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Student and Faculty Perceptions of Factors that Promote Persistence Among STEM Majors

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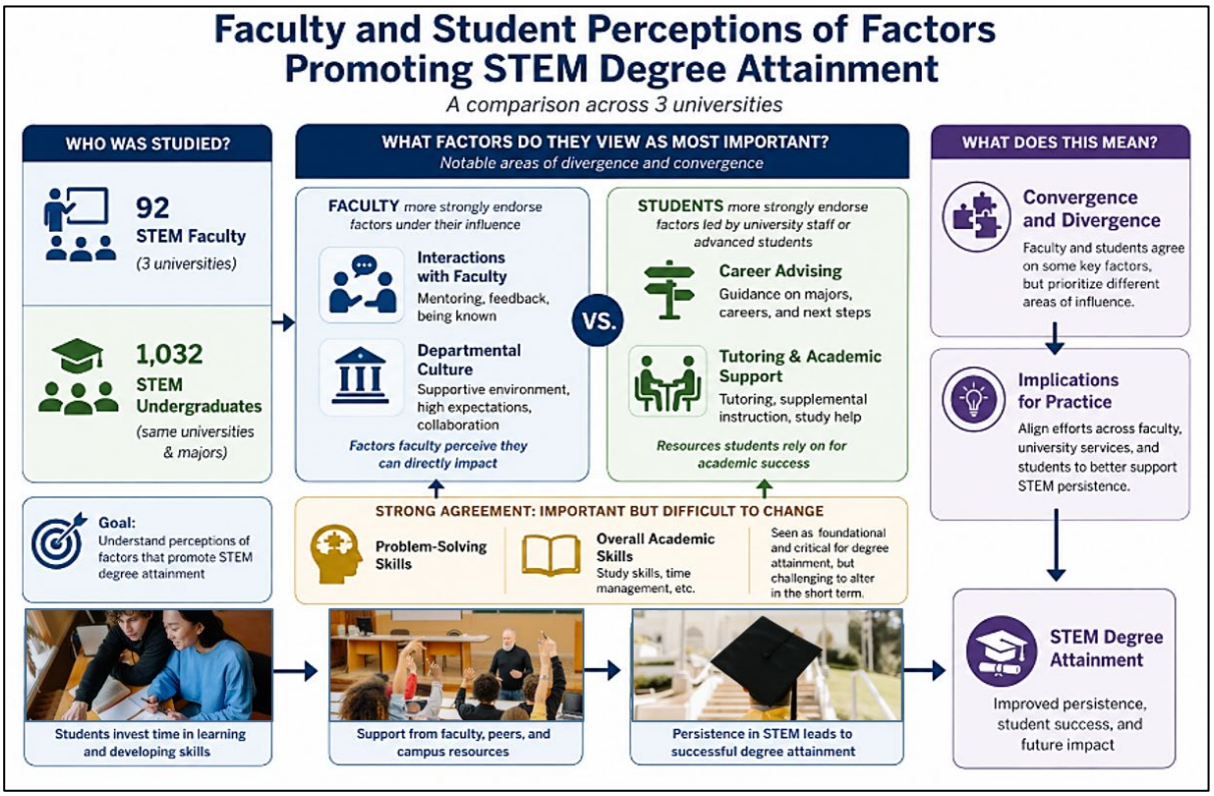
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Abstract: As undergraduates consider how to allocate their time outside the classroom, they are likely to choose behaviours that they view as helping them progress toward receiving a degree, and they may be unlikely to engage in non-required activities that they feel are unhelpful. Similarly, faculty members may not invest time—or ask students to engage—in activities that they do not perceive as helpful for promoting student success. Therefore, it is important to understand faculty and students' perceptions of the factors that promote degree attainment. This knowledge may be especially important within science, technology, engineering, and mathematics (STEM) majors, which tend to have high attrition rates and heavy workloads. This study examined relevant perceptions among 92 faculty at three universities who teach within various STEM majors and 1,032 undergraduates within those same universities and majors. The results highlighted notable areas of convergence and divergence. In particular, faculty more strongly endorsed the importance of multiple factors over which they have some direct control (e.g., interactions with faculty, departmental culture), whereas students more strongly endorsed multiple factors that tend to be led by university staff or advanced students (e.g., career advising, tutoring). In addition, students and faculty both strongly endorsed the importance of factors that may be viewed as difficult to change (e.g., students' problem-solving skills, overall academic skills). Implications for practice and future research are discussed.

Keywords: STEM students, STEM faculty, STEM persistence, degree attainment

Graphical Abstract



INTRODUCTION

Higher education researchers have long paid attention to undergraduate student persistence in science, technology, engineering, and mathematics (STEM) majors. Most of the existing studies on this topic have focused on a singular perspective, primarily drawing on student views or institutional data. This research has largely overlooked other potentially significant perspectives, such as those of faculty, in understanding the factors that contribute to persistence within STEM majors.

Previous studies have identified institutional factors related to STEM persistence, such as program size and the availability of academic and support services (e.g., Cromley et al., 2016; Ikuma et al., 2017), as well as individual factors that include motivation, self-efficacy, interest, and sense of belonging (e.g., Cardoso et al., 2013; Simon et al., 2015). Other work has emphasised academic performance and test scores in introductory STEM courses (e.g., Osunbunmi et al., 2024). While this inquiry has advanced knowledge of STEM persistence, approaches that focus heavily on student ability and performance may reflect fixed mindset beliefs that only certain students are intellectually capable of succeeding in STEM, which may overlook developmental, relational, and institutional factors in fostering persistence.

Another strand of literature has focused on persistence among students from historically underrepresented groups in STEM, including Students of Colour and women students (Estrada et al., 2016; Foltz et al., 2014; Packard & Hirst, 2022). These studies have examined a variety of

social, contextual, and relational factors that contribute to inequities and highlight ways to promote the success of students who hold minoritised identities.

Students' and faculty perceptions of influential factors are important because they may play a substantial role in shaping behaviours (Bowman et al., 2022). For instance, if a student thinks that tutoring is unhelpful for promoting success, then why would she use that resource? And if faculty think that their behaviours have little or no effect on student performance and persistence, then why would they spend a great deal of time preparing lesson plans or designing and facilitating intensive co-curricular experiences? Divergence in perceptions may also constitute a problem, since students may highly value and desire a particular experience or resource, but this may not be provided because faculty perceive it to be unimportant; if that occurs, then students may choose to leave the major that they feel is not providing them with sufficient support (Oliveira et al., 2025).

Study Objectives

Despite the breadth of the STEM persistence literature, the perceptions of relevant stakeholders—as well as the correspondence of these perceptions across different stakeholder groups—are often overlooked. Therefore, this study compares and contrasts student and faculty perceptions of the factors that affect undergraduate persistence in STEM majors. It specifically uses a cross-sectional comparative survey design to examine the degree to which both groups perceive various individual, academic, relational, and institutional factors as being significant for degree completion. By comparing their viewpoints, the study pinpoints areas of alignment and divergence between the perceptions of students and faculty, with the ultimate goal of informing faculty and administrators' efforts to support students majoring in STEM fields.

Theoretical Framework

This study was informed by Reason's (2009) comprehensive model of influences on student learning and persistence. This framework highlights the indirect and direct roles of pre-university characteristics, including academic preparation and student dispositions, on persistence. It also emphasises the role of the organisational context in shaping students' university experience and subsequent persistence. Moreover, faculty may affect students' experiences directly (via the classroom, curricular, and out-of-class experiences that they have with students) or indirectly (via their influences on the organisational context).

Reason's framework is relevant to this study in multiple ways. First, this study assumes that faculty's perceptions of the factors that influence persistence are important, and this framework delineates several ways in which faculty have the potential to influence students' experiences and persistence outcomes. If faculty believe that STEM persistence is mostly a function of fixed student characteristics, then faculty may perceive little incentive to invest substantial energy in promoting student persistence. A disconnect between student and faculty perspectives could also lead to misaligned priorities for efforts to support STEM majors; for instance, faculty may be highly invested in experiences that students feel are unhelpful and therefore may not be interested in pursuing. Second, the survey items to which students and faculty responded reflect the broad array of potential influences—which include entering characteristics as well as classroom, co-curricular, and out-of-class experiences—that are represented within the framework.

METHOD

Data and Participants

These data were collected as part of a large-scale project that explored educational and vocational pathways in biomanufacturing and biotechnology. Participants were faculty and undergraduate students at three public Midwestern universities in the United States, which included a regional comprehensive university, a land grant university, and a flagship university. Both faculty and students were recruited from various STEM majors and departments, which included biology, biochemistry, chemistry, computer science, engineering, genetics, mathematics, natural and physical sciences, physics, and other majors related to biomanufacturing or biotechnology.

Members of the research team compiled a list of all faculty members in these departments, along with their publicly listed university email address. Each faculty member was contacted via email in Spring 2024 up to three times depending on whether the recipient completed the questionnaire, the recipient declined to participate, or the prior email(s) were returned as unable to be delivered to the recipients' server. An initial survey invitation was emailed to each address and contained a personalised link to the questionnaire; two follow-up emails were sent to all remaining non-respondents.

Students from the majors offered by the above departments were also invited by email to participate in an online survey. Each of the institutions provided a list of all students with a declared major offered by these departments. All majors were invited from the regional comprehensive and flagship universities, while a random sample was invited from the land grant university (which had a very large number of STEM majors). An initial email invitation was sent in Fall 2024 that included the unique link, and two follow-up emails were sent to non-respondents. Upon completion of the survey, students were offered a $10 Amazon gift card.

The student sample consisted of 1,032 undergraduates; these participants were 74% White, 8% Asian, 8% multiracial, 4% Latine, 3% Black, 2% another race/ethnicity; 55% women, 42% men, 2% gender nonbinary; and 27% first-generation students (i.e., no parent or guardian with a bachelor's degree). In terms of year at the university, 30% were first-year students, 21% were sophomores, 23% were juniors, and 26% were seniors.

This study also included 92 faculty; this sample was 67% White, 11% Asian, 3% multiracial, 2% Black, 1% Latine, 1% Native, 2% another identity, 13% did not provide their race; 59% men, 29% women, and 12% did not provide their gender. In terms of rank, 52% were full professors, 27% were associate professors, 12% were tenure-track assistant professors, 5% were full-time non-tenure-track faculty, and 4% were adjunct faculty.

Measures

The primary measures consisted of 14 items administered to both faculty and students. Specifically, students responded to the following question stem: "How much of a factor, if at all, do you believe each of the following is for students to finish a degree

in your major?" The question had a slightly different phrasing for faculty to clarify that they should respond in relation to undergraduates: "How much of a factor, if at all, do you believe each of the following is for undergraduate student persistence to degree completion in your major?" These items were identical for both groups: a student's general curiosity/inquisitiveness, a student's problem-solving skills, overall academic skills (e.g., organisation, written and oral communication), incoming discipline-specific knowledge, incoming math skills, positive attitude toward STEM, high earning potential, financial support for educational costs, tutoring/academic support resources, academic advising, career advising/job placement assistance, departmental culture of inclusivity/equity, participation in undergraduate research experiences/interactions with faculty, and positive experiences with faculty inside or outside of the classroom. The perception items were presented in random order and were assessed using a four-point scale (1 = not a factor, 2 = a minor factor, 3 = a moderate factor, and 4 = a major factor). A "not sure" response option was also provided; these were recoded as missing data for the purposes of the present analyses.

These items were developed for the present study by a research team with complementary expertise in survey and questionnaire design and in higher education. The questionnaire items were developed through an iterative process of the research team that included brainstorming of relevant factors, an initial draft of items, and revisions made to those items based on the team's survey expertise. The items intentionally sought to cover a broad range of potential factors that diverse stakeholders may perceive as being influential, and the content of these items was inspired by previous qualitative work identifying faculty-perceived supports and barriers for STEM students (Gandhi-Lee et al., 2015).

Given this desire for breadth of topics, the questionnaire would have been quite long if we had sought to administer several items to represent each of the 14 constructs in this study, which would have likely led to a substantial reduction in the number of respondents. These items were not intended to be combined into multi-item scales, and preliminary analyses confirmed that these generally could not be condensed into reliable scales. The drawback of using single-item measures is that they inherently provide a unidimensional assessment of each relevant construct.

Two demographic control variables were also included. Dummy-coding was used to represent several categories, and the largest sample size was chosen to serve as the reference group for race/ethnicity (i.e., American Indian, Asian, Black, Latine, multiracial, another identity, and prefer not to say, with White as the reference group) and gender (man, nonbinary, another identity, and prefer not to say, with woman as the reference group).

Analyses

Differences between student and faculty endorsement of influential factors were explored via *t*-tests. These items were then arranged in terms of the extent to which they were endorsed more strongly by students versus faculty to provide an understanding of the nature of items that receive disparate endorsement. In addition, multiple regression analyses considered whether significant differences persisted

when accounting for participants' gender and race. Finally, items were arranged by mean separately for faculty and for students to determine which items were most or least highly endorsed within each group.

RESULTS

Table 1 displays the 14 items in order from the largest endorsement disparity favouring students to the largest disparity favouring faculty. Students more strongly endorse the influence of three factors for persisting to graduation within their major than faculty: career advising/job placement assistance, a student's general inquisitiveness, and tutoring/academic support resources. Conversely, faculty more strongly endorsed four factors than students did. These were incoming math skills, undergraduate research experience participation/interactions with faculty, departmental culture of inclusivity/equity, and positive experiences with faculty. Nearly all of these significant differences were also observed within regression analyses that controlled for participants' race and gender; the lone exception was for tutoring/academic support resources becoming nonsignificant (see Table 2).

The relative endorsement of items among faculty and students is displayed in Table 3. Both groups highly endorsed problem-solving skills, overall academic skills, and positive attitude toward STEM as influential for persistence within the major (i.e., all of these were within the top four for both groups). In addition, both groups had modest endorsement of the influence of departmental culture of inclusivity/equity and academic advising (i.e., within the bottom five but still above the scale midpoint). Financial support for education costs and high earning potential were both within the middle four responses of both faculty and students.

DISCUSSION AND IMPLICATIONS

These findings yield important implications for practice. It is a favourable finding that faculty strongly believe that they can play a role in student success, since this will help with their motivation to foster positive experiences with students (including via undergraduate research) as well as a culture of inclusivity and equity. Importantly, efforts to improve STEM cultures and student experiences are indeed successful at promoting university student success and equity (see Estrada et al., 2016; National Academies of Sciences, Engineering, and Medicine, 2017). College and university administrators and faculty should work together to identify ways to facilitate such experiences and cultures within their local contexts, which could include academic advising from faculty, individual gateway and advanced courses, and the curricula for STEM majors more broadly. Department chairs could reinforce these messages and work with their faculty to provide targeted professional development based on faculty needs and interests.

Importantly, positive experiences with faculty can occur in a variety of ways, which include instructional quality, feedback through assignments and exams, mentoring, accessibility of faculty, and out-of-class relationships with students. The present study examined this construct quite broadly, so it is unclear whether faculty or students

perceive particular types of positive experiences to be more influential. Future research should explore this issue in detail.

It is notable that students were more likely than faculty to endorse the role of higher education staff in promoting their success via career services as well as tutoring and other academic support resources. When taken collectively, student-faculty disparities in perceptions could be construed, in part, as faculty placing a lower value on factors over which they have little or no direct control. Because academic and career supports constitute a vital component of undergraduates' short-term and long-term success (Johnson et al., 2022; Toven-Lindsey et al., 2015), efforts should be made to inform faculty about resources at the department, collegiate, and university levels. Faculty may not rate these sources highly as a result of not knowing or understanding the supports that are available at their institution. In addition, hearing from students about the usefulness of these resources—whether through direct conversations or survey results—could also be helpful.

Finally, higher education administrators and faculty leaders should consider the fact that both students and faculty highly endorsed the role of student attributes that could be viewed as difficult or impossible to change during higher education enrollment. The relevant survey items were not explicitly framed as indicating a fixed mindset per se, but these were sufficiently broad and overarching in a manner that likely reflects such mindsets. For instance, faculty and students would be rather unlikely to talk about a goal of improving their overall academic or problem-solving skills (Muenks et al., 2020). People who hold a growth mindset might instead discuss how they can solve specific problems or study more effectively for exams. Conversely, strong endorsement of the importance of broad student capabilities seems far more likely to occur within faculty or students who perceive certain students to be unequipped to address the rigours of STEM course content (e.g., "These students just don't have the problem-solving skills needed to solve these advanced equations"). This interpretation is consistent with previous research about the prevalence of fixed mindsets in college STEM contexts (e.g., Canning et al., 2019; Dweck, 2006).

This endorsement of fixed mindset beliefs can be addressed in multiple ways. First, faculty should engage with resources designed to help them tailor their written and verbal communication to convey a growth mindset and bolster a sense of belonging (see https://studentexperienceproject.org/resources/), especially since prior research has demonstrated that tailoring syllabi, emails, and other written materials can promote overall success and equitable outcomes (e.g., Canning et al., 2022, 2024). Second, colleges and universities should implement psychological interventions to help students reframe their perceptions of challenges with academics and university transition in a productive manner. Existing interventions are often effective at bolstering university student success and equity (Burnette et al., 2023; Solanki et al., 2020), and these can even bolster persistence when administered online to all incoming students (Walton et al., 2023). Clearly, multifaceted efforts are necessary to help address long-standing challenges with STEM degree completion; the views of the most important stakeholders in this process can shed light on how best to proceed.

Table 1. Comparison of Student and Faculty Endorsement of Factors Contributing to Degree Attainment Within the Major

Factor	Student mean	Student SD	Faculty mean	Faculty SD	Difference	t-value	Greater Endorsement
Career advising/job placement assistance	3.17	0.80	2.91	0.82	0.26	2.95**	Students
A student's general curiosity/inquisitiveness	3.55	0.65	3.36	0.69	0.19	2.67**	Students
Tutoring/academic support resources	3.17	0.78	2.99	0.86	0.18	2.01*	Students
Incoming discipline-specific knowledge	3.00	0.85	2.86	0.87	0.14	1.55	No difference
Financial support for educational costs	3.24	0.83	3.12	0.75	0.12	1.22	No difference
A student's problem-solving skills	3.67	0.57	3.63	0.61	0.04	0.59	No difference
Positive attitude toward STEM	3.47	0.76	3.47	0.76	0.01	0.09	No difference
High earning potential	3.21	0.81	3.26	0.65	-0.04	-0.46	No difference
Academic advising	2.94	0.82	2.99	0.91	-0.05	-0.59	No difference
Overall academic skills	3.53	0.65	3.58	0.62	-0.05	-0.69	No difference
Positive experiences with faculty	3.32	0.74	3.49	0.72	-0.17	-2.09*	Faculty
Departmental culture of inclusivity/equity	2.64	0.96	2.98	0.91	-0.34	-3.13**	Faculty
URE participation/interactions with faculty	2.91	0.91	3.33	0.72	-0.42	-4.19***	Faculty
Incoming math skills	2.97	0.84	3.45	0.64	-0.48	-5.32***	Faculty

Note. Endorsement was rated on a four-point scale (1 = not a factor, to 4 = a major factor). *p < .05 **p < .01 ***p < .001

Table 2. Unstandardized Coefficients for Multiple Regression Analyses Predicting Endorsement of Factors Contributing to Degree Attainment Within the Major

Predictor	Career advising/job assistance	Students' general curiosity	Tutoring/ academic support	Incoming disciplinary knowledge	Financial support for education	Students' problem-solving	Positive STEM attitude
Faculty	-.226*	-.157*	-.111	-.151	-.035	-.032	.000
respondent	(.092)	(.075)	(.092)	(.098)	(.099)	(.066)	(.088)
Man	-.141**	-.080	-.215***	-.020	-.168**	.008	-.077
	(.050)	(.041)	(.049)	(.053)	(.052)	(.036)	(.048)
Non-binary	-.218	-.079	-.085	-.280	.356	-.264*	-.037
	(.185)	(.142)	(.173)	(.188)	(.188)	(.125)	(.169)
Another identity	-.303	-.042	-.366	-.544	-.373	-.142	.551
	(.564)	(.465)	(.554)	(.601)	(.586)	(.408)	(.539)
Prefer not to state	.275	.006	-.419	-.076	-.518	.106	.285
gender	(.259)	(.211)	(.248)	(.279)	(.275)	(.181)	(.251)
American Indian	.554	.076	-.447	-.380	-.088	-.676	-.404
	(.563)	(.464)	(.553)	(.599)	(.585)	(.407)	(.538)
Asian	.217*	.082	.281***	.253**	.142	-.019	.060
	(.087)	(.071)	(.085)	(.093)	(.092)	(.062)	(.083)
Black/African	.289*	-.165	.338*	.419**	.132	-.045	.120
American	(.148)	(.124)	(.145)	(.157)	(.156)	(.107)	(.144)
Latino/Hispanic	.208	-.082	.298*	.136	.199	-.083	-.064
	(.123)	(.101)	(.122)	(.130)	(.127)	(.088)	(.117)
Another identity	-.168	.560	.442	.505	-.427	.121	.396
	(.358)	(.295)	(.351)	(.381)	(.478)	(.258)	(.342)
Two or more	.018	.025	-.041	-.011	.096	-.058	.231**
ethnicities	(.090)	(.074)	(.091)	(.097)	(.094)	(.066)	(.087)
Prefer not to state	-.293	-.180	.094	.057	.068	-.162	-.182
race	(.203)	(.167)	(.193)	(.224)	(.212)	(.142	(.195)
R-square	.03	.02	.04	.02	.02	.01	.01
N	1,091	1,106	1,089	1,090	1,074	1,108	1,091

Note. Women and White were reference groups for gender and race, respectively. *p < .05 **p < .01 ***p < .001

Table 2 (continued)

Predictor	High earning potential	Academic advising	Overall academic skills	Positive experiences with faculty	Department culture of equity	URE/ interactions with faculty	Incoming math skills
Faculty respondent	.043 (.094)	.102 (.095)	.123 (.074)	.249** (.084)	.535*** (.110)	.469*** (.102)	.445*** (.094)
Man	.004 (.050)	-.203*** (.051)	-.152*** (.040)	-.231*** (.046)	-.392*** (.059)	-.308*** (.056)	.129* (.051)
Non-binary	.041 (.177)	-.122 (.177)	-.103 (.140)	-.234 (.159)	.448* (.207)	.283 (.202)	-.192 (.182)
Another identity	-.208 (.568)	-.113 (.580)	-.593 (.457)	.456 (.522)	.589 (.660)	.464 (.631)	.519 (.581)
Prefer not to state gender	-.093 (.264)	.026 (.257)	.064 (.205)	-.053 (.231)	-.426 (.303)	-.200 (.290)	.311 (.261)
American Indian	.288 (.566)	-.836 (.579)	.497 (.456)	-.310 (.521)	.117 (.934)	-.423 (.630)	-.726 (.581)
Asian	.213* (.087)	-.004 (.089)	.006 (.070)	-.015 (.080)	.213* (.103)	.244* (.097)	.168 (.089)
Black/African American	.145 (.149)	.603*** (.152)	.116 (.119)	-.096 (.139)	.296 (.179)	.280 (.171)	.387* (.152)
Latino/Hispanic	.043 (.124)	.250* (.127)	-.002 (.100)	.255* (.113)	.340* (.145)	.079 (.139)	.213 (.127)
Another identity	-.007 (.360)	-.026 (.368)	-.091 (.289)	-.285 (.331)	.237 (.419)	.524 (.400)	.019 (.369)
Two or more ethnicities	.030 (.091)	.115 (.092)	.031 (.073)	-.039 (.082)	.242* (.107)	.040 (.102)	.093 (.093)
Prefer not to state race	-.079 (.205)	-.062 (.203)	-.333* (.160)	-.234 (.182)	-.429 (.238)	.148 (.235)	.025 (.203)
R-square	.01	.04	.02	.04	.08	.05	.05
N	1,099	1,104	1,111	1,109	1,058	1,089	1,110

Table 3. Endorsement of Factors Contributing to Degree Attainment Within the Major Arranged from Most to Least Important for Students and for Faculty

Construct	Student mean	Construct	Faculty mean
A student's problem-solving skills	3.67	A student's problem-solving skills	3.63
A student's general curiosity/inquisitiveness	3.55	Overall academic skills	3.58
Overall academic skills	3.53	Positive experiences with faculty	3.49
Positive attitude toward STEM	3.47	Positive attitude toward STEM	3.47
Positive experiences with faculty	3.32	Incoming math skills	3.45
Financial support for educational costs	3.24	A student's general curiosity/inquisitiveness	3.36
High earning potential	3.21	URE participation/interactions with faculty	3.33
Career advising/job placement assistance	3.17	High earning potential	3.26
Tutoring/academic support resources	3.17	Financial support for educational costs	3.12
Incoming discipline-specific knowledge	3.00	Academic advising	2.99
Incoming math skills	2.97	Tutoring/academic support resources	2.99
Academic advising	2.94	Departmental culture of inclusivity/equity	2.98
URE participation/interactions with faculty	2.91	Career advising/job placement assistance	2.91
Departmental culture of inclusivity/equity	2.64	Incoming discipline-specific knowledge	2.86

Note. Endorsement was rated on a four-point scale (1 = not a factor, to 4 = a major factor).

CONCLUSIONS

This study identified major areas of convergence and divergence in faculty and students' perceptions of STEM. In particular, faculty more strongly endorsed the importance of multiple factors over which they have some direct control (e.g., interactions with faculty, departmental culture), whereas students more strongly endorsed multiple factors typically led by university staff or advanced students (e.g., career advising, tutoring). In addition, students and teachers both strongly endorsed the importance of factors that may be perceived as difficult to modify (e.g., students' problem-solving skills, overall academic skills). Implications for practice and future research are highlighted.

AI-ASSISTED TECHNOLOGY STATEMENT

The authors used ChatGPT and Microsoft PowerPoint to assist in creating the graphical abstract for this work. Photos by Yan Krukau and RDNE Stock Project from Pexels.

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