

Systematic Review on the Role of Culturally Relevant Pedagogy in Empowering International Students in Engineering Education: Addressing Deficit Narratives and Fostering Inclusivity

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Abstract

The global increase of international students in higher education presents unique challenges, including cultural adaptation, language barriers, and feelings of isolation. These challenges can contribute to deficit narratives that undermine students' potential and hinder their academic success. This work-in-progress systematic literature review (SLR) examines how Culturally Relevant Pedagogy (CRP) can empower international engineering students by addressing these challenges, challenging deficit perspectives, and promoting inclusivity. The review aims to answer two primary questions: (1) How does CRP support and empower international students in engineering education? and (2) What gaps remain in the current literature regarding CRP's implementation and impact? Following the PRISMA 2020 guidelines, an initial search identified 1,002 records, which were systematically narrowed to 37 relevant studies focused on CRP in international higher education contexts. Qualitative content analysis identified four key themes: (a) enhancing academic engagement via CRP practices for international students, (b) shaping international students' perceptions, (c) counter-narratives against deficit perspectives, and (d) the importance of faculty training and institutional support. The findings reveal that CRP effectively improves international students' educational experiences (e.g., enhance problem-solving, teamwork, and critical thinking skills in engineering courses), offers a counter-narrative to deficit views of international students in engineering ecosystems, and fosters inclusivity in engineering classrooms. To build a more inclusive and equitable learning environment, engineering educators and institutions must prioritize CRP in their pedagogical frameworks, thereby empowering international students to succeed both academically and socially.

Keywords: culturally relevant pedagogy, international students, systematic review, anti-deficit views, student engagement, engineering education

Introduction

In rapidly globalizing world, the landscape of higher education is witnessing significant shifts, particularly with the increasing enrollment of international students. According to the Institute of

International Education [1], over 5 million international students were enrolled in higher education institutions worldwide as of 2020. In the United States, international students comprised approximately 18% of the total student population during the 2021-2022 academic year, primarily from China [1]. A similar pattern is observable in countries like the United Kingdom, Canada, and Australia, where international students are regarded as vital contributors to their academic communities, with numbers expected to continue rising in the coming years.

However, despite this growing demographic, international students often encounter distinct challenges that can impede their academic success and overall educational experience. Cultural adaptation, language barriers, discrimination, and feelings of isolation frequently contribute to less-than-optimal educational outcomes [2], [3], [4]. To address these challenges, educators are increasingly turning to CRP as a framework to empower international students and improve their academic and social experiences in STEM fields, including engineering education.

CRP conceptualized by Gloria Ladson-Billings in [5], emphasizes the necessity of recognizing and valuing students' cultural backgrounds in the learning process. This pedagogical approach fosters an educational environment that celebrates diversity and provides all students with the support they need to excel. By challenging the deficit narratives that often frame international students as lacking the requisite skills for success in Western educational contexts, CRP equips educators with tools to affirm students' cultural identities and promote their learning through culturally responsive practices [2], [5], [6], [7]. CRP has emerged as a critical framework in contemporary discussions surrounding global education, particularly within STEM disciplines, including engineering education. The approach is anchored around three core elements: the academic success of students, the development of cultural competence, and the nurturing of critical consciousness [5], [8]. Academic success focuses on establishing high standards and rigorous curricula, while cultural competence emphasizes integrating students' cultural references into educational practices. Critical consciousness empowers students to critically analyze social, political, and economic disparities, equipping them to instigate meaningful change.

Given the multifaceted experiences of international students, CRP is especially pertinent in the global educational context. These students come from varied educational backgrounds, often struggling to adapt to new learning environments [2], [4], [9], [10]. By embedding students' cultural backgrounds into the curriculum and fostering discussions around their experiences,

educators can help international students navigate the complexities of adjusting to new educational landscapes while affirming their identities.

Empowering international students through CRP is critical, as implementing culturally relevant pedagogical components can enhance academic performance and foster a sense of belonging in the academic community [7], [11], [12]. Transforming the narrative surrounding international students from one based on deficits to one acknowledging their unique contributions and capabilities can lead to increased inclusivity within educational environments [13], [14]. Despite the potential advantages of CRP, there remains a gap in comprehensive reviews that consolidate existing research and explore its specific role in empowering international students in engineering education. This systematic literature review seeks to address this gap by examining the literature on CRP within the context of international higher education, focusing on engineering education. Our inquiry is guided by two central research questions: (1) How does CRP empower international students in engineering education? (2) What gaps exist in the current literature regarding the implementation and impact of CRP on international students? By systematically analyzing and synthesizing findings from recent studies, this review provides valuable insights and recommendations for educators, administrators, and researchers aiming to enhance the educational experiences of international students through culturally relevant teaching methodologies.

Methodology

Review Protocol Development and Data Sources

To establish the study dataset and guide the literature search, a review protocol was developed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standards [15]. The review protocol outlined search terms, information sources, study objectives, eligibility criteria, study selection processes, and methods for data collection, extraction, and synthesis as detailed in Appendix Table 1. Comprehensive publication searches were conducted in databases including Compendex, INSPEC, the ASEE PEER Repository, Scopus, Google Scholar, IEEE Xplore, and ProQuest. The chosen databases facilitate the integration of records with library tools (e.g., Zotero) for efficient downloading and exporting of relevant study characteristics (authors, publication year, abstract, citations, journal name, publisher, etc.). Utilizing a root search term—“culturally relevant pedagogy”—we incorporated four keywords:

“international students,” “engineering education,” “deficit narratives,” and “inclusivity,” as they appeared in article titles, abstracts, or keywords. These keywords were combined using Boolean operators ("AND" and "OR") to refine our search results further, capturing a broad range of studies illuminating the intersection of CRP and the experiences of international students in engineering disciplines. Variations in search strategies were applied across databases, detailing how root search terms, keywords, and Boolean operators were utilized for effective results [16], [17]. For instance, data from Scopus on June 30, 2024, utilized the search string: TITLE-ABS-KEY ((culturally AND relevant AND pedagogy) OR (international AND student) OR (deficit AND narrative)) AND PUBYEAR > 2013 AND PUBYEAR < 2025 AND (LIMIT-TO (SUBJAREA , "ENGI")) AND (LIMIT-TO (DOCTYPE , "cp") OR LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "cr") OR LIMIT-TO (DOCTYPE , "bk") OR LIMIT-TO (DOCTYPE , "ch")) AND (LIMIT-TO (EXACTKEYWORD , "Engineering Education")) AND (LIMIT-TO (LANGUAGE , "English")).

Inclusion and Exclusion Criteria

Records were deemed eligible for further review based on four predefined criteria. First, the article must focus on the STEM fields. Second, only articles published between 2014 and November 17, 2024, were included to ensure relevance in light of recent educational updates concerning CRP's contributions to equity and inclusivity in engineering education. Third, only full-length peer-reviewed empirical studies—including journal articles, theses, conference proceedings, theoretical works, and review articles published in English—were considered to focus on scientifically validated research. The final criterion mandated that selected studies explicitly address aspects of CRP, challenges faced by international students in engineering education, or the detrimental impacts of deficit narratives on teaching practices. Exclusion criteria included: (1) omission of non-peer-reviewed articles to uphold academic integrity; (2) exclusion of studies focusing on non-engineering disciplines, those not considering international student experiences, or lacking any reference to CRP; (3) exclusion of research published before 2014 to maintain currency in the context of contemporary teaching practices.

Selection Process and Cataloging

The selection process for this systematic literature review was meticulously constructed to ensure the inclusion of only relevant, high-quality studies. Initially, the first author established a robust set of inclusion and exclusion criteria, rigorously evaluated by three engineering education professors to maintain the study's focus on relevant literature. The criteria predominantly targeted articles within STEM fields, aligned with investigations into CRP's impact on international students in engineering education, and confined to publications dated from 2014 to November 17, 2024.

After identifying and sorting primary sources, a structured evaluation was executed based on the review objectives and predefined criteria. Two independent reviewers, comprising the first author and a recruited assistant reviewer, conducted blinded assessments to establish the eligibility of each study. During the article screening, if compliance with the inclusion criteria was ambiguous, the reviewers independently voted on eligibility, securing classifications of 'yes' for eligible articles, 'no' for ineligible articles, or 'maybe' for uncertain cases. 'Yes' or 'maybe' articles advanced to a full-text review, while those marked 'no' were excluded. In instances of disagreement—where one reviewer marked 'yes' or 'maybe' and the other marked 'no'—the article was classified as conflicting and discussed extensively until a consensus was reached.

Adhering strictly to the PRISMA 2020 guidelines ensured a transparent and replicable selection process. The comprehensive search across the seven designated databases yielded 1,002 records. Following the removal of 207 records classified as gray literature (e.g., blogs, extended abstracts, reports, preprints), the refined dataset comprised 795 publications. Thorough duplication checks subsequently eliminated 362 duplicates, narrowing the dataset to 433 records.

In the title screening stage, 123 articles were excluded for being off-topic, and five for non-English publication, yielding 305 records eligible for abstract review. A detailed review of these abstracts led to the exclusion of 215 studies deemed irrelevant, resulting in 90 articles proceeding to full-text evaluation. Ultimately, 53 studies were excluded for inadequately discussing CRP within the context of STEM education, resulting in a final selection of 37 publications that met all inclusion criteria. These selected studies focused specifically on CRP's influence on international students' experiences in engineering education, providing a robust foundation for subsequent analysis. The PRISMA flow diagram visually summarizes the selection process and flow of relevant literature as depicted in Figure 1.

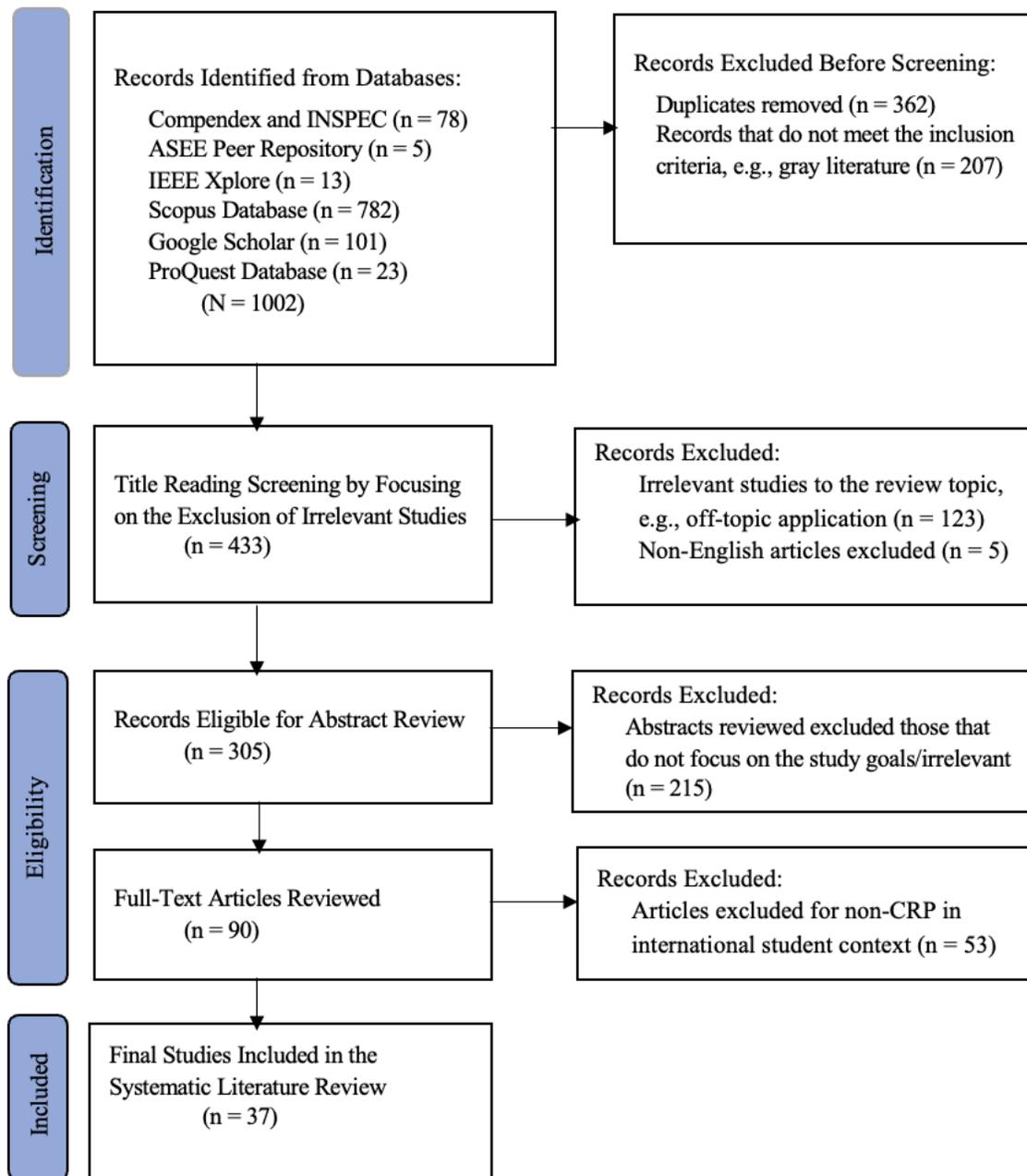


Figure 1. The PRISMA Flow Diagram for the Database Search of Publications for Systematic Literature Review

Data Analysis

For this study, qualitative content analysis was employed to examine the 37 identified publications, summarize the existing evidence and generate new insights by synthesizing multiple articles (Schreier, 2012). To achieve this, reviewers followed five structured steps to

synthesize the literature effectively. First, both reviewers independently engaged with a sample of 21 publications, crafting scholarly summaries that included the title, author list, abstract, keywords, publication year, study purpose, research design and context, document types (e.g., conference proceedings, journal papers, books), research methods employed, and research findings. These summaries were then compared to confirm consistency. In the second step, the reviewers collaboratively generated inductive codes that encapsulated common patterns across the initial 21 articles. This process revealed 19 distinct codes, including “Adding cultures into engineering curricula,” “CRP strategies on closing the achievement gaps,” “Cultivate authentic relationships in the classroom,” “Positioning international students as active knowledge producers,” and “CRP challenge deficit narratives,” as detailed in Table 1.

In the third step, both reviewers assessed an additional 17 publications, extracting scholarly summaries and categorizing each article according to the previously established codes. If an article did not align with any pre-existing code, new codes were developed. The fourth step involved an in-depth analysis of early-generated codes, which were organized into four emergent themes: enhancement of academic engagement through CRP, influence of CRP on students' perceptions, counter-narratives against deficit perspectives, and faculty training and institutional support. Table 1 outlines each theme, corresponding codes, and related publications.

Table 1. Distribution of Selected Literature Based on Thematic Classification

Themes	Definitions	Codes	N
Enhancement of academic engagement through CRP	This theme encompasses topics related to the infusion of diverse cultural perspectives and practices into the engineering curriculum, motivating students to actively engage with their education. Topics that encourage international students to share their unique experiences and insights. Also, open discussions around cultural narratives and social justice issues foster critical thinking and deeper academic engagement among students.	<ul style="list-style-type: none"> – CRP strategies for closing the achievement gaps – Enhance student engagement – Cultivate authentic relationships in the classroom – Adding cultures to engineering curricula – Adding cultural referents to teaching 	13

Influence of CRP on students' perceptions	Focuses on topics related to the practice of teaching that recognizes and incorporates students' cultural backgrounds into the learning process. Also, terms related to how CRP encourages students to embrace their cultural identities, fostering a sense of belonging and self-worth, as well as the role of CRP in enhancing student interest and participation in learning.	<ul style="list-style-type: none"> – CRP influences student learning – International students' feelings of marginalization – International student feelings of undervaluation – Positioning international students as active knowledge producers 	8
Counter-narrative against deficit perspectives	Topics and terms related to concepts that emphasize strength and the ability to overcome challenges, highlighting positive attributes instead of limitations. In addition, concepts that recognize and value the positive traits, skills, and resources that individuals or groups possess, rather than fixating on their deficits.	<ul style="list-style-type: none"> – CRP challenges deficit narratives – Impact of CRP on educators' perceptions – CRP counteracts prevailing deficit notions – CRP helps to focus on students' strengths – Depicting international students as passive – Depicting international students as needy 	10
Faculty training and institutional support	This theme describes the growth and improvement of faculty skills and knowledge through various training programs. In addition, concepts indicate the support systems provided by institutions to facilitate effective teaching and professional development.	<ul style="list-style-type: none"> – Professional development for faculty – Culture training – CRP training for faculty – Institutional commitment to culturally competent practices 	6

Lastly, to measure inter-rater reliability among the two reviewers, they conducted independent evaluations utilizing a binary rating system to determine whether the articles were satisfactory (1) or unsatisfactory (0) categorizations. Cohen's Kappa statistics assessed analysis reliability, yielding a value of 1.00 across the 41 reviewed articles (see Table 2), indicating total agreement between the reviewers [18].

Table 2. Inter-rater Reliability between Reviewer 1 and Reviewer 2

Measure of Agreement	Value	Asymptotic Standard Error	Approximate t-value	Approximate Significance
Cohen's Kappa	1.00	.000	6.403	<.001

Total number of valid cases: n = 4

Findings

This systematic literature review (SLR) aimed to explore the role of CRP in empowering international students in higher education, focusing on how CRP influences students' perceptions and academic engagement while counteracting deficit narratives. Our findings are organized into four key themes: enhancement of academic engagement through CRP, the influence of CRP on students' perceptions, counter-narrative against deficit perspectives, and the importance of faculty training and institutional support.

Theme 1. Enhancement of Academic Engagement through CRP

In the synthesis of thirteen articles exploring the intersection between CRP strategies and international student engagement, CRP has been identified as a significant factor in influencing student engagement, particularly in the fields of engineering. Five of these studies investigating the impact of CRP strategies on closing the achievement gap demonstrate their effectiveness in enhancing student engagement [19], [20], [21], [22], [23]. In addition, the implementation of CRP practices substantially enhances the academic engagement of international students [9], [24], [25], [26]. By integrating international students' cultural backgrounds and experiences into their learning, creating a welcoming environment, cultivating authentic relationships, and aligning the curriculum with culturally relevant content, engineering educators can create a more engaging and connected classroom, thereby effectively supporting international students' academic engagement in engineering classrooms. For example, Halkiyo [4], Kettle [27], and Heringer [28] note that courses designed around CRP principles encourage international students to actively participate in discussions, leading to more enriched exchanges of academic knowledge.

CRP also enables students to draw connections between their prior knowledge and the curriculum, making the content more relevant to their experiences. Quiñonez and Olivas [29] and Salmona et al. [30] report that students feel more motivated and invested in their academic pursuits when instructors validate and acknowledge their cultural perspectives. This type of

recognition not only enhances students' sense of belonging but also nurtures an environment where diverse ideas can thrive. Additionally, Snyder and Fenner [31] found that effective implementation of CRP led to higher levels of engagement, collaborative learning, and critical thinking skills among international students. This enhanced engagement translated into improved academic performance and a greater sense of ownership over their learning. Thus, the influence of CRP on international students' academic engagement in engineering classrooms is significant. By adopting CRP practices, educators can cultivate a supportive and inclusive learning environment that significantly enhances international students' engagement.

Theme 2. Influence of CRP on Students' Perceptions

In this theme, we examined eight articles that collectively highlight the influence of CRP on international students' perceptions across various educational settings. Four of these studies demonstrated that CRP positively affects international students' views regarding their educational environment, their instructors, and their roles within the classroom [2], [13], [32], [33]. Many international students reported feelings of marginalization or undervaluation under traditional pedagogical practices, which often prioritize Western-centric paradigms. In contrast, CRP facilitates a transformative shift in how students perceive themselves and their contributions to the classroom. Lomer and Mittelmeier [34] and Heng [13] underscore that by positioning international students as active knowledge producers rather than passive recipients of information, CRP empowers these students to assume more significant roles in their education. This empowerment not only helps to build their confidence but also enhances their capacity to navigate academic challenges. Supporting this perspective, research by Wu [35] and Tan et al. [10] found that when instructors effectively implemented CRP, students reported a heightened sense of agency, which encouraged them to engage more proactively with both their peers and academic coursework. Further, this empowerment extends beyond the classroom, positively influencing students' educational experiences, e.g., academic performance [21], sense of belonging [36], and self-identities [37]. When international students feel recognized and valued, they are more inclined to leverage their unique perspectives in academic discussions, thereby enriching the collective learning experience for all students in the class. Therefore, CRP plays a crucial role in shaping international students' perceptions, particularly within engineering classrooms, by fostering an inclusive environment that acknowledges and values diversity in learning.

Theme 3. Counter-Narrative Against Deficit Perspectives

In the analysis of ten articles, we identified the ability of CRP to challenge and counteract prevailing deficit narratives surrounding international students as a significant aspect of promoting anti-deficit notions. Six of these articles emphasized how international students are frequently viewed through a lens of deficiency, particularly concerning language skills and cultural adaptability [13], [28], [34], [38]. Heringer [28] pointed out that many educators continue to uphold deficit views, which results in a limited understanding of students' capabilities. Additionally, marginalized student populations, including Black and African American students, are often subjected to similar deficit framings [39]. As noted by Lomer and Mittelmeier [34], "international students continue to be subtly framed as in deficit or passive, rarely as partners or knowledge agents" (p. 1). This deficit perspective inherently poses the question, "What's wrong with the students?" For instance, students from China represent the largest international university population in the USA, yet the discourse surrounding them often reflects a deficit mindset, depicting them as passive, needy [35], or uncritical participants [34]. Similarly, in the UK, for a high number of international students,

recruitment hasn't re-shaped pedagogic practices. Rather, it appears that an assimilationist model predominates, wherein international students are still expected to 'adapt' fully to the assumed inherently superior British model of teaching and learning in higher education. These entrenched pedagogic practices contribute to the epistemic exclusion of international students [34, p. 1258].

These studies collectively suggest that negative depictions of international students significantly shape pedagogic practices in higher education that could perpetuate deficit narratives, implying students should 'assimilate' into the mainstream cultures of others. However, CRP provides a framework to reframe these narratives. As stated by Heng [13], shifting the focus from what students lack to what they bring to the classroom dismantles stereotypes associated with international students and promotes more equitable educational practices. This reframing is particularly essential in academic environments where international students are often expected to conform to established norms of engagement, rather than being recognized as valuable contributors.

Furthermore, Ladson-Billings' [40] assertion that asking "What's right with the students?" serves as a guiding principle reinforcing the notion that educators should actively seek out and promote the strengths of their students. This approach, when integrated into the engineering field's teaching methodologies, can mitigate the influence of deficit narratives, fostering an environment of inclusivity and appreciation for diversity. Thus, by embracing anti-deficit perspectives and recognizing the cultural capital of all students, engineering educators can create more equitable and supportive learning environments, empowering all students, where international students are included to succeed in their learning: international students' intellectual growth and moral development, affirm cultural competence and and empower critical consciousness to recognize and critique social inequalities.

Theme 4: Faculty Training and Institutional Support

Our review of seven articles highlighted the essential role that faculty training and institutional support play in implementing CRP in engineering education. Akili [41] emphasized the need for effective professional development specifically tailored for engineering educators in the Arab Gulf Region, asserting that such training is crucial for equipping faculty to perform their roles successfully and promote inclusivity in their classrooms. Similarly, Czajka and McConnell [42] explored the relationship between professional development, departmental culture, and the adoption of student-centered teaching practices among engineering faculty. Their findings indicate that fostering a supportive departmental climate that values educational innovation and offers continuous professional development opportunities can significantly enhance inclusivity for international students.

Despite the recognition of CRP's importance, many educators expressed a desire to adopt its principles but reported feeling inadequately prepared without appropriate training. Both Mbugua [43] (2010) and Fallon et al. [44] highlighted that professional development programs focused on culturally responsive teaching methodologies can substantially enhance faculty effectiveness in engaging international students. Moreover, institutions prioritizing diversity and inclusion in their strategic initiatives are more likely to cultivate environments conducive to CRP implementation. Heringer [28] noted that universities that invest in resources, workshops, and ongoing support for faculty development create an environment where CRP can thrive, ultimately benefiting international students. However, the absence of systemic changes in curriculum design and assessment methods can obstruct the effective integration of CRP. As

Hayes [38] and Czajka and McConnell [42] pointed out, without a firm commitment to culturally competent practices at the institutional level, the efforts of individual faculty members may fail to create the desired improvements in student engagement and inclusion. Therefore, it is essential for engineering education institutions to not only invest in faculty training but also to implement comprehensive institutional support structures that promote CRP principles throughout their curricula and policies. This holistic approach fosters an inclusive educational environment for international students, enhancing their academic experiences and overall success.

Discussion and Future Research Directions

The findings from this SLR shed light on the transformative potential of CRP in fostering a positive educational experience for international students in engineering education. Three key findings emerged from this comprehensive review: (1) CRP influences academic engagement among international students; (2) CRP shapes international students' perceptions of their educational environment; and (3) CRP counters deficit narratives about international students by leveraging their cultural backgrounds as valuable resources.

The first finding, that CRP positively impacts international engineering students' academic engagement, aligns with Heringer's [28] assertion that effective pedagogy connects the curriculum to students' cultural contexts. By embracing CRP practices, educators create opportunities for international students to actively participate in their classroom learning, increasing motivation and investment in their studies [30]. Ladson-Billings [39], [40], [45] emphasizes recognizing students' cultural resources as a means of building inclusive educational environments that support critical thinking and collaboration. The second finding highlights that CRP significantly influences international students' perceptions of their educational environment, instructors, and roles within the classroom [34], [35], [46]. When international students feel recognized and valued, they are more inclined to leverage their unique perspectives, enriching the collective learning experience for all students. Therefore, CRP plays a crucial role in shaping international students' perceptions, fostering an inclusive environment that acknowledges and values diversity in learning. The third finding underscores CRP's capacity to counter deficit narratives about international students by reframing their backgrounds as valuable resources. This shift from a deficit model to a strengths-based approach is in line with Gorski's [47] critique of the education system. By leveraging the unique cultural backgrounds of international students,

CRP cultivates an environment of empowerment, confidence, and academic success. This recontextualization serves as a critical step in dismantling stereotypes and reducing barriers to engagement and achievement.

In addition, this review highlights the necessity of faculty training and institutional support for the successful implementation of CRP to better support international students in engineering education. Educators expressed a desire to adopt CRP practices, but a lack of professional development opportunities and resources hinders their ability to do so effectively. Gorski [47] emphasizes the importance of ongoing training to develop culturally responsive teaching methods, advocating for institutions to invest in faculty professional development. A commitment to inclusivity at the institutional level is essential to provide a supportive framework for educators and students. This calls for actionable strategies that include comprehensive training programs and resources facilitating the implementation of CRP across curricula, in line with Chang and Viesca's [48] recommendations for holistic approaches to diversity and inclusion.

Despite the significant contributions of this systematic literature review on CRP, several critical research gaps remain, and future research directions are identified. One area that warrants further exploration is the limited scope of existing literature on CRP, which primarily focuses on specific cultural or geographical contexts. Future research should aim to address this limitation by conducting comparative studies that examine how CRP is implemented in different cultural or geographical contexts, identifying best practices and culturally context-sensitive adaptations that can enhance learning experiences for international students. Furthermore, there is a need for a more nuanced understanding of international students' perspectives on CRP, as much of the existing research relies primarily on educator viewpoints. Future studies should strive to center the voices of international students, gathering their perspectives and experiences regarding CRP through qualitative methodologies such as interviews or focus groups. This can provide rich, detailed accounts of their experiences and inform the development of more effective CRP strategies. Finally, future research should explore interdisciplinary frameworks that can enhance the understanding and implementation of CRP in higher education. Integrating insights from sociology, psychology, and cultural studies can provide a more comprehensive understanding of the sociocultural factors affecting international students and inform the development of more effective CRP practices. Addressing these gaps through focused research efforts will deepen our

comprehension of CRP, enhance its implementation, and promote equity and inclusivity across diverse educational settings.

Conclusion

This SLR highlights the transformative potential of CRP in empowering international students in engineering education. The findings underscore that effectively integrating CRP strategies can enhance international students' academic engagement and improve learning outcomes, including problem-solving, teamwork, and critical thinking skills. In addition, culturally relevant pedagogical practices can positively shape international students' perceptions of their learning environment and actively challenge prevailing deficit narratives that often undermine their potential. By recognizing and valuing students' cultural backgrounds, engineering educators and administrators can foster inclusive classroom practices where international students feel recognized, confident, and motivated to fully participate in their engineering courses.

Moreover, the review highlights the vital role of faculty training and institutional support in effectively adopting CRP. Ongoing professional development and supportive policies are necessary to embed culturally relevant approaches into engineering curricula and teaching practices, thereby advancing equity and inclusivity across programs. As international student enrollment continues to grow, these insights have broader implications, urging educational institutions to reassess and adapt their pedagogical strategies to ensure all students are supported and included. Despite the promising evidence, gaps in the literature—particularly regarding cross-cultural comparisons, students' own perspectives, and systemic institutional factors—warrant further investigation to optimize CRP's implementation and impact in engineering education.

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Appendix Table 1: Systematic Literature Review Protocol

Section and Topic	Item	Checklist item
TITLE		
Title	1	Systematic Literature Review on the Role of Culturally Relevant Pedagogy (CRP) in Empowering International Students in Engineering Education: Addressing Deficit Narratives and Fostering Inclusivity
THE OBJECTIVE		
Objective	2	This review aims to investigate the role of CRP in empowering international students within engineering education, focusing on how CRP can address deficit narratives and foster inclusivity. RQs: (1) How does CRP empower international students in engineering education? and (2) What gaps exist in the current literature regarding CRP’s implementation and impact?
THE SEARCH TERMS		
Search terms	3	The primary search term is "culturally relevant pedagogy." Our search strategy includes the TITLE-ABSTRACT-KEYWORDS syntax, combining the root term with four keywords: “international students,” “engineering education,” “deficit narratives,” and “inclusivity,” This comprehensive approach allows us to capture a broad spectrum of literature related to the effects of CRP on international students within engineering education.
METHODS		
Eligibility criteria	4	<p>Inclusion Criteria:</p> <ol style="list-style-type: none"> 1. The article must focus on the STEM fields. 2. Articles published between 2014 and November 17, 2024, were included to ensure relevance in light of recent educational updates concerning CRP's contributions to international students’ educational experiences 3. Only full-length peer-reviewed empirical studies—including journal articles, theses, conference proceedings, theoretical works, and review articles published in English—were considered to focus on scientifically validated research. 4. The selected studies explicitly address aspects of CRP, challenges faced by international students in engineering education, or the detrimental impacts of deficit narratives on teaching practices.

		<p>Exclusion Criteria:</p> <ol style="list-style-type: none"> 1. Omission of non-peer-reviewed articles to uphold academic integrity 2. Exclusion of studies focusing on non-engineering disciplines, those not considering international student experiences, or lacking any reference to CRP 3. Exclusion of research published before 2014 to maintain currency in the context of contemporary teaching practices.
Information sources	5	The review utilizes multiple databases for data collection, including ASEE PEER, IEEE Xplore, Google Scholar, Scopus, ProQuest, Compendex, and INSPEC
Search strategy	6	Comprehensive searches are conducted using tailored search strings for each database. Each search string will consist of the root search terms, targeted keywords, and boolean operators, which will help refine the search results based on each database's requirements. For example, in the Scopus database, the following search string will be employed: TITLE-ABS-KEY ((culturally AND relevant AND pedagogy) OR (international AND student) OR (deficit AND narrative)) AND PUBYEAR > 2013 AND PUBYEAR < 2025 AND (LIMIT-TO (SUBJAREA , "ENGI")) AND (LIMIT-TO (DOCTYPE , "cp") OR LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "cr") OR LIMIT-TO (DOCTYPE , "bk") OR LIMIT-TO (DOCTYPE , "ch")) AND (LIMIT-TO (EXACTKEYWORD , "Engineering Education")) AND (LIMIT-TO (LANGUAGE , "English")).
Study selection process	7	The study selection process adheres to the PRISMA 2020 guidelines, ensuring a systematic approach to literature evaluation. Two independent reviewers performed the selection process, consisting of three main steps: (1) Initial screening based on titles and abstracts to assess inclusion and exclusion criteria; (2) Full-text retrieval and assessment against the review criteria; (3) Decision-making regarding eligibility. Any discrepancies between reviewers were resolved through discussion. The review also incorporates a structured evaluation aligned with the research objectives and predefined criteria.
Data collection process	8	Data was collaboratively collected by two independent reviewers from the designated seven databases. Comprehensive searches were followed using the developed search strings.
Data extraction, synthesis, and writing up	9	After reviewing the selected articles, both reviewers took analytical memos. They jointly develop codes to capture emergent insights, resulting in the identification of nineteen distinct codes related to the influence of CRP on international students in engineering education. A detailed description of these codes was provided in Table 2. Subsequently, both reviewers will categorize the remaining twenty publications based on these codes. Any articles that do not align with existing codes may lead to the proposal of new codes. Themes were generated inductively from the identified codes, culminating in four emergent themes: validation of cultural identities, improvement of learning outcomes, challenge of cultural biases and stereotypes, and bridging opportunity gaps. Narrative writing methods were used.
Study risk of bias assessment	10	A comprehensive quality assessment was conducted for the studies included in this review, following PRISMA 2020 guidelines. The assessment included predefined criteria to evaluate credibility and relevance, ensuring that all studies appropriately address CRP's implications for international students. Two independent reviewers determined the robustness of each included study to minimize bias and enhance the reliability of the findings.

Synthesis methods	11	The synthesis of data followed the PRISMA 2020 guidelines, screening all datasets collected. A rigorous process resulted in 37 eligible studies. Using qualitative content analysis and scholarly summaries, codes were generated, and themes were developed. Significant insights from the literature were synthesized through a narrative synthesis approach to construct the manuscript.
RESULTS		
Study selection	12	The PRISMA 2020 Flow Diagram illustrated the search and selection process from initial records identified to studies included in the review.
Study characteristics	13	All included studies are cited in the manuscript, with characteristics detailed in Appendix Table 2.
Certainty of evidence	14	An assessment of inter-rater reliability was conducted, utilizing Cohen's Kappa statistics to evaluate reliability across the 41 reviewed articles, yielding a perfect Kappa value of 1.00, indicating complete agreement between reviewers.
DISCUSSION		
Discussion	15	The discussion interpreted results within the broader context of existing evidence, outlining practical implications and suggestions for future research.
OTHER INFORMATION		
Registration and protocol	16	The developed review protocol is available in the appendix of this study.
Support	17	This review is supported by Arizona State University; opinions expressed herein are those of the authors.
Competing interests	18	No potential conflicts of interest were reported by the authors
Availability of data, code, and other materials	19	Data relevant to this study are part of a larger project and are available upon reasonable request from the corresponding author.
Reviewers	20	Abba Ebba, U.S. Higher Education Sulto Madar, Ethiopian Higher Education

Appendix Table 2: Classification of the Reviewed Literature Based on Specific Themes

Authors (Year)	Title	Theme
Copeland-Solas, E., & Kamalodeen, V. (2022)	Culturally relevant pedagogies (CRP) and culturally responsive teaching (CRT) in science education: Black success stories in Ontario	Faculty Training and Institutional Support
Akili, W. (2012)	On the competencies of engineering educators in the Arab Gulf Region: Relevant thoughts, current practices, and challenges	
Heringer, R. (2019)	The Pertinence of a Culturally Relevant Pedagogy in Internationalized Higher Education	
Lattuca, L. R., Bergom, I., & Knight, D. B. (2014)	Professional development, departmental contexts, and use of instructional strategies.	

Ladson-Billings, G. (2021)	Culturally relevant pedagogy: Asking a different question. Teachers College Press.	
Kwok, M., Rios, A., & Kwok, A. (2023)	Dispelling deficit framing: Investigating preservice teacher beliefs about the intersections between literacy instruction and culturally relevant pedagogy	
Jenkins, I. A. (2023)	Consciousness and Context for Culturally Relevant Pedagogy (CRP): A Case Study of White Faculty Working to Learn About and Implement CRP in Their Teaching Practice	
Jenkins, I. A. (2023)	Consciousness and Context for Culturally Relevant Pedagogy (CRP): A Case Study of White Faculty Working to Learn About and Implement CRP in Their Teaching Practice.	
Maloney, T., Hayes, N., Crawford-Garrett, K., & Sassi, K. (2019)	Preparing and supporting teachers for equity and racial justice: Creating culturally relevant, collective, intergenerational, co-created spaces	Counter-Narrative Against Deficit Perspectives
Onwuachi-Robinson, S. (2023)	Exploring the Implementation of Culturally Relevant Pedagogy to Support Black Male Middle School Students' Success in Math	
Wu, Y. L. (2016)	Applying Culturally Responsive Pedagogy to the Vocational Training of Immigrants.	
Kim, H. J. (2024)	Culturally Responsive Pedagogy Amid the Internationalization of Teacher Education: Self-Study of Teaching International Teacher Candidates in US Teacher Education Program	
Lomer, S., & Mittelmeier, J. (2023)	Mapping the research on pedagogies with international students in the UK: A systematic literature review	Influence of CRP on Students' Perceptions
Brown-Jeffy, S., & Cooper, J. E. (2011)	Toward a conceptual framework of culturally relevant pedagogy: An overview of the conceptual and theoretical literature	
Bunnell, T., & Poole, A. (2024)	(Re) Considering “precarious privilege” within international schooling: Expatriate teachers’ perceptions in China of being marginalised and undervalued	
Tavares, V. (2024)	Feeling excluded: International students experience equity, diversity and inclusion	
Snyder, S., & Fenner, D. S. (2021)	Culturally responsive teaching for multilingual learners: Tools for equity	
Salmona, M., Partlo, M., Kaczynski, D., & Leonard, S. N. (2015)	Developing culturally competent teachers: An international student teaching field experience	
Quiñonez, T. L., & Olivás, A. P. (2020)	Validation theory and culturally relevant curriculum in the information literacy classroom	

Kettle, M. (2017)	International student engagement in higher education: Transforming practices, pedagogies and participation
Wang, R., & BrckaLorenz, A. (2018)	International student engagement: An exploration of student and faculty perceptions
Olayemi, M. (2023)	Understanding Culturally Relevant Engineering Education in Multiple Settings: A Case Study of Nigeria
Brown, B. A., Boda, P., Lemmi, C., & Monroe, X. (2019)	Moving culturally relevant pedagogy from theory to practice: Exploring teachers' application of culturally relevant education in science and mathematics. <i>Urban Education</i> , 54(6), 775-803.
Aronson, B., & Laughter, J. (2016)	The theory and practice of culturally relevant education: A synthesis of research across content areas
Brown-Jeffy, S., & Cooper, J. E. (2011)	Toward a conceptual framework of culturally relevant pedagogy: An overview of the conceptual and theoretical literature.
Zhao, C. M., Kuh, G. D., & Carini, R. M. (2005)	A comparison of international student and American student engagement in effective educational practices
Onwuachi-Robinson S. (2023).	Exploring the implementation of culturally relevant pedagogy to support black male middle school students' success in math
Lawrence-Pine, & Hannah A. (2015)	Enhancing Student Engagement Through Culturally Relevant Pedagogy
Hernandez, A. (2022)	Closing the achievement gap in the classroom through culturally relevant pedagogy