Final Paper Submission: Applying Theory to a Current Educational Problem
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Cultural Disconnect In Stem Education

Cultural disconnect in STEM learning is a persistent issue that hampers student engagement, retention, and success, particularly for students from underrepresented and diverse cultural backgrounds. Despite students from minority communities and diverse cultural backgrounds showing an equal interest in science as their peers, achievement disparities continue to be documented globally (Gichuru, 2024). This paper explores systemic barriers to culturally responsive STEM education via three themes symptomatic of the cultural disconnect in STEM:

1. Critical consciousness through Dialogue;
2. Pedagogy: Imposing vs. Transformational; and
3. Culturally Relevant Teacher Professional Development.

The thematic problems will be analyzed using two distinct approaches discussed in class. From this point forward, *CRE Approach* refers to the lens of Liberation and Critical/Culturally Relevant Pedagogy, and *Identity Approach* refers to the lens of Identity and Culture.

THEME 1: CRITICAL CONSCIOUSNESS THROUGH DIALOGUE

Defining the Problem

Cultural disconnect stems from the lack of critical consciousness and dialogue in STEM education, particularly for students from non-dominant cultural backgrounds. Gichuru (2024) highlights that collaborative learning environments that include community perspectives are

essential for bridging cultural gaps in education. However, UNESCO (2022) emphasizes that 40% of the global population lacks access to education in a language they understand, undermining the preservation of traditional knowledge systems. Language, therefore, becomes critical in facilitating meaning-making in STEM classrooms, yet multilingual and cultural diversity is often overlooked (Gichuru, 2024). However, identity plays a key role in shaping students' participation and success in STEM. For students from underrepresented groups, exclusionary expectations and stereotypes about "who can be a STEM person" often erode their identification with STEM disciplines (Cian, 2022). Social recognition, or the lack thereof, influences self-perception, as dominant discourses privilege white, male, middle to upper-class individuals, further marginalizing others (Gee, 2000; Cian, 2022). Insufficient scientific literacy, exacerbated by this disconnect, weakens public engagement with critical issues such as climate change and vaccination, which stifle transdisciplinary problem-solving essential for addressing global challenges (Romano et al., 2021).

Analysing The Problem Theme Through CRE Approach

Freire emphasizes that the oppressed often perceive their powerlessness "fatalistically, as a consequence of personal inadequacy or failure,"—a result of their own inadequacy rather than recognizing systemic inequities that marginalize them (Rugut & Osman, 2013, p. 27). This leads to a class of individuals who are "reconciled to their powerlessness,"(p. 27) unable to articulate their interests or address social conflict. Gichuru (2024) highlights that this lack of articulation in STEM education is due to the exclusion of community perspectives. Freire would see this as a failure to engage learners and communities in a process of dialogue, preventing students from gaining perspectives and questioning dominant cultural narratives and imagining new

possibilities aligned with their own rationality, thereby hindering their ability to connect their lived experiences with the curriculum, reinforcing the cultural gaps in education. Freire also argues that "learning can best be achieved through critical thinking and analysis of one's experiences and feelings."(p. 24) Freire would connect Romano et al.'s (2021) observation that insufficient scientific literacy weakens engagement with global issues to the lack of critical thinking opportunities in education. Without opportunities for critical reflection, students cannot engage in *decodification* of their situation—Freire's process of understanding a situation by identifying with it and critically examining its aspects (Rugut & Osman, 2013). UNESCO (2022) highlights that 40% of the global population lacks education in a language they understand, echoing Delpit's (1993) view that "we do not really see through our eyes or hear through our ears, but through our beliefs."(p. 297) Without culturally relevant linguistic access, students struggle to make meaning, preserve traditional knowledge, and engage in STEM, reinforcing inequities.

Solutions Based On CRE Approach

Freire's (Rugut & Osman, 2013) solution lies in the transformative potential of dialogue, which he defines as "the means by which we achieve significance as human beings."(p. 27) He proposed "culture circles,"—where learners and communities use their own language to share ideas and build a shared understanding of their world. These are non-hierarchal learning groups where all participants engage as equals in "reciprocal kindness"—supporting one another's growth through genuine care. This aligns with Gichuru's (2024) call for collaborative learning environments incorporating community perspectives. Participants discuss "generative themes"—cultural or political topics of great concern—challenge how knowledge is constructed

with discussions rooted in lived experiences. This could bridge the gap between students' lived realities and STEM curricula, fostering critical awareness. Freire's notion of *decodification*—understanding a situation by identifying with it and critically reflecting on its aspects—resonates with Romano et al.'s (2021) concern about insufficient scientific literacy. By connecting STEM concepts to students' lived experiences, decodification empowers learners to engage meaningfully with global challenges like climate change. Also, Ladson-Billing's (1995) advocacy for incorporating students' home languages in education echoes UNESCO's (2022) findings about linguistic barriers, suggesting that culturally relevant language use can enhance understanding and participation in STEM. However, implementing these solutions requires intentional efforts to challenge power dynamics and creating environments where dialogue and reflection can thrive—conditions that need to be actively created and do not occur naturally (Rugut & Osman, 2013).

Analysing The Problem Theme Through Identity Approach

Gee's concept of Discourse Identity (D-Identity) highlights how social narratives and interactions shape identities. D-Identity of a person is built through how they are seen and in turn how they perceive themselves, based on shared ways of thinking, behaving, and communicating. He notes that "nonelites are encouraged to accept inferior identities ascribed to them by elites," framing these identities as personal failings rather than systemic inequities (Gee, 2000). This aligns with Cian's (2022) observation that stereotypes about who can be a "STEM person" alienate underrepresented groups, discouraging them from identifying with these disciplines. In STEM education, institutional structures often validate identities tied to white, male, upper-class norms while ignoring diverse cultural identities and silencing non-dominant voices (Cian, 2022).

This can be seen through Gee's explanation of how identities can be *authorized* by rules of participation, expectations of participation and roles within social hierarchies. Zhang (2013) highlights this issue through the lens of *high-context cultures*—cultures where communication relies on subtle social cues such as body language, relationships and shared context rather than explicit verbalization. STEM education prioritizes low-context, explicit modes of instruction, the cultural norms of high-context groups are overlooked. This disconnect creates barriers to participation for students whose implicit communication styles are misaligned with dominant teaching approaches.

Solutions Based On Identity Approach

Gee's concept of Discourse Identity (D-Identity) emphasizes that identities are built on *interpretive systems*—shared cultural and historical views that influence how people are seen and valued. For marginalized groups in STEM, systemic inequities perpetuate ascribed identities that frame their exclusion as personal failure rather than systemic barriers (Gee, 2000). *Solidarity with other nonelites* allows these groups to redefine and celebrate achieved D-Identities that resist dominant narratives (Gee, 2000). Gee argues that empowering locals through new forms of discourse and dialogue helps create inclusive identities, acknowledging both global influences and local cultural values. For the stereotypes about who can be a "STEM person" (Cian, 2022), Zhang (2013) advocates for educators to integrate diverse cultural ways of discourse to enrich classroom dialogue, emphasizing the value of *collectivist thinking*—where individuals prioritize group harmony, shared goals, and collaboration over personal gain—and *dialectical thinking*, which involves finding balance between opposing ideas, rather than choosing one side, to resolve arguments constructively and collectively. Creating discourse spaces that validate nonelite

perspectives can counteract exclusionary norms in STEM classrooms. However, Zhang (2013) insists that for successful meaningful engagement in STEM, the design of inclusive spaces for dialogue must accommodate and adjust for cultural differences and misalignments.

THEME 2: PEDAGOGY: IMPOSING VS TRANSFORMATIONAL

Defining the Problem

Cultural disconnect arises from imposing Eurocentric knowledge in STEM curricula, alienating minoritized students and disregarding the cultural perspectives they bring to the classroom (Gichuru, 2024). This alienation results from a paradigm clash between Eurocentric ways of knowing and the cultural experiences of Indigenous or minoritized groups (Gichuru, 2024). Schools often perpetuate narrow, fact-based definitions of science, failing to connect culturally and linguistically diverse students' knowledge with STEM content (Boutte et al., 2010). Thevenot (2022) identifies four major barriers hindering Black and Latinx students' success in STEM: knowledge gaps, limited early exposure, unacknowledged funds of knowledge, and a lack of personal connection to the material. These challenges weaken students' academic identity and long-term success. As STEM skill shortages persist, reforming curricula to prioritize culturally relevant approaches is essential for fostering early interest, meaningful engagement, and career readiness in STEM fields (DeCoito, 2024). STEM pedagogy needs to respond to students' lived experiences to transform into an empowering practice.

Analysing The Problem Theme Through CRE Approach

Freire’s critique of traditional education as suffering from *narration sickness* (Freire, 1968) refers to a problem where teachers simply "narrate" facts to students, imposing their beliefs on

them without encouraging any real engagement, dialogue, or critical thinking. In this model, teachers are seen as the only source of knowledge, and students are treated like empty containers that need to be filled with information.When Freire described this concept, he was condemning the *banking model of education*, where teachers deposit fixed knowledge into passive students. This model of pre-prescribed, rigid curricula contradicts Freire's view that the unfinished nature is what makes education uniquely human (Freire, 1968)—as it allows learners to not just develop intellectually but also inspires personal and social change. Freire's philosophy would frame this as a failure to foster *conscientization*—building awareness of one's social reality through critical reflection and action—hindering students from connecting their lived experiences to the curriculum. This disconnect, highlighted by Gichuru (2024) and Thevenot (2022), weakens academic identity and engagement. Ladson-Billings (1995) states that "educators traditionally have attempted to insert culture into the education, instead of inserting education into the culture"(p. 159), critiquing traditional education for imposing culture rather than embedding education within it, echoing Boutte et al.'s (2010) and Thevenot's (2022) point that Eurocentric, fact-based science excludes diverse perspectives, which erode students' academic identity and engagement.

Solutions Based On CRE Approach

Freire's philosophy asserts that "experiences are lived and not transplanted," (Rugut & Osman, 2013, p. 27) emphasizing that education must connect deeply to students' realities rather than imposing external, disconnected knowledge. Freire advocated for *problem-posing education* (Freire, 1968), a method that rejects this static approach to education to instead affirm learners as beings in the *process of becoming*—the idea that students and society are constantly evolving and

capable of transformation (Freire, 1968). Education, therefore, should not merely transfer knowledge but cultivate *praxis* (Freire, 1968), which Freire defined as thoughtful action arising from critical reflection. Through praxis, learners are empowered to critically analyze and change their world. Freire believed education should explore the problems people face as opportunities for change, enabling learners to see society as open to transformation. By centering learning on what is most meaningful to students, problem-posing education aligns closely with the need for culturally relevant teaching (Rugut & Osman, 2013). However, Freire cautions that educators must balance critical engagement with academic rigor, challenging students' understanding rather than merely facilitating (Freire, 1996). Culturally relevant teaching, as Ladson-Billings (1995) notes, must also guide students to chose academic excellence, not just cultural validation by making them "feel good".

Analysing The Problem Theme Through Identity Approach

Gee's Institution-Identity Framework (I-Identity) (Gee, 2000) views identity as either "a calling or an imposition."(p. 103) I-Identity of a person is shaped by their position within formal institutions, such as schools, workplaces, or governments and defined by the rules and hierarchies of the institution. In STEM education, the Eurocentric curricula impose an institutionalized identity on students from minoritized groups, framing their cultural knowledge as irrelevant. This imposition reinforces barriers like those Thevenot (2022) identifies, such as unacknowledged funds of knowledge and limited personal connection to the material, alienating students and weakening their academic identities. Gee argues that such imposed identities marginalize non-dominant students by disregarding their lived experiences and cultural contributions, sustaining systemic inequities. The framework of Power Distance (Zhang, 2013)

reveals how cultural values shape perceptions of authority and learning. By *high power-distance cultures*, he refers to Asian societies where people accept and expect that power and authority are distributed unequally. Zhang (2013) notes that co-constructed cultural schema—shared values and practices within a group that shape collective thinking and behaviors—make students less likely to question educators or engage in exploratory learning. When STEM pedagogy perpetuates narrow, fact-based approaches, as Boutte et al. (2010) critique, it disregards these cultural dimensions and fails to adapt to "culture-specific conditions,"(Zhang, 2013, p.3) alienating students further and deepening the cultural disconnect.

Solutions Based On Identity Approach

Gee's Institution-Identity Framework (I-Identity) (Gee, 2000) suggests addressing STEM's cultural disconnect by challenging the imposed Eurocentric identities as described by Gichuru (2024), that marginalize students' cultural knowledge. A solution rooted in this framework involves creating spaces where students' cultural knowledge is validated and integrated into STEM pedagogy, allowing them to co-construct academic identities that reflect their unique contributions and experiences. Zhang's concepts of "transformative learning" and "context-specific challenges" (Zhang, 2013) further highlight the importance of adapting STEM education to diverse cultural norms and values. Transformative learning, which encourages reflection on personal identity through collaborative engagement, can help students connect their cultural schema with STEM practices. By designing pedagogy that incorporates students' shared cultural experiences and acknowledges power-distance dynamics, educators can foster a more inclusive learning environment. For example, collaborative activities emphasizing relationship-building over direct argumentation can align better with students from high

power-distance cultures, encouraging participation without conflict. This approach aligns with Boutte et al.'s (2010) critique of narrow, fact-based science that excludes diverse perspectives. However, implementing these solutions requires educators to navigate cultural misalignments due to resistance to non-traditional methods (Zhang, 2013), highlighting the need for culturally sensitive approaches in STEM reform.

THEME 3: CULTURALLY RELEVANT TEACHER PROFESSIONAL DEVELOPMENT

Defining the Problem

Despite the potential of culturally relevant education (CRE) to address inequities in STEM education, its adoption in teacher professional development remains limited. Research often overlooks the role of cultural relevance and social justice goals in STEM teacher education, which perpetuates biases and stereotypes that negatively affect underrepresented groups (Gichuru, 2024). Teachers themselves often hold implicit biases that shape their attitudes toward students and their own roles in STEM education. These biases, reinforced through stereotypes and microaggressions, contribute to inequitable outcomes for marginalized communities (Gichuru, 2024). Boutte et al. (2010) note that STEM teachers frequently misperceive CRE as only relevant for humanities subjects, neglecting its applicability to the "hard sciences." Additionally, reform efforts often sideline teacher agency, overlooking the importance of sustained, context-specific professional development that equips educators to enact culturally responsive practices (DeCoito, 2024). Effective professional development must address these biases, reframe teachers' perceptions of STEM, and provide tools for integrating CRE into STEM classrooms to cultivate equitable, inclusive learning environments.

Analysing The Problem Theme Through CRE Approach

Freire's 'Easter Experience' framework (Rugut & Osman, 2013) critiques the lack of self-reflection in teacher professional development. According to Freire (1968), educators must re-examine themselves constantly and they cannot remain as they were to authentically commit to their students. Without this ongoing transformation, as suggested by Gichuru (2024), implicit biases and stereotypes persist, negatively shaping teachers' roles and student outcomes. Freire's assertion that "teacher's thinking is authenticated only by the authenticity of the student's thinking" (Freire, 1968, p. 63) is reinforced by Delpit's claim that "to deny students their own expert knowledge is to disempower them" (Delpit, 1993, p. 288) in highlighting the inadequacy of professional development programs that fail to equip teachers to genuinely engage with and value the lived experiences and cultural perspectives of marginalized students. In the banking model of teaching (Freire, 1968), teachers "regulate the way the world enters into the students," reducing STEM education to mechanical knowledge deposits that dismiss students' cultural contributions. Boutte et al.'s (2010) observation that STEM teachers misperceive culturally relevant education (CRE) as unsuitable for hard sciences exemplifies this disconnect, reinforcing a curriculum that alienates underrepresented groups. As DeCoito (2024) notes, neglecting culturally relevant teacher development undervalues marginalized students' cultural knowledge and potential. For this, Ladson-Billings' (1995) suggests the criteria of *cultural competence*—the ability to value students' cultural identities while leveraging them for academic success. She demands that teachers "utilize students' culture as a vehicle for learning."(p. 161)—incorporate students' cultural experiences to enhance learning.

Solutions Based On CRE Approach

Freire's suggests the concept of "mutual humanization" (Freire, 1968)—the process of reciprocal growth where teachers and students transform together. According to Freire teaching demands continued personal reflection and an authentic engagement with students to foster genuine learning relationships. For Freire, teaching is a noble profession, which requires a transformative commitment to students' lived realities, countering the banking model of teaching (Freire, 1968). Ladson-Billings (1995) reinforces this by highlighting teaching as a way to give back to the community and "artistry"—the idea that teaching is a creative and dynamic process. Freire's critique of the banking model aligns with Ladson-Billings' insistence on the fluidity of teacher-student relationships. Teachers who view education as artistry challenge rigid frameworks, engaging students in collaborative critique, such as examining outdated textbooks or incorporating counter-knowledge to offer diverse perspectives. This approach directly counters the mechanical knowledge deposits of the banking model and addresses Boutte et al.'s (2010) concern that STEM teachers overlook culturally relevant practices. However, Ladson-Billings(1995) notes implementing these solutions may require systemic changes beyond teacher professional development arising from conflict with rigid curricula and standardized practices, which discourage creative teaching.

Analysing The Problem Theme Through Identity Approach

Gee's Framework of Affinity-Identity (Gee, 2000) emphasizes that identities are formed through participation in an *affinity group*—a collective defined by shared practices and values rather than institutions or natural traits. In the context of culturally relevant education (CRE) in teacher professional development, the lack of an affinity group advocating for CRE perpetuates

biases and stereotypes, as Gichuru (2024) notes. Teachers who are not part of such a group remain disconnected from practices that recognize and incorporate the cultural knowledge of underrepresented students. Similarly Machalow et al. (2022) highlight that pre-service teachers' *narrative arcs*—their evolving professional stories—and their *mathematical orientations*—how they understand and approach mathematics—significantly influence their teaching identities. Lacking exposure to culturally relevant training, these narratives or orientations may align with dominant norms, reinforcing systemic inequities. When CRE is mistakenly perceived as applicable only to humanities, as Boutte et al. (2010) note, disconnecting STEM educators from creating their own affinity groups for CRE. Zhang (2013) critiques traditional educational beliefs that hinder transformation, describing how deeply ingrained norms prevent educators from seeing new possibilities. These beliefs, reinforced by institutional biases, align with Gichuru's (2024) observation of how stereotypes and microaggressions shape teachers' attitudes and roles. This resistance to change is compounded by reform efforts that overlook teacher agency and fail to provide sustained, culturally responsive professional development (DeCoito, 2024). Zhang's assertion that transformative change requires addressing "context-specific challenges" underscores how the neglect of cultural relevance limits professional growth and reinforces systemic inequities in STEM education.

Solutions Based On Identity Approach

Zhang's *principle-based approach* (Zhang, 2013) to classroom innovation emphasizes the need for educators to transform their cultural beliefs and practices by adopting core educational principles that guide adaptive decision-making. This approach encourages teachers to engage in "reflective interpretation"—critically examining their practices to adapt them to students' needs

and contexts, deepening pedagogical understanding. Machalow et al. (2022) encourage a *relational understanding* of mathematics—where concepts are connected rather than taught as isolated procedures. Approaching STEM subjects through the lens of "knowing what to do and why"(p. 7), can open avenues for integrating cultural perspectives through dialogue and collaboration, rather than rigid instruction. Zhang emphasizes the need for teachers to reflect on and refine their pedagogy while experimenting with classroom strategies. This underscores the need for educators to challenge biases and embrace CRE as applicable to STEM education, addressing the disconnect outlined by Boutte et al. (2010) and Gichuru (2024). Additionally, Zhang highlights the importance of a *coherence systems perspective*, which recognizes that teaching occurs within a "complex system"— a system requiring "progressive problem solving to develop coherent solutions to interrelated problems."(p. 17) Simply put, Zhang emphasizes that teaching happens within a complex system where solving interconnected challenges requires ongoing problem-solving. This perspective aligns with the systemic challenges identified by DeCoito (2024), emphasizing that sustainable professional development must address constraints such as institutional biases and limited teacher agency.

CONCLUSION

Freire (1968) sees education as a collective, deeply cultural phenomenon. However, it's crucial to recognize that not all cultures hold equal footing. It will serve us well to remember Lisa Delpit's (1993) assertion that "good liberal intentions are not enough"(p. 296) to bridge the cultural divide in STEM.

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