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Contemporary Debates on Equity in STEM Education: Takeaways from a Doctoral Seminar in Equity in STEM Education

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Abstract: As the emerging field of equity in STEM education continues to grow, debates are also growing surrounding how to best serve populations with historically restricted access and successful outcomes within the STEM fields. In this article, a group of doctoral students who took a course titled Equity in STEM Education discussed their takeaways regarding the literature introduced in the course. The topics covered in this article center around Gutiérrez's (2007) equity framework of power, identity, access, and achievement. Through the lens of the equity framework, the dimension of power will be used to present discourse on the sociopolitical turn in STEM education. Identity will be used to explore debates on race, poverty, gender, and sexuality within STEM equity and education. Access will be used to examine discussions on students' ability to achieve STEM equity in rural settings and within specific domains such as computer science. Finally, achievement will be used to explore arguments on both sides of the achievement gap research. To conclude, we urge researchers, educators, and policymakers to listen and act upon the work of contemporary scholars in order to achieve an equitable STEM education system.

Keywords: *Critical; Equity; Higher Education; STEM Education; Social Justice; Sociopolitical*.

Introduction

Since the Civil Rights Movement in the United States (US; e.g., Mendez v. Westminister, Brown v. Board), equity issues have become more predominant in education discussions in general (Rodriguez & Morrison, 2019) and in the science, technology, engineering, and mathematics (STEM) fields in particular (Achieve, 2013; National Council of Teachers of Mathematics, 1989, 2000; National Research Council, 2012). As a result, doctoral programs have emphasized the importance of including classes investigating the context of current equity research. That was the case with Texas Tech University College of Education's Curriculum and Instruction Ph.D. program, which inaugurated its first seminar examining equity issues in STEM education in the Fall of 2022. In this article, a group of doctoral students who took the Equity in STEM Education course discusses their takeaways regarding the literature discussed in the course. The professor chose the discussion topics of the course based upon a need he identified to dismantle historical pre-conceived notions that might not attest to the doctoral students' experiences in STEM. This article highlights some ongoing debates on STEM equity and education presented in the Equity in STEM Education course. Topics will center around Gutiérrez's (2007) equity framework of *power*, *identity*, *access*, and *achievement*, which will be discussed further.

The first question concerning equity in STEM is, what place does it have within the context of STEM education and research? Equity in STEM education is a hotly contested issue, as can be seen from M. Kathleen Heid's (2010) editorial in the *Journal for Research in Mathematics Education* (JRME), entitled "Where's the Math (in Mathematics Education Research)?" As the editor of JRME at the time, Heid lamented the paltry number of manuscripts crossing her desk "in which mathematics is an essential component rather than being a backdrop for another area of inquiry" (p. 103). The reaction to the editorial was swift and contentious; although Heid never identified what these "other areas of inquiry" might entail, fellow researchers concluded this was a jab at equity-based mathematics education research (Confrey, 2010; Martin et al., 2010). Researchers such as Martin et al. (2010), Kumashiro (2004), D'Ambrosio (1999), and Gutiérrez (2013) argued against the absolutist stance that mathematics can be taught and researched devoid of the sociopolitical context in which students learn. For Martin and colleagues (2010), the question was not "Where's the math?" (Heid, 2010, p. 102) but "Who is empowered or entitled to decide what counts as mathematics educational research?" (Martin et al., 2010, p. 14). On the other hand, scholars such as Confrey (2010) adopted a *both-and* approach. While Confrey conceded that the field of education would be poorer without research on equity in mathematics, he agreed with Heid that it would be equally deprived if we did not research mathematics itself. Therefore, equity research is not an invitation to abandon mathematics research or vice versa. Instead, equity and mathematics education should be integrated and studied together.

These pro-equity debates are not unique to the field of mathematics. Similar arguments have been made in science education, stating that research should apply equity lenses; otherwise, it "has not produced, and will not produce, the advertised well-intended results" (Rodriguez & Morrison, 2019, p. 274). Furthermore, Mohr-Schroeder et al. (2020) maintained that equity should apply to all fields of STEM, individually and collectively.

While globally researchers in STEM education are embarking on a more equity-focused stance, there is far from a consensus on what equity in STEM education should look like or what equity even means. Equity has been defined and misconstrued in multiple ways throughout the literature. For example, *equality* and *equity* frequently get used interchangeably, yet they are not the same (Rodriguez & Morrison, 2019). According to Rodriguez (2016), "it is important to differentiate equity from equality . . . in order to be equitable, we cannot treat everyone the same. To be equitable, we must treat individuals according to their needs and provide multiple opportunities for success" (p. 243).

In this article, we use Gutiérrez's (2002) definition of equity. According to Gutiérrez, equity is "the inability to predict mathematics achievement and participation based solely on student characteristics such as race, class, ethnicity, sex, beliefs, and proficiency in the dominant language" (p. 153). In addition, we use Gutiérrez's (2007) theoretical framework comprising power, identity, access, and achievement to analyze discussions around equity issues. All four dimensions of the framework are necessary to achieve equity because there is a direct relationship between access and achievement, in addition to identity and power. Access relates to the student's available resources, such as quality teachers, a rigorous curriculum, and learning opportunities. Student access to these learning opportunities influences their outcomes or achievements. The achievement dimension measures student results and their implications for eventual jobs and societal standings. Equally important is for students to establish their identity in STEM, which includes seeing themselves and their culture in STEM content. Student identity relates to how students acquire the power dimension, which gives them a voice in the classroom. Together, these four dimensions build equitable education for students in STEM (Gutiérrez, 2007, pp. 2—3).

This article aims to highlight some of the ongoing debates related to STEM equity and education, predominately in the US but also internationally. In the following sections, we present different topics in relation to the four dimensions of Gutiérrez's (2007) framework of power, identity, access, and achievement. The dimension of power will be used to examine the sociopolitical turn in STEM education. Identity will be used to explore debates on race, poverty, gender, and sexuality within STEM equity and education. Access will examine students' ability to achieve STEM equity in rural settings and within specific domains such as computer science. Finally, achievement will be used to explore arguments on both sides of the achievement gap research.

Power

Gutiérrez's (2007) dimension of power discusses issues concerning social transformation specifically related to providing a voice to students within the classroom. However, within the STEM fields, there appears to exist a power struggle or a hesitation to transfer power to students. Incorporating students' voices in the classroom is impactful for their STEM career interests (Darwin et al., 2022) and can further provide positive learning experiences for students, especially those belonging to groups historically targeted for oppression (Ataide Pinheiro, 2022; Chase, 2020). The following section focuses on the need for a sociopolitical turn within STEM education and its implications for students' achieving power in the classroom.

The Sociopolitical Turn in STEM Education

In 2013, Rochelle Gutiérrez published an article entitled "Sociopolitical Turn in Mathematics Education." In it, she described the need for educators and researchers to move beyond sociocultural perspectives to address anti-racism and social justice issues within mathematics education. At the heart of the sociopolitical debate resides the question: Is mathematics teaching and learning politically neutral? While there are several philosophical positions, historically, mathematicians have ascribed to an absolutist epistemology, as discussed by Ernest (1991). Ernest states, "for over two thousand years, mathematics has been dominated by an absolutist paradigm, which views it as a body of infallible and objective truth, far removed from the affairs and values of humanity" (p. xi). As such, mathematics education has claimed an almost revered state of political neutrality. The results have made it challenging for mathematics educators and researchers to take an equity-based or sociopolitical stance (Martin et al., 2010). This is because acknowledging the influence of external factors (e.g., poverty, racism, and sexism) in students' mathematics learning brings mathematics down from the ethereal to the earthly plane.

Nevertheless, this latter argument is the very same one challenged by Gutiérrez (2013), when she argued that "mathematics is a human practice [which] means it is inherently political, rife with issues of domination and power, just like any other human practice" (p. 39). Acknowledging that mathematics is a human endeavor is an important epistemological shift. First, it allows mathematics educators to present multiple *truths* and acknowledge that mathematical knowledge has changed over time (Ernest, 1991). Second, these acknowledgments open the door to discussing whose mathematics is taught and to what end. According to Gutiérrez (2013), a post-structuralist view of mathematics allows scholars to challenge mathematical certainty and notions such as success, the achievement gap, or how we define mathematics. However, for Gutiérrez, this is not enough. If mathematics is a human practice, then "human practice[s] can become more just" (Gutiérrez, 2013, p. 55). Therefore, the sociopolitical turn requires conversations to move beyond sociocultural theories and turn to issues of identity, power, justice, and systemic change.

As in mathematics, some argue that science education is also heading toward a sociopolitical turn (Tolbert & Bazzul, 2017). However, the path of equity-based science education has had a few more twists and turns. Like mathematics, science education emerged within positivist paradigms claiming that truth could be ascertained from scientific knowledge and the scientific process (Goldfarb, 1996). While this knowledge was initially deemed the property of elites, events such as the industrial revolution and the launching of the Soviet satellite Sputnik into space convinced governments and educators of the need for universal science education (Matthews, 2015). While science education has not experienced the same privileged status as mathematics, that does not mean equity-based science education has been the focus or practice of most science educators. For example, a science education literature review from 1981 to 2008 by Maria Rivera Maulucci (2012) demonstrated that the term *social justice* was increasing in use. However, in the vast majority of articles, the term was used superficially.

Like Gutiérrez, researchers Rodriguez and Morrison (2019) have taken aim at researchers, educators, and policymakers who provide lip service to issues of equity within science education but do little to create transformative change. Therefore, they have embraced a *sociotransformative argument* that involves instigating social action to create transformative change personally and within society. This is similar to the sociopolitical turn in which researchers and educators address structural issues of identity, power, and oppression within science teaching and learning (Tolbert & Bazzul, 2017). However, Tolbert and Bazzul question whether those within science education research have the critical and political consciousnesses necessary to implement such transformative change, particularly when arguments of "this is not science" and accountability dominate the discourse. Despite this, scholars such as Rodriguez, Morrison, Tobler, and Bazzul have continued to push for transformative change in equity and social justice within science education.

Up to this point, we have presented researchers' arguments for the sociopolitical turn isolated to their respective fields. However, Owens and Sadler (2020) contended that to truly transform education and "solve problems or make decisions that benefit mankind" (p. 210) is the work of integrated and holistic STEM education. Failing to integrate the disparate fields of science, technology, engineering, and mathematics would undermine teachers' and students' ability to solve the problems that the sociopolitical turn has vowed to address. The sociopolitical turn in STEM education contends that teaching and learning is a political act. Moreover, systemic issues of power, identity, and social justice must be addressed to achieve truly equitable practices.

Identity

Despite years of research on the inequity in STEM education and careers, certain groups continue to be underrepresented (Ataide Pinheiro, 2021; National Center for Science and Engineering Statistics, 2021; Neto & Ataide Pinheiro, 2021). Students are often assigned to these groups using single identity qualifiers (e.g., gender, race, low socioeconomic status [SES]). However, educational researchers would do well to recognize that students rarely have a single identity (Hazari et al., 2013). The following section focuses on how isolated and intersecting identities (particularly those of race and ethnicity, gender and sexuality, and SES) impact students' equitable experiences in STEM education.

Race, Ethnicity, and Equity in STEM Education

The sociopolitical turn challenges educators to consider whether STEM education is politically neutral (Gutiérrez, 2013; Tolbert & Bazzul, 2017). Similar arguments have been made about race, particularly the roles of neutrality, color blindness, and meritocracy in our current education system (Rodriguez, 1998). Scholars have taken issue with all three factors, claiming they exacerbate systemic racism within our educational systems (Martin et al., 2017; Rodriguez, 1998; Sleeter, 2017). For example, a literature review from 2008–2018 by Jong et al. (2020) on the experiences and outcomes for racial and ethnic minorities (REM) in STEM in the US found evidence of systematic racism against REM in STEM education and the unfair comparison of these students to those who have access to power and privilege. Issues included tracking, treating students from different REMs as a monolithic group, lack of representation, and deficit mentalities involving dehumanizing students and blaming the victim.

The factors outlined by Jong and colleagues are not new and have plagued REM in STEM education for decades. Which begs the question, in what ways are contemporary STEM researchers and educators willing to have difficult conversations about race? An editorial by David W. Stinson (2011) in the *Journal of Urban Mathematics Education* entitled "'Race' in Mathematics Education: Are We a Community of Cowards?" looked at two major analyses of mathematics education literature on issues of race/ethnicity in mathematics education over the past three decades. The results indicated that most peer-reviewed articles on race/ethnicity in mathematics were published in non-mathematics education journals and, even then, only at a rate of about 4%. Furthermore, these studies primarily examined race in "dangerously limiting, one-dimensional perspective[s]" (p. 5). The lack of research in the field has dramatic consequences because scholars, educators, and policymakers use this research to inform their beliefs about race and, subsequently, students' racial abilities and competencies (Martin et al., 2017).

As a result, more comprehensive studies on race and ethnicity in STEM education are needed. However, REM students are still treated as a monolithic group by researchers, educators, and policymakers (Gutiérrez, 2007; Rodriguez, 1998). Asking students to put themselves in singular domains is problematic because race is often ill-defined, superficial, conflated with culture, and inadequate for multiracial students (Martin et al., 2017). For example, the term *Hispanic* is challenging to decipher because it has been used to describe skin color, ethnicity, and language acquisition, not to mention a broad group of people hailing from disparate backgrounds and cultures (Mexican Americans, Chicanos/as, Cubans, Puerto Ricans, Columbians, etc.; Rodriguez, 1998).

Issues of intersectionality are also compound the homogenization of REM. Intersectionality accounts for the particular experiences people with intersecting identities (e.g., race, gender, sexuality) go through in society (Crenshaw, 1991; Hill Collins & Bilge, 2020; May, 2015). While most of the research has focused on “classifying people on the basis of their single group membership” (Hazari et al., 2013, p. 84), the National Academies of Science, Engineering, and Medicine’s (NASEM) 2019 report *Monitoring Educational Equity* recommended disaggregating historically disadvantaged groups of students based on multiple factors such as race, gender, and ethnicity. It argued that race alone cannot be decoupled from other factors that impact student success. Lee and Luykx (2007) took this one step further by claiming that race and ethnicity are interrelated with language, culture, and SES. Untangling these variables is complex and portrays an incomplete picture of the multiple factors influencing students and their experiences within STEM education.

Counter-narratives are seen as an effective tool to combat the dangers of overgeneralization among REM students by bringing student stories to light (Jong et al., 2020). For example, Leyva (2021) found counter-stories depicting Black women’s experiences in P–16 mathematics education highlighted issues of marginalization, exceptionalism, competition, and stereotypes but also made space for affinity groups and resilience. Likewise, Jong et al. (2020) recommended using the lens of critical race theory more broadly to counter color-blindness as a form of racism that absolves those with power addressing racial issues, as well as a means of reinforcing monolithic perspectives of REM groups. While differences may exist on how to address issues of homogeneity, intersectionality, and superficiality when studying STEM equity among REM, with only 4% of peer-reviewed articles addressing the issue, there is plenty of room for all these perspectives.

Gender and Sexuality in STEM Research

Just as intersectionality is a prominent feature in discussions about REM, the same is true with gender and sexuality (Buck et al., 2020; Lubienski & Ataide Pinheiro, 2020). Hazari et al. (2013) clarified, “not all women are alike, nor are all underrepresented minorities alike” (p. 84). Scholars such as Buck et al. (2020), Lubienski and Ataide Pinheiro (2020), and Scantlebury and Baker (2007) have argued that additional themes influence differences in STEM enrollment and retention by gender, including the intersectionality of race, ethnicity, and SES. For example, students of all genders are more likely to do well in science if they come from a higher SES and have parents with higher education levels than those without (Scantlebury & Baker, 2007). Furthermore, Black girls have had an easier time with the cultural shift toward women's participation in science than Hispanic girls (Scantlebury & Baker, 2007). Moreover, Black girls are more likely to outperform their Black male counterparts on the National Assessment of Educational Progress. However, this has not resulted in more Black girls choosing STEM majors in college (Lubienski & Ataide Pinheiro, 2020).

Dissecting the intersectionality of race, ethnicity, SES, and gender is an important topic to explore in its own right. In addition, the field has also begun to recognize gender as a social construct rather than as biological sex (Butler, 1990, 1999; Damarin & Erchick, 2010; Esmonde, 2011; Rubel, 2016). This is important because, traditionally, gender research has focused solely on women (see Ataide Pinheiro, 2021). However, scholars have contended that gender research should also focus on men, the differences found within male/female gaps (Buck et al., 2020), and be expanded to include LGBTQ+ individuals (Ataide Pinheiro, 2022; Scantlebury & Baker, 2007). The inclusion of LGBTQ+ individuals in conversations surrounding STEM equity and gender has led to challenges not only to male-centric science education but also to the heteronormative nature of the field and how it has discouraged LGBTQ+ students from full participation (Ataide Pinheiro, 2022; Savage & Harley, 2009; Scantlebury & Baker, 2007).

Researchers have argued that attending to issues of identity, inclusion, and confidence in one's STEM ability is just as important as accessing high-quality prerequisite math and science courses in P–12 education (Buck et al., 2020). Buck and colleagues made this point by presenting research suggesting women tend to have lower confidence in their math and science abilities even when their academic skills are at the same level as men's. Students who lack confidence, even when successful in college mathematics programs, are more likely to exit STEM fields, particularly once they get to graduate-level programs (Lubienski & Ataide Pinheiro, 2020). Even when women succeed in mathematics and science and are confident in their abilities, this does not always translate to career choice (Buck et al., 2020). Scantlebury and Baker (2007) suggested that masculine stereotyping of science in Western culture is one of the major barriers to participation, especially when compared to non-Western countries. These stereotypes can lead to lower test performance, gender gaps in postsecondary education and beyond, and disidentification (Scantlebury & Baker, 2007). For example, stereotyping STEM fields as *men's fields* can cause women not to see themselves as STEM people and reduce the number of women entering those professions (Buck et al., 2020). This sociocultural exclusion of the STEM fields can start as early as primary and secondary education and persist through collegiate and graduate careers. Therefore, researchers have promoted changing teaching practices to improve students' attitudes and persistence toward STEM education, especially among girls (Buck et al., 2020; Scantlebury & Baker, 2007). Scholars such as Buck et al. (2020) have also stressed that these experiences are not unique to women but also affect members of the LGBTQ+ community, especially where intersecting identities exist.

Finally, one of the contemporary arguments surrounding gender and STEM equity is research on the STEM gender gap and whether this is still a relevant issue (see discussions of the achievement gap in general in Gutiérrez, 2008; Lubienski, 2008). Over the past years, we have seen substantial gains in women's enrollment in postsecondary STEM programs. However, looking closer into the statistics and narratives has shown that women still face challenges in postsecondary programs, particularly in specific disciplines (e.g., physics, engineering, and research-focused careers; see the decline of women receiving bachelor's, master's, and doctoral degrees from the NASEM, 2019). Han (2016) found similar findings across 49 counties in a gender achievement gap. As Lubienski and Ataide Pinheiro (2020) pointed out, some key metrics suggest that progress toward gender equity in mathematics has stalled. Thus, it is important to alert the field that "clearly, there is more work to be done, and mathematics education scholars have a role to play" (Lubienski & Ataide Pinheiro, 2020, p. 10). This is particularly the case because issues facing students of various genders and sexualities are nuanced. There is likely no single cause of performance gaps or lower retention of women and LGBTQ+ individuals in STEM majors and career pathways. Instead, consideration must be paid to the interactions between students' various identities and many other compounding variables.

Socioeconomic Status and Urban Education

So far, this section has addressed debates on STEM equity and education in terms of racial and gender identities. However, we would be remiss not to include discourse surrounding SES and its role surrounding identity and STEM education. Debates covering SES in STEM education have centered around poverty's impact on schoolchildren and their academic success, but many criticisms of these claims deserve exploration. In Richard Rothstein's (2008) article "Whose Problem is Poverty?", he questioned the role of schools, education, and researchers when it comes to issues of poverty. According to Rothstein, many academics, educators, and policymakers consider poverty a non-school issue, citing factors outside the school's control, such as income, health, housing, genetics, and parental involvement. Additionally, some feel that focusing on poverty creates a "blame-the-victim" mentality or excuses that "let schools off the hook." Rothstein passionately denounced those arguments by asserting that ignoring poverty perpetuates racism, contributes to achievement gaps, unfairly burdens schools and teachers, and denies students the educational opportunities they deserve. He called on researchers, educators, and policymakers to address school and non-school problems simultaneously because school reform efforts are not enough if more significant societal and structural issues affecting students (e.g., hunger, violence, and illness) are not accounted for and addressed.

Rothstein's case for the parity of societal and school reform has challenged those who choose to ignore or negate the impact of poverty on education. However, for researchers such as Lubienski (2003) and Battey (2013), their critique is for those who superficially attempt to address issues of poverty within STEM education. For example, Lubienski (2003) challenged the current push in educational research toward focusing only on the positive aspects of diversity. She acknowledged the benefits of moving toward more asset-minded approaches given the historical context of perceived genetic deficits, cultural deficits, and blame-the-victim mentalities that have plagued research on marginalized communities. However, she warned that by only focusing on the positives, researchers risk neglecting the genuine issues that come with systemic poverty.

Meanwhile, Battey (2013) examined how teachers at low-SES schools use relational interactions to enhance and inhibit students' mathematical abilities. In particular, the author found African American and EL (English Learners) students are particularly susceptible to negative relational interactions regardless of the teacher's mathematical knowledge or instructional style (teacher-centered versus student-centered). Battey warned that even when mathematics teachers embraced reformed-based practices such as student-centered learning and critical thinking, microaggressions such as sarcasm, eye-rolling, and focusing on behavior instead of mathematical thinking were still prevalent. Therefore, Battey cautioned that well-meaning educators and researchers might cause unintended harm to low-SES students when their subconscious biases go unchecked.

One final issue to address in this article is how the research community should define SES. Discussion on low SES often involves the inclusion of urban education. According to Calabrese Barton and Tan (2018), this is an alarming trend because while the term *urban* is designed to denote a large density of people in a population cluster, it has been misappropriated to refer to low-SES and REM students. Calabrese Barton and Tan took issue with this stance because it promotes deficit thinking about students from these communities and unfairly homogenizes them, their schools, and their experiences. Instead, they argued for the reframing of urban science education to move from a problem to be fixed to arenas of possibilities.

Access

While identity is crucial for equity in STEM education, even students with strong STEM identities still need access to resources such as qualified STEM teachers and rigorous curricula. While issues of access impact many areas of STEM education, this article will focus mainly on two areas with historically limited availability to students: rural communities and computer science education.

Rural Education in STEM

One of the biggest criticisms of STEM equity in rural education is how little attention it has received (Saw & Agger, 2021). The lack of attention is problematic because rural students experience many challenges, including a lack of resources due to their geographic isolation and decreased access to qualified educators, especially in mathematics and science (Murphy, 2022). Additionally, rural schools struggle to provide advanced coursework in mathematics and science, reliable internet access, and resources to encourage students in STEM fields (Ihrig et al., 2018; Marksbury, 2017; NASEM, 2021). The result of these barriers is that rural students experience reduced confidence and belonging in STEM, ultimately leading them away from postsecondary opportunities in STEM and STEM careers and developing STEM identities (Harris & Hodges, 2018; Oliver & Hodges, 2014).

Harris and Hodges (2018) decried the paucity of rural students pursuing STEM careers. They described the 6.5 million rural students in the US as having vast untapped potential because many of them could fill needed STEM jobs but are unaware of these opportunities due to a lack of exposure and access in their communities. This is because schools in rural and small-town areas are often neglected regarding recruitment and exposure to STEM opportunities (Ihrig et al., 2018). This lack of access in rural communities is not unique to the US. For example, similar issues have been found within rural populations in Australia and China (see Murphy, 2022 and Murphy et al., 2007).

Moreover, although rural environments are a rich context for learning science, rural students' opportunities to engage in their local communities often do not reflect traditional schooling systems in their counties (Saw & Agger, 2021). Therefore, providing access to rural students involves taking a unique approach. For example, in a systematic literature review, Esquibel and Darwin (2023) revealed that recruiting and retaining qualified educators was among the most significant barriers to rural students' obtaining a quality education. However, place-based education is an impactful model for rural students' learning, connecting the ecosystems of school and community through STEM (Adams & Farnsworth, 2020). Unfortunately, such models are not typically emphasized in teacher education programs (Brenner et al., 2021). To adequately prepare teachers for rural settings and therefore provide students access to STEM, communities and universities must restructure and rebuild these partnerships to better serve the unique needs of their rural students (Adams & Farnsworth, 2020; Kaden & Martin, 2020).

Increasing Access in Computer Science

Drawing on Gutiérrez's (2002) definition of equity as "the inability to predict mathematics achievement and participation based solely on student characteristics," the implications of equity are considered in the emerging field of computer science (CS) education. Considering how closely related math and CS education are in K–12 settings, the question of access is equivocal to both domains. For example, one finding from Torbey et al. (2020) showed that students who took Algebra I before high school had more than doubled their odds of enrolling in high school CS courses.

CS education is seen as an opportunity for all students to better understand the technological world in which they live. However, historically these initiatives have primarily focused on computer programming (García-Peñalvo & Mendes, 2018; Kite et al., 2021; Moreno-León et al., 2018), which has not been shown to be a practical approach when introducing new learners to CS concepts (Caeli & Yadav, 2020; Lu & Fletcher, 2009). Therefore, scholars have proposed a shift toward instruction that moves beyond computer programming efforts alone to include an approach centered on diversity, equity, and inclusion of groups that, up to this point, have yet to realize equity in the STEM disciplines. One suggestion is for CS instruction to focus on computational thinking (CT) to teach problem-solving processes throughout K–12 education (Barr & Stephenson, 2011; Grover & Pea, 2013; Lye & Koh, 2014). The intent is that this approach will help CS education reach a broader and more diverse student demographic by making CS coursework more inviting to nontraditional CS students, many of whom have been disengaged from a discipline that depends on their participation to shape a changing world (Google & Gallup, 2016). As noted by Hestness et al. (2018), this proposed shift has already been written into the Next Generation Science Standards and the Common Core Standards. Still, little evidence has been produced that shows CT approaches are being realized outside of CS coursework.

A second consideration within the discourse on increasing CS access is highlighting the roles of teachers and teacher education. Due to a lack of certified CS majors entering teaching, there has been a push to train non-CS educators to increase the availability of CS courses (Tucker et al., 2003). However, questions remain on the most effective approach to preparing teachers with little to no background in CS. This is an important issue because multiple studies have shown considerably low levels of access and discomfort from teachers concerning technology. Specifically, many non-CS educators identify learning new technology and computer programming training as barriers to their understanding of CT (Bower et al., 2017; Israel et al., 2015).

One promising pedagogy emerging for teacher training is CS Unplugged (Bell & Vahrenhold, 2018). Unplugged pedagogies have provided scaffolded inroads for CS and CT concepts for student and teacher training rather than concentrating on a predominately code-centric focus (Kite et al., 2021). In addition, this approach points to scholars who have argued for more intentional efforts to support teachers in other content areas (Grover & Pea, 2018; Sands et al., 2018; Yadav et al., 2014), specifically at the K–8 grade levels (Mouza et al., 2017), who come from non-CS backgrounds. The goal is to shift to a more CT focus and less code-centric approach to increase CS access to students and teachers who have not traditionally been engaged in the CS domain.

Achievement

Achievement gap data has been a staple of information for researchers, educators, and policymakers for decades. The achievement gap refers to discrepancies in measured STEM outcomes (typically standardized exam scores), particularly among White, mid- to high-SES males and other groups. However, current conversations have centered around the usefulness of this data and whether this information is helping to achieve STEM equity or just the opposite.

Closing or Condemning the Achievement Gap

On the one hand, scholars such as Lubienski (2008) have argued that achievement gap data is an important metric to highlight the inequities that exist in STEM education. Decades' worth of achievement gap data has allowed researchers to identify discrepancies in students' STEM performance and move beyond thinking in terms of short-term solutions to identifying long-term structural issues (Ladson-Billings, 2006). However, Lubienski (2008) cautioned that there are technical problems with researchers' current approaches to analyzing achievement score data. For instance, most scholars continue homogenizing and overgeneralizing groups within these data sets. Instead, she advocated for a more nuanced approach involving data disaggregation to capture subtleties among race, ethnicity, gender, SES, and the intersectionality within and between those groups.

On the other hand, Gutiérrez (2008) has challenged researchers, educators, and policymakers conducting achievement gap data research in an article discussing the fetishization of "gap-gazing" research in mathematics education. She cautioned against seeking technical solutions because, ultimately, the variables that have become the more significant focus to researchers (i.e., race, SES, and gender) have little to do with the student's mathematical ability. For Gutiérrez, the focus should be not on gaps but on gains. This focus involves letting students show mastery of their mathematical skills rather than being compared to their White, privileged male peers.

These comparison issues are not just isolated to individuals and can result in more significant sociopolitical implications. For example, South Africa began recognizing the "other" in mathematics by integrating People's Math and ethnomathematics in the 1990s. However, these efforts were neither valued nor continued when external assessments depicted South African schools and students as behind and needing "catching up" with their Western counterparts (le Roux & Swanson, 2021, p. 330).

Our takeaway from debates on research concerning the achievement gap is that this type of research cannot explain what causes the differences in achievement both within the US and internationally. Therefore, this type of research can be dangerous because of the creation of stereotypes and deficit thinking about certain groups regarding underachievement in the STEM disciplines. Moreover, these groups unfortunately, tend to be those that have been historically targeted for oppression.

Discussion and Conclusion

This article aimed to showcase critical discourse between prominent scholars in the field of STEM equity and education through the lens of Gutiérrez's (2007) equity framework. All four dimensions (power, identity, access, and achievement) are necessary to achieve equity, yet there are instances in every dimension where our education system is not fulfilling this framework. Although most scholars referenced in this article are US equity researchers, we believe their research can be extended to international audiences.

Sociopolitically, there still exists resistance toward equity-centered movements, further stripping students of their power in STEM. Through the framework, power is tied to identity (Gutiérrez, 2007); essentially, when students establish a sense of identity in STEM, they can begin to obtain power (i.e., classroom voice). However, this article has highlighted instances where certain groups are not provided the opportunity to establish their identity based on race, gender, or sexuality.

Regarding access, rural students have been historically excluded from STEM opportunities based on their geographical isolation. This is a shame, as the "6.5 million rural students are a wealth of relatively untapped potential for STEM degrees and careers" (Harris & Hodges, 2018, p. 4). Therefore, it is necessary to explore unique approaches best suited to help this population thrive in STEM. Additionally, the emerging fields of CS and CT have highlighted the exclusivity of this field, the necessity of providing access for all, and the challenges of achieving that goal through barriers to obtaining a qualified teaching population.

Finally, achievement data can be a powerful tool for identifying discrepancies within STEM populations. However, such data must be treated with caution lest the nuances within the numbers prevent researchers, educators, and policymakers from recognizing students' STEM abilities outside of homogenized test scores (Gutiérrez, 2002; Lubienski, 2008).

Just as Hazari et al. (2013) described the intersecting identities within students, we believe Gutiérrez's (2007) framework can do the same. Although this article has outlined and segregated topics of STEM education into power, identity, access, and achievement, there are undoubtedly intersections in many of these areas. For example, race, gender, and sexuality have historically hindered students' STEM identity, but these groups have also been excluded from (i.e., denied access to) the STEM fields (Gholson, 2016; Kersey & Voigt, 2021). Along the same lines, rural students have been denied access to quality STEM education and historically left out of policymakers' agendas (i.e., power; Brenner et al., 2021).

The purpose of this article was to bring to light the current debates and topics in STEM education. In order to achieve equity for all students, all actors (i.e., researchers, educators, and policymakers) must be willing to listen and act upon the work of contemporary scholars. In doing so, a system may be produced that no longer predicts students' achievement based on the color of their skin, gender, geographical location, sexuality, or economic status. While many aspects of equity in STEM education are discussed here, this article by no means presents a whole discussion of equity in the STEM education fields. Further studies must continue to examine issues related to disabilities, national origin, immigration status, and culturally relevant teaching of STEM subjects. We believe the more scholars and educators lend their voices to promoting alternative ways of thinking about discussions related to equity in the STEM fields, the more cracks they will make in the dominant discourse, which will consequently pave more just and equitable STEM teaching and learning for all students.

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