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Underrepresentation of Minoritized Groups in STEM Education: The Development of a Survey

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ABSTRACT

The current school system has an underrepresentation of People of Color teaching science, technology, engineering, and mathematics (STEM). Presently, there is a lack of data gathering tools to explore the STEM experience of Students of Color. This article focuses on the development of a survey using a Critical Race Theory framework to better understand the impact of race on the STEM education pipeline for underrepresented, racially minoritized (URM) learners. This article will review the survey's development process consisting of (a) creation of initial survey; (b) pilot study using interviews to receive feedback; (c) modifying the survey based on the feedback from the pilot study; and (d) implementation of the revised survey. Ultimately this instrument will support inquiry around racial representation in STEM education.

Keywords: diversifying STEM education, race congruence, survey design, underrepresented minoritized groups, people of color

INTRODUCTION

The racial achievement gap refers to the difference in student test scores based on race (Jencks & Phillips, 1998). The racial achievement gap is frequently used in the context of discussing science, technology, engineering, and mathematics (STEM) assessments (National Center for Education Statistics, 2015). When looking at the factors surrounding students' success in STEM, the problem can be reframed as an opportunity gap to explain the racial

disparities in test scores. The opportunity for high quality STEM education is not accessible to all students in the current education system (National Center for Science and Engineering Statistics, 2019). Previous research has analyzed how these inequitable opportunities impact students of minoritized groups' achievement and interest in pursuing STEM (Gipson, 2016; Grossman & Porche, 2014; Stipanovic & Woo, 2017). However, there is limited research on underrepresented racially minoritized (URM) individuals' interest in becoming STEM teachers (Rincon et al., 2020).

Racial diversity in the STEM teacher workforce allows SOC to see someone who looks like them succeeding in STEM. Existing research has analyzed the many benefits of racial representation among STEM teachers (Burciaga & Kohli, 2018; Fox, 2016; Grissom & Redding, 2016; Jacoby-Senghor et al., 2016; McGrady & Reynolds, 2013). Increasing the number of Teachers of Color (TOC) in STEM can improve SOC's success and interest in STEM (Fox, 2016; Grissom & Redding, 2016; Jacoby-Senghor et al., 2016; McGrady & Reynolds, 2013). However, research has primarily focused on URM students' interest in pursuing STEM or education as separate issues. The goal of this article is to develop and validate a survey that will analyze the intersection of racial inequities in STEM and education.

The STEM education pipeline will be examined through a survey that supports a better understanding of the STEM education experience of URM learners. This tool can be used to analyze the racialized influences that are most prevalent in STEM education at the K-12 and post-secondary levels. The survey can also be utilized to better understand whether and how those experiences impact a student's interest in becoming a STEM teacher. The participant demographic for the survey includes Black and Latinx populations in the United States because of the extent that they remain underrepresented in STEM teaching professions (National Science Foundation, 2019). Throughout this article the terms URMs and SOC will refer to those who identify as Black and Latinx due to their underrepresentation in STEM education. This article uses a Critical Race Theory (CRT) framework to better understand the impact of race on the STEM education pipeline for URM learners.

LITERATURE REVIEW

Existing research has primarily focused on URM learners in STEM and education as separate areas of study. This article reviews the literature related to URM learners in STEM and education to better understand the intersectionality of STEM education. The literature was reviewed to analyze the impact of race on URM learners' experiences during their STEM education journey through K-12 and post-secondary schooling.

Underrepresented Minoritized Learners in STEM

Experiences that impact URM individuals interest in STEM begin in the K-12 settings and continue into post-secondary education. In the K-12 setting, students have experienced microaggressions from classmates and their teachers (Grossman & Porche, 2014; Kohli & Solórzano, 2012; Marrun et al., 2019; Suarez-Orozco et al., 2015). These interactions included insensitive or dismissive comments (Lee et al., 2020; Park et al., 2019). Frequent experiences with microaggressions create a hostile academic environment making students feel isolated (Green et al., 2018; Lee et al., 2020) and disconnected from STEM (Hall et al., 2017). SOC have also experienced lower expectations from their teachers, which has led to students questioning if they belong in STEM (Cheng, 2019; Egalite & Kisida, 2018; Gershenson et al., 2016; McGrady & Reynolds, 2013). Finally, SOC have experienced a non-inclusive standardized curriculum (Collins et al., 2020; Madkins & McKinney de Royston, 2019; Milner, 2016). When SOC feel underrepresented in their curriculum, they miss out on engaging and meaningful STEM learning experiences (Alvarado & Muniz, 2018; King & Pringle, 2018). It is important for students to have a positive exposure to STEM early in education because this can impact a student's interest in pursuing STEM (Alvarado & Muniz, 2018). These negative K-12 experiences may deter a SOC from majoring in STEM.

At the post-secondary level, SOC have experienced additional obstacles in their STEM major. For example, SOC experienced stereotype threat, which is when a student doubts their ability to be successful in STEM classes due to stereotypes (Beasley & Fischer, 2012; Ben-Zeev et al., 2017). Students have also experienced unequal access to academic preparation (Gipson, 2016; Griffith, 2010; Stipanovic & Woo, 2017; Wang, 2013; White et al., 2018). This is not exclusive to SOC, but many URM students attended lower-income school districts that have less resources than White populated school districts (Stipanovic & Woo, 2017). This disadvantage can include lack of access to Advanced Placement classes or STEM enrichment programs. The more Advanced Placement classes a SOC has taken, the higher the likelihood of continuing in a STEM major (Gipson, 2016). The final possible influence at the college level includes financial concerns (Adams et al., 2016; Chang et al., 2014; White et al., 2018). Although this is another example that is not exclusive to SOC, research has found that financial concerns have led to issues of attrition among URM learners majoring in STEM (Adams et al., 2016; Chang et al., 2014; White et al., 2018). Research has found that these influences at the K-12 and post-secondary level disproportionately impact the extent of representation of People of Color (POC) in STEM fields.

Underrepresentation of Minoritized Learners in Education

There is also an underrepresentation of POC in the teaching profession (National Center for Education Statistics, 2018). URM students can be deterred from becoming a teacher due to negative education experiences at the K-12 level, similar to those described above (Grossman & Porche, 2014; Kohli & Solórzano, 2012; Marrun et al., 2019; Plachowski, 2019; Suarez-Orozco et al., 2015). Also, URM students may not be interested in teaching because of the societal undervaluing of the profession and the low pay of educators (Carver-Thomas & Darling-Hammond, 2019; Marrun et al., 2019; Smak & Walczak, 2017). Finally, SOC might not pursue teaching due to the lack of racial diversity within the field (Gist et al., 2018; Marrun et al., 2019).

Once an URM student decides to major in education, additional barriers have occurred including negative experiences in teacher preparation programs (Cheruvu et al., 2015; Morales, 2018). Students described a hostile academic environment and a lack of support from faculty members (Bell & Busey, 2021; Black & Cook, 2018; Cheruvu et al., 2015). SOC have also experienced discrimination from inequitable teaching license requirements (Ingersoll et al., 2019; Petchauer et al., 2018; Williams et al., 2019). Standardized teaching assessments have disproportionately impacted the success of preservice TOC (Petchauer et al., 2018; Williams et al., 2019). These influences have affected the low number of POC entering the teaching profession.

Although research has primarily viewed the underrepresentation of POC in STEM and education as separate issues, this research aims to provide a tool to analyze the intersectionality of the STEM education pipeline. The goal of the following survey is to examine which of the previously reviewed influences are most prevalent during K-12 and post-secondary education. The second purpose of the survey is to explore how these experiences have impacted URM learners' interest in pursuing STEM education. This survey will improve understanding about the racial underrepresentation in the STEM education pipeline.

THEORETICAL FRAMEWORK

The Critical Race Theory (CRT) framework examines the impact of race and racism within current systems (Brown, 2014; Sleeter, 2017; Solórzano et al., 2000). CRT originated during the Civil Rights Movement using critical legal theory and has expanded to other domains including education (Delgado & Stefanic, 2017; Ladson-Billings, 1998; Solórzano et al., 2000). A CRT lens analyzes the models of oppression with a social justice stance to find radical

solutions (Ladson-Billings, 1998). In this study, CRT is used to analyze the underrepresentation of POC in STEM education to get a better understanding of the racial inequities in the STEM education pipeline.

There are three basic tenets of CRT including racism, interest convergence, and storytelling (Delgado & Stefancic, 2017; Ledesma & Calderon, 2015; Sleeter, 2017). The first tenet involves the acceptance that racism is part of society. Ladson-Billings and Tate (1995) state that "race continues to be a significant factor in determining inequity in the United States-is easily documented in the statistical and demographic data" (p. 48). In this research, the inequities are evident in the underrepresentation of minoritized groups pursuing STEM education (National Science Foundation, 2019). The second tenet is interest convergence, which is the idea that racism will continue to be part of societal structures because of the benefits of the White population (Bell, 1980). It is important to analyze the privilege and oppression taking place in the current STEM education pipeline as it relates to race. The final tenet is storytelling, which allows marginalized groups to share their experiences (Ladson-Billings, 1998, Ladson-Billings & Tate, 1995; Sleeter, 2017; Solórzano et al., 2000). This research has created a tool for SOC to share their experiences on their STEM education journey. The CRT framework is used in this research to better understand the racial inequities causing the underrepresentation of minoritized groups in STEM education through a survey.

RESEARCH METHOD

The URM Learners in STEM Survey (see Appendix) examines the possible influences impacting URM learners' pursuit of STEM education. The survey development process consisted of (a) creation of the initial survey based on existing research; (b) a pilot study with interviews to receive feedback; (c) modifying the survey based on the feedback from the pilot study; and (d) implementation of the revised survey. The survey contains possible influences from existing research on the minoritized groups in STEM and education. The URM Learners in STEM Survey targets URM students majoring in a STEM subject. The purpose of this instrument is to better understand the STEM experiences in K-12 and post-secondary education. The survey is also intended to examine how those experiences impact URM learners interested in becoming STEM teachers. Following the tenets of the CRT the framework, the goal of this survey is to provide a storytelling tool to better understand the racial inequalities in the STEM education pipeline.

Development of Survey

The URM Learners in STEM Survey was developed using existing research with the following structure (a) demographic and background information (questions 1-6); (b) K-12 influences (questions 7-18); (c) post-secondary influences (questions 19-26); and (d) STEM education questions (questions 27-34). The section on demographic and background information includes the following factors: major, race, gender, year in school, racial diversity of high school, and racial diversity of college. The K-12 influences consist of questions relating to microaggressions, behavioral perceptions, academic perceptions, standardized curriculum, and race congruence. The post-secondary influences section includes questions concerning stereotype threat, lack of preparation, and financial concerns. The final section on STEM education contains a modification of "Survey of Your Ideas about Teaching as a Career" by Marrun et al. (2019), which focuses on minoritized students' opinions of teaching. Some questions were eliminated from the original survey and additional questions were added specifically relating to teaching STEM. A modification of the Marrun et al. (2019) survey was chosen because the questions align with URM learners' positionality with regard to entering teaching.

The survey contains a variety of questions including multiple choice, fill in the blank, short answer, and open ended questions. The background section includes multiple choice and fill in the blank questions. The rest of the survey contains multiple choice, open ended, and yes/no questions with a short answer option. The possible influences, questions related to those topics, and the existing research associated with those influences are displayed in Table 1. There are multiple questions related to each influence to get a better understanding of the experiences of the participants. For example, question 21 and question 22 relate to lack of preparation. Question 21 states "Do you feel like your K-12 education equally prepared you for college compared to your White classmates?" and question 22 asks "Were there any STEM classes that your high school did not offer compared to your classmates in college?". These questions allow participants to expand on their K-12 preparation compared to their fellow STEM majors. Although many questions are a yes or no question, they have short answer options to give participants the opportunity to provide specific examples.

Table 1: Possible Influences: URM Learners in STEM Survey

Possible Influence	Questions	References
Microaggressions	7, 8	Grossman & Porche, 2014; Kohli & Solórzano, 2012; Marrun et al., 2019; Suarez-Orozco et al., 2015
Behavior perceptions	9, 10	Cheng, 2019; McGrady & Reynolds, 2013
Academic perceptions	11, 12	Egalite & Kisida, 2018; Gershenson et al., 2016
Standardized curriculum	13, 14	Collins et al., 2020; Freire & Valdez, 2017; Madkins & McKinney de Royston, 2019; Milner, 2016
Race congruence	15, 16, 17	Fox, 2016; Gershenson et al., 2016; Gist et al., 2018; Grissom & Redding, 2016; Jacoby-Senghor et al., 2016; Ouazad, 2014
Stereotype threat	19, 20	Beasley & Fischer, 2012; Ben-Zeev et al., 2017; Steele & Aronson, 1995
Lack of preparation	21, 22	Chang et al., 2014; Gipson, 2016; Griffith, 2010; Stipanovic & Woo, 2017; Wang, 2013; White et al., 2018
Financial concerns	23, 24	Adams et al., 2016; Chang et al., 2014; White et al., 2018

The survey was implemented using an online survey system, Qualtrics. Participants were provided with a link to access the survey via email. Informed consent was part of the survey in two different sections, including participating in the survey and the optional follow-up interview. The survey was first implemented in a pilot study prior to being forwarded to multiple universities.

Pilot Study

A pilot study was utilized to explore the reliability and validity of the survey (Carmines & Zeller, 1979). The pilot survey was sent to STEM majors at one mid-sized university in the U.S., which is a similar representation to the individuals that would be participants for future studies (Sapsford & Jupp, 1996). Purposeful sampling was utilized in this study to identify participants based on their major who met the eligibility criteria of self-identifying as Black or Latinx and majoring in STEM (Patton, 2002). For the pilot study, STEM majors that fell within the following disciplines were invited to participate: biology, chemistry, physics, technology, computer science,

engineering, and mathematics. The researcher emailed the department heads of these majors asking them to forward the survey along to the students in their department.

The email to the participants contained details on the pilot study, selection criteria, and a link to the online survey. In total, 20 surveys were completed. After eliminating the surveys that did not meet the specific criteria for this study and those who only completed the demographic portion of the survey, there were 11 total surveys. The demographics of participants were collected including those who identified as Black (n = 7) and Latinx (n = 4). A diverse representation of majors included biology (n = 6), biochemistry (n = 2), chemistry (n = 2), and technology (n = 1). The average amount of time spent on the survey was 31 minutes. Based on the purpose of the inquiry of this survey and the representation of individuals, the sample size for the pilot study was deemed appropriate and the next step involved analyzing survey responses (Patton, 2002).

In the analysis of the survey responses, there did not appear to be confusion on the survey questions because participants responded as the questions were intended. Most questions contained a short answer section for participants to elaborate on the experience. Many participants chose to respond to the short answer questions related to their STEM education journey. Although the participants did not all have the same experiences, each possible influence was experienced by at least one of the participants and elaborated on in the short answer section.

The survey was open for participants to complete for one month. On the final page of the survey, the participants were able to sign up for an optional interview following the survey. After the surveys were submitted, the researcher contacted those who were eligible and interviews were scheduled based on the availability of the participants. The follow-up interviews took place after the survey data collection window closed. The interview sample included five participants, which was 45% of the total participants. Interviews took place in December 2020 and were conducted via Zoom. Each interviewee gave approval for audio recording and the researcher later transcribed these recordings by hand. Interviews took approximately 30 minutes depending on the responses of the participant. The pilot interviews were scheduled to assistance the researcher in deciding if questions needed to be modified or eliminated from the survey. The interviews allowed the researcher answer the following questions:

1. Do the respondents understand the question as initially written?
2. Are the participants able to think of a variety of answers to any particular question? If not, do questions need additional prompting?
3. Does the survey take too long to complete?
4. What is the best order for the questions? (Sapsford & Jupp, 1996)

In the interviews, participants shared that they did not think any questions were confusing or poorly worded. The interviews also allowed the researcher to ask about the short answer responses in more detail. The researcher anticipated hearing comments related to the length of the survey, due to the multiple influences analyzed in the 35 question survey. Although most participants described the survey taking 20 to 30 minutes, they did not think any part should be taken out. Many described enjoying completing the survey and being able to share their experiences. The layout of the survey was logical to participants by including sections on demographics, K-12 STEM influences, post-secondary STEM influences, and finally STEM teaching. Overall according to the feedback of participants, the instrument was deemed satisfactory with regard to its readability, clarity, and comprehensiveness. After the interviews concluded, the final survey items were decided upon without removing or revising any specific items based on the feedback from interviews.

Implementation of Finalized Survey

After the survey items were finalized, the survey was sent out to nine additional universities. The criterion for university selection included a racially diverse population of students in different geographical areas in the United States. These universities were determined by a Google search using the phrase "racially diverse universities in the United States" with the goal of finding schools with a similar racial enrollment compared to the U.S. population. The researcher selected nine universities in different geographical areas. The researcher emailed STEM department chairs at each university explaining the study and asking them to forward the email to students in their department.

At the conclusion of the study, 135 participants completed the survey. After eliminating those who only completed the demographic portion of the survey or did not fall into the demographic of the study, there were 43 total surveys to review. The average amount of time on the survey was skewed by a few participants who appeared to leave their survey open for hours. Generally, the participants took 20 to 30 minutes to complete the survey. Similar to the pilot study, follow-up interviews took place but were focused on participants elaborating on their experiences.

Participants

When including the pilot survey and survey, a total of 54 surveys were part of the data analysis. The interview process included 30 participants, which was 55% of the total participants. The racial demographic of survey

participants included those who identified as Black (n = 29), Latinx (n = 22), and biracial (n = 3). A variety of majors were also included within the study, including biology (n = 18), engineering (n = 8), technology (n = 7), computer science (n = 7), mathematics (n = 7), biochemistry (n = 3), chemistry (n = 2), and environmental science (n = 2). The diverse representation of participants was important for analyzing the use of the survey as a tool to understand the experiences of SOC in STEM education.

Validation and Reliability

Throughout the development of the URM Learners in STEM Survey, the survey demonstrates evidence of validity and reliability. Content validity refers to the survey questions accurately representing the measured content area (Carmines & Zeller, 1979). Content validity was established by thoroughly exploring the existing research on the underrepresentation of minoritized students in STEM education and basing the survey questions on these findings. The survey was also analyzed by expert education researchers in order to increase content validity. Construct validity refers to the accuracy of the generalizations made by the researcher (Carmines & Zeller, 1979). Member checking through respondent validation was utilized to address construct validity. In total, 30 follow-up interviews took place during the pilot and study.

Reliability refers to the survey being replicated in future studies (Merriam & Tisdell, 2016). Reliability was addressed in this survey but conducting a pilot survey to measure the internal consistency of the questions that measure the same concepts (Carmines & Zeller, 1979). There are multiple questions related to the same possible influence, for example experiences with microaggressions. When an instrument has multiple questions involving the same topic, this allows the researcher to ensure the responses are consistent. Many questions also have short answer options, which allowed the researcher to evaluate if the specific experience relates to the possible influence. In future research it is strongly recommended that interviews accompany the survey to increase the reliability and validity of the responses.

RESULTS

This survey was created to better position the voice of SOC majoring in STEM in the evidence gathering process. The development of the URM Learners in STEM Survey demonstrates evidence of validity and reliability and can be used to learn about the critical incidents in the STEM education pipeline. CRT lens was used to analyze the negative STEM experiences, positive STEM experiences, and the impact of these experiences on a SOC's

Table 2: Results: URM Learners in STEM Survey

Negative Experiences	Frequency	Quote
Microaggressions	37	"A teacher tried to pronounce my name and I corrected her when she said it incorrectly twice. Then under her breath she stated, "Y'all mamas and daddies got some names, boy. Just naming y'all anything."
Behavior perceptions	20	"I mean you could see that the day suspension room was mostly black and Latino."
Academic perceptions	23	"My high school advisor (white men) tried to discourage me to take two AP math classes (calculus and statistics) while the people around me had no trouble getting the permission to do it. he kept asking if I can even handle the courses and that it will be hard."
Stereotype threat	41	"I feel fear of failing STEM classes, as this will confirm several stereotypes about Hispanics being lazy." "Whenever I would fail or perform poorly I took it as a sign that I didn't belong. When it reality it was just a lack of proper preparation."
Lack of preparation	26	"I don't think our school felt the need to fund our STEM program or knew how to. Our high school was somewhat diverse, but mostly consisted of black students. As an athlete I could see where the funds were going. Every other year our teams got new uniforms or sponsors. Our school received a large grant, but if it wasn't a club that raised its own funds our STEM department was nonexistent."
Financial concerns	31	"I had to fend for myself since I was 12. I lived with uncles and other relatives and had to work in grocery stores since that age. Financial worries have always been a strain in my life because I was an undocumented student."

interest in becoming a STEM teacher. During the analysis of the URM Learners in STEM Survey, the researcher looked for frequency, quotes, and trends among the data. All 54 surveys, including the pilot surveys and

finalized surveys, were included in the analysis since no revisions were made throughout the research process.

Negative STEM Experiences

The survey questions included multiple questions related to negative STEM experiences in K-12 and post-secondary education. The possible influences at the K-12 level were reviewed for negative experiences in the following categories: microaggressions, behavior perceptions, and academic perceptions. Table 2 displays the frequency of the experience among participants and a participant quote describing the specific negative incident.

According to survey responses, the most common negative experience in K-12 was microaggressions, including 37 of the 54 participants. These microaggressions included negative experiences with classmates and teachers. One common experience with microaggressions involved teachers mispronouncing or refusing to say a culturally unique name. Table 2 also displays the post-secondary negative experiences, which includes stereotype threat, lack of preparation, and financial concerns. Stereotype threat was the most common post-secondary negative experience for participants in the study. Students generally described a fear of falling into a racial stereotype and the added pressure they feel to prove themselves in STEM classes.

Positive STEM Experiences

In addition to negative experiences, the STEM majors in this survey also described their passion for STEM and the positive experiences that led them on their STEM journey. For example, 35 out of the 54 participants said their STEM teachers encouraged their interest in STEM. For students who had a TOC in STEM, many described the positive impact that teacher had on them. One student described his experience of having a diverse representation of teachers as

> I think it had a lot of impact on how I viewed myself and how successful I thought I could become. I don't think I ever would have thought about even being a math major if I hadn't had black teachers throughout my K12 experience.

When asked why students were pursuing STEM, many participants described success in STEM classes, being fascinated by STEM concepts, or wanting a job that gives back to their community. One student, who is majoring in biology on a pre-med track, described the source of her ambition in STEM as

"The lack of representation of Black people in medicine and the injustice blacks face in the healthcare system is what drives me to become a healthcare provider". Other participants also described wanting to be the racial representation in a field that is predominately White.

STEM Education

Although the participants are STEM majors, only 11 of the 54 participants said they were interested in becoming a teacher. While there were participants who expressed an interest in teaching, none of the participants were enrolled in the education program at their university. For those who were interested in teaching, majority were only considering being a professor, not a K-12 STEM teacher. The survey gave participants the opportunity to share why they were not interested in becoming a teacher. The main themes included a lack of family support, the low pay of the profession, and self-doubt in their ability to explain STEM concepts. Based on the participant responses, the URM Learners in STEM Survey utilizes a CRT framework to provide a tool for the analysis of the underrepresentation of minoritized individuals in STEM education.

DISCUSSION AND CONCLUSIONS

The value of this instrument is that it can be used to analyze the critical incidents in the STEM education experience. This survey allows participants to elaborate on their positive and negative experiences in STEM at the K-12 level and post-secondary level. Students can also explain if they are interested in becoming a STEM teacher. This deeper understanding of URM students' experiences in STEM education can shine a light to the specific areas that need to change. Ultimately this instrument will support inquiry about racial representation in STEM education.

Limitations

Although this survey was sent to different geographical regions, the survey did not contain a question asking the name or geographical location of the participant's high school and university limiting further analysis. It would be interesting to analyze the experiences at different schools in various geographical areas to examine trends in the data. Future research should consider an additional question related to regions of academic study.

This study analyzed a specific demographic of participants. The participants were selected from universities with a racial demographic similar to the population demographic in the United States. This excluded

Historically Black Colleges and Universities (HBCUs), since those institutions are predominantly SOC. The university criteria was intentional with the assumption that the structural racism would look different at HBCUs compared to other universities. However, this is a limitation to the study and future research should include HBCU students to get a full picture of the experience of POC in STEM education. Another possible demographic could include the perspective of SOC who major in education but are not interested in STEM. This would give another dimension to the equity issues in the STEM education pipeline. Finally, it is important to note that the researcher is White female teacher and the researcher's positionality in the creation of the survey.

IMPLICATIONS

The goal of this instrument is to give a voice to SOC and get a better understanding of the positive and negative experiences in their journey through STEM education. This survey can be utilized to analyze problems in K-12 education, post-secondary education, and at the policy level. In the K-12 setting, it can be used to create a better learning environment for URM students by training teachers in anti-racism pedagogy. At the post-secondary level, the survey can be used to better understand the challenges disproportionately impacting SOC's persistence in a STEM major to determine support systems to improve retention. The findings from this survey can also be analyzed by policymakers to create policies and regulations to increase the number of URM STEM teachers. Future research needs to work towards a more equitable learning experience for all students. In order to move forward with that research, it is essential to understand the lived experiences of URM students in STEM education. This instrument will support inquiry related to the educational experiences of SOC in STEM, thus making it possible to better understand the underrepresentation of minoritized groups in STEM education.

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APPENDIX

URM Learners in STEM Survey

Background

1. What is your major?
    - Biology
    - Chemistry
    - Physics
    - Technology
    - Computer science
    - Engineering
    - Math
2. What race do you identify as?
3. What gender do you identify as?
4. What year are you in college?
    - Freshman
    - Sophomore
    - Junior
    - Senior
5. Would you describe your high school as racially diverse?
    - Yes
    - Somewhat
    - No
6. Would you describe your college/university as racially diverse?
    - Yes
    - Somewhat
    - No

K-12 Influences

7. During K-12 schooling, did you ever experience subtle verbal or non-verbal insults based on your race from teachers or classmates?
   - o Yes, there was an incident(s) where a teacher:

     _____
   - o Yes, there was an incident(s) where a student:

     _____
   - o No

8. During K-12 schooling, did you ever experience a teacher mispronounce, change or disrespect your name?
   - o Yes, there was an incident(s) where a teacher:

     _____
   - o No

9. Have you ever been unfairly punished during your K-12 schooling?
   - o Yes, there was an incident(s) where:

     _____
   - o No

10. In your K-12 experience, were punishments the same for students of all races?
   - o Yes
   - o No, there was an incident(s) where a teacher:

     _____

11. Has a STEM (science, technology, engineering, math) teacher ever had lower expectations for you compared to your White classmates?
   - o Yes, there was an incident(s) where:

     _____
   - o No

12. Have you ever been overlooked for an advanced class that you believe you belonged in?
   - o Yes, there was an incident(s) where:

     _____
   - o No

13. Was the curriculum in your K-12 STEM classes relevant to your life?
   - o Always
   - o Somewhat
   - o Never

14. Were minorities and diverse perspectives well represented in your STEM curriculum?
   - o Always
   - o Somewhat
   - o Never

15. How many K-12 teachers have you had who are the same race as you?
   - o None
   - o 1-3
   - o 3-5
   - o 5-10
   - o More than 10

- Most
- All

16. Based on your response to the previous question, what impact has having or not having teachers with a similar racial background had on your educational ambitions?
    - None, because: _____
    - Some, because: _____
    - A lot, because: _____

17. Did you have a role model that looked like you in a STEM teaching position?
    - Yes, he/she was_____
    - No

18. Did your high school STEM teachers encourage your interest in STEM? If yes, how?
    - Yes, they_____
    - No

Post-Secondary Influences

19. Do you think there is a negative stereotype about minorities being successful in STEM?
    - Yes, because: _____
    - No, because: _____

20. Have you ever felt pressure for fear of confirming a negative stereotype about your race?
    - Yes, because: _____
    - No, because: _____

21. Do you feel like your K-12 education equally prepared you for college compared to your White classmates?
    - Yes
    - No, because: _____

22. Were there any STEM classes that your high school did not offer compared to your classmates in college?
    - Yes, the classes include: _____
    - No

23. Do you have a job in addition to going to college? If yes, approximately how many hours do you work a week?

- o Yes, I work approximately:

  _____

- o No

24. Do financial worries add strain or stress to your life?

- o Yes, because:

  _____

- o No

25. Why did you choose to major in STEM?

26. What field(s) or career(s) are you interested in after you graduate with your STEM degree?

Survey of Your Ideas about Teaching as a Career: STEM Education

27. Generally, what do you think about the teaching profession?

- o Great profession! I might be interested in becoming a teacher because:

  _____

- o Great profession, but not for me, because:

  _____

- o Not a great profession, because:

  _____

- o Other, please explain:

  _____

28. Have you ever been encouraged to pursue teaching as a career?

- o No
- o Yes, by whom? (e.g. teacher, family member, friend)

  _____

29. If you decided to pursue teaching as a career, how supportive would your parents/guardians/family members be of your decision?

- o Not supportive at all
- o Somewhat unsupportive
- o Neutral (neither supportive or unsupportive)
- o Somewhat supportive
- o Very supportive
- o Other, please explain:

  _____

30. Why do you think most people go into teaching?

- o For the pay
- o To give back to the community
- o Easy job
- o Good hours/vacation
- o To inspire students
- o Other, please explain:

_____

31. If you were to pursue teaching, what would be the main reason?

- o For the pay
- o To give back to the community
- o Easy job
- o Good hours/vacation
- o To inspire students
- o Other, please explain:

_____

32. According to the U.S. Department of Education, 80% of the teachers in the United States currently are White women. How important do you think it is to have different kinds of people (e.g., people from racial and ethnic minority groups) in the teaching workforce?

- o Not important at all
- o Somewhat unimportant
- o Neutral (neither important or unimportant)
- o Somewhat important
- o Very important
- o Other, please explain:

_____

33. I think people of Color (e.g., racial/ethnic minorities) are not going into teaching because:

- o They are discouraged from pursuing teaching as a career by:

_____

- o They want to pursue careers with higher salaries, like:

_____

- o They don't think they can be good teachers, because:

_____

- o The steps to become a teacher are too complicated
- o Other, please explain:

_____

34. Describe specific reasons why you are not a STEM education major.
35. I would be interested in participating in a follow-up interview.

- o No
- o Yes
  My name is: _____
  I can be contacted at: _____

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