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Review of Mentoring Manuals in STEM to Improve the Mentorship Experience for Underrepresented Minority Students Through the Lens of Social Capital and Combating Social Reproduction

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Review of Mentoring Manuals in STEM to Improve the Mentorship Experience for Underrepresented Minority Students Through the Lens of Social Capital and Combating Social Reproduction

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We should be thankful for the gifts and opportunities that life gives us. With that being said, I want to take this time to acknowledge and thank those who have supported me throughout my life. I am grateful to have wonderful colleagues, friends, and family. My experiences at University of San Francisco has been amazing because of the individuals that I met who shared their wisdom and values. The people I met over the past few years were life changing. The adventures I have taken and memories I made throughout my journey were truly unforgettable.

ABSTRACT

There is a lack of diversity and inclusion in STEM (science, technology, engineering, and mathematics) education. Students who pursue a degree in STEM, only less than half of them complete them. However, this phenomenon occurs at a greater percentage for underrepresented minority students (UMS). To combat the lack of representation in STEM, mentoring has been suggested to promote retention and minimize attrition. Mentoring provide plenty of benefits for students, as they can gain academic and professional experience. Unfortunately, mentorship of UMS is not the same compared to Asian and white students, thus different approaches and recommendations must be implemented to fit their needs.

This study focused on examining and analyzing mentoring manuals in STEM disciplines. The purpose of the study was to find suggestions directed toward underrepresented minority (URM) mentee and faculty. Five mentoring handbooks were review and assessed through the seven recommendations mentioned in *The Science of Effective Mentorship in STEMM* (Byars-Winston & Dahlberg, 2019). Bourdieu's theory of social reproduction was the framework selected for the analysis to connect the link between UMS and their acquisition of social capital.

Many of the manuals aligned with the seven recommendations, with each containing similar themes and objectives. There were lack of information regarding diversity and identity, providing limited resources directed toward URM mentees. Improvements in the structure and content can be made in future mentoring manuals for them to be more inclusive. Recommendations for underrepresented minority mentees, faculty mentors, and future mentoring manual writers were made.

CHAPTER I: INTRODUCTION:

Obtaining a STEM (science, technology, engineering, and mathematics) degree is difficult for students to complete due to their rigorous curriculum and complex subjects. Nationally, students who pursue a bachelor's degree in STEM, but less than half of them will complete them, according to a 2009 study (Wilson et al., 2012). However, minorities in STEM are in an even more desperate position, where three-fourths of them leave the program (Wilson et al., 2012). According to a 2010 statistic on science and engineering performance indicators, the percentage of African Americans completing their undergraduate degrees in STEM is increasing between 8.3 to 8.4 percent every year between 2000 to 2006(Kendricks, Nedunuri, & Arment, 2013). However, this rate has not changed as much compared to 1997, which was increasing at the rate of 7.7 percent (Kendricks, et al., 2013).

To overcome this problem, the United States needs more people in STEM careers to push innovation and increase economic growth (Estrada, Hernandez, & Schultz, 2018). Increasing the number of these underrepresented groups may improve the STEM community and industries by providing diverse perspectives and solutions to current issues that lead to new breakthroughs and innovations. One method that is used to increase retention and academic performance of underrepresented students is through mentorship.

Statement of the Problem:

Mentoring provides valuable and professional experiences for the individual, leading to growth in academic performance and success in professional career (San Miguel & Kim, 2015). For example, mentorship is well documented as a successful educational model that supports the development of early career scientists (Tenenbaum, Anderson, Jett, & Yourick, 2014).

Mentoring and undergraduate research also help retain and improve students' motivation and academic performance (Wilson et al., 2012).

Mentors help provide resources and networks for mentees to utilize, such as participating in research. Research, like mentoring, also helps improve students' overall abilities (Haeger & Fresquez, 2016). Research may provide slightly more benefits for underrepresented minorities and first-generation students due to them being exposed to participating in research, as well as getting familiar with the STEM field (Haeger & Fresquez, 2016). Both research and mentoring can retain and influences underrepresented students to further their education or career (Aikens et al., 2017).This is beneficial for students of color, who are more likely to continue their academics if they have social support from advisors, mentors, and other reinforcements (McCoy, Winkle-Wagner, & Luedke, 2015).

However, simply implementing a mentor program or having someone to watch over students is not enough to overcome the obstacles in both STEM education and careers. Guidelines and establishing healthy communication between mentors and mentees should be properly addressed. By having a mentor who can guide, motivate, and help navigate underrepresented minority students (UMS) through the rigorous courses and hidden curriculums that are present in STEM education, it can provide and prepare them a pathway for success.

Background and Need:

The current representation of women and minorities in STEM does not reflect the national population. There is an over representation of Asian and white students in the discipline (Estrada et al., 2016). According to the 2015 National Center for Science and Engineering Statistics, 14.8% of working engineers were women (Seron, Silbey, Cech, & Rubineau, 2018).

Both black and Hispanic scientists and engineers represent 5% of engineers and scientists, even though the working population is 14% and 12%, respectively (National Science Foundation, 2017). There is a need for more people in STEM to meet the demands of society in today's economy. Increase in workforce diversity can lead to advancements that can be accelerated by introducing new perspectives from individuals from unique cultural and ethnic backgrounds.

There is an obvious discrepancy between "minority student in STEM and actual rates of degree attainment in these fields" (Griffin et al., 2010, p. 96). This disparity is often recognized as the "STEM leaky pipeline", where women and underrepresented minorities do not continue their persistence toward their STEM degree (Flynn, 2016; Estrada et al., 2016). This is not due to the lack of interest from minorities, but the lack of STEM degree completion rate (Hurtado, Eagan, Tran, Newman, Chang, & Velasco, 2011).

There is some evidence that students of color do not have the resources to their faculty mentors compared to white students (McCoy et al., 2015). There is also evidence that students of color experience disparities in their faculty member experiences, especially within Predominantly White Institutions (PWI). (McCoy, Winkle-Wagner, & Luedke, 2017). In contrast, students of color who attend historically black colleges and universities (HBCU) had a positive experience with their faculty members and were more willing to participate in a mentorship (McCoy et al., 2017). Findings by McCoy et al. (2015) show that minority students receive less support, time to interact, and other opportunities, especially for black students.

Even if a student of color can obtain a mentee position, their mentors are most likely a white faculty member based on the current demographics of STEM faculty (McCoy et al., 2015). Some white faculty members attempt to treat students of color according to the standards as white students (McCoy et al., 2015), which removes the cultural and racial identity of the

student. This phenomenon is referred to colorblindness (McCoy et al., 2015; Levinson et al., 2011). Colorblindness expressed by faculty mentors is one of these obstacles that make Students of Color uncomfortable and create difficulties when engaging with their mentors (McCoy, Winkle-Wagner, & Luedke, 2015).

With the current statistics on minority representation in STEM, it appears that there is a need for a way to increase and retain these students to increase the STEM workforce to push innovation and diversity. The environment, and interactions with their faculty members provide these underrepresented students an overall negative experience. Mentoring may be one of the key methods that will help guide them to success. However, it appears that there is a gap or barrier between the mentee and mentor that prevent their experience from progressing due to the lack of communication and cultural awareness from both sides of the mentorship.

Purpose of the Study:

The purpose of the study is to analyze mentoring manuals for students in STEM disciplines and compare them to mentoring guidelines for underrepresented minorities in STEM education. The data from these manuals will be analyzed to demonstrate the connection between the mentorship experience of underrepresented minority students and their faculty mentor. By establishing best practices for mentorship, this study will promote future mentoring programs to create a manual that encourages the development of minority STEM students, reduce minority STEM student attrition from stress and fatigue, and prepare minority STEM students for success.

Theoretical Framework:

The Science of Effective Mentorship in STEMM (Byars-Winston & Dahlberg, 2019) is a consensus study report written by experts that covered a wide range of topics involving mentorship within the STEMM (Science, technology, engineering, mathematics, and medicine) field. The report contains information and recommendations regarding mentorship relationships with a focus toward underrepresented minority (URM) students. In the text, there were a few theoretical frameworks and concepts mentioned to understand and explain mentorship. Due to the restriction on time, only one could be utilized for this study. Social capital was one of the many concepts mentioned throughout the report and across literature regarding mentorship in STEM for underrepresented communities. This led me to explore different frameworks involving social capital, which eventually led to social reproduction theory.

Bourdieu's social reproduction theory will be the theoretical framework for this study. This theory explains how the inequalities are formed across generations (McCoy et al., 2015), which is the result of repetition of passing down the knowledge, norms, and values within the dominant group. This theory focuses on ways that the social stratification system was perpetuated across generations (McCoy et al., 2015). Social reproduction theory has four major parts and they are: field, cultural capital, social capital, and habitus (McCoy et al., 2017).

Capital is referred to the strategic assets, power, or influence that is accumulated and developed within a certain social realm (field) (Levinson et. Al., 2011). Social capital is the concept that "individuals receive information about norms, values, standards, and expectations for education through interpersonal relationships with their parents, peers, and others" (Jorstad, Starobin, Chen, & Kollasch, 2017, p. 256). Cultural capital is the knowledge and influence that is fluid through the symbolic engagement and interaction within a certain field (Levinson et al., 201l). This form of capital can be broken down into three components: embodied state

(individual's knowledge), objectified state (individual's properties, and the institutionalized state (where the cultural capital is recognized) (Martin,2016). According to Levinson et. al. (2011), habitus is the system or environment that power and culture is ruling over through capital and field.

Mentoring manuals can contain useful information and resources, which can be converted into capital. Bourdieu's theoretical framework of capital can explain the social and cultural interactions and exchanges that take place in STEM institutions and education. Through this lens, one can see how an individual's capital can help navigate and influence their path to success within the STEM education field.

Research Questions:

The following questions frame the objective and research that the study aims to answer:

1. How do the contents and recommendations found in these manuals guide UMS mentees and faculty mentors toward a healthy mentorship?

2. How do these manuals address the acquisition of social capital and combating social reproduction, especially for UMS?

Significance of the study

With the lack of focus in the mentorship of underrepresented minority students in STEM, there is a need for guidance and resource that specifically targets their interests and development. There is an absence in identity within mentorship in STEM that makes UMS left out in experience and engagement (National Academy of Sciences, 2019). There are many different mentoring manuals and handbooks that provide plenty of resources and information. However, it

is important to critique current examples of mentorship to improve and develop future guidelines and practices. The significance of this study is to analyze recent mentoring manuals and create recommendations for those who may be interested in creating a handbook for their mentoring program or practices.

Limitations:

Due to the short duration of this study, there is a limited amount of time to gather and analyze a collection of pre-existing texts. Also, the data that will be collected are from a small sample of mentor manuals. The recommendations from this project are based on the synthesis and analysis from the text that were chosen.

CHAPTER II: REVIEW OF RELATED LITERATURE

Vast amounts of STEM related literature show that mentoring underrepresented minority and female students in STEM improves their academic performance, persistence, and retention. However, one of the major pitfalls in their mentorship is related to their interactions with their faculty mentors due to cultural and/or racial differences. My research aims to construct recommendations to help improve the quality and effectiveness in communication and learning outcomes for both mentors and mentees. The following literature provides background and support for the need for guidelines for students and faculty mentors in STEM.

This literature review uses the reasoning pattern in Machi and Envoy (2012) as a reference to explain the thought process and logical framework of my claim. The pattern that I will incorporate is the joint-reasoning method. This reasoning pattern describes that a conclusion can be reached when an accumulation of necessary evidence is present to provide an accurate and coherent explanation (Machi & Envoy, 2012). The following equation illustrates the joint reasoning pattern:

$$(R_1+R_2+\ldots+R_n) = C$$

Where reasons, R_1, R_2, and R_n individually do not provide enough arguments to articulate a conclusion (C), unless they are both present (Machi & Envoy, 2012).

The purpose behind using the joint reasoning pattern is to accumulate enough evidence to support my claim. In addition, some of the reasons that I selected do not, by themselves, provide a strong argument, which means that these reasons accumulate on each other to generate strong arguments towards my claim. The first reason provides background on the current climate regarding UMS and STEM to illustrate the gap in mentoring URM in STEM. The next reason addresses the need for guidance for these students, followed by mentorship as the central theme

to resolve this dilemma. Lastly, I will describe the flaws that occur in cross-cultural/racial mentoring in STEM education that illustrate a need for guidelines between the faculty member mentors and the UMS mentees. These reasons will support the claim that there needs to be a guideline within higher education in STEM for both faculty members and UMS, who are participating in a mentorship to help better understand their respective roles.

Reason 1: The STEM environment and atmosphere discourage Underrepresented Minority Students from continuing their education

There is an obvious discrepancy between "minority students in STEM and actual rates of degree attainment in these fields" (Griffin et al., 2010, p. 96). This disparity is often recognized as the "STEM leaky pipeline", where women and underrepresented minorities do not persist toward their STEM degree (Flynn, 2016; Estrada et al., 2016). This is not due to the lack of interest from minorities, but rather the lack of STEM degree completion rate (Hurtado, Eagan, Tran, Newman, Chang, & Velasco, 2011).

Literature prior to the mid-1990s explains that this phenomenon "was due to the difficulty of the content" (Flynn, 2016, p. 187). However, many students switch to a non-STEM program due to several different reasons, such as "lack of knowledge about science, perception of mismatch of talent, and perception of science being too competitive" (Perez, Cromley, & Kaplan, 2014, p.316). Also, a few studies suggest that the STEM education environment can be described as a "chilly climate" (Flynn,2016, p.187; Collins 2018) for these URM students, especially for women of color (Carlone & Johnson, 2007; Ong, Smith, & Ko, 2018), and makes students feel that STEM faculty members are difficult to engage or approach (Flynn,2016). There are various reasons found across literature that describe and explain the disconnect and

attrition found in students in STEM that result in failure in completing their undergraduate program.

When looking at the students, there was no difference between those who switched out of STEM majors than those who stayed in terms of cognitive abilities based on a 2004 study conducted by Daempfle cited in Flynn (2016). Both the climate of the institution and STEM departments greatly contribute to students' major selection (Flynn,2016). In general, retention of URM students is an issue across all majors, but in STEM, the leaky pipeline has a larger risk for these students (Flynn,2016).

Faculty members play a critical role when "shaping the culture of science" (Hurtado et al., 2011, p.5), as well as the growth of their students. The interaction between faculty members and the racial minorities is another factor for the gap in representation of minorities in STEM. Race is one of the factors that affects the "quality and frequency of faculty interactions" (Hurtado et al., 2011. p.3), along with the type of institution (Hurtado et al., 2011). PWI and Historically Black Colleges and Universities (HBCU) have different impacts on URM students, where the former has an overall negative effect and the other has the opposite effect for URM students when comparing the interactive experience between them and their faculty members (Hurtado et al., 2011). Discrimination due to the students' racial and ethnic background carry a baggage of stereotypes regarding their abilities and competency (Aikens et al., 2016). UMS reported that they were perceived as inferior in terms of intelligence compared to white students (Aikens et al., 2016).

Collins (2018) addressed the color-blind issue in STEM and how it affects black students, which represent a small percentage of STEM-degree recipients. The problem with the color-blind perspective is it ignores the aspect of racial and cultural inequalities as it promotes

meritocracy (Collins, 2018). Under this meritocracy, many students who pursue an undergraduate science majors often find themselves submitting to the norms and values that can be described as white and masculine dominant (Carlone & Johnson, 2007), which they describe it as the "culture of science". The article highlighted the "competitive nature of weed-out courses and unfriendly professors" (Carlone & Johnson, 2007, p. 1188) as a distinctive example of this ideology of meritocracy.

Both Martin (2016) and Org, Smith, and Ko (2018) used Critical Race Theory (CRT) to provide a narrative from the point of view of students of color. Martin (2016) uses critical social theories to explain the underrepresentation of women and minorities in STEM. In his work, he uses CRT, feminist theory, and the concept of capital to analyze the erasure of women and minorities' lived experiences. He concludes that the academic environment puts students into a position where they must either assimilate and adapt to the dominant cultural norms and behaviors (Martin, 2016). As a result, there is a "prolonged institutionalized mismatch between students' worldviews and college environment" (Martin, 2016, p.112) as one of the factors that dissuades women and minorities from pursuing toward the STEM field (Martin, 2016). The work that was done by Ong, Smith, and Ko(2018) demonstrated the gaps that were missing from literature regarding the experiences that women of color face in STEM education. Microaggression and the feeling of isolation within STEM were the two social factors that produce negative experiences for students of color that deter them from continuing the program (Ong, Smith, & Ko, 2018).

Reason 2: UMS need guidance to navigate through STEM

Crowley, Perez, and Kaplan (2016) suggested "multiple challenges in STEM achievements and retention" (Crowley, Perez, & Kaplan,2016, p.9) to improve the quality of STEM education. They investigated how faculty can be more engaging with their students, reviewing students' abilities to learn, and promote motivational orientations. These were few examples in which institutions can improve the quality of education and help maintain their students. Although this article addresses the issue for STEM students in general, it can be applied for UMS, as well since they are in a worse position compared to the majority.

Martin (2016) used the idea of capital to describe the lack of representation of women and other marginalized groups pursuing STEM, as well as how it affects these marginalized groups. The difference in worldviews, social capital, cultural capital, and education policy that exist between the marginalized groups and the majority can be seen in a classroom setting (Martin,2016). In relation to educational outcomes, there was a connection between capital and the "levels of student satisfaction and their motivation for college degree choices" (Martin, 2016, p.105). Due to how capital is distributed and utilized to navigate through a system, women, minorities, and underserved (Martin,2016) are put in a position where they cannot compete or navigate through their program (Martin,2016).

Estrada et al. (2016) mentioned five recommendations to promote change to improve the persistence of underrepresented minority students. These five recommendations are:

- track and increase awareness of institutional progress toward diversifying STEM
- create strategic partnership
- maximizing the potential of the curriculum and active learning
- informing students of resources that they have access to

- motive URM students' interest in STEM (Estrada et al., 2016, pp.3-4)

These recommendations were made to reduce the disparities that are found predominantly found among URM students and to promote diversity. The purpose behind this act for change was due to the lack of national commitment and interest in understanding the "leaky pipeline" that could be used to keep track and analyze the rate of completion of URM students in STEM ((Estrada et al., 2016).

Carlone and Johnson (2007) created a model which allowed them to analyze the factors that allowed students of color to complete their science degrees, despite the fact that they all experience the "culture of science" (Carlone & Johnson, 2007, p. 1211). Based on their model, the lived experiences of women of color in the study helped understand what needs to be done to make the STEM environment less unpleasant (Carlone & Johnson, 2007). They found that there was a gap between women of color and developing a "scientific identity" (Carlone & Johnson, 2007). They also mention that institutions should consider reforming their method to recruitment and retention of women in STEM (Carlone & Johnson,2007). The study addressed that women in STEM do not need support for their interest in science, but instead supported in developing a sense of identity in the field (Carlone & Johnson,2007).

Reason 3: Mentoring improves the retention and academic performance in UMS

Mentoring was one of the many methods suggested to improve and guide UMS to success in STEM. Mentoring has the potential to provide emotional, academic, and professional support that UMS need (MacPhee, Farro, & Canetto, 2013; Haeger & Fresquez, 2016; Byars-Winston, Branchaw, Pfund, Leverett, & Newton, 2015; Aikens et al., 2017; Hernandez et al.,

2018). There is a plethora of literature that were conducted involving the mentoring of UMS and its impact on them were positive.

Central State University (CSU) implemented the BBSP (Benjamin Banneker Scholars Program), which focused on mentoring potential at-risk students to increase the retention, academic performance, and graduation of minority students pursuing STEM (Kendricks et al., 2013). African American students in STEM at CSU were used for the BBSP (Kendricks et al., 2013). From this program, the students were able to improve their academic performance, interest in STEM, and other positive results (Kendricks et al., 2013). The result of the program was reviewed by using an annual BBSP Post-Satisfaction Survey, where 90 percent of the scholars ranked mentoring as having the largest influence on their academic performance (Kendricks et al., 2013).

Estrada et al. (2018) examined the growth of students from junior year through post-baccalaureate year. This was done by observing the integration of underrepresented minorities into the STEM communities over a long period of time, which included 1420 minority science students (mix of undergraduate and graduate) from 50 universities across the United States (Estrada et al., 2018). The research asked if research experience and mentorship contribute toward integrating students into the STEM field (Estrada et al., 2018). It also asked whether underrepresented minority students' science self-efficacy identity and values positively related to persistence in STEM career pathways up to four years later (Estrada et al., 2018). The key result from this study was that faculty mentor role modeling increased students' internalization of science community values, which translated to an increase in students' scientific career persistence intentions (Estrada et al., 2018).

The Howard Hughes Medical Institute (HHMI) Professors Program at Louisiana State University, under the leadership of HHMI Professor Isiah M. Warner, represents one of these programs and reports on a mentoring model that addresses the key factors that impact STEM student attrition at the undergraduate level (Wilson et al., 2012). STEM and non-STEM students at Louisiana State University participated in the study (Wilson et al., 2012). By integrating mentoring and strategic academic interventions into a structured research program, an innovative model has been developed to guide STEM undergraduate majors in adopting the strategies that allow them to excel in their programs of study, as they learn to appreciate and understand science more completely (Wilson et al., 2012).

A study by Cutright and Evans (2016) proposes a yearlong peer-mentoring approach that will help improve the transition and retention of incoming freshmen. Eight seniors were paired with eight freshmen and through this mentorship, the seniors supported the first years integrate and assisted with their experiences at college (Cutright & Evans, 2016). Based on past studies, it is believed that the effect of transition to college for freshmen can be less stressful when they receive social support (Cutright & Evans, 2016). The overall outcome from this program was positive and helpful for both seniors and freshmen. All participants were able to improve their soft skills, and their interest in STEM (Cutright & Evans, 2016). Lastly, the freshmen stated that the senior mentor was more helpful than faculty members and learned valuable collaborative skills with their mentors (Cutright & Evans, 2016).

In addition to mentoring, acquiring research experience for UMS not only improved their academic performance, but their interest in science and sense of identity in the field as well (Haeger & Fresquez, 2016). Byars-Winston et al. (2015) investigated research experience in undergraduate science programs and their benefits in STEM, the research mentors' interaction

with their mentee, and the impact it had on the students. The interactions with their research mentor contributed to the mentees' sense of identity and belonging in the field of science (Byars-Winston et al., 2015). Aikens et al. (2016) observed the differences in undergraduate research mentoring structure and their outcome between race and gender. The article illustrated that different mentoring methods lead to different outcomes. The results from the study uses the suggestions to improve the mentoring experience and outcomes in a positive direction for future students and faculty members.

Reason 4: Faculty members mentor UMS differently compared to white students in STEM

Providing guidance to UMS shows positive outcomes, but it does not mean that methods used are uniformly the same across racial groups. Cross-race mentoring in general is a touchy subject and sometimes difficult to maintain, according to Dolan (2005). Dolan (2005) challenges this hypothesis by interviewing a few minority Ph.D. and graduate students, which ended with mixed results, yet overall positive. Ten points were cited to describe the complexity, inclusive and sensitivity of cross-race mentoring (Dolan, 2005).

Studies conducted by McCoy et al. (2015) illustrated how racial identity affected the mentorship experience for UMS. Their 2015 study was an introductory research, which emphasized on the colorblind-mentoring experience by comparing how UMS interacted with their faculty mentors between a PWI and a HBCU (McCoy et al., 2015). In this study, they were able to highlight the importance of mentoring for students of color, as well as the impact of faculty mentoring has on racial inequality (McCoy et al., 2015).

Two years later, they continued furthering their research to analyze the experience between the interaction between the faculty mentor and student of color within the STEM

discipline. They compared the experiences between a PWI and HBCU, the same institutions used before. Findings from McCoy et al. (2017) suggests that faculty in HBCU were more supportive and amicable toward underrepresented students than the faculty in PWI. In fact, the faculty from PWI were discouraging some students to not pursue STEM (McCoy et al., 2017). As a result, faculty from HBCU were more willing to mentor their students as opposed to faculty from PWI, to the point that they could be described as "gatekeepers" (McCoy et al., 2017).

Faculty mentoring can either support or dismantle racial inequality based on how to engage with their USM mentee. Even though, white faculty members stated that they treat students of color fairly through a colorblind approach, they still see these students were not academically and professionally ready to enter the STEM field (McCoy et al., 2015). The gatekeeping mentality of some of these faculty highlight the lack of opportunities students of color have for growth and development, as well as the danger of being colorblind toward these students (McCoy et al. 2015; McCoy et al.,2017). The study done by Aikens et al. (2016) that was previously mentioned highlighted that there was a difference in treatment due to the mentee's identity from faculty members during their undergraduate research experience. There was a significant influence in how race and gender affected the research experience of female, URM, and Asian students (Aikens et al., 2016). Biases from the faculty members may be the reason for this phenomenon.

Summary

The literature mentioned in this chapter highlights the nature, culture, and issues that occur in post-secondary STEM education. From the cold, harsh treatment toward UMS created an environment where these students do not feel comfortable navigating through their education

with little to no assistance. Mentoring allows students to grow and be molded into someone who would enter STEM to make a difference. However, miscommunication between faculty member mentor and mentee due to the erasure of racial and ethnical identity, as well as, the bias that may be present from both parties may create an ineffective and potentially unsuccessful experience. By improving the interactions from the mentorship, it will help improve the retention and academic performance for UMS through the creation of a handbook that raises the concerns and awareness needed to remove these biases. Ultimately, this will lead to an increase in diversity and representation in STEM that will spark the future generation of minority students who are interested in pursuing STEM.

CHAPTER III: METHODOLOGY

With how wide the gap in representation between underrepresented minority students compared to Asian and white students in STEM, there should be a way to close it. Retention and lack of guidance for UMS is an issue that is constantly mentioned in literature. Mentoring has had a positive impact for UMS and may be one of foundation to increase diversity and representation. However, the disconnect between students and faculty member mentors may be one of the hurdles that needs to be addressed. Therefore, a guideline or handbook for both faculty member mentors and minority students in STEM should be recommended to improve communication between the two.

Methodology

Mentoring UMS in STEM disciplines is an effective method to promote retention, growth, and development. It provides valuable experience and resources that assist students further their academic and professional career. Mentoring manuals exist throughout different organizations and institutions to help establish guidelines between mentors and mentees. However, the contents mentioned in some of these manuals may not be applicable for UMS, as they are targeted more towards the general student population. The objective of this research will be to conduct an analysis of current mentorship manuals that are available to the public. The center of focus of this study will revolve around an analysis of common themes and key guidelines highlighted across these manuals, with the intention of encapsulating a list of recommendations for faculty mentors and UMS mentees.

Research Methodology

For the study, a systematic review of current available mentorship manuals that primarily focused on students in STEM was conducted. A systematic review was selected due to the nature of the study; observe current available data and synthesize new information, whether it be by qualitative or quantitative. The approach was influenced by the goal of synthesizing recommendations for UMS with the context that there is not enough focus toward this demographic mentioned within the manuals.

A few samples of mentoring manuals were found through the internet, ranging from mentoring guidebooks made specifically for an institution's mentorship program to mentoring manuals targeting undergraduate research. The content and recommendations found in each sample was compared, analyzed, and discussed. The recommendations will be compared to those found in *The Science of Effective Mentorship in STEMM* (Byars-Winston & Dahlberg, 2019).

This recent text was used as a reference and a baseline when comparing the contents found with the manuals. The purpose behind this step was to see if the findings and recommendations found from the report align with those found in the manuals. There was a total of nine recommendations made by the committee, but only seven were directed toward participants in a mentorship, such as mentors, mentees, department chairs, and other individuals, who organizes and facilitates mentoring programs. The following were the recommendations mentioned in the conclusion of the study report, along with a brief description:

1. **Adopt an operational definition of mentorship in STEMM:** The definition of mentorship is clearly stated within the context of the program or organization.

2. **Use evidenced-based approach to support mentorship:** The mentorship is based on evidence-based practices, guidelines, tools, and processes for both mentors and mentees.
3. **Establish and use structured feedback system to improve mentorship at all levels:** Assessment and evaluation of mentorship is applied to further improve future experiences for mentors and mentees.
4. **Recognize and respond to identities in mentorship:** The mentorship addresses the influence of identity and how it plays a role for all participating members.
5. **Support multiple mentorship structures:** Individuals are encouraged to engage and interact within or outside their personal or professional circles.
6. **Reward effective mentorship:** The institutional leadership recognizes and rewards effective mentors and mentees with incentives.
7. **Mitigate negative mentorship:** There are countermeasures in place when the mentorship experience is not going well (Byars-Winston & Dahlberg, 2019, pp. 8-12).

The final process involved the synthesis from all the chosen literature. Each manual was compared with one another. The synthesized information was then summarized across the literature. Also, consideration and recommendations specifically for UMS were addressed. The recommendations from this review was intended for potential improvements and suggestions that can help enrich the mentorship experience between UMS and their mentors.

Data Collection

The contents found in preexisting mentoring manuals that focused on STEM students were observed. The key connections and commonalities regarding the methods and techniques

used to mentoring UMS in STEM were also examined. The manuals that were examined were those that were created for a specific mentorship program or from a general relationship guideline approach for mentors and mentees.

Data was collected by analyzing texts from the mentorship manuals that were selected. Key components and common themes found within each source were compared. The contents in these manuals were the source for data gathering. The following were the manuals/handbooks that were used for this study:

- *A Handbook on Mentoring Students in Undergraduate Research: Proven Strategies for Success* (Acquaviva et al., 2016)
- *BLaST (Biomedical Learning and Student Training) Mentoring Handbook* (University of Alaska, 2018)
- *The Mentoring Relationship: A Guide for Mentors and Mentees* (University of Washington, 2018)
- *The Mentoring Manual* (Institute for Broadening Participation, 2012)

Data Analysis

Analysis of the data revolved around the context of the literature and its content. Each manual contained background information and purpose. By reading through the selected literature, key themes and concepts were highlighted, examined, and compared. Themes included mentorship approach, methods, advice, and techniques, as well as any mentioning of diversity and inclusion. Mentoring of UMS was also observed if it was discussed. Common features were coded and tabulated to create a quantifiable measurement of what each manual included. Noteworthy recommendation, tactics, and strategies involving mentoring UMS will be compared

to those mentioned to the general mentee population. Ultimately, the data analysis enabled me to dissect and organize each sample, providing enough information to outline significant similarities and contrast between the mentor-mentee relationship for UMS with the majority population in STEM.

CHAPTER IV: RESULTS

The purpose of this study was to analyze current existing mentoring manuals that focused mentoring UMS in STEM disciplinaries. The study also critiqued the recommendations found in manuals and compares them to those found in literature. Mentorship practices and styles are dependent on the relationship between mentor and mentee. Mentoring UMS in STEM will have a different approach compared to white and Asian students, due to the lack of representation and methods for acquiring social capital.

Each mentoring handbook contained its own unique structure and format. They were created based on the need of their institution. All the manuals had background information, guidelines, and practices that would help students achieve successful mentorship. By breaking down the contents of the manuals, their core components were dissected and analyzed.

A Handbook on Mentoring Students in Undergraduate Research: Proven Strategies for Success (HMSUR)

The handbook was developed by the Undergraduate Research Committee at New York City College of Technology of The City University of New York. The committee members involved were trained mentors in their respective discipline, ranging from liberal arts to STEM (Acquaviva et al., 2016). The guidelines and practices found in the document were based in literature that supported the benefits of students engaging in research under supervision as a form of mentorship. The skills and knowledge gained through the research experience prepares students toward their professional career and shape the future (Acquaviva et al., 2016). In addition, faculty members can share their wisdom and experience to “give back” to their community. As a result, the institution uses undergraduate research as an opportunity for

students to be mentored, and thus created the document to guide students to successful mentorship.

BLaST Mentoring Handbook

The BLaST Mentoring Program was a mentoring program that primarily focused to improve the training and mentoring of undergraduate students in biomedical research (University of Alaska, n.d.). According to their website, this was achieved through "increased diversity of students, increased integration of research and teaching, and enhanced integration of rural campuses into a cohesive biomedical community in Alaska" (University of Alaska, n.d.). BLaST is funded by NIH (National Institutes of Health) and encouraged individuals who were from underrepresented communities to join in the field of biomedical, clinical, behavioral, or social sciences (University of Alaska, n.d.). Students from the BLaST program experienced mentorship, gain research experience, and complete projects.

The Mentoring Relationship: A Guide for Mentors and Mentees

Underserved Pathway(UP) was as stated in the manual, "a program for medical students working toward careers caring for underserved communities" (University of Washington, 2018, p.4). The purpose of UP was to prepare students to understand the vulnerable and underserving population, gained experience in practicing medicine in underserved settings, and care for these population. There were four methods UP used to engage with student, which were mentoring, developing a foundation of knowledge, gaining various real-world experiences, and scholarship (University of Washington, 2018).

The Mentoring Manual (Faculty and Undergraduate edition)

The Mentoring Manual was created by The Institution for Broadening Participation (IBP), an organization that aims to promote diversity in the STEM workforce (Institution for Broadening Participation, n.d.). The IBP helped connect underrepresented students with STEM related funding and research opportunities, as well as providing faculty and administration with resources and tools to guide student toward success (Institution for Broadening Participation, n.d.). The organization made various versions of The Mentoring Manual depending on the audience, each with slight variations. The selected manuals for this study were those that was tailored to undergraduate students and another for faculty members. STEM students, especially underrepresented students were the target audience for this manual (Institution for Broadening Participation, n.d.). The contents of this text contained a general in-depth overview of mentorship, providing helpful advice and guidelines for both mentors and mentees.

Results

The comparison of the manuals in reference to the seven recommendations can be seen in Table 1. The check mark indicates the manual contained information relating to the corresponding recommendation, while those did not were marked X. When there was insufficient amount of information or lacked details, they were labelled with a triangle, as partially sufficient. The recommendations were used as a quantitative measurement to observe whether these documents aligned with those found in *The Science of Effective Mentorship in STEMM* (Byars-Winston & Dahlberg, 2019).Overall, most of the documents contained majority of the suggestions. Common features found across all the manuals included their definition of

mentorship, applied evidence-based approach and practices, and acknowledge the role of identity and its impact in mentorship.

Table 1:

Assessment of Selected Manuals Based on the Seven Recommendations

Recommendations	**HMSUR**	**BLaST**	**Underserve Pathways**	**Mentoring Manual (Faculty)**	**Mentoring Manual (Undergrad)**
Adopt an operational definition of mentorship in STEMM	✓	✓	✓	✓	✓
Use evidenced-based approach to support mentorship	✓	✓	✓	✓	✓
Establish and use structured feedback system to improve mentorship at all levels	✓	✓	X	X	X
Recognize and respond to identities in mentorship	✓	✓	✓	✓	✓
Support multiple mentorship structures	✓	X	X	Δ	Δ
Reward effective mentorship	Δ	Δ	Δ	Δ	Δ
Mitigate negative mentorship	✓	✓	X	✓	✓

The outline, structure, and format for the handbooks were relatively similar. Definition of mentorship were mentioned at the beginning in all the documents. They described the definition, along with examples, and how the handbook aims to achieve effectiveness through their style and practice. Most ended with addition resources of mentorship or furthering their experience by providing future goals, or an assessment of their mentor. Areas that were labelled partial were

due to the information regarding the recommendation were not clearly stated but had supporting components toward that recommendation.

All the manuals partially fulfilled the recommendation regarding rewarding effective mentorship. This is due to the lack of direct implications or mentioning of a reward to those who promote or documented effective mentorship. Instead, they described the rewarding aspect of mentorship as a personal reward rather than receiving an incentive. For mentees and mentees, they both gained professional experience, and personal development in their own respective roles. However, outside of the intended features of mentorship, none of the program had or mentioned a long-term award or prize for mentors and mentee who provided excellent results or documentations.

Diversity was another commonality found. The value of identity and the importance of inclusion of underrepresenting communities were mentioned at some point. BLaST had a section about diversity through cross-cultural mentoring. UP contained a section about mentoring in diverse community, addressing the hardship underrepresented and marginalized communities face finding role models who have common cultural or racial experiences as them. Similar sections were found in HMSUR, however they addressed a plethora of communities, such as first-generation students, ethnical/racial minorities, and women. They also had topics regarding mentoring STEM students, cross-cultural mentoring, and mentoring students in humanities and social sciences. Lastly, The Mentoring Manual for undergraduate, contributed to the topic of diversity under the section that described the preparation of adjusting to a new environment. However, in the faculty edition, it addressed the topic of conversing with mentees about gender, race, and ethnicity. Under this heading, the manual brought up the influence of difference in culture can impact the interactions and expectations of others.

Summary

The manuals contained most, but not all the recommendations that were mentioned from the consensus study report. Overall, these manuals had similar overarching themes, where some were better executed in certain areas compared to others. All the texts included components that explain the general concepts of mentoring, the roles in mentorship, the influence of identity, examples of challenges that are commonly found in a mentorship relationship. Each of them had different approaches, which indicated different emphasis on communication, guidelines, and responsibilities. The contents found in each of the observed documents can be utilized in developing future mentoring handbooks, and combating social reproduction found in STEM mentorship for UMS.

CHAPTER V: DISCUSSION, CONCLUSION, AND RECOMMENDATION

Mentorship provide plenty of opportunities for growth and development for undergraduates, resulting in a healthier transition toward graduate school or their career. Literature supports this notion through various mentoring style and methods. However, mentoring of underrepresented minorities in STEM has been an ongoing battle. There has been progress made over the past few years, and current mentoring manuals reflected these advancements.

Discussion

The manuals reviewed in this study highlighted the common recommendations, advice, and information that were beneficial to faculty mentors and mentees in STEM. There were moments throughout the manuals that focused on underrepresented communities, along with the approach that may be useful for mentors to engage and interact with them. Mentees and mentors can take advantages in their respective mentoring program by understanding the purpose, knowledge, and guidance that were included. In general, the contents that each of these handbooks provided can be adopted by UMS, who are in need to additional support compared to majority in STEM education.

Details surrounding UMS were not emphasized from the samples. It may be because the purpose of these manuals was to serve for all or the general student population. However, this goes to the idea of social reproduction, and these common practices, skills, and resources for mentorship were created and intended for the dominant group. Ignoring the racial, cultural, and ethnical differences within the STEM communities will lead to mentorship that lacks the emphasis on identity that is attached to UMS.

After reading and analyzing the manuals, UMS and faculty mentors may have a chance of not starting an authentic conversation regarding identity. The tone that were used to describe mentorship of underrepresented group or cross-cultural mentorship was colorblind, and generic. Most, if not all the documents marginalized the interaction with UMS into "ice-breaker" conversation, where mentees and mentors share personal stories about their identity, making it appear forced and rehearsed. There were lack of historical significance or the cultural context of the lack of representation found in STEM. Prioritizing the contextual details behind the experiences of UMS over the explanation of cross-cultural mentorship may raise more interests and concerns regarding diversity and identity.

Accumulating Social Capital

In general, the information regarding mentorship, networking, and navigating through resources, all can lead to growth and familiarity of their connections and their environment. Social capital is the knowledge of norms, values, standards, and expectations built by individual's personal connections (Jorstad, Starobin, Chen, & Kollasch, 2017). All mentoring manuals, in a sense were providing guidelines for mentees to gain social capital and help prepare them both academically and professionally.

The recommendations that were used to assess the mentoring manuals contributed to UMS in the acquisition of social capital. Establish and use structured feedback system, recognition and respond to identities, support multiple mentoring structures, and mitigate negative mentorship played a role in assisting mentees gain knowledge and resources that helped them manage and navigate through their mentorship, and environment. Also, UMS can take advantage of the social capital that they gained to combat social reproduction. This can be done through effective communication and building healthy mentor-mentee relationship. UMS can

understand the practices, norms, and standards that the mentors taught them, and give feedbacks to improve their mentoring styles and methods toward those from underrepresented communities.

UMS can understand the dynamic of the habitus that they are in with the assistance from their mentors. Although, the guidelines and information were not directly targeted toward UMS, information from each of the manuals share the same intentions of guiding student toward a successful mentorship. The importance of establishing effective communications, providing feedback, and maintaining connections with mentors and role models were constantly brought up. It was unfortunate that the topic of understanding underrepresented communities and diversity were swiftly mentioned, and then returned to highlighting general mentorship etiquettes.

Combating Social Reproduction

Recommendations regarding feedback, identity, supporting multiple mentoring structures, and mitigate negative mentorship can help combat social reproduction. The norms formed and set by generations of the dominant group create the culture within the space. Mentor and mentees can challenge these norms by acknowledging their presence, while opening opportunities to share the space with individual who are from different backgrounds.

Evaluations and assessments surveys and questionnaires were found in HMSUR, and BLaST. HMSUR had a section that focused on evaluating the mentoring process and experience. Evaluation of mentors, evaluation of mentees, and an overall evaluation of the mentoring program were covered in this section. BLaST contained a section filled with templates and checklist for both mentor and mentee to review and plan their mentorship experience. Mentors

check for progress and organize meetings throughout the years utilizing the worksheets that focused on mentee's expectations, goals, and self-assessment of skills. By reviewing the performance of the mentors and the mentorship experience, program directors and faculty can make changes in presentation, engagement, and objectives to fit the needs of future participants.

Negative mentorship and other mentorship challenges provided obstacles for both the mentees and mentors. Examples of common mentorship issues, such as miscommunication, incompatibility, and other interpersonal conflict were mentioned in all documents, except UP. HMSUR provided case study examples for mentoring in STEM discipline, which were not found in the other manuals. The advice and tips from these manuals can reduce or prevent mentees from discouragement from their mentors or academic environment by gaining the knowledge to overcome, collaborate, and discuss concerns with their mentors.

Gaining knowledge, resources, and familiarity can be translated to the acquisition of social capital. Difference in identity was one of the common struggles UMS face in STEM and in mentorship. All the documents contained the topic of either cross-cultural mentoring or acknowledging the impact of identity has on mentorship. By explaining the concept of identity in a predominantly white environment can challenge the norms, and expectations that promote social reproduction. In addition to identity, support structure is important in any mentorship, but more important for UMS in STEM due to their difficulties finding their sense of belongness and representation.

Negative experience and challenges dissuade mentees from continuing their mentorship, and by reducing them can change it to a healthy one. By having support from different networks of mentors and role models, allow mentees to gain mobility and navigational capital. Though these connections, students can have access to different faculty members and resources, leading

them to obtain more social capital. Feedback through evaluation and assessment can guide faculty mentors in development for future mentees, as well as voice their thoughts and experience of the mentorship. Manuals that fulfilled these recommendations provided useful information to help students acquire social capital, while minimizing the dominant norms and behaviors that hinder their mentorship experience.

Conclusion

Future mentoring manual authors may need to include more details and information to highlight the concerns and difficulties that UMS face in STEM mentorship. The lack of focus toward UMS, their struggles, their lack of access in gaining social capital, and combating social reproduction appeared throughout the analysis. Future mentoring manual authors may need to include more details and information to highlight the concerns and difficulties that UMS face in STEM mentorship. Using the seven recommendations found in *The Science of Effective Mentorship in STEMM* (Byars-Winston & Dahlberg, 2019), the manuals were assessed and analyzed. The purpose of these documents emphasized the key components that were necessary for an effective mentorship. Many aligned with the seven recommendations, and common themes of defining mentorship, effective communication, providing feedback, maintaining support structures, overcoming negative mentoring experiences, and importance of diversity and identity were explained as the sources for a successful mentorship.

Recommendations

UMS in STEM often struggle finding presence in their institution or major, which resulted in the use of mentoring as an overall solution. However, URM mentees may still have difficulties fitting in. Mentoring programs can utilize the seven recommendations (adopt an operational definition of mentorship in STEMM, use evidenced-based approach to support

mentorship, establish and use structured feedback system to improve mentorship at all levels, recognize and respond to identities in mentorship, support multiple mentorship structures, reward effective mentorship, and mitigate negative mentorship) mentioned in *The Science of Effective Mentorship in STEMM* (Byars-Winston & Dahlberg, 2019) to promote effective and successful mentorship. The following below are additional recommendations that can assist URM mentees with their growth and development:

For underrepresented minority mentees:

- Establish connections and create a support structure to build social capital. Reach out to mentors, other faculty members, and other individuals who may provide potential role models to contact and connect with.
- Be vocal about the goals, skills, and other needs to your mentor. Take advantage of the resources and knowledge within and outside of mentorship. Mentorship should prioritize the needs of the mentee with the guidance of a mentor.

For faculty mentors:

- Assist mentees to develop their own support structure by providing them with networking opportunities.
- Be patient and understanding toward your mentee. Building effective communication is key in forming an effective mentorship. Find opportunities to connect with them personally, before having a conversation about their identity. Difficult conversations should not be rushed and is better when the time is right.

For future mentoring manual authors:

- There needs to be clear transparency about the lack of representation and diversity in STEM, as well as the benefits of creating an inclusive space. This contrasts with how diversity and identity were explained under the umbrella of cross-cultural mentoring, which shifts away the focus from the importance of inclusion. Providing historical and cultural context of underrepresented communities in STEM may change the perception of UMS, but also create opportunities to tackle the representation issue directly.
- There should be incentives or awards for both mentors and mentees for them to remain motivated and continue professional development. Mentoring may be rewarding, but the lack of recognition could result in attrition for the effort that mentors invest in producing effective mentorship and documentation.
- Develop a longitudinal record of documentation, assessments, and evaluation. This can be beneficial for other mentoring programs and for future research. Feedback and suggestions can change lead to improvements and program outcomes to fit the needs for UMS. With the current lack of literature in STEM mentorship, especially for URM populations, creating an archive of successful mentorship could support future evidence-based practices.

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