Enacting inclusive practices in STEM environments by engaging STEM faculty in self-reflexivity

Selyna Pérez Beverly*

Department of Leadership and Counseling, Eastern Michigan University, Ypsilanti, MI, United States

Introduction: Integrating self-reflexive work in STEM faculty professional development that interrogates aspects of identity, power, and privilege can lead to inclusive practices within the classroom and beyond. The purpose of this study is to examine the effects of purposefully centering self-reflexive processes focused on identity to create more inclusive STEM faculty.

Methods: The NSF Eddie Bernice Johnson INCLUDES Aspire Alliance Summer Institute (ASI) was a week-long summer intensive program geared toward faculty, institutional leaders, and faculty developers to learn how to support STEM faculty and higher education leaders in engaging in inclusive practices centered on an equity mindset. In this study, interviews were conducted with twelve faculty (tenure and non-tenure track) from a variety of STEM disciplines from the 2021–2023 cohorts. Participants were asked about their learning experiences in the ASI and what they did with the knowledge they gained.

Results: Findings indicate that self-reflection activities, focused on social identity, moved participants toward self-reflexivity in which they were made more aware of their power and privilege. Participants also discussed how their identity awareness contributed to changes in their teaching practices as well as their relationships with students and colleagues. Finally, participants that were already aware of their identity continued to engage in inclusive practices in STEM, further deepening their awareness.

Discussion: This work reveals that having STEM faculty critically reflect on their identity leads to self-reflexivity, a recognition of power and privilege in various contexts, thus creating a pathway to more inclusive learning conditions for underrepresented students in STEM. This research further indicates that self-reflexivity can also contribute to inclusive practices beyond the classroom in other environments, impacting how people interact with others in their daily work.

1 Introduction

Continuing the advancement of Diversity, Equity, and Inclusion (DEI) work in STEM higher education is challenging, but needed, since diversifying the STEM workforce is essential to maintaining global competitiveness (National Academies of Sciences, Engineering, and Medicine, 2023). One strategy [see NSF Eddie Bernice Johnson Includes Aspire Alliance (Aspire), 2024] has been to focus on faculty professional development that encourages inclusive teaching practices which can lead to more meaningful connections with students, thus improving their overall experiences in the classroom. Faculty relationships with students can have positive effects and contribute to students' pursuit of STEM academic careers (Griffin et al., 2010). Currently, most STEM faculty professional development focuses on

evidence-based teaching practices and methods and tools for active learning. Evidence-based teaching methods and tools are useful in engaging students and can have positive effects on students' self-confidence and persistence toward graduate school (e.g., Hanson et al., 2016). Yet, although strategies such as active learning are excellent tools, evidence suggests that it does not always improve outcomes for underrepresented populations (see Aguillon et al., 2020). Inclusive teaching, a more holistic instructional approach centered on equity, can enhance student learning and engagement especially for underrepresented students (Hockings et al., 2008, 2010). Students, in a study by Hockings et al. (2008), valued inclusive teaching practices because of the recognition of their academic and social identities thus fulfilling their individual learning needs and interests.

Faculty professional development centered on evidenced-based teaching methods and tools, such as active learning, can miss important aspects of inclusive teaching practices that peel back the layers of power and privilege that can manifest in a STEM classroom. Dewsbury (2020) argues that instructors who develop self-awareness by understanding their social positions can contribute to a positive classroom climate. This self-awareness can be developed through a process of critical reflection, which requires instructors to consider their own identity in the classroom as well as the identities of their students while also considering aspects of power and privilege that exist in the space (Milner, 2003; Patton et al., 2017). Esposito et al. (2016) characterized self-reflection as a "mental process" from which a person is able to gain "self- knowledge" (pp. 36). Esposito et al. (2016) further indicates that a person needs to first engage in self-reflection before they reach self-reflexivity, which is an individual's ability to recognize how their identity affects relationships and the act of changing behaviors based on such knowledge.

Integrating self-reflexive work in STEM faculty professional development that interrogates aspects of identity, power, and privilege can lead to more self-awareness and therefore inclusive practices within the classroom and beyond. Positive classroom climates, particularly in STEM, can improve conditions for underrepresented students increasing their persistence and retention (Beverly, 2022). Within K-12 education, engaging in self-reflexive processes are well-known as a way of creating teachers that are more empathetic and culturally responsive (Bowman, 1989). Recently, there has been a recognition regarding the importance of integrating inclusive teaching practices in the classroom at universities. Most faculty professional development focuses on inclusive pedagogical tools rather than offering opportunities for self-reflection of identity (e.g., Ceo-DiFrancesco et al., 2019). Yet, Bifulco and Drue (2023) discuss the importance of instructors recognizing bias and identity and offered a workshop focused on self-awareness. But it is unclear whether activities centered on self-reflexivity or if the topic was merely discussed and shared. Some STEM faculty development initiatives targeting STEM faculty focus on social identity awareness and how it connects to the classroom, but the process by which self-reflexivity occurs is not necessarily outlined (O'Leary et al., 2020). Overall, within postsecondary education, these self-reflective practices are not commonly integrated in STEM faculty professional development nor is their impact fully understood.

The purpose of this study is to examine the effects of purposefully centering self- reflexive processes focused on identity to create more inclusive STEM faculty through a high- engagement faculty professional development program (the Aspire Summer Institute). The Aspire Summer Institute (ASI) was developed by the National Change Initiative of the NSF Eddie Bernice Johnson INCLUDES

Aspire Alliance (Aspire heron) and consisted of a week-long, online training for STEM-focused institutional teams. More specifically, this study examined two research questions:

1 How does a process of self-reflexivity impact Faculty's understanding of their own identity and the identities of those they interact with?
2 How does Faculty's understanding of identity contribute to their inclusive practices within and outside learning environments?

1.1 Literature review

Historical beliefs of objectivity in science have contributed to the idea that science is universal and that a person's social identity does not influence scientific practice. Ladson-Billings (2000) argues that these dominant paradigms that have shaped science exclude those with differing cultures and identities. Black Feminist Standpoint Theory (Collins, 1986) reveals that social structures tether together economic, racial, and gender oppression and all must be addressed to solve issues of oppression. These systems of oppression also exist in spaces such as the STEM classroom and hooks (1994) argues that there are ways to dilute the power structures that exist.

In STEM classrooms, where instructors may employ a traditionally accepted scientific teaching approach, students are often treated as passive learners where material is regurgitated. Often, students are not viewed as partners in the teaching process contributing to the knowledge created in the learning environment (hooks, 1994). hooks argues that this type of passive teaching reinforces domination and prevents liberatory education, which is the dissolution of power structures and the development of a community that is inclusive of the students and the instructor. According to hooks, building community in a classroom enhances engagement and learning and ensures that all student voices are heard.

Often, students underrepresented in STEM encounter microaggressions in classrooms that can have negative effects on their personal and academic success (Patton et al., 2017).

Particularly students of color can experience racial stereotyping and racist comments in their classrooms (Harper and Davis, 2016). Shah and Leonardo (2017) discuss how classrooms can also emulate racial positions that exist within society. They argue that racial discourses within schooling dictate who is considered good at math and science thus creating a narrative that some racial groups are better or worse at certain subjects than others. Patton et al. (2017) explain that pedagogical models that work to disrupt whiteness and hegemony are critical to creating classroom environments that foster positive learning experiences for underrepresented populations, such as students of color. Yet, instructors must possess their own self-awareness of understanding racism to achieve an equitable classroom (Patton, 2023). According to Haynes and Patton (2019), White instructors who have a critical understanding of their whiteness are more likely to change their pedagogical practices to be more inclusive. They argue that White STEM instructors should engage in a self-awareness process examining their personal beliefs and biases.

There are many benefits of a positive classroom environment on students' socioemotional outcomes. Students who interact with faculty who are inclusive and welcoming are more likely to have a higher sense of belonging (Hurtado et al., 2018). Moreover, students are able to recognize whether or not an instructor is approachable based on the instructor's engagement with an ethic of care in the classroom (Hurtado

et al., 2011). In a study by Perna et al. (2010), Black women's persistence in STEM increased as a result of having access to faculty, engaging in a cooperative culture, and receiving encouragement from faculty. Bensimon et al. (2019) found in her study on Latinx faculty that the mentorship they provided to Latino students was essential to assist them in successfully navigating STEM culture. Thus, positive faculty-student interactions can counter the meritocratic and competitive STEM environments that are responsible for pushing underrepresented students out. Yet, STEM faculty may be resistant to enacting supportive inclusive practices conducive to learning because of the disciplinary culture they themselves encountered in their own experience (Smart et al., 2000). Russo-Tait (2022) found in her study of Science faculty members that they used color-blind frames which included pointing out deficits, individual choices, under-preparedness, and poverty as reasons for the underrepresentation of racially minoritized students. Although individuals within STEM disciplines may attempt to identify their academic cultures as gender- and race-neutral, research suggests science culture is influenced by perspectives of White men thus excluding women and people of color (Carter et al., 2019; Ladson-Billings, 2000). Thus, instructors through their various identities and lived experiences, contribute to the cultural norms that emerge in and outside STEM classrooms.

Within the P-12 literature, creating classroom spaces that are conducive to students' cultural needs (culturally relevant pedagogy, see Ladson-Billings, 1995) have been discussed for decades but have minimally translated into STEM higher education spaces. Xie and Ferguson (2022) recently researched how eight STEM instructors adapted their instructional practices to meet the needs of their diverse students. Although the goal of the study was to understand how instructors alter teaching practices to be more culturally responsive, it does not address how faculty professional development centered on self-reflexive praxis can potentially impact faculty's adoption of such practices. Pedagogical practices sensitive to students' cultural needs ensure that the learning environment enhances students' ability to develop their own perspectives and participate as active learners (Milner, 2011). Milner argues that for teachers to be effective in creating positive learning environments, teachers need to develop cultural competence by acknowledging their own identity and their students' identities. Milner (2003) indicates that teachers who are engaged in authentic reflection gain not only personal understanding, but an understanding of other groups and power structures. Howard (2003) refers to this process as critical reflection on race and culture which can lead to impactful changes in the classroom. Within higher education, reflective practices among faculty in STEM are not highly practiced and can be beneficial since equity is not typically addressed in STEM education at the K-12 (see Rousseau and Tate, 2003) or higher education level.

In summary, self-reflection is a vital component of inclusive teaching, which is needed to effectively prepare and retain diverse students in higher education for the larger STEM workforce. However, it is unclear, within a higher education setting, what impact self-reflective-focused faculty professional development, with a goal of self-reflexivity has on instructors' identity awareness and their resultant engagement with advancing inclusivity within their classrooms and institutions.

1.2 Theoretical framework

The Inclusive Professional Framework (IPF), designed by Aspire (Gillian-Daniel et al., 2021) and rooted in literature (e.g., Bryson and Grunert Kowalske, 2022; Salazar et al., 2010; Yosso, 2005), is

FIGURE 1
The inclusive professional framework (Gillian-Daniel et al., 2021).
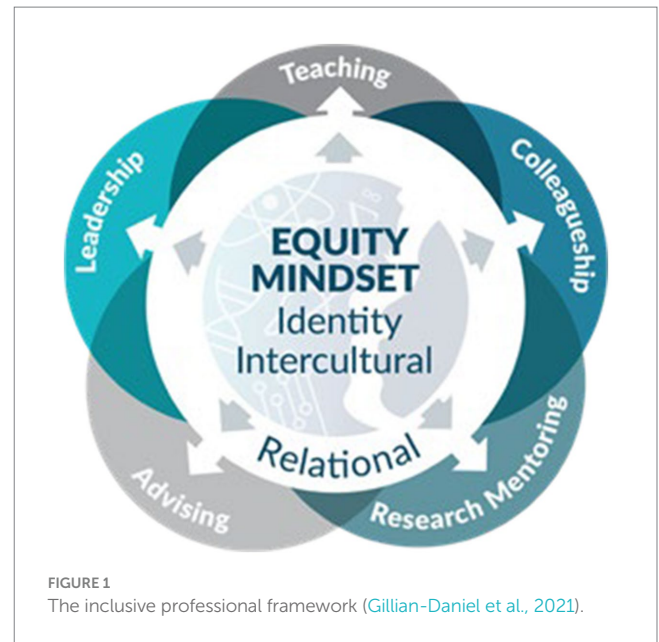
focused on promoting self-reflexivity by developing an individual's equity mindset, a way of understanding the historical disproportionate educational outcomes of underrepresented students as a product of systemic barriers rather than viewing these populations as having deficits (Bensimon, 2007). By utilizing a framework (see Figure 1) that is centered on self-exploration it can shape the various roles of a faculty member in STEM which includes teaching, advising, and mentoring to create behaviors that are sustainable and effective. This framework also reveals that it can have a positive impact on developing colleagueship and leadership (Dukes et al., 2023).

The IPF consists of three main domains to develop an equity mindset (Gillian-Daniel et al., 2021). These domains include identity, intercultural, and relational. The identity domain is focused on understanding your own identity as well as your students' identities and how intersecting identities can contribute to the learning environment (Crenshaw, 1991; Dessel and Rogge, 2008; Ensher and Murphy, 1997; Museus and Ravello, 2010; Salazar et al., 2010). This domain also allows individuals to reflect on how identity shapes different contexts and how they may shift identities based on those specific contexts. The intercultural domain involves having intercultural awareness to recognize individuals' backgrounds to create more positive interactions with students (Bibus and Koh, 2021; King and Baxter Magolda, 2005; Lee et al., 2012; Okun and Jones, 2000; Stanley, 2010; Yosso, 2005). An aspect of this domain also includes intercultural humility, a willingness to address power dynamics when they occur. This can often be useful with interactions between the student and the instructor where power dynamics are not always recognized or acknowledged. The relational domain involves building trust by utilizing communication skills to build a positive relationship with others (Alfred et al., 2005; Bryson and Grunert Kowalske, 2022; Gillian-Daniel et al., 2021; Ives and Rowley, 2005; Zurn-Birkhimer et al., 2011). This domain can be effective in improving the way instructors communicate with students allowing for more positive interactions where students are able to thrive and be successful. The domains work together to build an equity mindset (viewing students through an anti-deficit lens) that can influence all

aspects of faculty life which include areas such as leadership, advising, teaching, research mentoring, and even colleagueship. The IPF is a tool that is not limited to building inclusive classrooms but is also effective in championing overall inclusive practices utilized in faculty daily activities (Beverly and Gillian-Daniel, 2024). By cultivating an equity mindset, faculty can consider areas of inclusion as they navigate interactions with students and colleagues.

The IPF is utilized to structure the research methods and to inform the data analysis to examine the two research questions posed in the study. The three domains offer insight into the intersection of self- reflexivity and the advancement of inclusivity in STEM. Yet, this article is focused mainly on the identity domain and its impact on faculty professional development.

1.3 Researcher positionality

My experience working as a higher education administrator in STEM environments and my past and current research, which focuses on STEM teaching and learning informs this study. These past experiences in STEM contribute to the questions I pose as I use a feminist lens when examining issues of power within STEM environments. As a Latina researcher I utilize critical perspectives as I engage in research that is in support of advancing underrepresented populations in STEM. My awareness of my identities and experiences in STEM allow me to embrace my subjectivities while recognizing any biases I may bring to the research. This process contributes to enhanced perspectives that are discovered in the research.

2 Methods

The Aspire Summer Institute (ASI) was a week-long summer intensive program geared toward faculty, institutional leaders, and faculty developers to learn how to support STEM faculty and higher education leaders in engaging in inclusive practices centered on an equity mindset. A total of 135 individuals participated in the 2020–2023 ASI cohorts, of which 68 were faculty members. Self-reflexive practices were developed to conceptualize the various domains for those learning about the conceptual framework. Various speakers attended during the week providing interactive opportunities to learn about the different domains and to process with their cohort mates.

2.1 Self-reflexive ASI activities

To explore the identity domain, participants were asked to utilize the Academic Wheel of Privilege particularly developed for faculty (Elsherif et al., 2022) where they were asked to identify the privileges they had. The Academic Wheel of Privilege includes approximately 20 identity types in concentric circles across seven categories which include caregiving, living and culture, education and career, gender and sexuality, race, health, and well-being, childhood and development, and are also placed in a circular pattern. Participants were asked to indicate in the circle their various identities, with higher forms of privilege moving toward the center of the circle. Participants were also provided with a worksheet where they were able to respond to a series of prompts as they spent time identifying aspects of their identity on the wheel. After this

process, they were then placed in groups of 2–3 and were asked to discuss the process of the activity with a partner as they considered the relationship between their identities and privileges. This process allowed participants to reflect on how the activity made them feel and to hear from others about how the activity impacted them as well. The second activity involved providing space for participants to think about their personal biographies and how they could share this in a story form with students on the first day of class. Initially, participants would reflect on aspects of their identity and personal experiences that they would feel comfortable sharing with students following a set of prompts. After engaging in this activity, participants would meet with another participant where they would take turns practicing their stories. After this, there would be an opportunity to debrief with the larger group regarding what they heard from each other and how the process felt.

Overall, participants were encouraged to practice deep reflection throughout the entire week focused on each of the three IPF domains.

2.2 Data collection

Data comes from a broader mixed methods study that included interviews from individuals in the 2021–2023 cohorts. An initial email with an intake survey was sent out to each cohort of participants (2021–2023) approximately 6 months after participation in the ASI to request participation in a 60 minutes interview. The intake survey was used to gather demographic information including gender, race/ethnicity, campus role, and discipline and to schedule the interview. Participants in the 2022 cohort were offered a $50 gift card incentive and those in the 2023 cohort were offered a $75 gift card incentive. All participants were interviewed for 30 min to 60 min via Zoom using semi-structured, phenomenologically based interviewing focused on personal meaning-making based on experiences in the ASI and what they did with the knowledge they gained (Seidman, 2019). A total of 21 participants were interviewed for the broader study but only 12 had instructional responsibilities and were considered relevant to the current study. Participants were representative of R1 and R2 institutions across the United States. For the purpose of this study, only those individuals that had forward-facing student responsibilities that included teaching were included in this analysis.

Initially, an interview protocol was developed for those that participated in ASI 2021.

The protocol was quite broad focusing on participants' understanding of the conceptual framework and how they were implementing aspects of the framework into practice to advance DEI initiatives in STEM. Through these interviews, it was recognized that individuals frequently discussed the exploration of identity as having a pivotal impact on their experience in the ASI. As a result, the interview protocol was adapted for the 2022 and 2023 cohorts to capture the emerging discussions related to identity.

Twelve faculty from a variety of STEM disciplines from 2021 to 2023 participated in the interviews. The sample was viewed as adequate because data from the larger study reached a level of saturation in which participants were reflecting on the same constructs related to their identity awareness. For the purpose of this study, the term faculty is used to identify those that have teaching responsibilities at their institution and are designated as tenure-track, non-tenure track, or lecturer. Pseudonyms are used to identify participants in the study. The demographics are shown in Table 1.

TABLE 1 Demographics.

Pseudonym	Discipline	Gender	Race/Ethnicity	Professional position
Julie	Environmental sciences	Woman	White	Faculty
Reba	Biology	Woman	White	Faculty/Administrator
Cynthia	Information technology	Woman	White	Faculty/Administrator
Jeff	Engineering	Man	White	Faculty
Rose	Information science	Woman	White	Faculty/Administrator
Lianne	Biology	Woman	White	Faculty
Miriam	Biology	Woman	Asian	Faculty
Amir	Physics	Man	Asian	Faculty/Faculty Developer
Rakia	Public health	Woman	Black	Faculty
Linda	Physics	Woman	White	Faculty
Ruby	Education sciences	Woman	White	Faculty
Cathleen	Chemistry	Woman	White	Faculty/Administrator

2.3 Data analysis

During each interview, a process of member checking occurred to ensure that the participants' responses were being accurately captured and understood by the researcher. After each interview, an analytic memoing process was used to capture initial thoughts, interpretations, and questions related to what participants were sharing (Charmaz, 2014). After all of the interviews were conducted, *a priori* codes were developed to reflect the important concepts that were emerging by using the interview protocol as an initial guide. As the transcripts were coded, inductive coding was utilized to expand on the initial codes as certain concepts emerged that did not fit into the original codes. After the coding process was complete, interpretations of the data were developed by creating themes and categories based on emergent concepts and a process of saturation (Saunders et al., 2018). Throughout this process, the researcher consulted with colleagues on the research team who had expertise in STEM education to determine if the themes, categories, and interpretations made sense. Often, these consultations would occur with at least two other individuals on the team where questions were posed and debated leading to strengthened findings due to these discussions.

3 Results

ASI participants varied in how they self-reflected on identity and how this awareness contributed to their DEI work. Participants described how impactful recognizing the role of identity, power, and privilege was on them and described desires to use this to advance DEI in their faculty responsibilities, particularly with students. Some individuals used what they learned about their identity to alter their teaching, changing their course design or the way they introduced themselves in class. A group of participants shared how learning about their identity changed the way they viewed relationships. This knowledge of their identity and other's identities shaped how they interacted with both students and colleagues. Finally, some individuals who had experienced discrimination in the past or were from underrepresented groups in STEM, felt that they already had a keen awareness of their identity. Yet they still felt that revisiting their identity made them think about the complexity of identity and kept them engaged in DEI work.

3.1 Identity, power, and privilege

Faculty ($n = 6$) discussed how their understanding of their privileges through self-reflection of their identity impacted how they viewed their role in advancing DEI. Cathleen, a White woman, discussed how she had a clearer understanding of "sense of agency and belonging and competency, and that all of those are intertwined at all levels for those in positions of power and those who are not." Jeff discussed the difficulty with coming to terms with his position of privilege as a White man for the first time sharing, "it was sad in some ways. It was sad, but that is okay because sometimes you have to face some hard truths about yourself."

Amir, who was an Asian man, recognized his position of power and used it to support underrepresented students, "I see how much they are fighting and doing the right thing, but they do not have the right support. They do not have the correct opportunities." He discussed how he "will take every opportunity and any privilege that I have to kind of minimize this gap." Miriam, an Asian woman, explained that she had been lucky enough not to have any serious issues come up in her career but discussed how the ASI made her recognize that every experience is different which made her take on a role of advocacy for junior colleagues in her department,

> People have always been super supportive and super just helping me advance career-wise. So in that case, it's been really good. But I see other people not having that same experience. So I guess knowing what I've been through, but saying like, oh no, it's not that easy for everyone.

Similarly, Reba felt that speakers during the ASI helped her reconnect to the "systemic view of issues around DEI" through their "really tangible and horrific personal experiences" that she felt can get lost when you are viewing things from a "10,000-foot view." She felt that it reminded her "that the reason people are opting out of education is because of repeated, accumulated awful things that continue to happen to folks who enter these spaces." She indicated that hearing the speakers discuss this reminded her that these acts are still occurring and that there is "still so much work to be done." She also acknowledged that even though she had some previous awareness of her identity, she felt she gained "additional identity contexts" of her

privileges such as being a White woman from an upper middle class background. She recognized that her identity allowed her to "take breaks in a way that other people do not" which made her more "hyper- vigilant" about her power and privilege.

Through self-reflection during the ASI, Rakia, who was Black and identified as a person of color, gained awareness about her privileges which consisted of being able to move to the United States and pursue education while not working a full-time job,

> So it was in itself some of these inherent privileges, I guess, that I did not really acknowledge as privileges before. So doing that did help me see that it's not just about how my identities could sort of marginalize me, but also certain aspects of my identities could also make me more privileged than other people.

Overall, these six participants felt that reflecting on their identities made them realize the privileges they had, thus further influencing them to figure out ways to utilize the power that they had to enact inclusive practices as faculty members.

3.2 Identity and teaching

Faculty members ($n = 6$) that were engaged in instruction felt that focusing on their identity made them consider changes in the learning environment to make the spaces more inclusive. Cynthia explained how her identity awareness made her course design more student centered,

> I need to consider my students and my diverse student population and how this is going to impact the course design, for example…I gained more awareness, also, of being a woman and an international faculty at [name omitted], and so was more intentional then in mentoring my students and being a role model for my students, especially in my class.

Jeff also had a more conscious understanding of how identity contributed to the classroom. He felt that his awareness of identity made him reflect on his teaching in STEM, specifically his pedagogical approaches and student assessment,

> When I started as a faculty member decades ago, I essentially just modeled on what I had experienced as an undergraduate for our students. And now I realize that was really wrong, that we really do have to evolve the way that we convey information and how we assess students. Because there's much more richness out there to be had to get input from students and help them develop their own thinking in areas related to engineering. And so this role of identity is really important to recognize it and work with it as you are trying to carry out duties related to teaching.

Julie felt that reflecting on her identity made her more aware of her privileges in the classroom which made her want to talk about it more with her students,

> I thought more about roles, and I had not really thought about talking about my own privilege before. I've always been comfortable being vulnerable in front of my students, but I would say that it's just made me want to maybe talk more about identity, and also recognize, rather than just doing business as if we are all the same.

Julie also shared that she had never considered her first generation student experience before when speaking with her students. Her reflection on her identity made her think more deeply about her background and how it could help make connections with students. Rakia, who had some awareness of her identity, felt that the ASI allowed her deeper reflection which translated into how she discussed issues of systemic racism in her classrooms in regard to public health (her area of expertise),

> It made me sort of more aware of more context or more sorts of nuances and different ways of framing discussions that I did not have before… attending the ASI gave me just more tools to be able to frame what I was saying or to sort of relate to students in a deeper way.

As a result of the activities that centered identity and self-reflexivity in ASI, Miriam was more intentional about building teams in her classroom that worked well together to enhance the learning experience. She did this by giving students a questionnaire where they could identify areas of strength and once she placed the teams together she had them do team building activities. She also recognized she was in "a position of power" and wanted to make it clear to her students, that were largely first-generation, that she was a "guide." She described to her students that the learning process was a "two-way street." Lianne, through her various experiences with inclusive teaching workshops, decided after ASI to give her students a survey at the beginning of her course that asked them about themselves and what they were most worried about in the course. She then shared the results with the class and every class went over one area of concern and shared a campus resource. She felt that being accessible, sharing aspects of her identity in class, and acknowledging her students' backgrounds, was key to creating an inclusive environment for her students.

These faculty members, as a result of engaging in self-reflexive practices based on identity, were able to recognize how identity contributes to the learning environment. As a result, they adapted their pedagogical approaches to be more inclusive of their students' needs.

3.3 Identity and relationships

Participants ($n = 5$) discussed how identity awareness impacted the way they interacted with others, such as students and colleagues. Miriam described how her being more aware of her own identity and the identities of her students, who were mostly first-generation, made her recognize that "you cannot lump everyone together." She felt this knowledge contributed to her openness to her students and her willingness to empathize with their personal struggles. Rose also shared how the identity domain of the IPF made her consider its effects on relationships and giving people space to present their social identity and to "welcome it."

Rakia's awareness of identity after the ASI allowed her to recognize how her students' own identities could play a role in how they engage in the classroom so it made her more understanding of her student's diverse backgrounds. She described how she had gained an "understanding of how people's identities really play into their performance in class, the things they say in the classroom, the position that they may take in the discussion, interactions with them outside of class as well." She felt that her relationships and interactions with students were better informed after reflecting on her identity, power, and privilege.

Reba, in her work with graduate students and postdoctoral students began asking her students questions about their prior experiences when they were experiencing a conflict. She felt that she did not want to be the "White administrator" fixing the problems or telling students how to fix the problems they were having but rather wanted to give students agency to understand how their experiences could inform how they were viewing a certain conflict. Among her colleagues, she was focused on deemphasizing aspects of identity, such as institutional prestige, in order to view individuals in a more equitable way.

Jeff described how his understanding of identity contributed to relationships with his colleagues in his department and he felt that the disciplinary culture specifically in his engineering department created an environment that prevented inclusivity, even among faculty that were underrepresented,

> These interactions, they are critical. It is about people and understanding the role that identity can play in developing those interactions. I'll be honest with you, I look at some of my colleagues when I'm in faculty meetings, and some of them might be from an underrepresented group, but they violate every aspect of creating an inclusive environment. And that challenges my thinking too, because I'm like, well, they are from an underrepresented group, and they clearly feel that the way they are behaving is how they are going to achieve their success. And it is not necessarily what we think success should be necessarily in the future. It's almost like they have joined the club in order to succeed, but the club has the wrong rules.

These participants utilized their new awareness of the way identities shift in different contexts to alter their interactions with both students and colleagues. This allowed them to recognize how their own identities contribute to interactions but also how others' identities contribute as well.

3.4 Previously identity aware

There were also individuals ($n = 5$), Amir (an Asian man), Linda, Ruby, Lianne, and Cathleen (White women) who indicated they were already aware of the impact of identities on experiences and relationships. Amir shared how he had been discriminated against in the past, particularly because of his international background, which affected the ways he understood the effects of identity. Ruby shared that her research was focused on identity in education so she was already well aware of identity and identity in context. Linda, who felt she was aware of her identity, described herself as, "a 70-year old woman in physics who's very visible." She had endured many years of discrimination and thought that the identity part in the institute was a reminder that she needed to speak up more against identity-based discrimination. Lianne, who explained that being a woman and a mother were important aspects of her identity, explained that even though she had been through a number of diversity type workshops, she felt that each one pushed her further toward deeper reflection,

> I find that every time I'm in that space where these topics are discussed, it certainly is an opportunity to reflect and think about, well, how am I moving about in that space? How am I presenting myself to students? How am I hearing what they have to say?

Cathleen also felt that her past involvement in faculty development focused on inclusive practices contributed to her "big awareness" of her identity but she felt "refreshing my memory and deepening my connection with the literature" was helpful for her continued engagement with work in the DEI space.

Overall, these participants continued to engage in DEI work with a complex understanding of their identity and the roles that it played in their daily lives. Many of these participants had experienced some type of discrimination or were from an underrepresented group in STEM which impacted their understanding of identity.

4 Discussion

As Esposito et al. (2016) indicate, self-reflection is a crucial first step before becoming self-reflexive. Self-reflexivity is the ability to recognize how your identity contributes to various contexts and provides individuals with the impetus to change their behaviors as a result of this awareness. Findings reveal that the identity domain in the IPF is critical to achieving inclusive environments. The identity domain in the IPF is focused on helping individuals understand their own identity, the identity of their students, and how identities intersect and contribute to dynamics in the learning environment. Key findings indicate that self-reflection activities, focused on social identity, moved participants toward self-reflexivity and thus, had an effect on their desire to enact inclusive practices with students and with colleagues both in and outside of the classroom. ASI participants engaged in self-reflective practices that helped them to recognize their privileges and how power played a role in their interactions with students and colleagues, thus pushing them toward self-reflexivity.

Findings indicated that after the ASI, six participants discussed how their newly developed awareness of identity, power and privilege was influential to them understanding their roles as faculty members in STEM. They discussed how this awareness of their power made them recognize the importance of advocacy for their students. They also felt the ASI had exposed them to privileges they did not realize they had, causing them to be more self-aware of their own privileges compared to their students.

Participants also discussed how the knowledge they gained through the ASI identity activities made them think differently about how identity is an important aspect of the learning environment. They were able to take this new knowledge about their own identities and that of their students to create changes in their pedagogical practices. Six faculty members discussed changes they made such as discussing their identity and backgrounds with their students, making changes to course design, changing ways of assessing students, navigating discussions of systemic racism differently, and getting to know students and their worries early on in the course to address them. Overall, these types of inclusive practices such as introducing your background in class, showing concern for the needs of your students, making assessment more student-centered, and adding flexibility in the course can be instrumental in supporting student learning and success in the classroom (Hockings et al., 2008). Outside of the classroom, five participants felt that their understanding of identity also affected their relationships with not only students but colleagues, making the interactions more positive and inclusive. Participants gained empathy, felt they were more welcoming to their students' differing identities, recognized how to better support the most vulnerable students, felt empowered to call out others within their departments that were not behaving in inclusive ways, and informed how they navigated class discussions with an understanding of how student backgrounds can inform the ways they participate in class.

Although there were five participants who were already quite aware of their identity and how it contributed to their interactions and experiences, these individuals still felt that further reflection was helpful. Many of these individuals had already participated in other professional development that focused on identity or had personal experiences related to their identity that previously prepared them for self-reflexivity. For example, both Amir and Linda had experienced discrimination in the past in their field and were therefore made aware of the impact of their identity in certain contexts.

Overall, findings demonstrated both the importance and impact of professional development focused on self-reflexive introspection. High engagement programming that centers identity work can help participants develop a more complex understanding of their privilege and power, classrooms and diverse students, colleagues, and institutional dynamics. This appears to be a more effective way to get faculty to take steps to enact inclusive practices rather than merely sharing strategies for enacting inclusive instructional practices. Self-reflexivity can promote behavioral changes (Crossan et al., 1999; Mezirow, 1991; Veenman et al., 2006), such as becoming more inclusive, which can benefit students, especially those who are underrepresented, and other campus constituents in which faculty interact. Thus, self-reflexivity intersects behavioral, attitudinal, and cognitive dimensions, which when combined, are critical to advancing positive changes in higher education institutions.

Furthermore, much of the literature on STEM pedagogical improvement has followed a tips, tricks, and tool mentality where the simple acquisition of "things" to put in one's toolbox is sufficient to improve student success. However, teaching requires a deeper transformation that intertwines with one's identity and is sensitive to others' identities to be able to create a productive teaching and learning environment. Providing STEM faculty, or any faculty, with professional development that promotes self-reflexive praxis is key to overcoming the entrenched cultures, values, and "objectiveness" that permeates STEM fields. Helping faculty examine their identities, power, and privilege can create deep and long-lasting change, increasing STEM faculty members' ability to recognize systems of oppression and shape how they want to overcome these systems.

Therefore, this study has demonstrated the importance and impact of professional development focused on identity work that promotes self-reflexivity and change. However, there are limitations to the study. First, the study was only concerned with a single, high engagement program that, while successful, represents a single datum amidst other professional development programming. Second, the study relies upon self-reported data in the form of interviews. Future studies could be designed to address both limitations and explore the impact of identity-focused faculty development efforts using multiple data sources and over a longer period.

5 Conclusion

Overall, this work reveals that having STEM faculty critically reflect on their identity leads to self-reflexivity, a recognition of power and privilege in various contexts, thus creating a pathway to more inclusive learning conditions for underrepresented students in STEM. This research further indicates that self-reflexivity can also contribute to inclusive practices beyond the classroom in other environments, impacting how people interact with others in their daily work.

Further research should identify the ways that faculty integrate knowledge of identity, privilege, and power inside and outside the classroom. Research should also consider the linkage between a faculty's sense of identity, how it affects departmental culture, and whether or not they encounter resistance from departmental colleagues that are not identity aware. Further exploration of the role of self-reflexivity on STEM faculty and its effect on inclusive environments inside and outside the classroom may prove to be key to creating spaces where underrepresented students feel that they belong.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the author, without undue reservation.

Ethics statement

The studies involving humans were approved by University of Wisconsin, Madison and Eastern Michigan University. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

SB: Conceptualization, Formal analysis, Investigation, Methodology, Writing – review & editing, Writing – original draft.

Funding

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.

Generative AI statement

The author declares that no Gen AI was used in the creation of this manuscript.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

References

Aguillon, S. M., Siegmund, G. F., Petipas, R. H., Drake, A. G., Cotner, S., and Ballen, C. J. (2020). Gender differences in student participation in an active-learning classroom. *CBE—Life Sci. Educ.* 19:ar12. doi: 10.1187/cbe.19-03-0048

Alfred, L. J., Atkins, C., Lopez, M., Chavez, T., Avila, V., and Paolini, P. (2005). A science pipeline pathway for training underrepresented students in the biomedical sciences. *J. Women Minor. Sci. Eng.* 11:30. doi: 10.1615/jwomenminorscieneng.v11.i1.30

Bensimon, E. M. (2007). The underestimated significance of practitioner knowledge in the scholarship on student success. *Rev. High. Educ.* 30, 441–469. doi: 10.1353/rhe.2007.0032

Bensimon, E. M., Dowd, A. C., Stanton-Salazar, R., and Dávila, B. A. (2019). The role of institutional agents in providing institutional support to Latinx students in STEM. *Rev. High. Educ.* 42, 1689–1721. doi: 10.1353/rhe.2019.0080

Beverly, S. P. (2022). Raising their voices: exploring women's experiences with instruction in engineering courses. [doctoral dissertation]. Ann Arbor, MI: University of Michigan.

Beverly, S. P., and Gillian-Daniel, D. L. (2024). Facing the challenge: connecting concepts to practice to improve STEM faculty professional development. *Innov. High. Educ.* 49, 735–755. doi: 10.1007/s10755-024-09705-9

Bibus, A. A., and Koh, B. D. (2021). Intercultural humility in social work education. *J. Soc. Work. Educ.* 57, 16–27. doi: 10.1080/10437797.2019.1661925

Bifulco, C., and Drue, C. (2023). A collaborative model for faculty development: helping faculty develop inclusive teaching practices. *Improve Acad. J. Educ. Dev.* 42:3168. doi: 10.3998/tia.3168

Bowman, B. T. (1989). Self-reflection as an element of professionalism. *Teach. Coll. Rec.* 90, 444–451. doi: 10.1177/016146818909000313

Bryson, T. C., and Grunert Kowalske, M. (2022). Black women in STEM graduate programs: the advisor selection process and the perception of the advisor/advisee relationship. *J. Divers. High. Educ.* 15:111. doi: 10.1037/dhe0000330

Carter, D. F., Dueñas, J. E. R., and Mendoza, R. (2019). "Critical examination of the role of STEM in propagating and maintaining race and gender disparities" in Higher education: Handbook of theory and research. eds. M. B. Paulsen and L. W. Perna. *34th* ed (Cham: Springer), 39–97.

Ceo-DiFrancesco, D., Kochlefl, M. K., and Walker, J. (2019). Fostering inclusive teaching: a systemic approach to develop faculty competencies. *J. High. Educ. Theory Pract.* 19, 31–43. doi: 10.33423/jhetp.v19i1.666

Charmaz, K. (2014). Constructing grounded theory. *2nd* Edn. London: Sage Publications.

Collins, P. H. (1986). Learning from the outsider within: the sociological significance of black feminist thought. *Soc. Probl.* 33, s14–s32. doi: 10.2307/800672

Crenshaw, K. (1991). Mapping the margins: intersectionality, identity politics, and violence against women of color. *Stanf. Law Rev.* 43, 1241–1299. doi: 10.2307/1229039

Crossan, M. M., Lane, H. W., and White, R. E. (1999). An organizational learning framework: from intuition to institution. *Acad. Manag. Rev.* 24, 522–537. doi: 10.5465/amr.1999.2202135

Dessel, A., and Rogge, M. E. (2008). Evaluation of intergroup dialogue: a review of the empirical literature. *Conflict Resolut. Q.* 26, 199–238. doi: 10.1002/crq.230

Dewsbury, B. M. (2020). Deep teaching in a college STEM classroom. *Cult. Stud. Sci. Educ.* 15, 169–191. doi: 10.1007/s11422-018-9891-z

Dukes, A. A., Gillian-Daniel, D. L., Greenler, R. M. C., Parent, R. A., Bridgen, S., Esters, L. T., et al. (2023). "The aspire Alliance inclusive professional framework for faculty—implementing inclusive and holistic professional development that transcends multiple faculty roles" in The handbook of STEM faculty development. eds. S. Linder, C. Lee and K. High (Washington, DC: American Society for Engineering Education).

Elsherif, M. M., Middleton, S. L., Phan, J. M., Azevedo, F., Iley, B. J., Grose-Hodge, M., et al. (2022). Bridging neurodiversity and open scholarship: how shared values can guide best practices for research integrity, social justice, and principled education. doi: 10.31222/osf.io/k7a9p

Ensher, E. A., and Murphy, S. E. (1997). Effects of race, gender, perceived similarity, and contact on mentor relationships. *J. Vocat. Behav.* 50, 460–481. doi: 10.1006/jvbe.1996.1547

Esposito, G., Freda, M. F., and Picione, R. D. L. (2016). "Reflexivity or "reflexivities" in higher education: conceptualizing unique reflexive process" in Working with underachieving students in higher education. eds. M. F. Freda and J. González-Monteagudo (London: Routledge), 32–42.

Gillian-Daniel, D. L., Greenler, R. M. C., Bridgen, S. T., Dukes, A. A., and Hill, L. B. (2021). Inclusion in the classroom, lab and beyond: transferable skills via an inclusive professional framework for faculty. *Change Magazine Higher Learning.* 53, 48–55. doi: 10.1080/00091383.2021.1963158

Griffin, K. A., Perez, D., Holmes, A. P., and Mayo, C. E. (2010). Investing in the future: the importance of faculty mentoring in the development of students of color in STEM. *New Dir. Inst. Res.* 2010, 95–103. doi: 10.1002/ir.365

Hanson, J. M., Paulsen, M. B., and Pascarella, E. T. (2016). Understanding graduate school aspirations: the effect of good teaching practices. *Higher Educ.* 71, 735–752. doi: 10.1007/s10734-015-9934-2

Harper, S. R., and Davis, C. H. (2016). Eight actions to reduce racism in college classrooms. *Academe* 102, 30–34. doi: 10.4324/9781315737225-18

Haynes, C., and Patton, L. D. (2019). From racial resistance to racial consciousness: engaging White STEM faculty in pedagogical transformation. *J. Cases Educ. Leadersh.* 22, 85–98. doi: 10.1177/1555458919829845

Hockings, C., Cooke, S., and Bowl, M. (2008). Learning and teaching for social diversity and difference in higher education. *ESRC End of Award Report, RES*, 139–25.

Hockings, C., Cooke, S., and Bowl, M. (2010). "Learning and teaching in two universities within the context of increasing student diversity: complexity, contradictions and challenges" in Improving learning by widening participation. ed. M. David (London: Routledge).

hooks, b. (1994). Teaching to transgress. London: Routledge.

Howard, T. C. (2003). Culturally relevant pedagogy: ingredients for critical teacher reflection. *Theory Pract.* 42, 195–202. doi: 10.1353/tip.2003.0031

Hurtado, S., Alvarado, A. R., and Guillermo-Wann, C. (2018). Creating inclusive environments: the mediating effect of faculty and staff validation on the relationship of discrimination/bias to students' sense of belonging. *J. Committed Soc. Change Race Ethnicity* 1, 60–81. doi: 10.15763/issn.2642-2387.2015.1.1.59-81

Hurtado, S., Eagan, M. K., Tran, M. C., Newman, C. B., Chang, M. J., and Velasco, P. (2011). "We do science here": underrepresented students' interactions with faculty in different college contexts. *J. Soc. Issues* 67, 553–579. doi: 10.1111/j.1540-4560.2011.01714.x

Ives, G., and Rowley, G. (2005). Supervisor selection or allocation and continuity of supervision: Ph. d. Students' progress and outcomes. *Stud. High. Educ.* 30, 535–555. doi: 10.1080/03075070500249161

King, P. M., and Baxter Magolda, M. B. (2005). A developmental model of intercultural maturity. *J. Coll. Stud. Dev.* 46, 571–592. doi: 10.1353/csd.2005.0060

Ladson-Billings, G. (1995). But that's just good teaching! The case for culturally relevant pedagogy. *Theory Pract.* 34, 159–165. doi: 10.1080/00405849509543675

Ladson-Billings, G. (2000). "Racialized discourses and ethnic epistemologies" in Handbook of qualitative research. eds. N. Denzin and Y. Lincoln. *2nd* ed (London: Sage Publications), 257–277.

Lee, A., Poch, R., Shaw, M., and Williams, R. D. (2012). The need for intercultural competency development in classrooms. *ASHE High. Educ. Rep.* 38, 1–132. doi: 10.1002/aehe.v38.1

Mezirow, J. (1991). Transformative dimensions of adult learning. New York, NY: Jossey-Bass.

Milner, H. R. (2003). Reflection, racial competence, and critical pedagogy: how do we prepare pre-service teachers to pose tough questions? *Race Ethn. Educ.* 6, 193–208. doi: 10.1080/13613320308200

Milner, H. R. (2011). Culturally relevant pedagogy in a diverse urban classroom. *Urban Rev.* 43, 66–89. doi: 10.1007/s11256-009-0143-0

Museus, S. D., and Ravello, J. N. (2010). Characteristics of academic advising that contribute to racial and ethnic minority student success at predominantly White institutions. *NACADA J.* 30, 47–58. doi: 10.12930/0271-9517-30.1.47

National Academies of Sciences, Engineering, and Medicine (2023). Advancing antiracism, diversity, equity, and inclusion in STEMM organizations: Beyond broadening participation. Washington, DC: The National Academies Press.

O'Leary, E. S., Shapiro, C., Toma, S., Sayson, H. W., Levis-Fitzgerald, M., Johnson, T., et al. (2020). Creating inclusive classrooms by engaging STEM faculty in culturally responsive teaching workshops. *Int. J. STEM Educ.* 7, 1–15. doi: 10.1186/s40594-020-00230-7

Okun, T., and Jones, K. (2000). White supremacy culture. Dismantling racism: A workbook for social change groups. Durham, NC: Change Work.

Patton, L. D. (2023). "Foreword" in Race, equity, and the learning environment: The global relevance of critical and inclusive pedagogies in higher education. eds. F. Tuitt, C. Haynes and S. Stewart. *2nd* ed (New York, NY: Taylor & Francis), 1–3.

Patton, L. D., Haynes, C. M., Stewart, S., and Ivery, S. M. (2017). Enhancing classroom learning environments for students of color. *Adv. Equity Diversity Student Affairs* 2017, 149–164.

Perna, L. W., Gasman, M., Gary, S., Lundy-Wagner, V., and Drezner, N. D. (2010). Identifying strategies for increasing degree attainment in STEM: lessons from minority-serving institutions. *New Dir. Inst. Res.* 2010, 41–51. doi: 10.1002/ir.360

Rousseau, C., and Tate, W. F. (2003). No time like the present: reflecting on equity in school mathematics. *Theory Pract.* 42, 210–216. doi: 10.1353/tip.2003.0035

Russo-Tait, T. (2022). Color-blind or racially conscious? How college science faculty make sense of racial/ethnic underrepresentation in STEM. *J. Res. Sci. Teach.* 59, 1822–1852. doi: 10.1002/tea.21775

Salazar, M. D. C., Norton, A. S., and Tuitt, F. A. (2010). 12: weaving promising practices for inclusive excellence into the higher education classroom. *To Improve Acad.* 28, 208–226. doi: 10.1002/j.2334-4822.2010.tb00604.x

Saunders, B., Sim, J., Kingstone, T., Baker, S., Waterfield, J., Bartlam, B., et al. (2018). Saturation in qualitative research: exploring its conceptualization and operationalization. *Qual. Quant.* 52, 1893–1907. doi: 10.1007/s11135-017-0574-8

Seidman, I. (2019). Interviewing as qualitative research: A guide for researchers in education and social sciences. New York, NY: Teachers College Press.

Shah, N., and Leonardo, Z. (2017). Learning discourses of race and mathematics in classroom interaction. Power and privilege in the learning sciences: Critical and sociocultural theories of learning. New York, NY: Routledge, 50–69.

Smart, J. C., Feldman, K. A., and Ethington, C. A. (2000). Academic disciplines: Holland's theory and the study of college students and faculty. Nashville, TN: Vanderbilt University Press.

Stanley, C. A. (2010). Conceptualizing, designing, and implementing multicultural faculty development activities. *Guide Faculty Dev.* 22, 203–224.

Veenman, M. V., Van Hout-Wolters, B. H., and Afflerbach, P. (2006). Metacognition and earning: conceptual and methodological considerations. *Metacogn. Learn.* 1, 3–14. doi: 10.1007/s11409-006-6893-0

Xie, J., and Ferguson, Y. (2022). STEM faculty's perspectives on adopting culturally responsive pedagogy. *Teach. High. Educ.* 29, 1215–1233. doi: 10.1080/13562517.2022.2129960

Yosso, T. J. (2005). Whose culture has capital? A critical race theory discussion of community cultural wealth. *Race Ethn. Educ.* 8, 69–91. doi: 10.1080/1361332052000341006

Zurn-Birkhimer, S., Geier, S. R., and Sahley, C. (2011). "ADVANCE-PURDUE: retention, success, and leadership for senior female STEM faculty," in 2011 ASEE Annual Conference & Exposition, 22–145.