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Understanding the Barriers of Culturally Relevant, Responsive, and Equity-Centered Teaching in STEM Higher Education: Faculty Insights from the Literature

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ABSTRACT

Our review examined the literature on faculty perceptions related to implementing CRP in STEM higher education. Following PRISMA guidelines, we synthesized studies from multiple disciplines to identify the trends in faculty perspectives on barriers to adopting CRP. The findings revealed: 1) limited understanding and practical constraints in applying CRP, and 2) resistance to CRP from students, colleagues, and institutional structures, as the broad classifications of the challenges faculty face with CRP. We also discussed the implications for overcoming the barriers. The implications highlight the need for comprehensive professional development, institutional support, and a shift in disciplinary norms to foster inclusive and equitable STEM education. This work provides insights into creating more culturally responsive learning environments in STEM higher education.

Keywords: CRP, Culturally Relevant Pedagogy, Curricular, Faculty, Higher education, Professional development, STEM

INTRODUCTION

Throughout this paper, we primarily used the term Culturally Relevant Pedagogy (CRP), conceptualized by Gloria Ladson-Billings (Ladson-Billings, 1995), emphasizing three interconnected tenets: academic success, cultural competence, and sociopolitical consciousness. The literature includes related frameworks such as Culturally Centered Pedagogy (Sheets, 1995), Culturally Relevant Education (Aronson & Laughter, 2016); Culturally Relevant Teaching (Ladson-Billings, 1992); Culturally Responsive Pedagogy (Villegas, 1991); Culturally Responsive Teaching (Gay, 2002); Culturally Sensitive Pedagogy (McGee Banks & Banks, 1995) and Culturally Sustaining Pedagogy (Paris, 2012); this is not an exhaustive list. We acknowledge that these terms are often used interchangeably or in complementary ways. However, each has its distinct theoretical lineage and pedagogical focus. For clarity and consistency, this paper adopts the abbreviation “CRP” to refer to its central framework of analysis, while also drawing on insights from the broader family of culturally grounded pedagogies when relevant. Readers should interpret references to CRP with this broader context in mind, recognizing that institutional and disciplinary usage may vary across the literature.

College and university student diversity continues to increase, while the corresponding diversity in faculty is not keeping pace (Heitner & Jennings, 2016; Mattingly, 2024). CRP has emerged as a promising approach to address this disparity by aligning teaching practices with the cultural backgrounds of diverse student populations (Gay, 2018; Ladson-Billings, 1995; Villegas & Lucas, 2007). CRP can bridge cultural divides between students and faculty. In the context of STEM higher education in the United States, some studies have sought to reveal the pedagogical factors that influence how faculty teach and engage with their culturally and ethnically diverse students (Ortiz-Rodríguez et al., 2021; Winstead et al., 2022). Furthermore, there are only a few existing studies that have investigated existing challenges in adopting CRP from the perspectives of STEM faculty (Xie & Ferguson, 2024). The objective of this literature synthesis is to highlight what factors influence STEM faculty implementation of CRP in higher education settings. “By ‘factors’, we refer to a broad set of challenges that not only hinder implementation but also carry implications for how they might be addressed”. In exploring this topic from the viewpoints of faculty, this review hopes to contribute to a body of knowledge that informs current knowledge on efforts to develop a safe and cross-cultural collaborative CRP learning environment in STEM higher education.

LITERATURE REVIEW

A crucial component of CRP is recognizing students’ varied cultural identities, creating space for those identities to be expressed, and finding meaning in the

course content and learning environment (Heitner & Jennings, 2016; Sealey-Ruiz, 2007). Another way to view CRP is as a pedagogy of opposition focused on collective empowerment, and there are three tenets of CRP: “(1) students must achieve academic success, (2) students must be culturally competent, and (3) students must develop a critical consciousness to challenge society’s status quo” (Ladson-Billings, 1995). CRP can also be seen “as practices that use students’ cultures as ‘conduits for teaching’ to drive academic engagement and success” (p. 106) (Gay, 2002). This emphasizes the importance of incorporating students’ cultural references in their learning. Gay (2002) suggests that for faculty to effectively instruct diverse students, they must develop a knowledge base on cultural diversity, design culturally relevant curricula, foster a compassionate learning environment, hone their cross-cultural communication skills, and be flexible enough to modify their lessons to fit the learning styles of diverse students (Gay, 2002). The goal of CRP is to develop educational environments that embrace the customs, values, and behaviors of students of color, have belief in them, and challenge them to reach their full potential (Brown-Jeffy & Cooper, 2011). Research shows that when concepts are couched in contexts that are alien to students’ lived experiences (an instructional decision influenced by cultural values), the students’ resources are strained and are diverted away from learning the concepts. Learning the unfamiliar often results in underperformance (Song & Bruning, 2016). Research also shows that students from racially, ethnically, culturally, and linguistically diverse backgrounds perform better academically when provided with culturally relevant examples. These effects were shown for Native Hawaiians (Boggs et al., 1985; Tharp & Gallimore, 1991); for African Americans (Foster, 1995; Moses & Cobb, 2002); for Latinos and limited English speakers (García, 1999); and for Alaska Natives (Lipka et al., 1998). In addition, many of the culturally responsive strategies used by innovative educators to create cultural matches, intersections, or bridges between curriculum, teaching methods, and student learning styles have been validated by researchers (Krasnoff, 2016).

STEM— an acronym for Science, Technology, Engineering, and Mathematics — refers to a collective set of academic disciplines that are essential for innovation, economic competitiveness, and technological advancement. In the context of higher education, STEM disciplines are viewed not only as critical for national development but also as essential to preparing students for a dynamic global economy (National Science Board, 2022). STEM emphasizes analytical reasoning, problem-solving, and quantitative skills, and they are often prioritized for research funding and workforce development initiatives. By engaging students in experiential learning, STEM aims to develop a workforce capable of addressing global challenges and advancing economic growth (National Science Board, 2022). For STEM higher education, this entails creating learning environments where students do not experience conflict between their lives as a science student and other parts of their identities. It provides opportunities to critically examine

how the culture of science benefits some students while being a disadvantage to others (Johnson & Elliott, 2020). This approach challenges the traditional notion of STEM as culturally neutral and advocates for a more inclusive curriculum that reflects diverse perspectives (Gay, 2002). CRP is an inclusive teaching strategy. Education research indicates that implementing more inclusive teaching methods is one way STEM areas can increase and retain student diversity (Dewsbury & Brame, 2019; Tanner, 2013). While CRP addresses the learning demands of diverse populations, research has primarily been focused on K-12 education; its application in higher education, particularly in STEM disciplines, remains underexplored (Han et al., 2014).

In STEM higher education, instructional methods are especially critical due to the perceived rigor and complexity of its disciplines. In this regard, CRP has proven to be an invaluable approach for enhancing student engagement, comprehension, and persistence, particularly among ethnic minority students (Pickering et al., 2023; Xie & Ferguson, 2024). CRP-based instruction helps students connect abstract STEM concepts to real-world cultural and community contexts, hence deepening students' understanding and motivation (Xie & Ferguson, 2024). For instance, Young et al. (2018) make a case and provide evidence that rap song lyrics or lyrical concept mapping can serve as a viable pedagogical substitute for concept maps in the context of reinforcing STEM vocabulary. Hip-hop pedagogy is a culturally responsive approach that makes use of the funds of knowledge derived from hip-hop culture (Young et al., 2018). These authors' work focused on the use of hip-hop pedagogy to affirm and empower dually marginalized students. They contended that while hip-hop pedagogy is well-established in the science content area, it is still underdeveloped in mathematics education. They also pointed out that the lyrical structure of a rap song is fundamentally similar to that of a concept map and offers a framework to support lyrical concept mapping as a culturally responsive instructional tool that can be used as an alternative to traditional concept mapping (Young et al., 2018). Recently, Haywood (2025) studied the impacts of using hip-hop as a culturally relevant instructional concept in a PSYC 1101 "Introduction to Psychology" course on students' academic achievement, engagement, and class attendance. To compare any significant differences between two courses taught at an HBCU in Georgia that incorporated hip-hop pedagogy with two courses that did not, the study employed descriptive statistics. Overall, the study's findings indicated that students who took a course that incorporated hip-hop pedagogy had better final grades, attended class more frequently, and were more engaged than those who did not. It showed that using hip-hop pedagogy is associated with better academic achievement, attendance, and student engagement in the course (Haywood, 2025). A National Research Council (2012) evaluation of discipline-based education found that evidence-based instructional methodologies surpass traditional lectures in terms of enhancing conceptual knowledge and attitudes

about learning STEM (National Research Council, 2012). One such evidence-based instructional method is CRP.

Research Questions

From the selected papers, we extracted information relevant to addressing our research questions:

- According to STEM faculty, what challenges hinder the implementation of CRP in higher education?
- What are the implications of these challenges?

RESEARCH METHOD

Literature Review Protocol

The current study was designed in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 recommendations, whereby we justified any significant restrictions to study eligibility (Page et al., 2021). Following the initial identification of publications and removal of duplicate records, we proceeded with a multi-step procedure that comprised three sequential eligibility phases tailored to research design and reporting, as well as an initial screening centered on relevance and study setting. Figure 1 shows our PRISMA-compliant flow diagram, showing the visual representation of the studies in our analysis.

Search Strategy

To direct our database searches, the eligibility criteria and the search query were defined during laboratory meetings. We specifically chose to search the Education Resources Information Center (ERIC), Web of Science, and Google Scholar's electronic databases. To find any additional studies that met the inclusion requirements, we also looked through the papers' reference lists. Notably, in an effort to include all of the CRP STEM higher education publications in the literature within the scope of our study, we did not establish any publication year criteria. Because CRP-related terminology is so broad, we searched for terms using the connectors "AND" and "OR" that combined concepts and search terms. Appendix A contains a comprehensive list of all the search word combinations associated with CRP, faculty, perceptions, barriers, higher education, and STEM disciplines. As our study's focus was on CRP in U.S. higher education, we only included studies carried out in the United States. This allowed us to assess faculty perceptions of CRP practices from the standpoint of the country's sociocultural, racial, and geographic landscape. Additionally, our search was not limited to journal articles or empirical studies alone. We included journal articles, conference papers, institutional research reports, book chapters, theses, and dissertations within our search parameters. We excluded any studies identified as retracted.

As higher education contexts vary substantially, the evaluation only included studies that examined CRP at the postsecondary education level. Many noteworthy studies that surveyed undergraduates about their work as preservice teachers were found in the search and included. After identifying the studies, we removed duplicate records using Zotero reference management software. We reviewed all records (title/abstract) during this initial screening, even though some of the eligibility criteria were automatically filtered using search filters (such as English, studies conducted in the United States, etc.). A subsample of 10% of the eligible records was independently examined by two reviewers, who compared their inclusion/exclusion decisions and determined 86% reliability before moving on to the remaining records. Reviewers used Zotero's organizing tools, such as shared libraries, folders, subfolders, and color-coded tags indicating study inclusion or exclusion, during the selection and data collection phases. The primary reviewer would consult with his coauthor, a more senior researcher with experience in systematic reviews, if he were unsure whether a study satisfied the inclusion criteria. This process would continue until the authors agreed to use the predetermined eligibility criteria. In their weekly meetings, the authors also kept an eye out for rater drift by applying criteria separately and cross-referencing with randomly selected studies from the dataset.

Eligibility Criteria

The literature on CRP is voluminous, and we therefore applied strict criteria to our search to ensure that the review was both relevant and feasible. The eligibility criteria were:

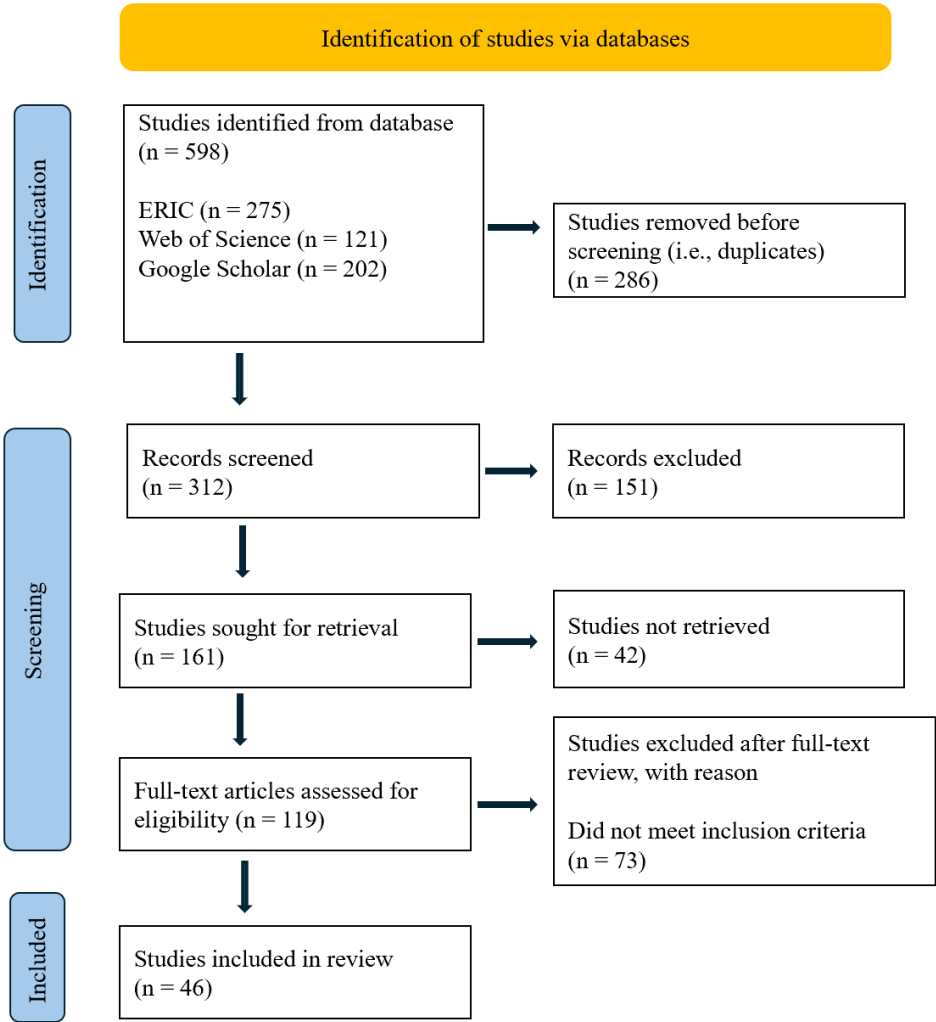
1. Only publications with participants in science, technology, engineering, and mathematics (STEM) fields at universities (undergraduate, master's, and doctoral programs) were included.
2. Only publications produced by our stipulated search term combinations were included.
3. Only English publications were included.
4. Only publications carried out in the United States were included.

Study Selection

Our most recent database search for records was conducted in May 2025. The initial search yielded 275 articles from ERIC, 121 from Web of Science, and 202 from Google Scholar. After removing duplicates, we reviewed a total of 312 articles. Of these, 151 were excluded for either not being relevant to the review scope or because they were written in languages other than English. Following this screening, 161 articles remained. Out of this number, 119 articles could be assessed, and their full texts were reviewed for eligibility. Ultimately, 46 articles met all the inclusion criteria for this review (see Figure 1 for a detailed description of the paper selection process).

Figure 1

PRISMA 2020 flow diagram



The 73 excluded articles either did not directly address the main purpose of the review or did not meet any of the inclusion criteria. To address the first research question regarding the challenges hindering the implementation of CRP in higher education, we conducted a qualitative analysis of the 46 selected articles. The second aim of this systematic review was to narratively describe the implications of these challenges; this information was also extracted from the selected studies.

The Boolean term “OR” separated the search terms within each column. The Boolean term “AND” connected the search terms across columns.

RESULTS AND DISCUSSION

Barriers to Culturally Relevant, Responsive, and Equitable Pedagogies

Faculty are frequently at the forefront of efforts to apply CRP even as higher education institutions work to promote equity and inclusion in STEM. A body of research shows that CRP approaches have the potential to increase student engagement and achievement for students from historically underrepresented groups (Gay, 2018; Ladson-Billings, 1995; Paris & Alim, 2017). It is still vital to investigate the challenges that faculty face when implementing these pedagogies, especially when it comes to STEM higher education. The perspectives of STEM faculty about the challenges they encounter in implementing CRP frameworks are the focus of our work. We determined through this review that the ability of faculty to use CRP is impacted by a complex interaction of professional, institutional, and sociocultural factors as they manage the demands of teaching in culturally diverse environments. To advance equity in STEM education and make sure that reform initiatives are both long-lasting and sensitive to the realities of faculty work, it is imperative to comprehend these factors. The barriers discussed here reflect recurring themes in the research literature and represent ongoing tensions in the movement toward more justice-centered pedagogical practices in STEM higher education. By centering faculty perspectives, we aim to contribute to a more nuanced understanding of the institutional and instructional challenges that shape the implementation of CRP in STEM. This section of the paper is focused on the two barriers to implementing CRP in STEM college courses, from faculty perspectives: 1) Limited Understanding and Practical Constraints in Applying CRP, and 2) Resistance to CRP from Students, Colleagues, and Institutional Structures.

Limited Understanding and Practical Constraints in Applying CRP

Studies indicate that STEM faculty often have limited awareness or understanding of CRP principles (Baldwin, 2015; Franco et al., 2024; Mattingly, 2024). Although the idea of incorporating CRP into the teaching process for STEM is becoming more widely accepted, many faculty feel ill-equipped or unsure of how to move forward with it; even those who have had experience implementing more diverse instructional practices feel like they still have a lot to learn (Baldwin, 2015; Jenkins & Alfred, 2018; Taylor, 2013). STEM faculty often indicate that they need guidance and resources to incorporate culturally relevant content in their courses (Xie & Ferguson, 2024). During their doctoral studies, STEM faculty frequently receive little pedagogical training, and when they do, equity-oriented approaches like CRP are rarely included (Lund & Stains, 2015). Because of this, a lot of faculty are either unaware of CRP or uncertain about how to use its concepts

in lecture-based or laboratory settings. There is often little or no departmental/institutional support for CRP. This translates to a lack of investment in professional development. Professional development programs play a crucial role in equipping faculty with the skills and knowledge necessary for teaching with CRP (Ralston et al., 2025; Williams et al., 2021). Without adequate training and resources, faculty may feel ill-equipped to modify their teaching practices (Williams et al., 2021). This is evidently needed, given faculty statements about CRP from the Mattingly (2024) study:

“So if we want 100%, I think we [full-time faculty] have to put it in there....freshening and refreshing things more consistently or once a year, at least. I mean, it would be more work to stay more current on things, but it’s possible. When you go from course development, we assume that’s full-time faculty, chairs, and so forth [creating curriculum]; when we look at teaching and facilitating, we’d have to look at how are we providing training to adjuncts to make sure they’re doing some of these components, or have an awareness of these components?” (Mattingly, 2024)

“But there was really no metric. It was just conversation. And I said at times, I felt sorry for the other instructors. Because how do you define it? That’s why I said operationalizing it would really help everyone, because there’s no way to determine whether it’s successful or not, whether we’re meeting that particular need of the students.” (Mattingly, 2024)

In a study on faculty perspectives on CRP by Xie & Ferguson (2024), some participants reported that it takes longer to understand students’ learning needs in STEM courses, making changes in such courses more difficult. Time was also mentioned as a constraint. In the same study, a participant expressed how difficult it was to incorporate culturally related stories in STEM courses than in other liberal arts courses. A specific case was made for chemistry courses compared to social science courses, implying that CRP does not naturally fit with science courses. This notion is found in the excerpts below:

“I feel like the biggest challenge is content. Like the Chemistry faculty ... there’s not a lot of leeway to ...introduce other things [that improve cultural relevance in the course] if you’re in poly sci [political science] and sociology or psychology ... I think these other things are a little easier ... for me, you know I want to stay in my syllabus and get things across to them” (Xie & Ferguson, 2024)

In a faculty learning community, someone said,

“I have all of these ideas for how I want to improve this course, and there just is not enough time in the day for me to even begin on that because of the workload.”(Xie & Ferguson, 2024)

STEM disciplines often uphold epistemological beliefs that value objectivity and universality, which can conflict with the principles of CRP (Shultz et al., 2022). There is a conception about the nature of science and the nature of

scientific knowledge as one that cannot be altered or reconstructed, and is devoid of subjectivity (Mathis et al., 2023; Stefanidou & Skordoulis, 2014). This is further exacerbated by the widely held beliefs that STEM content does not fit with topics relating to diversity and culture; this seems to be an obstacle that prevents some STEM faculty from enhancing the cultural relevance of STEM to students of diverse backgrounds.

“To me, mathematics has no color. Maybe that’s debated, but you look at something like the ocean and the color currents in it. And you know that those are all governed by mathematics. And many forces. And that’s just nothing about ethnicity in it. It’s bigger than that.” (Shultz et al., 2022)

Hence, many perceive STEM disciplines as objective and culture-free, leading to a reluctance to adopt culturally responsive teaching methods (Mathis et al., 2023). This view of STEM courses as having rigid curricula, the perceived deficit of technical know-how about CRP, coupled with the barrier of considering the factors related to the courses, such as course content and enrollment size, presents a challenge (Brooks & Grady, 2022). These structural factors often discourage faculty from experimenting with CRP approaches.

Resistance to CRP from Students, Colleagues, and Institutional Structures

In adopting CRP, one issue that colleges and universities face is having faculty and leadership who primarily identify with the majority culture (Ash & Schreiner, 2018; Heitner & Jennings, 2016; Hunt & Oyarzun, 2020; Mattingly, 2024).

The department structure and/or leadership in certain universities and colleges may pose barriers and limit the flexibility of instructors to modify their STEM courses, which is particularly common in introductory STEM courses (Xie & Ferguson, 2024). We see this in the excerpt in Xie & Ferguson’s (2024) paper below:

“For a lot of courses (in my department), there’s not a choice of textbooks; it’s decided by the department, and the syllabus can be decided by the department, and so there’s not a lot of opportunity ... [for individual instructors to] work on that. ...I’ve certainly engaged. I’ve become the kind of leader at the departmental level who committed this, trying to make departmental-level changes.” (Xie & Ferguson, 2024)

Some have reported that their departments are not unified on the role of CRP in instruction. Also, tensions with colleagues on CRP have reportedly made some faculty feel lonely and unsupported, as they were often “the only one” teaching using CRP in their department (Han et al., 2014). Though the resistance from faculty colleagues appeared to be subliminal most of the time, a lack of coherence could impact the fervor of their work because faculty often desire a stronger sense of unity to adopt CRP, especially at the institutional level. Many perceive STEM as apolitical and fear that integrating cultural content could

compromise academic rigor or lead to accusations of politicizing the classroom. Some faculty oppose the concept of CRP, either because they believe it would compromise academic standards, are skeptical about its relevance to higher education, or because of their unwillingness to critically consider their position in a society that includes marginalized people (Lucey & White, 2017; Shultz et al., 2022). See excerpts from these studies:

“You want to stop racism, stop talking about it. [...] People talk about [race] all the time; they’re used to it, and it hurts people. When I teach a student, I don’t care what their color is or what their gender is; none of that matters.” (Shultz et al., 2022)

“I am the instructor, but I’ve situated myself as an equal and a facilitator, so I still struggle with giving or withholding points as this process feels philosophically incompatible with my role.” (Lucey & White, 2017)

There are significant pieces of data that show that faculty faced resistance from their students and their colleagues in implementing CRP (Adams & Glass, 2018; Baldwin, 2015; Han et al., 2014; Hodson, 2004; Jett, 2013; Lucey & White, 2017; McComas & Burgin, 2020). In his paper, Jett (2013) conveyed that some students believed his CRP teaching practices and perspectives of mathematics education might be relegated to what is discussed in a mathematics methods or cultural diversity course (Jett, 2013). The resistance from students stems from those who felt that the assignments were “too political” (p. 302). This was reflected in the course evaluation feedback he received from a student:

“Don’t focus on race; focus on math.” (Jett, 2013)

Similarly, Adams & Glass (2018) reported similar concerns with CRP related to faculty evaluations:

“Last year, I did a multi-week unit of study on African American language, and an expert came to lead a workshop with them. It was hostilely received. I am trying to find that fine line between being untenured, needing to have good evaluations, and also wanting to push my students. This was not a topic they digested very well, so I backed down a little bit this semester. It is not a place I want to stay, but it is the place I am in right now, so we did a general overview of language and language discrimination.” (Adams & Glass, 2018)

Hence, while some faculty may desire to enrich students’ experiences in their classrooms, they tend to also be mindful of the possibility of students and other faculty showing their resistance to CRP in evaluations. This affects the willingness to implement CRP in course design and generally to engage in CRP-related work in their classrooms.

IMPLICATIONS

Two barriers are identified in this paper’s analysis of CRP implementation in STEM contexts in higher education from the perspectives of faculty.

The challenges highlighted in this review have important implications for faculty professional development, research, policy, and institutional transformation. In the paragraphs that follow, we explicitly connect and pair these implications to the barriers in an attempt to address them.

Barrier 1: Limited Understanding and Practical Constraints in Applying CRP

The actionable strategies discussed in the literature for overcoming this barrier are:

- a) Faculty Professional Development and Support, and
- b) Curriculum Design and Pedagogical Innovation

a) Faculty Professional Development and Support

The importance of purposeful and ongoing faculty development programs is among the study's most significant implications. In a study that found lack of training, time, incentives, and tensions with professional identity as barriers to CRP implementation, the same research demonstrated that participating in structured professional development produced statistically significant positive gains in culturally responsive teaching self-efficacy for university engineering faculty members (Ralston et al., 2025).

STEM faculty's poor comprehension of CRP points to a lack of exposure to pedagogical methods that deviate from objectivist, content-driven paradigms. Faculty professional development programs must be tailored to address these disciplinary beliefs to facilitate the integration of CRP (Mack & Winter, 2015; Williams et al., 2021). Challenging these norms requires a paradigm shift that acknowledges the role of culture in shaping scientific knowledge and practice (Gay, 2002). Professional development programs should be created to close this gap by: (a) introducing faculty to the theoretical underpinnings of CRP, (b) providing specific, discipline-specific examples of CRP in action, and (c) creating spaces for critical reflection on instructors' own positionalities and classroom practices (Gay, 2018; Paris & Alim, 2017).

The Transforming Institutional Drivers for Excellence in STEM (TIDES) project has demonstrated success in enhancing faculty competence in culturally responsive teaching at several colleges in the United States (Mack & Winter, 2015). Although the most significant changes were planned for curricular changes, the TIDES project team anticipated that faculty professional development would, in turn, have an impact on students at all levels. Proceeding in parallel with curricular changes were a number of faculty professional development initiatives related to pedagogy. In these initiatives, amongst other things, faculty were exposed to the distinction between "cultural competence" and "culturally responsive teaching." The former implies a one-time or permanent fix, whereas the latter more accurately suggests an ongoing response to the cultural backgrounds

and experiences of one's students. In addition, all faculty participants were sponsored to travel and attend a professional conference outside their school that was entirely concerned with teaching and learning, as opposed to a conference that was primarily related to their research. It was an eye-opening experience in the very best way, for the faculty took away ideas related to pedagogy and curricular changes that they could apply to their own classrooms and their own teaching to promote student success. More specifically, the TIDES project at the University of Dayton (UD) achieved its objectives concerning (i) overcoming barriers to student interest and persistence in computer science, especially among underrepresented students, (ii) monitoring, assessing, and disseminating outcomes from project implementation, and (iii) institutionalizing and scaling project initiatives to other disciplines. By the end of the grant period, the authors report that faculty felt much more comfortable engaging with the idea of cultural responsiveness, and they reported having made changes in their teaching practices in order to engage students from all backgrounds (Speed et al., 2019).

Generally, instructors who have taken part in CRP professional development and training tend to report feeling more sensitive to the cultural backgrounds of their students and being prepared to modify their teaching methods accordingly (Bottiani et al., 2018; Mack & Winter, 2015). Models such as the "Inclusive Excellence Workshop" have recorded successes. These culturally responsive immersion teaching workshops for university faculty members from departmental divisions of life sciences and physical sciences involve interventions that raise awareness of student and instructor social identities and explore barriers to learning, such as implicit bias, microaggressions, stereotype threat, and fixed mindset. These workshops, among other things, help faculty become more knowledgeable about CRP teaching practices and social identities, and, in turn, become more aware of their own and students' social identities, hence supporting faculty in overcoming such barriers in STEM classrooms (O'Leary et al., 2020).

Furthermore, mentorship programs should be created in which CRP-experienced faculty members assist others with implementation by offering models of success and troubleshooting challenges. For instance, Culturally Aware Mentoring (CAM), a program of the National Research Mentoring Network (NRMN), targets faculty and administrators (Womack et al., 2020). This program demonstrated the lasting influences of CAM on faculty participants' awareness of cultural differences. It also helped faculty participants address approaches toward interacting with colleagues and students, largely leading to a change in behaviors to promote more inclusive practices in the teaching of ethnic minority students in STEM (Womack et al., 2020). Overall, institutional programs like these should be continuous, not just a one-time affair.

b) Curriculum Design and Pedagogical Innovation

The way STEM curricula are designed and taught is another important issue. Students whose cultural backgrounds, experiences, and epistemologies deviate from these standards are frequently marginalized by the prevalence of Western-centric, decontextualized content in many STEM fields (Ong et al., 2018). To link course content to students' real-world experiences and community contexts, CRP requires the incorporation of culturally relevant examples, case studies, and problem-solving scenarios (Hill et al., 2025; Villegas Molina et al., 2025). For instance, the Inclusive STEM Teaching Project (ISTP), which is a massive online open course that provides training on diversity, equity, and inclusion (DEI), instructor identity, student identity, classroom climate, and creating inclusive courses demonstrated iterative growth in incorporating identities in cognitive, affective, confidence, and behavioral outcomes (Hill et al., 2025). Another notable example is the Transforming Institutional Drivers for Excellence in STEM (TIDES) programming, in which introductory courses "Introduction to Computer Science with C++ (CSCI 2215)" and "Introduction to Computer Programming with C# (CSCI 1205)" were redesigned with real-world examples to include components of human-computer interaction, history of the cell phone, virtual reality and mental health, lessons of great African American men and women who made significant contributions to computing, etc. These improved the enrollment for the courses, with a notable increase in the number of female and ethnic minority students' enrollment (Sharma et al., 2019).

In the TIDES project conducted at the University of Dayton (UD), curricular changes were implemented through the creation of a new foundational course, the substantial renovation of two additional courses, and smaller-scale changes in a number of other courses, namely, the introduction of active and inquiry-based learning (Speed et al., 2019). Based upon feedback from students, they found that the three courses that were either created or revised in connection with the TIDES project (CPS 149, 150, and 151) indeed were successful in promoting interest and retention among students from all backgrounds. Although the overall numbers are small when compared to those of other schools that were a part of the TIDES project, it had major gains in the total number of majors, the total number of underrepresented students, and retention from the first to the second year.

With the growing emphasis on diversity, equity, and inclusion in higher education, the CRP framework in STEM is especially crucial. Nonetheless, these efforts need the cooperation of institutions. Co-creation of curricula materials that adhere to CRP principles should be promoted by educational institutions. This could entail creating databases of case studies that are culturally relevant, forming collaborative curriculum design teams, or establishing interdisciplinary collaborations that unite STEM faculty and experts in multicultural education. These programs will not only increase the inclusivity of

STEM subjects but will also validate the wide range of methods that students know and learn.

Barrier 2: Resistance to CRP from Students, Colleagues, and Institutional Structures

Evidence-based approaches from the literature that offer practical ways to tackle this barrier are:

- c) Institutional Structures and Policy, and
- d) Equity and Student Success

c) Institutional Structures and Policy

Institutions can prioritize CRP in several ways: (i) engage in efforts to change the thinking of faculty and administrators about knowledge, students, and societal issues, (ii) elicit and create space for student’s voices and other forms of expressiveness, (iii) implement curriculum changes to be more multicultural and gender friendly and, (iv) implement curriculum changes to be more active and collaborative (Sharma et al., 2019). Broader institutional structures that support traditional norms of academic objectivity, neutrality, and meritocracy frequently influence faculty opposition to CRP (Prescod-Weinstein, 2020). By characterizing CRP as “political,” “unscientific,” or outside the purview of disciplinary rigor, these structures may deter some faculty from putting it into practice. Furthermore, professors may be discouraged from devoting time and effort to equity-focused pedagogy if promotion and tenure procedures prioritize research above teaching excellence. Rethinking institutional reward systems and organizational culture is necessary to meet these problems. Institutions must update their evaluation standards to recognize and incorporate culturally sensitive instruction. Faculty who show leadership in implementing CRP should be rewarded through recognition programs, teaching prizes, and merit-based incentives. Simultaneously, department and college leadership must formally support CRP as an academic goal by incorporating it into mission statements, accreditation reports, and strategic plans. Furthermore, data must guide changes in institutions. Institutional climate surveys can evaluate faculty and student views of inclusion in STEM learning environments, while disaggregated student performance data can reveal disparities that CRP aims to relieve. Continuous improvement and focused interventions can be based on such data (Johnson & Elliott, 2020).

d) Equity and Student Success

Supporting the success of students from historically marginalized backgrounds is the overarching objective of CRP. The stakes are particularly high in STEM, where Black, Latinx, Indigenous, and first-generation college students continue to be underrepresented. According to Carlone and Johnson (2007), CRP provides a means of achieving more inclusive, affirming, and empowering STEM

learning environments that cultivate a sense of belonging as scientists or engineers (Carlone & Johnson, 2007). Faculty are called to critically reflect on their biases and use pedagogical strategies that validate and empower ethnic minority students. Administrators can institutionalize CRP through professional development initiatives, support for inclusive teaching practices, and the recruitment and retention of diverse faculty. These programs support underrepresented students' success and retention in STEM higher education, in addition to improving student engagement (Chen, 2013). However, some students' resistance to CRP, especially those from majority backgrounds, could create tension in the classroom. Faculty need to be ready to handle these situations through an inclusive dialogue, being open and honest about their instructional goals, and encouraging a diversity of viewpoints. Explaining how culturally relevant teaching methods improve learning for everyone, not just particular groups, is another way to increase student support for CRP. Inclusive teaching practices improve learning outcomes and student engagement across demographics (Eddy & Hogan, 2014).

LIMITATIONS AND FURTHER RESEARCH

Although PRISMA offered an organized and transparent method for finding and evaluating relevant literature, a few limitations surfaced during the literature search that might have affected the comprehensiveness of the review. First, it is possible that the inclusion criteria and keyword technique inadvertently left out relevant studies that discussed CRP using other terminologies not stipulated in our search term combinations. For instance, some studies may use phrases like “inclusive pedagogy” or “equity-oriented instruction” to describe equivalent pedagogical approaches without precisely using the specific search terms we employed. As a result, some important empirical studies that may have shed more light on faculty adoption of CRP-like techniques in STEM settings might have been unintentionally excluded. Furthermore, another limitation of this review is that it did not search for the disciplines of STEM (biology, chemistry, physics, mathematics, engineering, psychology, etc.) individually. Instead, literature reflecting the interdisciplinary and integrated nature of these disciplines in higher education was captured using the acronym “STEM” in our search. This approach was chosen because many initiatives, policies, and pedagogical strategies involving CRP are often designed and implemented at the institutional or programmatic level across multiple STEM departments, rather than within isolated disciplines. Recognizing that our search results might be different if individual disciplines were included in our search terms is pertinent.

The review's scope was further limited by issues with database coverage and indexing methods. Even though multiple databases (such as ERIC, Web of Science, and Google Scholar) are used to ensure broad coverage, some discipline-specific journals in STEM education or faculty development may not be

consistently indexed, especially those housed in engineering, physical sciences, or institutional repositories. This might have limited generalizability by contributing to a bias in representation toward some STEM fields (like mathematics and computer science) over others (like chemistry or physics). Together, all of these factors imply that although the analysis provides a thorough synthesis, it might not adequately represent the range of initiatives and challenges related to CRP implementation across all higher education STEM faculty populations.

Even though this review study highlights the factors affecting CRP adoption and implementation in STEM higher education, there are still several areas that might require more investigation. First, while the current study focused on reviewing the challenges faculty encounter with the adoption and implementation of CRP, future studies can focus on the challenges they face in translating CRP frameworks into practice. Longitudinal studies that look at how faculty perceptions and practices about CRP develop over time are also needed. These kinds of studies could shed light on the steps faculty take to go from awareness to adoption. In addition, disciplinary variations in the implementation of CRP require further study. Disciplines like physics, engineering, biology, and mathematics have quite different norms, epistemologies, and educational systems, which suggests that CRP may show up differently across STEM fields. Comparative research can be used to pinpoint common problems and effective approaches to mitigate them. There is a greater demand for student-centered research. More information is required to understand how students perceive CRP-informed STEM instruction, as the majority of studies concentrate on faculty perceptions. A more comprehensive understanding of the impact of CRP might be possible through mixed-methods studies, performance data, student interviews, and classroom observations. Lastly, future studies should look into institutional change strategies that facilitate the broad adoption and implementation of CRP. Which organizational structures, policy levers, and leadership practices work best to promote STEM education that is culturally relevant? Scalable models for change across various institutional contexts can be informed by the answers to these questions.

CONCLUSION

Research on CRP in higher education has many gaps, as demonstrated by our review of its literature. The fact that our understanding of the scope of CRP keeps evolving compounds the challenge with implementation. For one, students vary from semester to semester, and CRP is dependent on the specific individuals present in the classroom (Rychly & Graves, 2012). Furthermore, the concept of CRP is constantly evolving in line with the ways the educational system is adapting to the evolving student body (more students of color with diverse cultural backgrounds, for instance) and the neoliberal epistemologies influencing

education, making CRP harder to adopt by all. Also, despite efforts by individuals and institutions to eradicate them, biases and assumptions, particularly regarding students and communities of color, make CRP challenging to implement (Hyland, 2009). Additionally, the majority of CRP research focuses on teacher education programs and pre-service teachers. These K-12 programs are distinct from the higher education landscape. Furthermore, the number of empirical studies on CRP is limited. As a result, there is greater knowledge regarding the theory of CRP and generally less knowledge regarding its practical implementation. These gaps make sense given the values that underlie higher education: research on diverse learners receives less funding, teaching is generally undervalued, and due to the prevalence of whiteness in higher education, faculty and/or institutions may even consider CRP content and the way it is taught to be an issue (Cabrera et al., 2017; Cooper & Voigt, 2025; Southern, 2025).

Higher education institutions and faculty must be better equipped to teach a varied population of students with a range of learning styles to be more inclusive and responsive to the rising diversity of their student body. Faculty and institutions may be better prepared to do so if more research on CRP is conducted. Complex, interrelated factors, such as institutional structures' opposition and a limited understanding among faculty, influence the adoption of CRP in STEM higher education. Multi-level interventions—faculty professional development, curricular reform, policy changes, and data-informed decision-making—are needed to address these issues. Higher education institutions can establish more inclusive and equitable settings where all students have the chance to succeed in STEM by embracing CRP as a fundamental component of teaching excellence.

Declaration of Conflicts of Interest

The authors declare that there are no conflicts of interest associated with the publication of this manuscript.

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Note:

The authors did not use OpenAI's ChatGPT or any other AI tools in the drafting, editing, or refining of this manuscript. All content was generated, reviewed, and refined solely by the authors.

Appendix A

Search Term Combinations

CRP	+	+	+	+	+
Teachers	Lecturers	Instructors	Educators	Faculty members	Faculty
Conceptions	Beliefs	Opinions	Views	Insights	Perceptions
Tensions	Constraints	Issues	Obstacles	Challenges	Barriers
Undergraduate education	Tertiary education	Postsecondary education	University education	College education	Higher education
STEM majors	STEM domains	STEM areas	STEM fields	STEM subjects	STEM disciplines

Professors

Understandings

Limitations

Graduate education

STEM
concentrations

Note. CRP serves as an umbrella term capturing multiple conceptualizations found in the literature and used in our search, such as culturally relevant/responsive/sustaining pedagogy, culturally competent/inclusive/sensitive teaching, and socio-culturally conscious educational approaches.