Fostering a sense of belonging in STEM mentoring of underrepresented minority (URM) students though use of Common Factors

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ABSTRACT

Over the last 30 years over 30,000 articles and chapters have been published related to mentoring, with over 40% focused on mentoring students in STEM disciplines. What have we learned from this voluminous literature and what concepts stand out as needing further attention? A review of the literature indicates that mentoring of underrepresented minoritized (URM) students involve attention to the professional development of these students, active engagement in research activities, and a willingness and ability to develop a strong relationship that supersedes the aspects of traditional mentoring activities.

Psychology graduate programs have long been known to teach and develop the skills necessary to help students foster strong therapeutic relationships. The foundational interpersonal skills taught in domains of psychology (e.g., counseling psychology, social psychology) are directly relevant to other relationship-building scenarios, such as mentor/mentee dyads. Budding psychologists typically learn therapeutic techniques that help build trusting relationships with clients that hold different identities than their own. But these skills apply beyond client/therapist relations and could be used to inform intensive/inclusive mentoring approaches with URM students, especially when the mentor holds a different identity. The training techniques proposed can be adapted for both formal and informal forms of mentoring and may enhance a student's sense of belonging, which is the strongest predictor of science identity development and success in STEM.

This paper will focus on elements necessary to develop a strong relationship between URM students and their mentors based on the development of a therapeutic relationship using concepts from theories related to the Common Factors (Rosenzweig, 1936). These theories posit that the development of a meaningful client/therapist relationship and behavior change requires attention to four common factors: therapist qualities or in this case mentor qualities, change processes or how students are trained, treatment structures which are specific techniques, and development of a strong relationship. These factors can easily be applied to create a truly inclusive mentoring model.

LITERATURE REVIEW AND CONTENT

The field of Science, Technology, Engineering and Mathematics (STEM) include some of the most difficult areas of study in higher education. This is due to a combination of uninspiring introductory courses, difficulty with required math, and an unwelcoming academic culture that creates barriers which impede students' persistence and success (Gates Jr & Mirkin, 2012; Holmegaard et al., 2014). STEM disciplines are also prone to social and motivational barriers such as lack of support and poor student-faculty relationships (Stolle-McAllister, 2011). This is alarming, as foundational research on college student retention has demonstrated that social and motivational components are essential for student success (Bean, 1980; Tinto, 1975).

Fortunately, these components can be improved. Research has shown that self-efficacy, or "convictions for successfully performing given academic tasks at designated levels" (Bong &

Skaalvik, 2003, p. 13), is a strong predictor of academic achievement (Ackerman et al., 2013; Eagan et al., 2010; Veenstra et al., 2008). More specifically, confidence and STEM self-efficacy are linked to persistence in STEM (Chang et al., 2011; Linnenbrink-Garcia et al., 2018), degree attainment (Ackerman et al., 2013; Larson et al., 2015), and STEM career selection (Blotnicky et al., 2018). However, Estrada-Hollenbeck and colleagues (2010) argued that self-efficacy is only one small piece of the persistence effect. In their review, the authors use Herbert Kelman's (Kelman, 1956, 2006) proposed model of social influence to differentiate surface-level science self-efficacy from deeper-level science identity. The review suggested self-efficacy is simply a 'rule orientation', whereby students who receive praise or approval from others believe they can conform to the required skills of a scientist and the STEM community at large, and in turn, determine themselves capable of doing scientific work. On the other hand, science-identity is a 'role orientation' that promotes a sense of belonginess and allows students to *identity* or see themselves as a member of the scientific academic social system. The authors contended that science-identity, rather than self-efficacy drives a deeper level of integration in STEM. As the authors state, a student may have the necessary scientific skills (self-efficacy), but if they lack a sense of belonging and identity within their scientific community, they will depart from STEM.

The two concepts of STEM self-efficacy and science-identity are not mutually exclusive. Students require a self-efficacious foundation to build a strong science-identity. But the opportunity to build self-efficacy and ultimately science-identity are not equally available to all students. It is well documented that discrepancies exist between the number of underrepresented minority (URM) students who choose and remain in STEM majors compared to their majority counterparts (National Science Foundation, 2022). This is due to various recruitment and attrition issues. Although important, for the purposes of this paper, we will focus on the experience URM students have once they *enter* a STEM major. For example, URM students disproportionately lack the vicarious experiences in STEM that majority students are accustomed to. Vicarious experiences refer to instances in which tasks are effectively modeled to a learner (Flowers III & Banda, 2016), such as when teachers complete challenging math problems that in turn encourage the learner that they too can succeed (Joet et al., 2011). Since minority groups are severely underrepresented in STEM, URM students miss out on learning skills and career trajectories from someone that "looks like them," which jeopardizes their ability to build self-efficacy. Although research agrees that a robust science-identity is necessary for URM students to persist and pursue a scientific career or STEM graduate program (Andersen & Ward, 2014; Chemers et al., 2011; Hazari et al., 2013; Merolla et al., 2012; Merolla & Serpe, 2013), researchers still do not agree on *why* a positive science identity is so beneficial. For that reason, Chen and colleagues (2021) sought to investigate factors that contribute to the merit and positive academic outcomes from URM science-identity. They hypothesized that an increased sense of belonging may account for the effect of science identity on performance for URM students. Strayhorn (2018) explained sense of belonging in the context of education as a feeling of inclusion that satisfies physiological needs and encourages students' behaviors and perceptions (Strayhorn, 2018). Chen and colleagues (2021) found that science identity was more predictive of positive outcomes (i.e., academic performance) for minority students than for majority students. However, in support of their hypothesis, the effect was attenuated for minority students who received a social-belonging intervention. Meaning that for minority students, a sense of belonging mediates the relationship between science identity and positive outcomes. Many other researchers agree that a sense of belonging is particularly important to the experiences of historically marginalized undergraduate students (Holloway-Friesen, 2018, 2018; Hurtado et al.,

2005; Strayhorn, 2012). Chen and colleagues (2021) concluded that a sense of belonging may be the key ingredient for URM students because it protects from science-specific threats. Science-specific threats occurs when a student believes they are incapable of completing a task due to perceived difficulty (Putwain & Remedios, 2014; Uphill et al., 2019) or, for URM students specifically, when they fear their "performance "confirms" negative academic stereotypes attributed to their group membership" (Chet at al., 2021, para. 8.). This means that if students feel they belong, it will be less likely that they feel intimidated or disheartened by challenging STEM courses and may counteract science-specific stereotype threat.

Unfortunately, a sense of belonging is not always easy to foster in URM students. Their sense of belonging is threatened due to the discrimination and negative stereotyping that they inordinately face compared to their majority-identity peers (Hurtado et al., 2007; Hurtado & Ruiz Alvarado, 2015; Locks et al., 2008). These experiences lead to negative outcomes, as demonstrated in a study by Aronson (2004) which showed that repeated exposure to stereotype threat can lead to "disidentification" with the field of study the student previously identified with (Aronson, 2004). This "disidentification" causes students to distance themselves from STEM areas of study (Deemer et al., 2016) and leave their STEM major. This ultimately widens the gap in achievement, and further perpetuates underrepresentation of URM students in STEM majors. Alarmingly, STEM degree attainment rates among URM students continue to lag those of White and Asian Pacific Islander students. While 50% of Asian students and 40% of White students complete their bachelor's degree in science and engineering within six years of initial enrollment, only 24% of URM students do the same (Center for Institutional Data Exchange and Analysis, 2000).

To avoid these negative outcomes, and close the diversity gap in STEM, institutions and educators are left wondering what can be done to enhance a sense of belonging and science identity? What interventions or behaviors can instill this sense in students? Research suggests that mentorship may hold the answers.

In the past, mentorship research has been criticized for lacking a consistent definition and clear methodology (Jacobi, 1991). Without a comprehensive theory, it becomes difficult to identify necessary elements and advise mentors on best practices. Despite this, authors Nora and Crisp (2007) were able to identify four major domains of mentoring in the literature: 1) psychological or emotional support, 2) goal setting and career paths, 3) academic subject knowledge support and 4) the existence of a role model (Nora & Crisp, 2007). Research shows that students with mentors earn higher GPAs (Campbell & Campbell, 2007) and feel more socially integrated into their academic programs (Wallace & Haines, 2004) compared to students without mentors. Unfortunately, URM students disproportionately lack the quality mentorship that their non-URM counterparts frequently receive (Aikens et al., 2017; Brunsma et al., 2017; Robnett et al., 2018). This lack of mentorship – and effective mentorship – may account for the gap in URM individuals pursuing careers in STEM (Valantine & Collins, 2015). Research demonstrates that mentorship may be one of the most powerful tools to increase a sense of belonging (Apriceno et al., 2020) and subsequently increase STEM retention for URM students.

In a recent review, Allen and colleagues (2021) summarized the existing perspectives within belonging research. The authors cover a wide breadth of belonging research, providing definitions from multiple disciplines. But their most important contribution is their definition of school-based belonging. They use Goodenow and Grady's (1993) definition: "the extent to which students feel personally accepted, respected, included, and supported by others in the school social environment" (p. 80). Allen and her colleagues distinguish trait (i.e., belonging as a

core psychological need) and state (i.e., situation-specific senses of belonging) belongingness. Multiple articles in their review suggest that state belonging is influenced by various daily life events and stressors (Ma, 2003; Sedgwick & Rougeau, 2010; Walton & Cohen, 2011). A person's subjective sense of belonging can change many times a day, depending on the situations and experiences that one encounters, as well as their perceptions and attributions of said experiences (Trampe et al., 2015). The authors summarize that a sense of belonging is dynamic and is constantly influenced by an individual's 'system.' A system, such as one's family, friend, school, or work environments, exert four interrelated components on the individual that influences their sense of belonging. The four components are: "(1) competencies for belonging (skills and abilities); (2) opportunities to belong (enablers, removal/ reduction of barriers); (3) motivations to belong (inner drive); and (4) perceptions of belonging (cognitions, attributions, and feedback mechanisms – positive or negative experiences when connecting)." Although it is widely accepted that URM students' sense of belonging within their academic programs have far reaching positive effects on their performance (Graham et al., 2013), these four components have not yet been analyzed in the context of URM students in STEM. For that reason, the following paragraphs describe the benefits that each can have, and ultimately a suggestion for educators and mentors on how to promote belonging.

First, competencies for belonging can be fostered by the skills and abilities developed in research laboratories and in undergraduate research experiences. URM students who participate in well-structured undergraduate research programs can benefit in many ways, including enhancing their knowledge and comprehension of science (Sabatini, 1997), clarifying graduate school or career plans in the sciences (Hurtado, Cabrera, Lin, Arellano, & Espinosa, 2009; Kardash, 2000; Sabatini, 1997), and obtaining other professional opportunities that further develop students' scientific self-efficacy (Gándara & Maxwell-Jolly, 1999; Hurtado et al., 2009; Mabrouk & Peters, 2000). Additionally, research gives students the opportunity to feel, think, act, and be recognized as a "science person" by others, such as faculty members and other role models. This boosts and reinforces their belief that they can succeed in the sciences (Carlone & Johnson, 2007). As such, those students are more likely to identify with a STEM field and view it as an important aspect of their self-identity, which should in the long run enhance their chance of persisting. Students who report participating in research as undergraduates are substantially more likely to sustain their interests in science as well (Lopatto, 2007). A growing body of research supports the positive impact research experiences can have on young science students (Morley et al., 1998; Nagda et al., 1998; NSF, 1989; Russel et al., 2007; Seymour et al., 2004). Although there are still discrepancies in which students obtain research experience and opportunities, it is critical that mentors feel equipped to foster a positive research experience for the URM students that do.

Second, opportunities to belong implies the actual experience of being in environments that create or enhance a sense of belonging. This speaks specifically again to research experiences; however, it also relates to the experiences within the lab. A recent study by Dortch and Patel (2017) interviewed black, female STEM doctoral students at a predominantly white institution (PWI) regarding their lab experiences. The authors found that microaggressions directly negatively impacted a sense of belonging. Interestingly, interviewees reported greater racism and same-race discrimination, than experiences of sexism (Dortch & Patel, 2017). Such negative racial experiences are unfortunately quite prevalent across disciplines. For example, it is reported that that nearly 20% of Black students and 15% of Latino students experience some form of discrimination or bias at predominantly White institutions (PWI) (Hurtado & Ruiz

Alvarado, 2015). Those who experience discrimination, racial bias, and negative stereotyping in academia also tend to report a lower sense of belonging (Hurtado et al., 2007; Hurtado & Ruiz Alvarado, 2015; Locks et al., 2008) which is a direct threat to persistence in college. Mentors and others working in science laboratories must be made aware of the experiences of URM students and must be challenged to investigate their own biases and perceptions to create an inclusive environment for those who do not see others like themselves in the research endeavor. Allen and colleagues (2021) use Putnam's (2000) work on bridging and bonding social capital as a process that creates opportunity by providing an individual the opportunity to interact with others working on common solutions such as a research experience in a laboratory.

Third, motivations to belong refer to an individual's desire to belong to a given group or social entity. Motivations can be understood in the framework self-determination theory (SDT), proposed by Deci and Ryan in 1985. According to SDT, there are three psychological needs: competence, relatedness, and autonomy. When these needs are met in a school setting, for example, the quality of student's motivation is more autonomous, making them more likely to achieve their goals (Scott et al., 2015). Educators and mentors play a crucial role in either fostering or hindering these psychological needs (Clifford, 1999; Lambeir, 2005). Mentors have the unique opportunity to work intimately with URM students to enhance their competence, relatedness, and autonomy required for intrinsic motivation. For example, relatedness, which is defined as "feeling attached and connected to important others and valued implicitly by others in one's social world" (Deci & Ryan, 2000), has been shown to be important for URM students. Research suggests that interventions to increase relatedness improve health and academic outcomes for URM students (Walton & Cohen, 2011) and first-generation math and science students (Harackiewicz et al., 2014). Additionally, mentors can guide acculturation into a STEM discipline that URM students may not be accustomed to (Estrada et al., 2018). This acculturation can promote agency and autonomy in STEM, but it is not always easy to achieve with URM students. Minority students face unique incompatible cultural expectations, prejudice, and professional and social isolation that makes their integration into STEM vastly different from majority students. Although mentors may be well-intentioned and eager to help, they may lack the mentor training necessary to serve diverse populations (Fleming et al., 2013).

Perceptions of belonging is the fourth component described by Allen and her colleagues (2021) and it is defined as "a person's subjective feelings and cognitions concerning their experiences." A student may have competency, opportunity, and motivation for belonging, but if they do not perceive themselves as belonging, they still report dissatisfaction. The authors cite several studies related to the impact that past experiences can have on one's sense of belonging (Coie, 2004; Baumeister & Leary, 1995; Walton & Brady, 2017). Past experiences can include rejection, stereotypes, and attribution errors, each of which undermines a student's perception of belonging (London et al., 2007; Mello et al., 2012; Walton & Wilson, 2018). These experiences are dependent on the environment in which a student learns, works, and studies, such as a laboratory. Negative experiences can impact interpretation and attribution to behaviors within the lab, and this last area is the one that this talk will focus upon. How does one create an environment that generates a sense of culturally competent acceptance for individuals who may had negative experiences with teachers or peers in STEM disciplines? How does one meet the individual where they are?

The authors recommended that these four components be a focus of interventions for groups and individuals (Allen et al., 2021). Although psychological principles such as self-efficacy and belonging have been incorporated into mentorship training, in a review of the

literature, training in *how* to effectively develop a relationship between mentor and mentee and apply those principles is still lacking. Further, the four components mentioned (Allen at al., 2021) are highly reliant on an understanding of mental health and human behavior, which has not previously been integrated into the literature. For that reason, the present study recommends incorporating psychology and counseling skills to increase perceptions of belonging in students.

Clinical and Counseling Psychology has long been interested in the development of "helpful" relationships. For example, in 1958 Carl Rogers stated that, "it seems clear that relationships which are helpful have different characteristics from relationships which are unhelpful" (Rogers, 1958, p. 118). Although Rogers was discussing psychotherapy and counseling relationships in this quote, a similar case can be made for mentoring relationships. In his 1958 article Rogers goes on to enumerate 10 important criteria for establishing a helpful relationship: Establishing trust, communicating clearly, experiencing positive attitudes warmth, caring and interest toward someone, separating one's feelings and needs from the other, acceptance of the other, empathy toward the experience of others, communicating empathy and acceptance, avoiding judgmental attitudes, and lastly, meeting the person where they *are,* not where they *were* or where *I* want them to be. The characteristics which Rogers applied to the counseling relationship are easily transferrable to the mentoring relationship. As discussed earlier, creating an environment where underrepresented students feel a sense of belonging is paramount to helping these individual students remain and succeed in STEM. But what are these components and how do we implement them?

In a review of meta-analytic studies, Lambert (1986,1992) discussed the effectiveness of counseling in helping individuals change and identified four major components required for positive change. These were: extra therapeutic factors, relationship factors, the modality of therapy, and lastly placebo. What are these factors and how do they relate to mentoring and the mentoring role?

Extra therapeutic factors are the factors attributable to the client, or in this case, the mentee. These can include personal strengths, weaknesses, beliefs, attitudes, and environmental impacts which are independent of either therapy or the mentoring process. These factors relate most closely to belonging competencies, motivations, and perceptions described by Allen and colleagues (2021). It also relates to outside factors such as external circumstances outside of laboratory experience. An example of this could be positive (or negative) life events that may change or limit a student's ability to sustain their work and interest in the lab. Such circumstances are outside of a mentor's ability to control but can have devasting impact on a student's ability to successfully navigate a STEM mentoring experience. Because mentorship and education happen in the greater context of life, it is essential that mentors are equipped to listen and understand a mentee's life and experiences so they can foster a stronger mentor-protégé relationship.

Relationship factors are related to the strength and development of the relationship. These factors are most directly related to both the discussion by Rogers (1958) on helpful relationships, and the discussion of opportunities to belong and perceptions of belonging in Allen and colleague's (2021) paper. Mentors must develop a strong alliance with their mentees. In the common factors model, positive alliance is a perceived partnership between the client (in this case the mentee) and the therapist (the mentor) to achieve shared goals. Developing a strong positive alliance requires the mentor to develop empathy skills, have an openness to their mentee, and a focus on positive experiences. These relationship factors extend beyond the simple content knowledge and advice that most STEM mentors should be able to offer. Interesting, in a

study by Beyene and colleagues (2002), college-age mentee respondents indicated that the most important qualities for a mentor are openness, friendliness, and a sense of humor. This means that mentees prefer mentors that are person-oriented and take a humanistic approach to their relationship. These interpersonal skills may not come naturally to all mentors; therefore, it is necessary to incorporate psychological skill training to increase the likelihood of developing such a person-centered relationship.

The third factor, modality, does not fully relate or translate to the mentoring model. However, it does relate to the mentor's "world view", or conception of the world around them. To what extent does the mentor view the development of mentee skills as an important element in their own performance as professionals? What implicit biases and preconceived notions does the mentor bring to the mentor/mentee relationship which might hinder the development of a strong positive alliance? And lastly how important is mentoring to the mentor?

The fourth factor, placebo, takes on a different meaning. In the sciences, a placebo is considered to be a sham treatment or substance that is considered "real" but isn't. Despite this, placebos tend to exact a therapeutic effect, in part due to expectancy. In counseling or psychotherapy, having a true placebo is difficult, but some researchers in the common factors model assume that the placebo may actually relate to hope. For a client, it is a hope that things can and will change (Bertolino, 2018). In a mentoring relationship, hope and expectancy may be related to mentee performance and the mentor-mentee alliance. Hope can be bolstered when mentors create a sense of belonging for their mentees, like the one described by Allen and colleagues (2021). This creates a positive feedback loop, whereby hope ignites an expectation that mentees can and will succeed in STEM, with the help of their trusted mento, which further perpetuates their success. Much like the way that therapists can create a sense of hope and expectancy through the ways they develop their relationships with clients (Bertolino, 2018), mentors can do the same through the relationship they develop with their mentees.

CONCLUSION

In conclusion, we are asking mentors to extend their training and competencies beyond what is expected. We recommend mentors consider the elements of the mentoring relationship which contribute to a mentees sense of belonging, and foster belonging through practices identified in counseling research. A "helpful" relationship can be attained through skills discussed by Rogers (1958) and Lambert (1986,1992) such as relationship skills (trust, communication, acceptance, empathy), extra-relational understanding (appreciating strengths, weaknesses, attitudes, and environmental impacts that are independent of mentoring) and world-view awareness (recognizing biases or preconceived notions toward a mentee). Each of these skills, which can be derived from counseling and other psychology teachings, help promote a sense of belonging and eventual science identity necessary for URM students to persist in the sciences. Mentors have the special opportunity to be intentional with their relationship development, in turn creating a supportive, encouraging environment for their mentee to thrive. The redesign of mentorship training models will not come without challenges and will require intense self-reflection and willingness to incorporate deeper-level counseling skills into everyday interactions. However, we hope that this novel approach to mentorship development will fortify mentor-mentee dyads, increase URM STEM retention, and promote a future of strong, diverse, scientific leaders one relationship at a time.

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