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Genius culture: how we influence student identity in STEM

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In Science, Technology, Engineering, and Mathematics (STEM) fields, identity and belonging are affected by how students view themselves as belonging in STEM or not. The movement to help students understand that anyone can be successful in STEM is an incredibly important one. However, how students construct their identities within STEM is important for maintaining their engagement within STEM fields over time. If we condition students to expect positive feedback for having an aptitude in a STEM field early-on, what I deem *genius culture*, we risk helping these students develop resilience when faced with challenges. Although, if we tell students that everyone can succeed in STEM, we risk deflating students who are gifted or talented in STEM and equating growth/improvement as mastery, thereby discouraging inquiry. Moreover, as instructors, our own sense of STEM-self affects how we teach and reward our students for their successes. A more sustainable goal is to make students aware of their STEM-self and help students bolster their sense of belonging in STEM rather than acknowledging only their perceived successes or failures.

KEYWORDS

mindset theory, implicit theory, STEM identity, STEM education, genius culture

1. Introduction

As educators, we relay information to our students in various forms, but the ways in which we do this affect how our students learn. In our movement to student-centered teaching, many of us consider how we can help individual students reach their potential. We think about learning strategies, modes of instruction, and even implicit biases about our individual students' identities, but something that we neglect is how our own thoughts on intelligence may affect our effectiveness in the classroom. Our own sense of self in STEM interfaces with our students' senses of self in STEM; that interaction can be instrumental to the success of an instructor in the classroom and to the subsequent success of STEM students.

STEM identity formation has been shown to be a powerful tool in the classroom (Hughes et al., 2013; Singer et al., 2020). But what STEM identity conception relies on is the validation, praise, or acknowledgement from a valued 'member' in STEM. Classroom teachers are often the first recognition we have of someone being a 'member' of STEM whether in an elementary arithmetic lesson where you were rewarded for getting the multiplication tables correct or in an intro Chemistry class where you give the correct answer as witnessed by a full lecture hall of your peers. Fitting in and envisioning oneself as a member of STEM develops over time, so what, exactly, can we do to humanize this aspect of our fields? This behavior and sense of self that we must develop in our students easily morphs into gatekeeping, and what I have deemed "genius culture." I define *genius culture* as a broad category of validation and value signaling to our students that perform quickly and effectively on assessments. We, as instructors, attempt to create an inclusive environment where everyone is valued for their efforts and accomplishments, but, I argue, our own conception of STEM-membership and our own STEM identities may be getting in the way of inclusion. Our own implicit theories of intelligence may guide how and what we reward, leading us astray when trying to support our students.

To understand how our own STEM identities affect our students,' we must first define implicit theories. Implicit theories were defined by Dweck (1986) as "lay beliefs about the malleability of personal attributes that affect behavior." This concept, in its traditional form, was used to examine behavioral biases witnessed in the workplace or to understand a company's lay-culture. For example, corporations typically define their viewpoints on implicit theory in their hiring statements.

> We're perfectionists. Idealists. Inventors. Forever tinkering with products and processes, always on the lookout for better. Whether you work at one of our global offices, offsite, or even at home, a job at Apple will be demanding. But it also rewards bright, original thinking, and hard work. And none of us here would have it any other way. –Apple, Inc (2017).
>
> There's no one kind of Googler, so we're always looking for people who can bring new perspectives and life experiences to our teams. If you're looking for a place that values your curiosity, passion, and desire to learn, if you're seeking colleagues who are big thinkers eager to take on fresh challenges as a team, then you're a future Googler. –Google (2017).

In the above two examples, subtle language differences signal different lay-culture implicit theories. Apple uses language that puts forth a view of behavior or aptitude that is *fixed* or *entity*-based, i.e., successful Apple candidates are *already* "bright, original thinking, and hard work[ing]" individuals, markedly exclusive: "and none of us here would have it any other way." Meanwhile, Google uses language that is indicative of a *malleable* or *incremental*-based lay theory by placing emphasis on "curiosity, passion, and desire to learn," all of which connote dynamism in ability.

Like corporations, each of us has a lay theory or implicit theory of *intelligence*. When applied to intelligence or aptitude, implicit theories also take the form of entity-based or incremental-based. This presents two popular genres of thought regarding intelligence: (1) entity-intelligence, you either have it or you do not for any given subject, and (2) incremental-intelligence, intelligence increases (and decreases) in each area. Xu and Plaks (2015) suggest that these differences are not only psychologically relevant but have a neurological basis. You have some idea of where you fall on this dichotomy, whether you have been a Mensan since you were 7 or were a "late-bloomer" in Chemistry. But what does this mean for how we teach or how our students learn in STEM?

Not surprisingly, many fields have their own take on implicit theories of intelligence. These fields are those that traditionally identify students who excel early-on in their academic careers and foster their positions as the leaders of the future. Many STEM fields fall into this category. Other fields notoriously value the art of failure and recovery, emphasizing hands-on experience and effort. Unfortunately, we typically internalize the implicit theory of our fields and put forth that culture to the next generation. Murphy and Dweck (2010) found that companies that exhibit entity-based theories produced hiring committees that favored applicants who presented themselves as predominantly "smart" rather than "motivated;" incremental-based companies similarly favored applicants who were "motivated." However, candidates were more likely to have a more balanced presentation of "smarts" and "motivat[ion]" to incremental-based companies.

Because there is no *correct* implicit theory of intelligence to hold, it is more productive to understand how our fields within STEM may have influenced our views of intelligence and then consider how both theories might present challenges and opportunities in our classrooms. While knowing what predictors are best for identifying potential in STEM fields, such as SAT scores, undergraduate success, undergraduate rigor, etc., is useful, understanding how STEM identities and ideologies are formed and how we can access multiple facets of those identities may better support longevity in STEM fields and careers. Starting from the most inclusive point would always be preferrable to retroactively trying to make STEM accessible later in our students' academic careers. Therefore, understanding how our students and ourselves conceptualize STEM identity and our intelligences is crucial to setting our students up for a successful maturation of their places in STEM.

1.1. Entity-based theories of intelligence

Many fields, but especially philosophy, sciences, and mathematics, are entity-theory based—valuing those that show academic prowess early and often. These students will not need extra attention because they will explore more advanced topics on their own. Entity-based theories can be used to motivate students who may not identify themselves as exceptional in a field. For example, entity-theorists typically do not suffer from initial motivation problems like their incremental counterparts. For entity-theorist students, an entity-based classroom becomes a self-fulfilling cycle of success and reward. If you can convince every student that they belong in your field/classroom, an entity-based approach can be very fruitful for student outcomes. Students will rise to high expectations if they think they are each *individually* valued and successful.

This approach, however, has its challenges. Entity-based environments can become more competitive and promote hostility and cheating. Emerson and Murphy (2015) found that women and other minorities exhibit higher rates of stereotype threat in entity-based environments, predisposing your classroom to inclusivity challenges. Entity-based fields and environments have also been shown to prevent people from taking advantage of valuable opportunities because they constantly feel they must prove themselves or that they will fail. You should have precautions in place for when your students encounter a challenge or failure because entity-based environments are prone to students giving up or avoiding responsibilities when they have previously failed.

1.2. Incremental-based theories of intelligence

Fields that require a lot of trial-and-error and experience, by nature, are typically more incremental-based, such as Foreign Languages, Applied Sciences, Technology, and Engineering. Participants reported feeling more accepted and more congenial in these environments. Students are more likely to pursue learning goals and overcome failures more easily in an incremental-based environment. It is thought that incremental-based environments promote mastery of knowledge, as opposed to pursuing new challenges (Heslin et al., 2005).

The challenges to taking an incremental-based approach include not reaching prescribed goals or benchmarks. In an environment where emphasis is placed on growth and improvement, students can demonstrate improvement and remain "below standard." Another challenge to this environment is that most assessments are based on a benchmark approach; the way we grade often does not include growth in its evaluations. Assessing goals can become difficult and amorphous; high-achieving students can become disinterested or frustrated if assessed on growth, which can be minimal for these students. Though participants reported feeling more included in these environments, entity-theorist students may not have the motivation to enter these fields or classrooms fearing constant failure or mediocrity. Finally, entity-based students may feel uncomfortable or undervalued in these settings, presenting a different, yet no less challenging, inclusivity issue.

2. Discussion

One could argue that inclusivity in STEM fields is not a single entity. For example, biological science fields typically have little gender-bias at the undergraduate level whereas women students represent many fewer math-intensive fields like computer science and physics (Robnett, 2016). The STEM-self-concept, however, runs much deeper and occurs much earlier in our educational development than the undergraduate level. Without engaging in a lengthy discussion of how to overcome barriers and biases in STEM [although see Wajngurt and Sloan (2019) and Deanna et al. (2022)], another possibility is to understand how STEM-self-identity originates and support its maturation for all of our students, regardless of their implicit theory of intelligence. Some of our students may engage with and respond to *genius culture*; some of them will invariably not. We cannot let our own conception of intelligence dissuade our students from pursuing STEM careers. Instead of broadly painting entity-based mindsets as always negative, it is important to explore the positive notions of how our students have constructed their sense of STEM-self. It is equally important to then push that understanding to help our students understand that their notion of STEM-self is also malleable and can be built upon. This gets us to a place of resilience, where new challenges can be faced. To generate and maintain the behaviors necessary to be successful in STEM fields, it is paramount that our students feel accepted as they are in whichever mindset theory they hold and that we can foster their belonging in STEM fields by engaging with that mindset. Entity-and incremental-based mindsets are often presented as a dichotomy, but I argue it is a false one. There are instances where both are necessary for our budding STEM students to feel like they belong in our broader community. The caution is that when we are helping our students build their senses of STEM-self, we cannot tear down entire pillars of their identity structure without helping them understand the other support systems necessary for them to not lose those feelings of belonging in STEM.

In lieu of holding only one type of implicit theory of intelligence or the other, it is more beneficial to understand your own implicit theory of intelligence as an instructor and how you may be presenting your theories to your STEM students. For example, if you tell students at the beginning of the semester that you are willing to consider their growth over the course of the semester when assigning final grades, make sure to do that! Assigning a C to a student who has made substantial gains over the semester can be very damaging if they thought increasing from a 30 to an 80-average meant something more. Similarly, it can be damaging to students if they feel an instructor is not acknowledging their natural aptitude in an area, causing them to become defiant, disengaged, or defeated. We require a validated and consistently reliable tool to measure our students' lay theories about intelligence, such as the ULTrA survey under development by Limeri et al. (2022), in order to best serve them. Such a tool would help educators tease apart the intricacies and interplays between what Limeri et al. classify as three distinct domains: mindset, brilliance, and universality. Limeri et al. (2022) provide a framework for understanding what I term *genius culture* (they: "brilliance") as a third prong of lay theory construction, whereas, I argue here that *genius culture* is an underlying layer of identity. The outcomes of this research and such a tool will be tantamount for creating structures that support our students' STEM identity construction and persistence in field.

It is important to consider how your own and your field's implicit theories of intelligence affect how you teach and how your students present themselves to you in the classroom. Neither implicit theory is better or worse, but challenges often arise when there is a mismatch between the instructor's and the students' theories. I encourage you to be aware of your own thoughts about how intelligence is formed, how you present that to your students, and how they may be reacting to you. As educators, our goal is to foster passionate and motivated STEM experts. Understanding STEM-self-identity construction is only one step in that process. Attempts to ameliorate STEM career bias occur too late, typically at the secondary or undergraduate level. A culture of "inclusive excellence" (ten Hagen et al., 2022) may begin as soon as our students enter the education system as children, not when they are becoming faculty or being recruited by Google or Apple. And we need to be ready to receive them, regardless of how they view their own intelligence.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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