   E. Moderately disengaged
   F. Very disengaged
   G. Highly disengaged

4. Regarding the PD session topic, Introduction to Implicit Bias and the Intersectionality of Gender and Race, I would describe my overall engagement level as:
   A. Highly engaged
   B. Very engaged
   C. Moderately engaged
   D. Neutral
   E. Moderately disengaged
   F. Very disengaged
   G. Highly disengaged

Open-ended Survey Questions (researcher-developed):

1. Please explain what components of the PD session, Introduction to Implicit Bias, captivated your engagement the most and why:

2. Please explain what components of the PD session, Introduction to Implicit Bias and Gender, captivated your engagement the most and why:

3. Please explain what components of the PD session, Introduction to Implicit Bias and Race, captivated your engagement the most and why:

4. Please explain what components of the PD session, Introduction to Implicit Bias and the Intersectionality of Gender and Race, captivated your engagement the most and why:

Appendix G

Implicit Bias Awareness Survey

Implicit Bias Awareness Survey for pre-and post-IAT attitudes related to implicit bias IAT tests and PD sessions (adapted from a survey from Gonzales et al., 2014; Okorie-Awé et al., 2021):

1. Please choose the answer that best describes your gender:
   A. Female
   B. Male
   C. Transgender female
   D. Transgender male
   E. Gender Variant/Non-Conforming
   F. Not Listed (optional fill-in)
   G. Prefer not to answer

2. Please choose the answer that best describes your race/ethnicity:
   A. Asian or Pacific Islander
   B. Black or African American
   C. Hispanic or Latinx
   D. Native American or Alaskan Native
   E. White or Caucasian
   F. Multiracial
   G. Race/Ethnicity not listed (optional fill-in)
   H. Prefer not to answer

3. I have been teaching for the following amount of time in years: (fill in years)

4. Are you familiar with implicit bias?
   A. Not familiar at all (have never heard of implicit bias)
   B. Slightly familiar (have heard of it but don't know what it means)
   C. Somewhat familiar (I have a general understanding of the term)
   D. Extremely familiar (I have extensive knowledge on implicit bias)

5. Have you previously attended PDs/seminars about implicit bias?
   A. Yes, at West Regional School
   B. Yes, outside of West Regional School
   C. Yes, both at West Regional School and outside of WRS
   D. No, I have not

6. (POST PD ONLY) Did this PD program increase your knowledge on implicit bias?
   A. Yes
   B. No

7. (POST PD ONLY) If yes, could you provide an example(s) of how you might incorporate in your work environment (advising and/or teaching)?

8. *Please answer this question in relation to how you **agree** to the following statement:* I have a preference for White people on implicit association test (IAT).
   A. Strongly agree
   B. Agree
   C. Neither agree or disagree
   D. Disagree
   E. Strongly disagree

9. *Please answer this question in relation to how you **agree** to the following statement:* I believe the IAT is invalid.
   A. Strongly agree
   B. Agree
   C. Neither agree or disagree
   D. Disagree
   E. Strongly disagree

10. *Please answer this question in relation to how you **agree** to the following statement:* Racial disparities do not exist in the US educational system.
    A. Strongly agree
    B. Agree
    C. Neither agree or disagree
    D. Disagree
    E. Strongly disagree

11. *Please answer this question in relation to how you **agree** to the following statement:* Gender disparities do not exist in the US educational system.
    A. Strongly agree
    B. Agree
    C. Neither agree or disagree
    D. Disagree
    E. Strongly disagree

12. *Please answer this question in relation to how you **agree** to the following statement:* Advisors/teachers treat all students the same, no matter what "group" they belong to at WRS.
    A. Strongly agree
    B. Agree
    C. Neither agree or disagree
    D. Disagree
    E. Strongly disagree

13. *Please answer this question in relation to how you **agree** to the following statement:* WRS is fair and equitable and provides "blinded" education.
    A. Strongly agree
    B. Agree
    C. Neither agree or disagree
    D. Disagree
    E. Strongly disagree

14. *Please answer this question in relation to how you **agree** to the following statement:* At WRS, I have personally observed teachers who treat students differently based on race, ethnicity, gender, or other similar factors?
    A. Never
    B. Seldom

C. Sometimes
D. Frequently
E. Always

15. *Please answer this question in relation to how you **agree** to the following statement:* At WRS, I have personally observed academic advisors who treat students differently based on race, ethnicity, gender, or other similar factors?
    A. Never
    B. Seldom
    C. Sometimes
    D. Frequently
    E. Always

16. *Please answer this question in relation to how you **agree** to the following statement:* At WRS, I have personally observed other non-teaching school adults (deans, administration, counselors, *etc*.) who treat students differently based on race, ethnicity, gender, or other similar factors?
    A. Never
    B. Seldom
    C. Sometimes
    D. Frequently
    E. Always

Appendix H

Self-Efficacy Survey

Self-Efficacy Survey for pre-and post-intervention as it relates directly to academic advising (adapted from a survey from Bodenhorn & Skaggs, 2005).

1. Gender:
   A. Female
   B. Male
   C. Transgender female
   D. Transgender male
   E. Gender Variant/Non-Conforming
   F. Not Listed (optional fill-in)
   G. Prefer not to answer

2. Race/Ethnicity:
   A. Asian or Pacific Islander
   B. Black or African American
   C. Hispanic or Latinx
   D. Native American or Alaskan Native
   E. White or Caucasian
   F. Multiracial
   G. Race/Ethnicity not listed (optional fill-in)
   H. Prefer not to answer

3. I have been teaching for the following amount of time in years: (fill in years)

4. Years in academic advising: (fill in years)

5. Have you been formally trained as an academic advisor at West Regional School?
   A. Yes
   B. No

6. Have you received informal training as an academic advisor at West Regional School?
   A. Yes
   B. No
   C. I do not know

7. *Please answer this question in relation to how you agree to the following statement:* I am confident in my daily/week abilities to perform the duties of a West Regional School academic advisor:
   A. Strongly agree
   B. Agree
   C. Neither agree nor disagree
   D. Disagree
   E. Strongly disagree

8. *Please answer this question in relation to the level of your agreement or disagreement with the following statement:* I am confident in my daily/week abilities to give academic enrollment advice to my advisees at West Regional School in my role as their academic advisor:
   A. Strongly agree
   B. Agree
   C. Neither agree nor disagree
   D. Disagree
   E. Strongly disagree

Appendix I

Focus Group Questions

Focus Group Questions (researcher-developed questions):

1. Do you feel that your participation in the PD program engaged you as it relates to implicit biases around gender and race/ethnicity?

2. Can you describe specific activities of the PD program that you felt were particularly engaging? Engaging meaning, you felt highly invested/involved in the activities.

3. Do you feel that participation in this PD program changed your self-efficacy around advising at West Regional School? If so, do you mind elaborating?

4. Do you believe that after participating in this PD intervention program that you are more confident in the conversations you have with advisees around course-enrollment discussions? Can you give examples?

5. What aspects of this PD program were the most helpful for you as they pertain to increasing your self-efficacy? Can you give examples?

6. What aspects of the PD program were the least helpful as they pertain to increasing your self-efficacy? Can you give examples?

7. What suggestions do you have for changing this PD program to make them more beneficial or meaningful for participants in relation to the role you play as an advisor and/or teacher?

Appendix J

Personalized Written Process Plan Example

Personalized, written process plan by Ada O'Brien (fictional participant):
"Using the online-based tool StoryBoard That, I have created a simulated interaction with a current student and advisee. She is interested in taking a STEM elective offered at WRS during her junior year. In years past, I would often speak over my student and start talking specifically about the class and what it entails. I now realize I haven't given my students enough space to talk about why they might want to take an elective, what they are interested in, what concerns they might have prior to signing up. I have decided that I will be sure to start all my course enrollment discussions with students (especially students of color and my non-male students) by asking questions first and listening intently. I have included a portion of my StoryBoard That comic strip to show a conversation with one of my advisees, Eshe…who I know LOVES chemistry but worries she might not fit in to this particular STEM elective."

Appendix K

Sample of A-Ha Implicit Bias Activities

Sampling of A-Ha Implicit bias Activities (researcher-adapted examples) Including the Tag Game, Jelly Beans, and Buffalo: The Name Dropping Game

The Tag Game researcher-adapted from Fowler and Mumford (1999) and Include-Empower (2018)

- Without giving any specific instructions, the facilitator hands out various shapes (circles, squares, stars, rectangles, etc.) in different colors that are strung onto different colors of string or ribbon to participants.
- The facilitator then tells participants simple to “group” themselves without talking.
- After groups have been formed, the facilitator asks participants to share with the group what factors each participant considered and used to determine which groups in which they thought they belonged. They also ask participants to described the reasons they might have excluded other members.
- The facilitator asks the participants if they remember the original instructions. They then share that those instructions never required the participants to use the tags as a means or requirement for grouping themselves.

Race, Ethnicity, Nationality, and Jelly Beans (adapted from Pipes, 2018)

- The facilitator gave each participant a plate full of different types of Jelly Belly jelly beans and ask them to devise a method for sorting their jelly beans.

- After participants had sorted their own piles, the facilitator asked participants to share their reasoning for sorting as they did and, if they encountered any issues with their sorting methods that forced them to adjust or even create new sorting categories for their jelly beans.
- After the discussions, the facilitator showed the video: Race, Ethnicity, Nationality, and Jelly Beans [YouTube, Pipes, 2018]

Buffalo: The Name Dropping Game (adapted from Flanagan, 2012).

- Buffalo is a high-speed card game intended to bring awareness of the unconscious bias we all have.
- The card game Buffalo has two decks of cards. The first deck consists of nouns. The second desk consists of descriptors. For example, "wizard" for the noun and "British" for the descriptor.
- The objective of the game is to quickly name a person or fictional character that fits the description on both cards before anyone else can. If you are the first to answer, you keep the cards. If no one can answer, that is considered a "buffalo" and no one earns the cards.
- When the deck runs out, the player with the most cards wins.
- The ultimate aim of the card game is to "inspire greater assertiveness in confronting social bias" (Flanagan, 2012).

Appendix L

PD Program Norms or Working Assumptions