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Commentary

Using quotients as a mentor to facilitate the success of underrepresented students

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Abstract

Choosing a mentor requires a certain level of introspection for both the mentor and the mentee. The dynamics of mentorship may change depending on the academic status of the mentee. Regardless, mentors should help their trainees grow both academically and professionally. The success of an individual in the fields of science, technology, engineering, mathematics, and medicine (STEMM) depends on more than intellectual capacity; a holistic view encompassing all factors that contribute to scientific achievement is all-important. Specifically, one new method scientists can adopt is quotients, which are scales and techniques that can be used to measure aptitude in a specific area. In this paper, we focus on these factors and how to grow one's adversity quotient (AQ), social quotient (SQ), and personal growth initiative scale (PGIS). We also look at how mentors can better understand the biases of their trainees. In addressing this, mentors can help trainees become more visible and encourage other trainees to become allies through reducing biases.

Keywords: adversity/adaptability quotient, social quotient, COVID-19 pandemic, mentorship, personal growth initiative scale, bias, prejudice

Introduction

Mentors, whom we define as guides for trainees in research or associated positions, can be perceived as guides or role models for their trainees. A mentor's objective should be to help the mentee navigate uncertainties, professional difficulties, and life challenges. This results in a bond that is defined by a mutually beneficial relationship with the exchange of perspectives and learning experiences. Mentors promote the development of their trainees by providing accountability through the establishment of goals and the verification of achievements; key instructions and strategies, including constructive feedback; and career coaching via the identification of opportunities. However, we believe that when a mentor provides insight or knowledge, the application of quotients can be utilized. Quotients are methods and scales that can be used to measure intellectual, emotional, or other realms of aptitude in a specific area. Past literature has shown that the usage of quotients can have positive effects, including perceived efficacy, identity, resilience, or sense of belonging of the subjects. Specifically, we believe that quotients can be effectively used to aid the development of trainees, especially those who identify as underrepresented, as per National Institutes of Health guidelines, who may have their own unique challenges (Hinton Jr *et al.* 2020b). Along with the right practices, a good mentor can inspire a mentee to accomplish great things, reach new heights, and provide a sense of belonging in the science, technology, engineering, mathematics, and medicine (STEMM) field (Derck et al. 2018).

The implementation of quotients, which can measure different aspects of a trainee and be used as a technique for the measurement of trainee progress, can be incredibly useful for mentors. Academic mentors have tremendous responsibility for trainees at every academic level. Academic mentors are closely linked to their trainees' (especially undergraduate and graduate trainees) future success and can play foundational roles in career and personal development. Mentorship can be especially critical at the postdoctoral level because mentors may also train their trainees to thrive within their chosen field and in becoming effective mentors. Every decision and action that occurs within the mentor/mentee relationship can have macroscopic effects that will ultimately sculpt

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the laboratory culture and influence the mentee's growth academically, professionally, and personally. Therefore, we believe it is imperative for mentors to become allies in developing and adopting an inclusive environment that is founded on mutual respect, equity, and the positive recognition of other cultures. This idea is the crux upon which the quotients are formed. An inclusive environment can be established by introducing expectations regarding both social behaviors and intellectual participation early in the mentorship relationship, which allows trainees and colleagues to understand and be properly equipped to fulfill their roles within the academic setting. Establishing such standards will ultimately empower trainees to take an active role in their development and better understand strengths and weaknesses as they expand their intellectual and emotional capacities.

Many minorities still have barriers to entry and retention in STEMM fields, and as a result, their innovation and struggles may remain invisible. The usage of mentors is critical in overcoming these barriers and ensuring equitable educational and career outcomes in STEMM. However, it can be possible that mentors do not fully satisfy the needs of their current position in certain situations. For example, mentoring an undergraduate may require different strategies than mentoring a postdoctoral fellow. Pertinently, mentoring does not have a clear guidebook, sometimes leaving mentors to figure it out themselves. Mentors should understand that underrepresented minorities (URMs) in STEMM face many systematic difficulties that contribute to burnout and a feeling of "otherness" throughout their academic and professional careers (Strayhorn et al. 2013, Hinton Jr *et al.* 2020b, Marshall et al. 2021, Termini et al. 2021). This results in lower academic and career achievement, such as poorer performance in classes, among minorities, despite diverse scientific teams producing more high-impact work of novelty (Whalen and Shelley 2010, Ding et al. 2021). For minorities who can overcome these systematic difficulties, they face microaggressions that can slowly reduce their self-esteem (Marshall et al. 2021). Furthermore, they also deal with John Henryism, which postulates that the higher amount of effort required for minorities to succeed results in more psychological stress and burnout (James 1994, Hudson et al. 2016). All of these challenges have resulted in a leaky pipeline in STEMM education, in which many minorities are not able to complete their education with successive departures at each career stage (Hinton Jr *et al.* 2020a). As a mentor grows their mentorship brand, they may adapt their mentoring style to intentionally respond to their trainees (Shuler et al. 2021). For example, this can include presenting ways of responding to minority stress, such as that incurred by John Henryism, by teaching trainees the power of saying "no" or highlighting strategies to combat micro- and macroaggressions to avoid burnout (Staveley 2019, Hinton et al. 2020, Marshall et al. 2021, Shuler et al. 2021). In dealing with both majority and minority trainees, mentors should seek to instill values and beliefs that help to foster an attitude that encourages diversity across STEMM fields. Diversification is important as it increases both research innovation and scientific literacy for a diverse audience (Hofstra et al. 2020). We believe mentors can be instrumental in increasing diversity, equity, and inclusion (DEI) in STEMM, and during formative years of mentorship, they can instill skills crucial to becoming successful scientists. Here, we recommend a method to aid mentors in developing these traits in trainees and themselves through the usage of quotients and scales.

Quotients are a method by which to measure how much a certain quality exists in an individual (Phoolka and Kaur 2012). We believe they may be utilized by mentors to assess various qualities in trainees. Specifically, we believe the social quotient (SQ), the adversity quotient (AQ), the personal growth initiative scale (PGIS), and various scales to measure implicit and explicit biases are useful tools that may be underutilized by mentors. Becoming an effective collaborator and communicator is critical to the achievement of interpersonal success, which can be strengthened through a commitment to the continuous development and fine-tuning of SQ. Similarly, AQ and PGIS can be used to test how open trainees are to growing and adjusting to new circumstances. Using these scales, mentors may better direct their efforts to growing skills that trainees may lack. Fostering improvements in these areas may result in the development of resilience, cognitive power, and social awareness. These attributes can be used by both mentors and trainees to empathize, embrace, and empower people of varying cultures (Cooper 1997, Phoolka and Kaur 2012). The quotients discussed here are quantitative in nature, and we propose that mentors should consider the use of these quotients as tools and assessment devices to identify areas in their trainees' skill sets that could be improved or developed. While here we discuss the context in which quotients can be utilized by mentors for trainees, importantly mentors should also consider using them for their personal growth.

Adversity quotient

One of the key ways for mentors to boost trainees' resilience to setbacks is by raising their AQ. AQ, also known as the adaptability quotient, has been defined as the capacity of the person to deal with life's adversities and is a measurement of human resilience (Phoolka and Kaur 2012). Adversity occurs when one faces an unforeseen circumstance or experiences a state of serious, continued difficulty during their career or life (Tian and Fan 2014). Overall, AQ gauges how well someone withstands and potentially overcomes adverse events. Mentors need to understand the student's AQ to predict how well trainees will be able to problem solve (Phoolka and Kaur 2012). Building AQ is crucial as it allows for greater resilience in dealing with others, which ultimately results in more tolerance for others. Additionally, for underrepresented individuals in STEMM, building AQ can be crucial in overcoming obstacles such as microaggressions (Marshall et al. 2021).

Life can present many different ups and downs that result in the need to quickly adapt to succeed. For example, in response to the COVID-19 pandemic, many universities rapidly shut down many of their research enterprises without warning and with little clarity on when research would resume. In a very short period, trainees had to indefinitely halt their projects while figuring out how to resume their work remotely. Therefore, understanding a student's AQ is a critical skill needed by mentors to help facilitate a student's capacity to problem solve, adapt in the face of difficulty, and eventually succeed. This is especially important as these problems are exacerbated for underrepresented individuals (Carver et al. 2017); therefore, it can be critical to help them learn to endure.

Mentors may help to improve their mentee's ability to adapt and succeed in different environments by using assessment tools to measure their AQ. One way to measure AQ is by utilizing the Adversity Response Profile Assessment (ARPA) tool. This is a quiz that asks interval scenario questions regarding the participant's response to potential adversity, such as a financial setback. This tool is an accurate predictor of a person's success, stress threshold, performance, risk taking, capacity for change, and levels of productivity (Venkatesh and Shivaranjani 2016). The responses to this assessment are used to determine the metrics of an individual's control, ownership, reach, and endurance dimensions as

they undergo tribulations. Similar to this tool is the Rasch model, which uses Likert scale questions, but specifically corrects for the difficulty of various questions to create a type of weighted questionnaire (Effendi et al. 2018). For a more qualitative tool, "listen, explore, analyze, and do" (LEAD), developed by Stoltz (Stoltz 1997), focuses on implementing four strategies. These strategies are (1) Listen—how the mentee responds to unfortunate situations, (2) Explore—how the mentee determines the cause of the problem and maintains self-accountability, (3) Analyze—how the mentee uses their critical thinking skills to assess the situation, and (4) Do—evaluate how the mentee makes a plan to solve a problem (Stoltz 1997).

Critically, these measurement techniques will allow mentors to know if traits and skills relating to adaptability are necessary to be built for trainees. For example, the ARPA tool may show that a mentee has high performance, but a poor stress threshold. Therefore, a mentor can help their mentee become more well-rounded by providing resources and guidance in strategies such as proper time management and mindfulness, which may reduce future stress. If a mentee has a poor capacity for change, it may be important for the mentor to help the mentee embrace a mindset more open to change through increasing cognitive flexibility. Past literature has found that cognitive flexibility can be increased through techniques such as meditation and cardiorespiratory fitness (Themanson et al. 2008, Müller et al. 2016). Mentors may also consider using AQ tools to create challenges for their trainees to result in a positive outcome. For example, if a mentee lacks a strong AQ, a mentor may ask them to figure out how to independently create a new protocol. This challenge can help the mentee utilize and fine-tune their problem-solving skills and ensure they do not become overly dependent on the mentor. Importantly, mentors measuring AQ in their trainees and themselves can allow mentors to begin creating strategies to remedy areas for improvement.

Social quotient, networking, and maintaining relationships

We believe that SQ may improve the relationship between the mentor and mentee due to building SQ allowing for smoother communication in both academic and professional settings. SQ, essentially, exists parallel to the intellectual quotient (IQ) test as a measurement of the ratio between social and actual age (Lurie et al. 1941). Networking social relationships is an area of professional development that needs to be fostered by both mentors and trainees and falls under SQ. For instance, those with better-developed SQ may be more able to convey their message, captivate a targeted audience, and draw in people who may offer potential professional opportunities. For URMs, this can allow them to better gain valuable relationships and better move into positions advantageous to their current career stage. SQ can also contribute to building networks and fostering relationships. Being able to engender trust and prove their competence is a vital component for healthy, working relationships to thrive. Therefore, it is essential to be flexible and develop functional ways of communicating with others that are practical while leaving a lasting impression. These skills can also be critical for the majority of trainees.

Improving SQ provides the capacity to conquer unforeseen social circumstances, which may overlap with one's intellectual ability and comfort level as verbal and non-verbal cues are needed to fully comprehend the intentions of others in a social setting (Riggio 1986). For example, this can include better communication with individuals from different cultures and avoiding misinterpretation differences in communication. Finally, for mentors, who might often deal with students and cross-laboratory communication, this can prove an important skill in forging effective relationships. Beyond this, self-applied SQ measurement in mentors ensures that communication with trainees who feel invisible is considerate and encourages them to continue in the field.

These skills can be measured through the assignment of a self-reported social skills inventory (SSI), which quantifies how well an individual is able to interact in social settings (Riggio 1986). This technique is based on testing seven social skills that measure the ability to effectively communicate with others (Riggio 1986). Developing SQ allows trainees to better influence their perceptions of others to ultimately better navigate social and academic relationships (Ganaie and Mudasir 2015). Through the development of SQ, one can interpret others' decorum based on non-verbal cues such as eye contact, facial expressions, and physical closeness (Kihlstrom and Cantor 2000). Another key scale that has been proposed is the Tromsø Social Intelligence Scale, which is the self-report instrument that includes 21 questions that test social skills but also includes factors such as social awareness. (Silvera et al. 2001). Finally, given that typically SQ is correlated with emotional intelligence, it may also be worthwhile to evaluate this dimension (Silvera et al. 2001). Emotional intelligence may be scored through the Bar-On Scale, which includes some questions to measure the social intelligence (Bar-On 1997).

The SQ score can be improved by adjusting attitudes and behaviors in response to social environments (Ganaie and Mudasir 2015). Determining a mentee's SQ will help mentors identify the social skills that their trainees need to strengthen so that they may cope with adversities and tackle the changing social world. Some important social skills that can be developed to increase one's SQ include social communication, interpersonal problem-solving, cognitive, and role-playing abilities (Riggio 1986). Low SQ may result from trainees being too independent and not utilizing their team-building capacity. While this is not always an issue, this could potentially be worked on by assigning the mentee to work on team projects more often. Similarly, if low SQ is consistent across an entire lab, the mentor may consider creating more opportunities to increase it by assigning more independent responsibilities. For example, this can include having mandatory presentations during lab meetings. If this policy is not already in place, a mentor can create dedicated journal clubs and encourage each individual to do presentations and model substantive critiques of relevant literature in the field. Ultimately, increasing SQ can be critical in opening opportunities for individuals who have previously had difficulty speaking up and making themselves visible in STEMM.

PGIS

PGIS is a method to measure attitudes relating to an individual's impressions on their ability to change factors in their life, which allows for an indication of growth and function for individuals (Robitschek 1998, Weigold et al. 2013). This includes self-efficacy, but also the willingness to take the first step toward change for self-improvement (Robitschek 1998). Critically, those who score high in PGIS typically have higher well-being, lower stress levels, and better management of future career goals (Weigold et al. 2013). The modern PGIS scales specifically focus on four main dimensions in a self-administered questionnaire. The four factors are Readiness for Change, Planning, Using Resources, and Intentional Behavior (Yang and Chang 2014). Given the taxing demands to be a highly productive scientist in STEMM, having this drive can be critical for minorities navigating the waters of STEMM.

A key factor in securing grants as a faculty is productivity, which is determined by manuscripts published. Therefore, a mentor can be critical in ensuring that minority trainees will be ready for the demanding field by working to increase their initiative. Importantly, PGIS has been linked to increased well-being across numerous studies (Weigold et al. 2013, Yang and Chang 2014). Underrepresented minorities are especially susceptible to feelings of low self-worth, negative well-being, anxiety, and even depression (Shuler et al. 2021); therefore, mentors can help to improve this through improving skills related to personal growth initiative. Similarly, for all trainees (including those who are not underrepresented), improving their growth initiative may go a long way in creating stronger allies. Specifically, past literature has found an inverse correlation between well-being and prejudicial attitudes such as racism, homophobia, sexism, and ethnocentrism (Dinh et al. 2014). Therefore, mentors improving the well-being of the majority of trainees, through increasing their personal growth initiative may also facilitate in helping them become agents of change.

Mentors may utilize several methods to increase the personal growth initiative of their trainees. Firstly, using the PGIS, mentors may better understand in which areas their trainees need improvement. For example, a trainee may possess high personal growth initiative, and showcase many signs of being very adaptable to a wide range of situations, but they may falter in creating long-term plans. In such a scenario, mentors may consider building with the mentee an individual development plan (IDP) and create career timelines to realize their goals (Shuler et al. 2021). Similarly, if a mentee's PGIS shows they lack intentional behavior, a mentor may show the mentee the power of saying "no," so priorities can be the focus (Hinton et al. 2020). Alternatively, if utilizing all available resources is an issue for many trainees, mentors may consider encouraging their laboratory to engage in networking and show trainees a webinar on how to network effectively. Importantly, the PGIS allows for a mentor to identify the areas for improvement of a trainee and work with the trainee to develop remedies. From there, the trainee-mentor team can monitor progress over time to see if their efforts are making a difference, adjusting techniques and methods as needed.

Biases in trainees and mentors

In reducing the invisibility of minorities in STEMM, techniques targeted at strengthening hard and soft skills are oftentimes discussed. However, equally important is helping to remove the preexisting conditions that can contribute to the difficulties faced by minorities. One such way to do this may be for mentors to employ scales and quotients to better understand the biases trainees have, in what dimension these biases present, and work to create more inclusive trainees. In an attempt to measure bias, the mentor should be aware that bias exists on explicit and implicit levels. On an explicit level, this includes overt acts and basic beliefs that align with the formal definitions of prejudice against a certain group (Maass et al. 2000). This is typically easier to measure, even if the individual in question may not feel they have a bias. In comparison, implicit bias remains more elusive to measure and represents a combination of internalized feelings that may or may not affect the actual actions of the individual (Blanton and Jaccard 2017). While individually, explicit and implicit biases can form an incomplete picture, combining measures of both may allow mentors to get an accurate representation.

Currently, several methods exist to measure explicit bias. Explicitly, mentors can evaluate this on a qualitative level. For example, they can observe behavior, see how mentee speech may change, and see if their cognitive thought consistently may be predisposed against certain populations (Maass et al. 2000). Explicit bias can also be measured by modern sexism and racism scales, which are self-evaluations that trainees, may fill out (Campbell et al. 2016). These may ask questions such as "Women are generally not as smart as men." In general, these scales will offer the most realistic view of if biases exist in trainees, and modern scales exist to examine aspects of many biases, including sexism, racism, ageism, and homophobia (Raja and Stokes 1998, Chonody 2013, Fiske and North 2015, Campbell et al. 2016, Morrison and Kiss 2017, Ayalon et al. 2019). Also possible is to measure the overall tolerance of outgroups through the social dominance orientation, which measures preference in individuals for one group to have more power than others (Pratto et al. 1994). In administering these scales to trainees, mentors can understand if biases exist, and the specific questions may allow mentors to begin to help reduce these biases in trainees. However, the issue with these scales, as with all self-reported techniques, remains that trainees may choose to select what they believe is the socially acceptable answer, or what they think the mentor wants to hear, rather than what they believe. Given the need for transformative action in the DEI space, it is important to move away from people simply pontificating on DEI in theory but not in action or intentionality. Therefore, methods that better measure the true feelings of an individual can be important. In contrast, other scales can ask more tangential questions to better understand the drive to inhibit prejudice, such as asking whether a participant would challenge a racist joke (Maass et al. 2000). These can do better at measuring bias but can also inadvertently measure other factors. For example, the scenario above may potentially be dependent on introversion or other factors, less so than bias. Given these drawbacks of traditional measurements of explicit bias, mentors may consider also employing measurements of implicit bias.

Numerous scales have been proposed to measure implicit biases and prejudices. Here, we just highlight several current scales that offer certain advantages; however, we encourage mentors to tailor which ones they use to be most applicable in their current environment (e.g. in a primarily white institution, a scale measuring attitudes toward other races may be the most beneficial for trainees' future career). The Miville-Guzman Universality-Diversity Scale seeks to understand prejudice by measuring in a self-reported survey whether individuals are aware of differences and similarities among separate culture groups (Miville et al. 1999). Previous research has shown that awareness of them can foster greater empathy and reduce prejudice against outgroups (Miville et al. 1999). Similarly, the Gender/Sex Diversity Beliefs Scale measures belief toward transgender feelings not by directly asking about opinions, but rather by taking an ontological approach and asking participants about the very nature of what gender is, which can be an indication of prejudice (Schudson and van Anders 2021). In this scale, social constructionist beliefs—or feelings that society constructs definitions of gender, race, sexuality, etc.—can show a higher level of tolerance toward outgroups, especially transgenders (Schudson and van Anders 2021). In a slightly more overt method, the Symbolic Racism Scale (Henry and Sears 2002) measures racism by asking questions such as whether respondents believe other races get too much welfare or whether actions such as affirmative action unfairly benefit them (Fiske and North 2015). One of the most potentially useful scales is the Ambivalent Sexism Inventory, which measures both hostile and benevolent sexism (Glick and Fiske 1996). While the questions measuring hostile sexism are fairly typical, such as asking

if respondents believe women exaggerate problems, the questions measuring benevolent sexism may better cause trainees to examine their preconceived beliefs by asking questions such as whether women should be saved first in a disaster or whether women have more refined culture than men (Fiske and North 2015).

Another option of measurement is by testing subconscious awareness. This can include giving the participant a primer (e.g. the word "black" or "white") and then having individuals select positive and negative stereotypes (Wittenbrink et al. 1997). While these measures correlate with explicit bias and remove the chance of trainees being untruthful (Wittenbrink et al. 1997), they also offer the least information to mentors about the ways trainees may specifically present their biases. The ease to perform these tests is higher with computer programs that can test them. For example, Project Implicit from Harvard offers a version of the Implicit Association Test for many biases, including ageism, racism, and sexism (https://implicit.harvard.edu/implicit/takeatest.html). Another similar method to test this implicit bias is the method by Fazio (Fazio et al. 1995) by priming respondents with a picture that represents certain groups (e.g. for someone of a certain race, age, and gender) and then asking respondents to quickly associate adjectives as positive or negative, then alternate associating faces as positive or negative (Fiske and North 2015). This is done in many trials to establish baselines and comparisons. In the event respondents are more quick to categorize a certain group as negative, this can be associated with bias. Importantly, if employing one of these methods to measure implicit bias, mentors should keep in mind that implicit bias is just one aspect of an individual. Simply, implicit bias is not a perfect psychometric analysis, and other factors such as the environment, individual, and context also contribute to how individuals may express their inclusion (Blanton and Jaccard 2017). However, mentors should also be aware of how prejudice presents itself is changing, and the difficulties of measuring it in modern days with direct questionnaires (Gattino et al. 2008). In this way, measuring implicit bias is a simplistic measurement, but with this limitation in mind, it may still be effectively used to aid in helping the majority of trainees become stronger allies.

Once a mentor understands the biases in their trainees, they may begin taking steps to help trainees become stronger allies. While tolerance is often discussed in terms of reducing prejudice, the ultimate goal should be allophilia, which is defined as having positive emotions for outgroups (Pittinsky et al. 2011). Currently, the Allophilia Scale can measure this by asking questions to measure the kinship, enthusiasm, comfort, and preference of an individual to other outgroups (Pittinsky et al. 2011). This can also introduce another dimension for mentors to consider, as proactive mentors should work not only to reduce prejudice but also to foster an environment that nurtures allophiliain trainees. Therefore, mentors may need to adapt their strategies to optimally do this; however, past studies have shown that increasing the well-being of the trainees may be key in reducing prejudice (Dinh et al. 2014). Using the scales, mentors should seek to understand the specific areas in which biases exist. For example, when measuring the social dominance orientation (Pratto et al. 1994), trainees may score low on bias overall, but have a strong sense of competition and feel as though another's gain would be their loss. In such a scenario, mentors may consider helping the mentee participate in more group work or cross-lab collaborations that show them how STEMM is not a zero-sum game. In general, exposure is very key in reducing biases. Therefore, simply finding ways to allow trainees to regularly interact with other groups can be critical. Alternative avenues have been developed for learning about different cultures and include attending virtual cultural events, such as affinity group meetings, and reviewing anthropology and sociology literature. Mentors should emphasize that one should not impose one's values and beliefs onto another but, rather work to learn about the other beliefs and groups in a method that incorporates cultural relativism, which is a practice of understanding that cultures are separate and can, and should, co-exist (Brown 2008). These skills are critical in both an academic environment and in an increasingly globalized virtual world.

Quotients during COVID-19

The development of quotients is especially important in STEMM and has become even more critical as virtual environments have become more prominent due to the new challenges of the COVID-19 (Singh and Singh 2020). Increased collaborations using virtual platforms resulted in a myriad of challenges associated with asynchronous schedules and transient interactions, which demonstrates a salient need for clear communication. Examples of these challenges include difficulties identifying both verbal and non-verbal cues, voice fluctuations, and other communicative signals that are used to gauge the effectiveness of interactions that may be lost when communicating virtually. Furthermore, the increased use of virtual communication has underscored the need of reducing biases and being more open to collaborating cross-culturally. These skills and difficulties may also be necessary for non-virtual environments, so they are factors that many STEMM trainees should be prepared to face. To address these challenges, AQ, SQ, PGIS, and bias scales can be utilized to prepare trainees for collaborating with diverse groups of people across their careers, especially on virtual platforms.

It should be noted that the transition to working remotely during the COVID-19 pandemic forced mentors to provide professional development opportunities for their trainees that promote active learning, listening, and memory. These opportunities include trainees' participation in online journal clubs, grant writing workshops, and diversity and inclusion webinars, which encouraged trainees to self-reflect and expand their ways of thinking while improving their scientific communication skills. In addition to the changes affecting the trainees, mentors needed to be adaptive to respond to the changes brought about by the pandemic. For example, due to the safety restrictions imposed by the COVID-19 pandemic, laboratory-based scientists had to adapt to make progress on their research, and many reported a loss in work (Korbel and Stegle 2020). However, many stabilized their lab's output by publishing manuscripts from their pre-pandemic findings. In the face of the reduced ability of bench work, new tasks and ways to offer students relevant experience were necessary. For example, from our experience, mentors did this while providing trainees with a unique opportunity to develop figures and understand the competitive process needed to publish in high-impact, peer-reviewed journals. Additionally, mentors and trainees learned new computational modeling software such as *RuleBender*, *CellOrganizer*, and *CellBlender* to improve the quality of their data analysis. Many worked together to create virtual reality spaces and move as avatars to present information and gather with one another. This was fostered by high AQ, paired with being open to communicating and working with labs from different cultures to further the pursuit of science. Critically, this time showed the ability of mentors and trainees to persist through times of hardships and underscored the importance of further working toward making underrepresented individuals and individuals from different cultures fully involved in STEMM.

One of the first challenges mentors and trainees faced by working virtually was the need to re-establish and maintain open lines

Table 1. Summary of quotients discussed.

Quotient	Quality measuring
AQ	The ability to have resilience and grit, especially during difficult times.
SQ	The ability to know oneself and others and utilize these techniques for skills such as mentoring.
Emotional quotient	The ability to understand and utilize own emotions and those of others to overcome challenges.
Personal growth quotient	Growth mindset and general attitude toward learning new skills or broadening current knowledge.
Implicit bias quotient	Subtle or unknown biases toward certain groups or populations.

of communication to ensure research experiences remained on track and expectations were met. The lack of in-person meetings and laboratory experiences resulted in the improvement of the online written and digital platform communication (Termini et al. 2021). Both trainees and mentors were challenged to quickly learn and adapt their communication, while mentors needed to alter their mentoring style to be able to use virtual platforms such as Zoom, Skype, and Microsoft Teams (Hinton Jr et al. 2020b). Promoting the use of these forms of communication within a lab encourages trainees to meet with each other to brainstorm, problem solve, and complete research assignments as if they were working together in person in the laboratory. This also led to an increase in cross-cultural communication as labs were more easily able to collaborate due to the acceptance and shift to digital mediums. Other things that successful mentors did to further develop trainees' survival skills were to show trainees how to schedule a meeting, plan an agenda, carry out a meeting, and follow up with their co-workers. These accountability activities all serve to increase the trainees' AQ and SQ as they face new challenges with communicating online.

Those who were able to continue conducting research in their laboratory facilities also faced a plethora of challenges, including the need to develop and maintain a COVID-19 contact tracing and physical distancing plan of action. These new regulations sometimes became an added burden for mentors. For example, mentors needed to determine the maximum capacity of people who could work in the labs at any given time and to establish a screening system to check for any COVID-19 symptoms. These are just a few of the difficulties faced during the COVID-19 pandemic, and having a high AQ certainly was needed to identify innovative ways to navigate the "new normal." Having a honed AQ was critical for both mentors and trainees in navigating the COVID-19 pandemic. A mentor should work to identify gaps in trainees' knowledge or skills when it comes to AQ and help the mentee build them. However, in addition, social and networking skills were critical to being able to maintain relationships. During this time, it would be easy to allow trainees who are already at a disadvantage due to their race, gender, age, ethnicity, sexual preference, or disability to further fall behind; however, mentors who had instilled a sense of growth, resilience, and sociability in their trainees gave them the chance to thrive in this new turbulent time. Further, for individuals who were able to recognize and attempt to remedy their preconceived biases, virtual communication during COVID-19 allowed for new collaborations that may not have otherwise existed.

Considerations and potential challenges of implementation of quotients

While the usage of quotients is well supported by other fields and STEMM, it may be a daunting process for many mentors, especially since most mentors in academia are not given formalized mentorship training (Hund et al. 2018). While ideally, institutions would offer formalized training in mentoring to reduce the burden on faculty members, quotients may be used as a self-diagnostic for mentors. Intentional mentoring typically employ mentoring strategies, including IDPs and one-on-one meetings (Shuler et al. 2021). Quotients are ideally suited for this style of mentoring since quotients are based on personalized mentoring. Utilizing this mentoring style, mentors may offer trainees advice on skills to grow based on quotients. Growth, or lack thereof, of skills associated, may then be discussed during one-on-one meetings and implemented into IDPs (Vincent et al. 2015). However, future studies are required to better analyze and understand the impact of quotients, specifically the mentoring of underrepresented trainees. For example, it remains poorly understood how quotients can be utilized for trainees with documented and disclosed disabilities.

Other forms of mentoring may also adapt quotient usage. Distanced mentoring may still utilize some of the scales discussed here, which may be administered through online platforms; however, distanced mentoring is limited by not allowing the mentor to observe the mentee's progress regularly. Another common form of mentoring is group mentoring, which implements meetings involving more than two individuals (Huizing 2012). However, mentors may offer quotient tests across entire groups of trainees, although extra care must be taken to monitor and help promote the growth of individual trainees. For example, shadow mentoring is a form of unrecognized mentoring which mentors coming from underrepresented groups often engage in (Davis-Reyes et al. 2022). Shadow mentoring may begin to implement quotient monitoring during regular meetings, but it should not be applied if it requires too much unrecognized time on the part of the mentor. In the implementation of the quotients, mentors will be able to observe whether it is an effective strategy and work to try different scales if progress is not being made. In general, we believe the path to implementation of quotients will be best aided by training at departmental and institutional levels; however, individual mentors may implement them with little time or cost effort and can alter or forgo usage according to effectiveness.

Finally, a potential difficulty may be the issue of confidentiality in these surveys. Especially in the context of the mentor–trainee relationship, trainees may feel an issue with giving personal responses to many questions. Here, mentors can aid in the implementation by offering mentees the chance to fill out the specific questions in confidentiality, and only require reporting of the overall scores. However, for full usage of quotients, eventually, open communication, including when it comes to quotients, must be established. Understanding that the mentor–trainee relationship aims to benefit both parties will go a long way.

Conclusion

In general, we believe the mentoring process is enhanced through the usage of quotients. While quotients may be utilized for all trainees, their usage among underrepresented mentees may be especially beneficial. Mentors possessing and teaching tolerance

ware cruical for the diversification of STEMM. . Therefore, in addition to improving the score on these quotients in their trainees, mentors should also aim to improve and increase them in themselves. Critically, testing one's own biases can sharpen the mentor's perspective and allow them to understand the importance of creating an inclusive environment. Self-awareness and the intellectual capacity to adapt to different social situations, through the growth of the SQ, while remaining socially aware of the reactions of the receiver are crucial to developing an inclusive and welcoming mentorship environment. Building allophilia and learning how to embrace the diverse cultures of those around them can help build camaraderie, leading to more productive and positive, long-lasting relationships that contribute to an organization's mission and goals. We propose that mentors use the quotients described here, in addition to fostering a diverse lab environment for themselves and their trainees. Fortifying these traits and quotients will also allow mentors and their labs to increase diversification by aiding in the retention of minority trainees. Importantly, these can cultivate strong skills in sociability and adaptability in all trainees (Table 1). Specifically, it can give minorities who are invisible in STEMM the power to be able to gain a voice and overcome challenges through personal and professional growth. Equally, for the majority of trainees, it can help mentors to reduce biases in them and create an STEMM environment in the future that is welcoming for all groups of people.

Importantly, these changes cannot only occur at the level of mentors. While we have discussed these quotients principally in the context of being administered to mentees, they may also be utilized by mentors to improve their leadership. Various philosophies have considered the presence and characteristics of effective leadership (Black 2015, Mango 2018, Alotaibi et al. 2020). Collectively, effective leadership in academia begins at the institutional level; however, at this level, adversity and social intelligence tend to be disregarded as leadership skills (Hendrickson et al. 2013). These types of intelligence refer to one's ability to read other people's signals and react to them appropriately (Cooper 1997). Unfortunately, the existing literature does not indicate a systematic approach to identifying, developing, and assimilating such leadership skills, especially in STEMM higher education. We hope that institution leaders will use the information gathered here to incorporate AQ, SQ, PGIS, and bias monitoring into their leadership approaches by effectively cultivating an environment that encourages student diversity, participation, and overall success. We believe that, as academic leadership improves these skills, the trainees' overall success will also improve. Embracing these quotients at the institutional leadership level will ameliorate the trend of talented trainees leaving academe for industry positions. Therefore, an institution's success depends on progressive leadership strategies that incorporate the emotional awareness of its trainees. In creating this environment, we believe a top-down information flow can occur in which a good mentor may help their trainees grow through quotients. Increasing overall representation in STEMM is an important goal. Mentors can be an important asset in taking the first step by measuring and increasing their own quotients' score and those of their trainees to promote an environment that is comfortable for people from diverse backgrounds, helping to support minority trainees who are invisible, and supporting minorities' continued engagement with STEMM.

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