Shaping positive STEM identity for student success

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Data show that students who have a strong science, technology, engineering and mathematics (STEM) identity are more likely to take STEM courses and persist to the academic finish line—graduation.

Positive STEM identity is multifaceted, but at the core, it is the sense that one "belongs" in STEM and can succeed in STEM. A person with strong STEM identity tends to feel confident of the following:

- They have, or can acquire, the knowledge necessary to understand STEM concepts (i.e., competence).
- They can appropriately showcase their STEM related skills in public settings (i.e., performance).
- Others, particularly those within the STEM community, will recognize their competence and performance.

Faculty can empower students to shape and maintain a positive STEM identity. This can have a positive effect on student success and retention, especially for students who are from groups that are historically underrepresented in STEM.

The development of stem identity

Even at a young age, many students adopt mantras such as "I'm not a math person," or "I'm not a science person," and repeat these phrases to themselves whenever they struggle with their STEM coursework. They hear these phrases from adults—often their teachers and parents. Such mantras cement that any struggle with science and math coursework is simply because one is not inherently wired to learn or understand the core concepts, and therefore, it is natural, and even expected, that one will not succeed in STEM work. Imagine how differently students would approach STEM coursework if these limiting ideas were obliterated.

STEM identity is a form of social identity and is usually studied and discussed as having 2 key facets:

1. Typicality: Believing that who you are as a person is compatible with being a STEM professional.

2. Centrality: Feeling that the members of the STEM disciplines accept you.

STEM identity is generally defined as perceiving oneself as a person who can succeed in a STEM discipline/career. Overall, STEM identity from a typicality standpoint is rather low—only about 30% of students view themselves as a "science person." This number is even lower for women and underrepresented racial groups, such as Black students, and ethnic groups, such as Latine students. However, it does not have to remain this way because STEM identity is malleable.

Helping students strengthen STEM identity

Focusing on shaping the typicality aspect of STEM identity seems to be especially important for students from historically excluded/underrepresented groups and can help them overcome stereotype threats.

A student's concept of what a STEM professional is may vary considerably based on their experiences. For example, although the common illustration of a scientist remains a middle-aged (or older), white, cis-man, some students may have had mentors, professors or research supervisors who defy that stereotype, thereby changing their image of what a STEM professional looks like. There are several things that STEM faculty can do to help students shape a positive STEM identity.

Embrace and model a growth mindset

It is helpful to praise performance as a sign of student effort rather than a sign of intrinsic intelligence. Statements like, "you're a math person/I'm a math person," or "you're a science person/I'm a science

person," reinforce an all-or-nothing construct. They emphasize the notion that math is not something that is learned, but rather it is an intrinsic property—you either are, or are not, a math person. In reality, science and math skills develop over time with exposure and practice. It is important to remind students of this and to highlight that successful engineers or scientists are not born; they develop only with persistent commitment to their work. Remind students that assessments are diagnostics of current skill levels—and skill levels can improve with practice.

Consider how you give feedback

Faculty should emphasize their high standards and strong belief that all students have the potential to reach delineated expectations. Students also need useful feedback about ways to improve to meet those expectations.

Certain introductory STEM courses are sometimes regarded as "gatekeeper" or "weed-out" courses because many students start such courses with STEM career aspirations, and then change their major as a direct result of their introductory course experiences. Sadly, many talented students are lost at this stage—and attrition is statistically more pronounced for underrepresented students in STEM as compared to majority groups. Importantly, achievement gaps in such courses remain, even when the analysis is controlled for academic preparation.

Although a one-size-fits-all solution remains elusive, there are some things that faculty can do to make the learning environment more welcoming. For example, faculty should refrain from highlighting the high failure rate of a course or remind students that many people in the class are "not going to make it." This type of low-expectation dialog can adversely affect student success and retention. Furthermore, this "Pygmalion Effect" seems to have an even greater impact on the

achievement of historically excluded racial and ethnic groups in STEM as compared to majority groups.

Normalize struggles

It is valuable to remind students that just because someone must work at something doesn't mean they aren't good at it or have somehow taken up the "wrong" field of study. Faculty must be honest with students—it's useful to share that every professor they have has had to work to improve their skill set and knowledge, and there are many things that even STEM professionals must work to understand in their discipline.

Stop un-credentialing

Un-credentialing comes in many forms. It occurs when a person addresses certain people using an earned honorific (e.g., doctor), but does not address others who have the same credential in the same manner. And before dismissing un-credentialing with "it's just a title…who cares," be aware that un-credentialing is not random. For example, women are statistically less likely to be recognized with their honorific than majority group men.

When underrepresented students in STEM see women, people of color and additional historically underrepresented groups greeted and introduced with their earned credentials (and such professionals embrace and model using those earned titles), it is a social signal worth celebrating.

When young women see other women unapologetically use their title as naturally as their first name, it can reinforce a positive STEM identity—"She's Dr. Superwoman, and I can be too!" or "I notice that Dr. Awesome is a person of color who confidently uses their title. I can

also be a Dr. Awesome." In other words, faculty who are members of underrepresented groups in STEM are real-time STEM-identity role models for underrepresented students in STEM, and un-credentialing is damaging to promoting a positive STEM identity.

Avoid reinforcing cues that can trigger stereotype threat

Stereotype threat is a situation in which a person has a concern that they will confirm a negative stereotype that exists for their cultural, racial, ethnic and/or gender group. Studies have suggested that collecting demographic information prior to testing can trigger stereotype threats that may adversely affect the performance of underrepresented groups. Also, avoid referencing grade distributions before testing, as it may stimulate feelings of stereotype threat.

Overtly emphasize the value of diversity in STEM

Advancing DEI in STEM is required to effectively and sustainably address pressing problems. Discoveries require new perspectives, and women and historically excluded racial and ethnic groups are a rich source of new perspectives. For example, a group of only men engineers built the first automotive airbags and failed to consider how they might need to be altered to protect women and children. As a result, early airbags were designed for men, "resulting in the avoidable deaths for women and children." Sharing history like this will help to emphasize the importance of DEI.

Make space for positive affirmations

Have students affirm their personal values—remember why they are studying in their selected STEM discipline. Help students learn to

manage their feelings of stress and stereotype threat. For example, a simple 10-15-minute writing exercise that prompts students to write about their most important personal values before an upcoming stressful activity (e.g., an exam) can go a long way to remind students of their intrinsic value and empower them to tackle a challenge.

STEM faculty are in a unique position to be change agents and must not underestimate how they can be a force for positive change. By utilizing the steps above, faculty can drive this change forward.

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