

Building a Pipeline to the Future of STEM by Addressing Social Determinants of Health

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Abstract

Introduction: Marginalized groups such as racial and ethnic minorities and people of low socioeconomic groups are not as exposed to the fields of Science, Technology, Engineering, and Medicine (STEM) as their majority counterparts. Due to the lack of resources and access to opportunities, many students from disadvantaged backgrounds are never introduced to advanced fields in STEM. Many minority students may also have feelings of isolation, depression, and stress related to their academic and career future. The University of Rochester created an intensive week-long minority mentorship program in order to introduce students to various STEM and healthcare fields in addition to giving them guidance, support, and experience through research and personal development activities. The aim of this study is to analyze the effects of exposing students from underrepresented minority backgrounds to mentorship, learning experiences, and health professionals in the fields of STEM.

Methods: A Qualtrics survey was created for the students and faculty/mentors to ask about their experiences and reflections. The survey consisted of various multiple-choice questions, rankings, and free-text fields for elaboration and further comments. Questions aimed to quantify mentee and mentor satisfaction, mentee self-reported growth, skill development, mentorship quality, and progress.

Results: The survey results were analyzed by descriptive analysis and highlighted the patterns and relationships about the mentorship program. The program received favorable feedback, with numerous participants expressing satisfaction and a willingness to recommend it to others. Overall, all students were able to complete the program in 2024. 58% of the students were Black or African American, and all the high school respondents attended public schools. 90% of students found the program helpful and would recommend it. 100% of the students went on to higher education or are planning on going forward to higher education. Students generally viewed their time in the program positively, felt included and supported, made new friends and connections, and enjoyed the experience.

Conclusion: The diversity in presenters and activities not only introduced students to new fields and opportunities but also gave them more experience with public speaking and research. As a result, students generally reported decreased stress about their future career after participating in the program. Early mentorship and guidance play a crucial role in providing support to underrepresented students in order to increase confidence, promote academic engagement, and enhance life experiences. Programs that provide resources and mentorship to minority students should continue to develop and expand in order to promote diversity and decrease barriers to entry to STEM and healthcare careers.

Keywords: Science, Technology, Engineering, and Medicine (STEM); Mentorship; Learning Experiences; Health Professionals

Introduction

Students from marginalized groups, including those from minority backgrounds and low socioeconomic status, are insufficiently represented in the fields of science, technology, engineering, and medicine (STEM). Many marginalized groups are economically and educationally disadvantaged due to poor and under-resourced schools preventing them from accessing opportunities to gain exposure in these STEM fields. Exposing students at a younger age may be crucial in giving them a pathway and hope of obtaining a career in STEM [1].

Many marginalized groups are subject to many social factors that impact healthcare. There exist both upstream and downstream Social Determinants of Health. A significant number of students lack sufficient educational opportunities, appropriate mentoring, and exposure to a variety of career options. A major contributing factor to this issue is the educational framework and access to healthcare services [1]. This program creates a possible pipeline exposing students to careers in STEM, mentors, and collaboration with others.

In New York State, there are several schools that participate in the Science and Technology entry programs (STEP) funded by the State Education Department. These programs target junior and senior high school students interested in science, technology, and health related professions [2]. The objective of STEP is to support students who are interested in the STEM curriculum, thereby promoting their pursuit of college and graduate education. The provision of a pipeline into STEM is the initial goal, and further benefit is seen from the relationship building with various healthcare professionals of minority descent, allowing students to see people in these fields that look like them and/or have similar backgrounds. By introducing minority students to advanced career professionals of similar backgrounds, students not only feel more comfortable but also more confident in their ability to reach those respected fields.

Many minority students may have feelings of isolation, depression, stress related to academic and career future, and the extra burden of the so-called minority tax along with constant scrutiny [3]. This is only worsened due to the limited access to educational resources, networking and mentoring opportunities, and dedicated support groups. Studies have reported that the highest allostatic load, the cumulative burden of chronic stress and life events, was seen in minorities at all educational levels [4,5]. Minority groups such as immigrants or Black Americans report having higher levels of allostatic load as well [4,6,7]. These harmful feelings of stress, alienation, or loneliness are only worsened in minority students from low-income backgrounds [8,9]. Mentorship and connections available to low-income minorities are oftentimes limited compared to those of higher socioeconomic background or the ethnic majority [3]. These challenges and feelings of uncertainty can be mitigated or even alleviated by having a mentor who can provide advice on career and educational pathways and success. Mentorship has been shown to increase the likelihood of students pursuing STEM careers [3]. Being mentored by someone who has similar background, race, and gender allows students to see themselves in a similar position. As a result, they have more motivation and likelihood to pursue positions in advanced fields that oftentimes are lacking in diversity.

The University of Rochester, Flaum Eye Institute, created a Minority Mentorship Program STEM initiative in 2021 under the directorship of Karen Allison, MD. The objective of this initiative was to introduce students of minority populations and low socioeconomic status to potential careers in science, technology, engineering, and medicine. The fundamental mission of the program was to enhance the awareness of students who have not traditionally been exposed to these fields. This effort addresses the considerable disparities and social determinants that arise from limited exposure of minority and disadvantaged students to professionals and experiences in these areas. The aspiration is that fostering interest and curiosity will serve as the initial step toward pursuing careers in these disciplines. Increased exposure is expected to improve awareness of different opportunities, leading to possible internships in both clinical and research activities. Engaging in a range of internships and career development initiatives will enhance interest, leading to enrollment and the successful completion of pertinent programs. This program aims to establish a pipeline for students to healthcare and research professions, thus contributing to the reduction of disparities in these fields.

The aim of this research is to analyze and measure the effects of exposing high school students from underrepresented minority backgrounds to health professionals in the fields of STEM. It remains essential to see if mentorship programs increase the awareness, interest, and engagement of the students. This program has the potential to not only create exposure to STEM fields but also to help identify if the students are more likely to pursue these fields in their future career.

This one-week intensive program has been in effect for 3 years: 2021 to 2024. Overall, 37 students participated in this program from different races, ethnicities, genders, and socioeconomic distributions, with each subsequent year having more students (Figure 1).

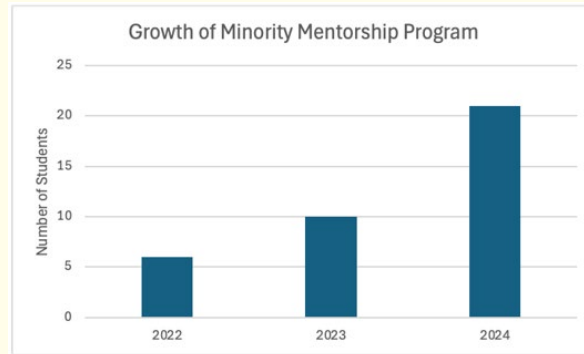


Figure 1: Growth of Minority Mentorship Program.

During this program, our students are exposed to the medical school and healthcare environment with the opportunity to interact with medical student and medical resident mentors under the supervision of clinical and research professors. Numerous professors specializing in clinical and research fields deliver presentations, impart life skills, and offer group mentoring to these students. The students are able to interact by asking questions, participating in discussions, and seeking advice from these experts. College counselors from local and regional colleges and universities give presentations and provide advice and academic guidance in order to help the students prepare their applications for undergraduate colleges. One of the most impactful parts of the program is the communication, public speaking, self-reflection, and writing skills development seminar by Dr. Norma Holland: one of University of Rochester’s communication experts. This is a major confidence builder that helps with personal development and various skills that are needed to pursue advanced career positions. Other activities such as the self-reflective seminar enables the students to reflect on personal experiences and put those thoughts into writing and speeches, which will contribute to future applications to undergraduate and graduate schools. This leads to the main activity of the program: the research project. The research project entails that the students work as a group in pairs to develop collaboration and trust. They are also assigned a medical school student as a peer mentor on the project as well as a coach and sponsor to elevate their projects. After thorough guidance and research, the students present their work as both a poster and a podium presentation, allowing them to gain crucial early experience in research. By obtaining early research experience in addition to presenting those results to a large audience, these students will be able to pursue further opportunities in research and academics to build upon what they achieved in the program.

A significant benefit of this program is building self-esteem, promoting multicultural development, and establishing connections between students and professors. At the graduation celebration, the students received awards and graduation certificates, and they celebrated their achievements with friends and family. By being exposed to a positive and diverse environment in academics, students can be more motivated to pursue advanced career positions and educational opportunities in the future. The funding for this program was

provided by the Flaum Eye Institute as well as a private foundation for prevention of blindness from glaucoma and age related macular degeneration with a \$4000.00 grant.

Methods

An anonymous Qualtrics survey was designed that contained questions regarding the program effectiveness and student/mentor experience. The survey consisted of various multiple-choice questions, rankings, and free-text fields for elaboration and further comments. Questions aimed to quantify mentee and mentor satisfaction, mentee self-reported growth, skill development, mentorship quality, and progress. Further questions were dedicated to analyzing program value and whether students and mentors would recommend this program to peers. Other metrics of the survey looked at participant engagement, enjoyment, and feedback. There was also a section dedicated to participant demographics including age, gender, race/ethnicity, school type, and residence type. Many questions included a 11-point scale from 0-10 [10]. Students and Faculty/Mentors who participated in the program were eligible to complete the survey.

Results

12 participants (5 female) responded to the faculty/mentor survey and 17 participants (9 female) responded to the student survey. Although the students were primarily in high school, a small portion were enrolled in college as well.

Student survey

Overall, all students were able to complete the program in 2024. 58% of the students were Black or African American, and all the high school respondents attended public schools. Students generally viewed their time in the program positively, felt included and supported, made new friends and connections, and enjoyed the experience (Figure 2).



Figure 2: Student Experiences During the Program.

Most students felt that the bulk of activities were very useful. The students also rated the quality of mentoring highly with a mean score of 7.7 out of 10. On a scale of 0 to 10, student responses had a mean of 8.11 when asked how well the program gave experience with research, 8.53 about how well the program enhanced understanding of fields in healthcare, and 8.52 about the usefulness of the program (Figure 3). Moreover, they believed that the program allowed them to attain more exposure and experience in research and other fields in healthcare. The end of program poster and research presentations were viewed as most useful while the college workshops and discussions were ranked as the least useful compared to the rest of the activities, although still moderately useful (Figure 4).

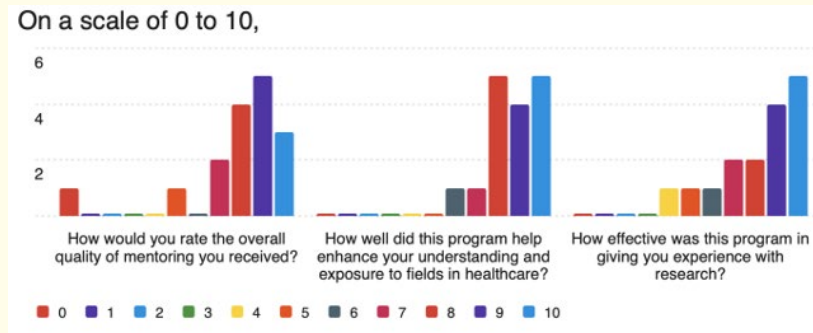


Figure 3

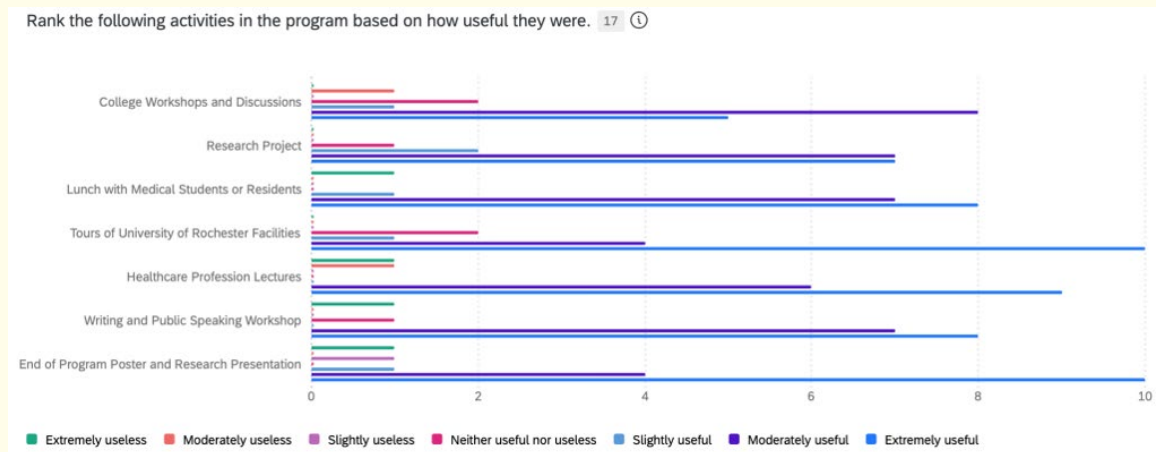


Figure 4: Mentorship program activity rankings.

Although 12 students believed there was a balance between lecture time and interactive activities, 5 participants did respond that they desired more activities. Moreover, the amount of anxiety that students had toward their future career before the program was generally spread evenly from low to high with a mean of 6.18 on a scale from 1 to 10. After the program, students reported less anxiety overall with a mean of 4.42, highlighting how the experience and guidance they received helped in decreasing the fear of the unknown (Figure 5). The majority of students were very satisfied with their experience in the program, with the vast majority believing they were excellently supported in their goals (Figure 6).

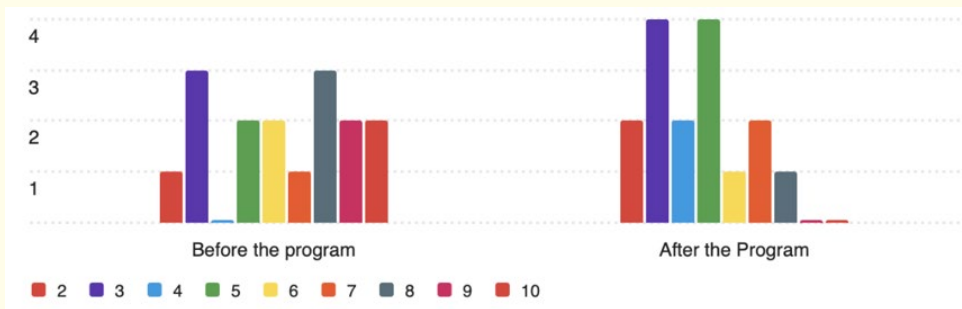


Figure 5: Anxiety that Students Felt Toward Their Future Careers on a Scale of 1 to 10.

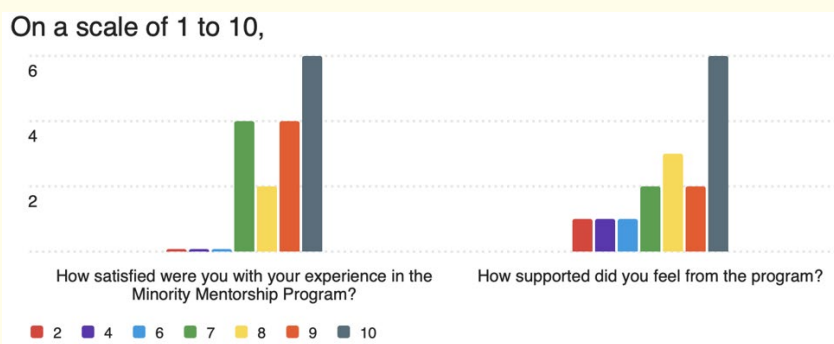


Figure 6: Degree of Satisfaction and Level of Support Students Received During the Mentorship Program.

The minority mentorship program increased the students' confidence in transitioning to the next step in their educational journey and their presentation skills in addition to research skills to a lesser degree. 100% of the students went on to higher education or are planning on going forward to higher education. Students were able to become more comfortable in a healthcare environment, obtain get access to more career opportunities, and develop new connections with professionals (Figure 7). Most students believed that the program was very useful, and many students responded that they are likely to recommend this program to their peers. The majority of students found the program useful and would be willing to recommend it to others with a mean score of 8.52 and 7.77, respectively, on a scale from 0 to 10 (Figure 8).

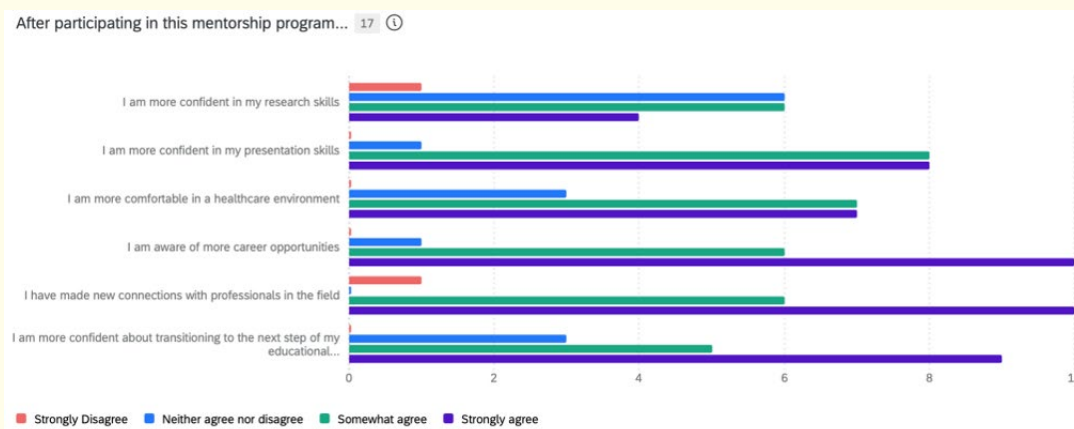


Figure 7: Student Reflections after Participating in the Mentorship Program.

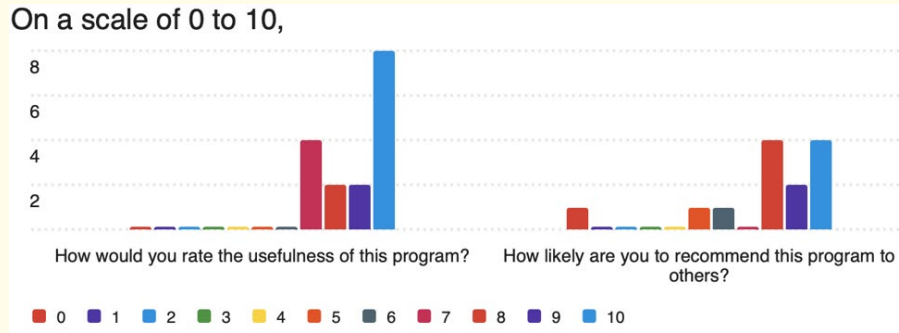


Figure 8

Faculty/mentor survey

The faculty and mentor experiences were perceived as positive, with easy set up and adequate time slots for most faculty and mentors. Overall, communication was good as well, with most faculty and mentors being able to effectively set up presentation materials and find the conference room where the program was being held (Figure 9). As a result, faculty and mentors were able to make use of most of their allotted time to engage and teach the students, resulting in greater satisfaction (Figure 10).

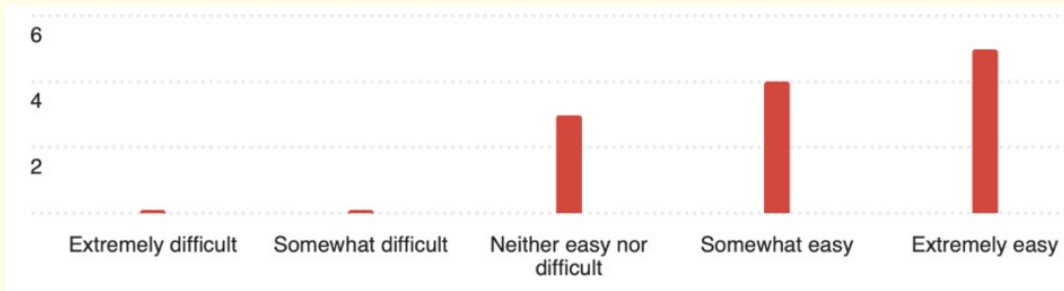


Figure 9: Ease of Setting Up Presentation Materials for Mentors and Faculty.



Figure 10: Where Faculty/Mentors Given an Adequate Time Slot?

Furthermore, all the faculty and mentors felt they were able to enhance the students' understanding and exposure to their respective fields. Although 73% of faculty and mentors did not get receive follow up emails from the students after the program, those that did were able to further assist them and answer any questions. Overall, faculty and mentors enjoyed their time in the program, were able to answer all questions, engaged with the audience, and were satisfied with their presentation/discussion. Faculty also had a positive outlook on the usefulness and success of the program, with 100% being willing to recommend the program to others (Figure 11 and 12). Moreover, all faculty were willing to participate in a similar program in the future, which will help scalability. By retaining current mentors, the program will have the opportunity to build and add new faculty and mentors from fields that were not discussed in previous years. As a result, students will be exposed to more careers from a larger and more diverse cohort of faculty and mentors compared to previous years.

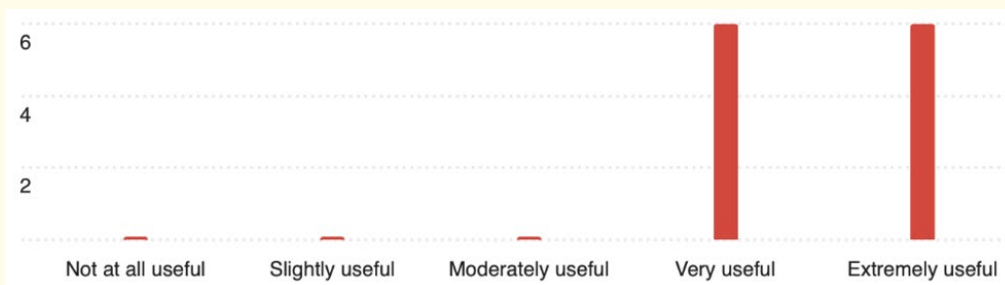


Figure 11: Faculty/Mentor Ratings of Mentorship Program Usefulness.

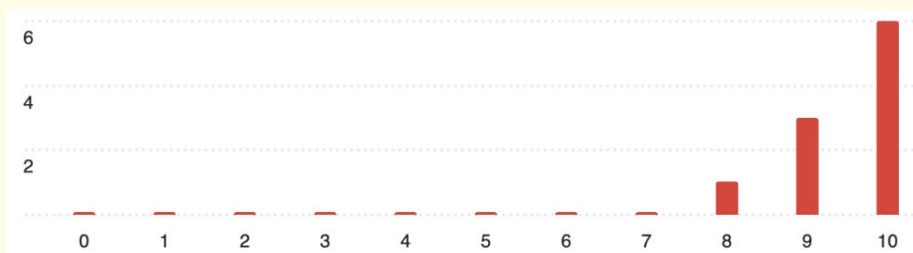


Figure 12: How Likely are Faculty/Mentors to Recommend this Mentorship Program to Others.

Discussion

Among the faculty, mentors, and student participants, the vast majority had a positive outlook on this program, with many being willing to refer to others. Students were able to participate in a diverse range of activities as well as meet various medical students, residents, and faculty. By having a multitude of activities, students were able to get exposure to personal development workshops in addition to many different aspects of STEM. As of now, all students from the first two years of the program are now enrolled in universities, with the students from the 2024 program currently applying to undergraduate institutions. This program helped decrease the overall stress students have toward their future career, enabling them to gain confidence to pursue further career development and educational opportunities.

With Black and Hispanic students having a 61% and 58% respective immediate college enrollment rate compared to White and Asian students (64% and 74%), continued work in the future is necessary to help the minority communities [11]. By providing guidance and support during the stressful transition from high school to college, mentors can guide students toward their dream careers. Mentorship can

not only provide feedback, advice, and access to resources and opportunities to advance one's career but also contribute to a person's long term educational attainment [12]. By having mentors with similar backgrounds, students can understand the barriers and struggles that need to be overcome in order to achieve their goals. In addition to simply identifying those barriers, seeing others of similar background in high status positions can increase motivation to overcome those challenges and reject negative perceptions [12].

Mentoring can be done through various methods such as in-person and virtual. In a study regarding the shift to virtual research mentorship from in-person interaction, mentors and mentees who prioritized communication and defined clear goals and expectations had the most success [13]. Other studies reported the heterogeneity of the impact of virtual mentoring as it largely depends on the people involved [14]. Mentoring can also be in a group-based setting in addition to being one-on-one. One study found that group mentoring provided more benefit for talented girls in STEM due to better discussions and more networking opportunities [15]. Other studies have found that the mentor relationship does not develop as well for some individuals during group sessions compared to the traditional one-on-one mentoring [16]. Therefore, providing the option of different modalities of mentorship can be just as critical as the mentorship itself. In this program, some students expressed the desire to have continued mentorship through the year. Providing them the option between different modes of mentorship will enable them to make the most out of what works for their situation, especially with some students moving for college.

However, there is still a lack of disparity across the STEM fields, with Hispanics representing a total of 15% of the workforce, Asians representing 10%, and Blacks representing 9% [17]. This is even worse in health care. In 2024, a large proportion of physicians are White (63%) compared to other ethnicities like Asian (21%), Black (5%), and Hispanic (7%) [18]. The lack of diversity amongst the workforce in healthcare can have a direct impact on the experiences of minority patients in the healthcare setting. A study reported 47% of healthcare workers indicating that they have witnessed discrimination against patients based on race or ethnicity [19]. Not only does the lack of diversity potentially worsen a patient's experience in healthcare, but it can also worsen the experience of the staff and prospective workers. The goal of this minority mentorship program is to help students see themselves in the roles that are not traditionally exposed to them. This way, they can become more confident in their pursuit of achieving their goals.

Some limitations in this study are that the mentorship program was only one week in duration, with the survey being sent 3 months after the conclusion of the 2024 program. This could have resulted in variability and recall bias in the survey results. Moreover, the program only ran for 3 consecutive years and had a relatively small sample size, especially with the survey itself. However, these results provide valuable insight that can be built upon with larger programs. Country wide initiatives need to continue to develop and improve in educating and exposing minority and disadvantaged students to various career opportunities. Future efforts can be dedicated to scaling up the program to support more students, increasing access to various fields and professionals in STEM, and providing continued mentorship for students who desire.

Conclusion

It has been demonstrated that early mentorship and guidance play a crucial role in supporting all students; however, underrepresented students often lack access to these services compared to their peers. This disparity arises from various factors, including socioeconomic status, biases, and limited exposure. Initiatives of this nature can foster confidence, promote academic engagement, and enhance life experiences and opportunities. The establishment of similar programs is recommended to address the significant gaps present throughout the STEM workforce.

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