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Pipeline Schmipeline: A New Survey to Examine Youth Pathways in Science

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Abstract

Increasing diversity in science, technology, engineering, and math (STEM) and STEM-related degrees and professions is a national priority. Research on students' pathways in STEM may contribute to our understanding of how to change institutions to achieve diversity; however, until recently, the dominant narrative invoked a "pipeline" metaphor. In this work, we challenge the pipeline metaphor by interrogating what is meant by a "STEM" pathway, measuring constructs not typically measured in STEM pipeline research, endeavoring to make our measures intersectional, and imagining alternative outcomes in addition to "staying in STEM." We have been following students who completed an out-of-school mentored science research program since 2017. Three hundred fifty-eight participants responded to an alumni survey designed to collect data about their location along their pathway, constructs related to the pursuit of a pathway, and demographic information. Here, we describe the characteristics of this sample and initial findings about the new constructs we measured. By measuring constructs not typically measured in pathways research and designing items and scales using an intersectional approach, we challenge the problematic pipeline metaphor that dominates the STEM persistence literature.

Keywords

survey, STEM pipeline, youth pathway, belonging, flourishing, microaggressions

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Problem

From the title of this paper, it is clear that we question the “pipeline” metaphor for retaining diversity in science, technology, engineering, and math (STEM) fields. However, given the critical nature of the challenge and lack of easy solutions, it is understandable how a simple, linear metaphor has been invoked to try to tackle the problem. Increasing diversity in STEM education and industries is essential. Lack of diverse voices contributes to marginalized communities continuing to suffer disproportionately from the impacts of STEM-related crises, including public health and climate. Broadening access to STEM opportunities, as well as recruitment and retention of people from marginalized populations in STEM, is critical for our future. Currently, women and people of color in the United States remain underrepresented in the STEM workforce (Landivar, 2013; Fry et al., 2021). This is a stark, persistent, and problematic inequity.

Early efforts for promoting diversity in STEM education focused on broadening participation by creating more “access” for students from backgrounds historically marginalized in STEM (Bevan et al., 2018). Although creating access is important, such programs can reinforce messages about participation that ultimately work best for participants from dominant communities. More recent efforts have reflected an increasing understanding of the challenges facing marginalized students and are focused on the need to develop the academic and cultural capital necessary to combat imposter syndrome. However, these efforts tend to focus on the need for individuals to personally take on the challenges of racism or sexism (McGee, 2020; Ong et al., 2011), rather than tackling how institutions can change.

The “STEM pipeline” metaphor contributes to the problems described above. The pipeline metaphor conceptualizes the journey through STEM as a single, linear path that loses participants as they “leak out” at various points. Inherent in the comparison is the negative connotation associated with “leaks,” as though a decision not to pursue a terminal degree in STEM is a failure. Furthermore, the metaphor does not fully capture the heterogeneity of pathways or the cultural or contextual features of marginalized students and groups (Cannady et al., 2014; Lykkegaard & Ulriksen, 2019; Metcalf, 2010, 2014; Tan & Barton, 2020). Though the goal of increasing diversity in STEM is critical, by continuing to study the problem as a “leaky pipeline,” we put the responsibility on people from historically underrepresented backgrounds to persist through challenges, rather than trying to understand how to change institutions in such a way that there are fewer challenges that necessitate persistence.

This paper describes how we are deliberately pushing back on the pipeline metaphor in our research by designing a quantitative survey instrument to measure constructs not typically investigated in the literature about recruitment and retention of diversity in STEM. We have collected one year of data with this new instrument from a group of 358 participants in a longitudinal study of pathways in STEM. The field has learned about the “terrain” that students cross during their journey from K–12, through college, and then into the workforce through studies focusing on pathways of youth into STEM (e.g., Espinosa, 2011; Maltese & Tai, 2011; Mein et al., 2020). This literature is extensive and uses diverse datasets and methodologies, from large, quantitative studies including variables associated with formal schooling (e.g., grades, coursework, completed majors) to ethnographies describing the experiences of individual students. This work contributes a quantitative measurement strategy that adds additional nuance.

Conceptual Framework

Many previous studies have used a framework that predicts staying in and leaving STEM using demographic information such as gender and race, previous coursework, and previous achievement in STEM disciplines. Such studies can tell us variables that are associated with staying or leaving STEM; however, they provide limited information about the journey. This paper proposes a “pathway” perspective, which acknowledges that individuals move toward and away from STEM-focused work at various points in their education and career. We address this by asking participants about the disciplinary work they are pursuing in each year of the study and their likelihood of staying in that discipline. Furthermore, our approach acknowledges that STEM pursuits are not easily classified; during the course of the development of this survey, we expanded the definition of STEM to include health and education fields (e.g., nursing, science teaching), and thus we use the STEMM acronym going forward (science, technology, engineering, mathematics, and medicine/health). A key aspect of our conceptual framework is the perspective that psychological and social constructs, not typically a part of pipeline studies, are as important as academic features in influencing pathways. For example, sense of belonging, flourishing, and science identity are constructs addressed in our survey. Furthermore, to measure these social constructs in appropriate ways we may need to update instruments for inclusion and equity. In addition, we argue that a pathway includes not just the individual, but also the context; we strive to describe the “terrain” rather than just the destination. For example, we use a measure of experience with microaggressions to try to understand individuals’ experiences in particular contexts (see the following Methods section). Finally, we strive to conduct our work in a way that acknowledges that staying in STEMM is not the only outcome of interest; rather, individuals can pursue meaningful pathways in and out of STEMM. For example, we use a measure of “flourishing” in combination with the “in STEMM” outcome variable.

In the following section we describe how the survey instrument was designed and summarize the characteristics of our participants. We offer the measurement of three constructs (experience with microaggressions, sense of belonging, and flourishing) as examples of the way that we are problematizing the pipeline in our quantitative approach to describing youth pathways.

Methods

Overview

This paper describes findings from Year 6 (but Year 1 of the new round of funding) of a longitudinal study examining the pathways of participants in a mentored science research program in 2017–2019. The youth participated in mentored science research at one of 24 different sites across a large Northeastern city, including universities, cultural institutions, and community-based organizations. The mission of the program was to provide youth from communities that have historically been excluded or marginalized from entering STEM professions access to research internships that would support them in college and career pathways. Youth worked alongside scientists to conduct research in life, physical, medical, and anthropological science. Although the programs were offered at different institutions, all of the sites shared the following program features: 70 hours of free preparatory coursework to introduce youth to needed scientific concepts, software, and technologies; over 100 hours of mentored science research; and academic and career guidance for science success. (Program features are described in further detail in Chaffee et al., 2023 and Hammerness et al., 2021.) Out-of-school time (OST) science opportunities for youth—in particular, mentored science research—have been shown to positively impact youth interest in and pursuit of STEM careers (e.g., Carrick et al., 2016; Chan et al., 2020; Young et al., 2017). However, estimating the impact of these experiences in middle and high school on future career decisions is difficult due to methodological and practical constraints (e.g., Chan et al., 2020; Chi et al., 2015). The work reported here describes youth pathways toward and away from STEM following their experience in the program, with the goal of ultimately understanding the features that matter.

In Year 6, we designed a new survey including constructs that we hypothesized impact the "terrain" of participants' pathways from high school to college to the workforce. In addition to the alumni survey, participants complete annual social network surveys, which capture information about the people in their lives that they go to for information and support. A subset also participate in in-depth, semistructured interviews. In Year 6, we used purposive quota sampling (Mason, 2002) to select 30 participants that represented variation in gender, ethnicity/race, college/professional disciplines, and experience with microaggressions. We used the interviews to shed light on key patterns in students' commitment to or divergence from STEM; in particular, to help show how these choices develop and change over time. To center youth voices, we established a cohort of six youth to serve as co-researchers for the duration of the longitudinal study (Habig et al., 2021; Yosso, 2005). Youth co-researchers contributed to the selection of measurement scales, participant recruitment, analysis, and hypothesis building. We triangulate alumni survey, social network survey, and interview findings to iteratively refine theories about the terrain of youth pathways toward and away from STEM disciplines. *This paper describes quantitative findings from the alumni survey only.*

Participants

We distributed a Qualtrics survey via email to 865 participants who completed a mentored science research program between 2017 and 2019. Participants were youth between ages 15 and 18 who participated in one of the 24 different out-of-school mentored research programs available through a research mentoring consortium. The program is a partnership among more than 25 academic, research, and cultural institutions who share the goal of engaging high school youth in STEM research experiences alongside scientists. Predominantly students of color (75%), 77% were from families with one or more parents born outside the United States, and more than half (52%) were multilingual, communicating with their families in languages other than/in addition to English. Sixty-seven percent of the sample identified as female.

Of the 865 participants, 358 completed a Year 6 Alumni survey (41.4% response rate). These 358 participants are now considered the sample for the present study. We deliberately recruited participants to maintain the gender and ethnoracial balance of the initial 865. Table 1 shows the characteristics of the participants.

Survey Development

To develop the survey, we hypothesized about psychological and social constructs that impact students' pathways, based on literature search and research findings from the previous years of research. We constructed a survey consisting of questions about participants' current activities (school, work), current primary discipline (major or professional field), a set of validated scales from the literature, and demographic items. The survey took participants, on average, 12 minutes to complete.

Describing Participants' Major and Field. We asked all participants, using an open-ended text entry item, to describe their "intended major," "declared major," or "professional field." We coded each as a field or career in "STEM" or something "other-than-STEM." It is not straightforward to code all pursuits as STEM or something else. We began with a strict adherence to the current list of National Science Foundation–approved STEM disciplines. We expanded the code category to include fields "from science." Wong (2015) distinguishes between careers in science versus careers from science. Careers in science would include occupations that are involved with science research as their primary purpose (U.S. Census Bureau, 2011). The other constituents of STEM, namely technology, engineering, and mathematics (and medicine), are considered to be careers related to science, or careers from science. Medical professions would be careers from science, because medical staff tend to practice and apply medical as well as scientific knowledge. We renamed our more inclusive category STEMM (science, technology, engineering, mathematics, and medicine/health).

Measuring Microaggressions. Experience with microaggressions has been the focus of research into the experiences of students from historically marginalized backgrounds

Table 1. Participant Demographics (n = 358).

Variable	Percentage of Participants
Gender Identity	
Female	67
Male	28
Gender nonconforming, nonbinary, other	4
Missing	<1
Racial Identity	
East Asian	24
White	20
South Asian	16
Hispanic/Latinx	15
Black/African American	14
Multiethnic/Multiracial	5
Middle Eastern/North African	1
Native Hawaiian or Other Pacific Islander	<1
American Indian or Alaska Native	-
Prefer not to state	2
Missing	3
*First-Generation College Student**	
Yes	39
No	56
Prefer not to state	1
Missing	4
One or Both Parents Born Outside the U.S.	
Yes	73
No	21
Prefer not to state	2
Missing	4
How Often Do You Speak English with Your Immediate Family?	
All of the time	46
Part of the time	41
Never	9
Missing	4

Note: Some categories will not add up to 100% due to rounding.
*A first-generation college student is a participant where neither parent has completed a 4-year college degree.

in STEM. To measure microaggressions, we selected a scale developed by Lee et al. (2020), which asks respondents to rate the frequency of racial microaggressions in three areas: campus/workplace, academic/intellectual, and peer. In previous work, participants reported microaggressions connected not only to race, but also to ethnicity, first-generation status, and gender identity. We altered the Lee et al. scale to ask about microaggressions respondents experienced "because of who [they are]" (Scheim & Bauer, 2019). There are tradeoffs with intersectional scale development (Harnois & Bastos, 2019)—for example, by including multiple ways to identify we might lose a sharp focus on an important axis (e.g., ethnoracial identity and microaggressions). In this case, we had previous findings that led us to seek a more intersectional approach. Each subscale included a set of statements about experience with microaggressions (e.g., I have had my contributions minimized because of who I am"). Each statement was rated using a frequency scale from 0 ("Never had the feeling") to 5 ("Once a week or more"). Thus, the maximum score on each subscale was the number of statements times five. (Campus/workplace scale maximum score was 25, academic/intellectual maximum was 25, and peer maximum was 30.)

Measuring Sense of Belonging. Sense of belonging has also emerged as an important focus in studies of students' experiences in higher education. Sense of belonging is defined as one's "sense of being accepted, valued, included, and encouraged by others. . ." (Goodenow, 1993, p. 25). It is a documented predictor of academic success and retention in college (e.g., Booker, 2016; Freeman et al., 2007; Pittman & Richmond, 2008). Interpersonal relationships, perceived competence, personal interest, and science identity contribute to a sense of belonging for STEM students (Rainey et al., 2018). Some of the literature on this topic has focused specifically on belonging in STEM (e.g., Johnson, 2012), revealing that sense of belonging is associated with retention in STEM majors (Freeman et al., 2007; Pittman & Richmond, 2008).

Gender and ethnoracial gaps exist such that women and students from groups historically marginalized in STEM tend to feel less like they belong in STEM relative to their male and majority counterparts, respectively (Espinosa, 2011). Women of color are doubly disadvantaged, having less sense of belonging in STEM relative to other groups (Johnson, 2012). Particularly relevant to the present work, Sax et al.'s (2018) study of gender, race, and sense of belonging in STEM reveals that there is a gender gap such that men from underrepresented minority (URM) groups report a significantly greater sense of belonging than URM women.

Our survey included scales to measure belonging to two groups: sense of belonging in one's major/field (Good et al., 2012) and sense of belonging in university (Bollen & Hoyle, 1990; Hurtado & Ponjuan, 2005). Both of these scales have been validated and extensively used to measure belonging at the college level (e.g., Hausmann et al., 2007, 2009; Hurtado & Ponjuan, 2005; Museus & Maramba, 2011). Moreover, both scales have been used to explore feelings of belonging for marginalized populations on college campuses and STEM majors/fields as characterized by gender identity (Good et al., 2012) and ethnoracial identity (Hurtado & Ponjuan, 2005). Taken together, these scales provide us significant measurement and analytic purchase; they paint a broad understanding of participants' belonging profiles and allow flexibility for building models to answer research questions.

The sense of belonging in major/field scale consisted of 12 statements (e.g., "I feel like I belong to the *X* community") rated on a scale from 1 ("Strongly disagree") to 6 ("Strongly agree"). Scores across items were averaged for the total major/field belonging score. Participants entered their current intended major, declared major, or professional field, and their entries were piped into each statement. The sense of university belonging scale consisted of six statements (e.g., "I feel that I am a member of the university community"), rated on a scale from 1 ("Strongly disagree") to 10 ("Strongly agree"). Scores across items were averaged for the total university belonging score.

Measuring Flourishing. Flourishing can be thought of as an ideal state of well-being. It is what Keyes (2016) calls "the pinnacle of mental health" (p. 100). Diener et al. (2010) describe flourishing as social-psychological prosperity. Their scale captures the degree to which participants have supportive and rewarding relationships, contribute to the happiness of others, feel respected by others, and feel as though they live a meaningful life. The flourishing scale consisted of eight statements (e.g., "I lead a purposeful and meaningful life") rated on a scale from 1 ("Strongly disagree") to 7 ("Strongly agree"). Scores on each item were summed, so the total maximum flourishing score was 56. We initially measured flourishing as an independent variable that we hypothesized impacted pursuit of a STEM field. However, we hypothesize that flourishing might represent an alternative outcome to "staying in STEM" or may be associated with other positive outcomes. We imagine using "flourishing in STEMM" as a possible outcome going forward; it is more important that we prepare students to flourish in STEMM rather than insist they persist so they can end up in a field that is hostile and unsupportive.

Other Scales. We included several other scales measuring constructs we hypothesized would impact students' pathways. We chose to measure science identity prominence with a four-item scale (Brenner et al., 2014). An example item asks participants to rate the degree to which they agree with the statement: "Being a science person is an important reflection of who I am." We measured belonging to a community of practice (Cadiz et al., 2009). We measured engagement with science and engineering practices using a scale originally designed for classroom science teachers (Hayes et al., 2016) and altered the stem of the item to probe the degree to which participants engaged in practices in school and work (e.g., "How frequently do you analyze and interpret data"). We also measured network intentionality (e.g., "I actively seek out professional relationships"; Moolenaar et al., 2014). The complete survey can be found in the Supplemental Materials.

Findings

We calculated summary statistics for all scales measured on the Year 1 Alumni survey and used regression and quartile analyses to begin to investigate relationships between constructs. Table 2 shows where in their school/work trajectories our participants were

Table 2. Academic and Professional Pursuits of Participants ($n = 358$).

Variable	Percentage of Participants
Pursuing a Degree at a 2- or 4-Year Institution	
Yes	54
No	43
Missing	3
Year in School (n = 192)	
Freshman	6
Sophomore	22
Junior	34
Senior	31
5th year +	4
Other	3
Graduated or Not in School (n = 161)	
Currently attending tech or trade school	-
Currently enrolled in grad program or professional school	30
Currently working full time	56
Currently working and grad school	5
Currently other	9
Graduate Degrees Being Pursued (n = 55)	
PhD	33
MD or DO	20
MS	20
MA	3
MAT	2
MBA	2
JD	2
More than one	1.5
Other	3

Note: Some categories will not add up to 100% due to rounding.

in spring 2022. We found that 54% of participants were still in college, 45% were working, and 1% were doing something else (e.g., traveling).

Table 3 summarizes the major/field of the Year 6 participants. Seventy-two percent of participants' majors or fields were coded as "in STEMM." Data from Years 1–5 of the longitudinal study showed between 70% and 76% planning to pursue or pursuing STEM fields.

Microaggressions

Experience with microaggressions was a new construct on the alumni survey in 2022, and we were curious about the extent to which participants experienced microaggressions and

Table 3. Percentage of Participants in STEMM Majors or Fields (n = 358).

Variable	Percentage of Participants
STEMM Major (n = 192)	
Yes	72
No	28
STEMM Graduate Degree/Profession (n = 153)	
Yes	77
No	23
STEMM Major or STEMM Graduate Degree/Profession (n = 358)	
Yes	72
No	25
Missing	03

Note: Some categories will not add up to 100% due to rounding.

Table 4. Microaggression Scales All Participants (n = 329).

	Mean	SD	Min	Max
Campus or workplace microaggression[1]	6.30	5.88	0.0	24.0
Academic/intellectual microaggressions[1]	5.45	5.75	0.0	25.0
Peer microaggression[1]	4.42	5.26	0.0	30.0

[1] Paired t tests found a significant difference between each of the subscales ($p < 0.001$).

the relationship between these frequencies and other demographic characteristics. For all scales, scores range from a possible low of 0 to a high of 30—a higher score indicates experiencing these microaggressions more frequently. Table 4 shows that participants reported experiencing microaggressions most often on campus or at their workplace, followed by academic/intellectual microaggressions, and then peer microaggressions. We conducted paired t tests and found significant differences between each of the different microaggression subscales ($p < 0.001$).

Figure 1 examines experiences with campus and workplace microaggressions in and out of STEMM across gender identities. This analysis highlights the trend that non-STEMM participants reported experiencing more microaggressions relative to their peers in STEMM; however, women reported significantly higher microaggressions in STEMM fields than did men, and nonbinary participants experienced higher levels than both women and men.

Sense of Belonging

The mean value of acceptance belonging (Good et al., 2012) for all participants was 4.5 out of a possible 6; membership belonging (Good et al., 2012) was rated, on

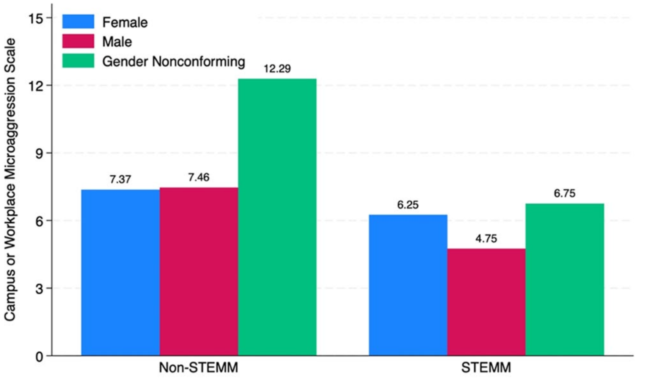

Figure 1. Microaggressions in STEMM versus non-STEMM fields.

average, 4.7 out of 6. Participants rated their sense of university belonging (Bollen & Hoyle, 1990; Hurtado & Ponjuan, 2005), on average, 7.4 out of 8. Participants who identified as Black or African American or Hispanic or Latino/a rated acceptance, membership, and university belonging lower, on average, than participants that identified as White and Asian; however, these differences were not statistically significant. Table 5 reports mean scores and standard deviation for gender, ethnoracial, and STEMM and other-than-STEMM subgroups.

In terms of the relationship between the belonging construct and other constructs measured in the survey, participants' rating of experience with microaggressions was negatively correlated with acceptance belonging (but there was no significant relationship with membership or university belonging).

Flourishing

On average, participants rated their degree of flourishing at 45.0 out of a possible 56, which is almost exactly the mean value found in the validation study (Diener et al., 2010) for the scale (44.97/56, also a diverse set of college students). There were no strong patterns across subgroups, except participants currently pursuing STEMM reported significantly higher levels of flourishing than participants currently pursuing a field other than STEMM. However, this effect seems to be due to a small group of especially low ratings in the other-than-STEMM group (see Figure 2).

Examining relationships between constructs will be a focus of the work in future years; however, an initial analysis of the relationship between belonging and flourishing showed that rating sense of belonging higher was associated with large gains in ratings of flourishing. For example, being in the top quartile of "sense of belonging" was associated with a 10-point bump in flourishing score (see Table 6).

Table 5. Mean Scores by Subgroup on the Three Belonging Scales.

	Acceptance Belonging		Membership Belonging		University Belonging	
Subgroups	Mean	SD	Mean	SD	Mean	SD
Gender Identity						
Female	4.55	0.82	4.67	.98	7.27	2.39
Male	4.52	0.92	4.62	1.03	6.39	2.22
Gender nonconforming, nonbinary, or decline	4.42	0.75	4.78	0.94	7.52	2.19
Ethnoracial Identity						
Black or African American	4.30	1.00	4.58	1.13	6.71	2.46
East Asian	4.56	0.73	4.54	0.86	7.59	2.15
Hispanic or Latino/a	4.43	0.93	4.42	1.10	6.50	2.42
Middle Eastern or North African	4.38	0.62	5.05	0.54	7.44	2.50
More than one group	4.70	0.78	4.75	1.09	5.42	2.76
Native Hawaiian or Pacific Islander	4.88	.	4.00	.	7.37	2.02
South Asian	4.70	0.84	4.86	0.95	7.28	2.52
White	4.59	0.84	4.86	0.93	8.08	2.25
Decline to State	4.66	0.64	4.68	1.09	6.71	2.46
STEMM Field or Major						
Other-than-STEMM	4.41	0.88	4.76	0.96	6.64	2.53
STEMM	4.58	0.83	4.64	1.00	7.19	2.29

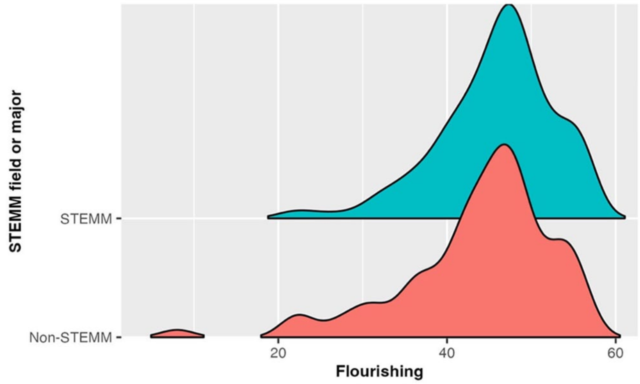

Figure 2. Flourishing in STEMM versus non-STEMM fields.

Table 6. Mean of Flourishing for Quartiles of Membership Belonging.

Membership Belonging Quartile	Mean Flourishing	Standard Deviation	Frequency
Bottom quartile	40.51	7.61	101
2nd quartile	45.30	6.56	70
3rd quartile	47.06	6.50	80
Top quartile	49.60	5.19	78
Total	45.28	7.44	329

Discussion and Implications

Given the number of different scales we tried on this survey, we are still making sense of what the summary statistics and subgroup analyses can tell us about the participants in our study. These scales are new to us, so we are learning how to interpret the findings. We were surprised, for example, that we did not see significant differences across ethnoracial groups in experience with microaggressions, though interview findings seem in direct conflict with this quantitative finding. Furthermore, participants in STEMM reported fewer microaggressions than participants in other-than-STEMM fields; our initial hypothesis was that STEMM fields might have more microaggressions. When we looked at the intersection of gender, field and microaggressions, however, we found that participants that identified as female or nonbinary experienced microaggressions in STEMM more frequently than participants that identified as male. This is a finding that has emerged in numerous other studies (e.g., Kim & Meister, 2023; Yang & Carroll, 2018) and points to the importance of analyzing data with an intersectional lens. As this project progresses, we will also have the benefit of longitudinal scale data, which will allow us to look at relationships over time and the ways in which multiple intersecting aspects of participants' identities and experiences impact their trajectories.

Though we are only able to present a single year's data in this short research note, the ultimate goal of quantitative analysis is to predict outcomes such as "flourishing" and "pursuing STEMM." In addition to more typical "survival analysis" to model our binary "Staying in STEMM" variable, we will have enough data at each time point to use latent growth curve models to model our continuous dependent variables over time. For example, we will collect measures of participants' "flourishing" at four time-points over three years and will be able to model the growth or decline of flourishing over that time and explore how different variables (e.g., belonging, experience with microaggressions, as well as demographic variables such as gender and ethnoracial identity) are related to that trajectory. This way of studying trajectories acknowledges the contribution of multiple variables in movement toward or away from STEMM, rather than the deficit-minded "you are in or you are out" perspective.

Though not the focus of this paper, our interview data serve to illuminate the survey findings. When talking to participants in interviews, we hear the details of the terrain on their pathways into college and the workforce. For example, we hear how interactions and the way in which those interactions made participants feel may have nudged them toward a particular discipline or away from it. We hear about the subtle microaggressions, wrong turns, helpful guides, and missed and realized opportunities. For example, though we were surprised that we did not see differences between ethnoracial subgroups on the microaggressions scale, some of our participants talked about their experiences with racialized microaggressions—these experiences impacted the participants' feelings of belonging and their decisions to pursue STEMM. We would not be able to do the work of describing the pathway without qualitative data. However, identifying scales that measure psychological and social factors and meet our goals of equity and inclusion (e.g., are intersectional and appropriate for all social groups in the study) is important because having these quantitative measures allows us to see patterns at a larger scale. Underrepresentation of people of color and women in STEM is a grand challenge to be tackled, and the "leaky pipeline" metaphor is insufficient; we need different approaches, and this work contributes toward that effort.

Declaration of Conflicting Interests

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