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Students Mathematical Problem Solving Abilities With a Culturally Responsive Teaching Approach: Systematic Literature Review

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ABSTRACT

The low mathematical problem-solving ability of Indonesian students is often attributed to learning designs that neglect students' cultural backgrounds, making the material feel abstract and less relevant. This study aims to synthesize research findings regarding the implementation of Culturally Responsive Teaching (CRT) and ethnomathematics in improving the mathematical problem-solving abilities and self-efficacy of Junior High School (SMP) students. This study employs a Systematic Literature Review (SLR) method using PRISMA 2020 guidelines, reviewing 28 selected articles from 1,248 publications between 2019-2024 across five reputable databases. The synthesis results indicate that integrating CRT with learning models such as Problem-Based Learning (PBL) and Realistic Mathematics Education (RME) consistently has a positive impact on critical and reflective thinking skills, as well as strengthening students' self-confidence through relevant cultural contexts. Although there are challenges related to teacher training and the lack of culture-based learning resources, it is concluded that the CRT approach is an effective, inclusive, and contextual pedagogical strategy to improve the quality of mathematics learning, which requires continuous training support for teachers.

1. Introduction

In the twenty-first century, education systems worldwide are challenged to equip students with higher order thinking skills (HOTS), including critical, creative, analytical, and reflective thinking, as a foundation for active participation in a complex, technology-driven, and culturally diverse society. Mathematics education has a central role in this agenda because it provides structured opportunities for students to reason logically, generalize patterns, and solve non-routine problems that mirror real-life situations.

International assessments such as PISA consistently emphasize problem solving as a core mathematical competency from primary through secondary levels, showing that the ability to formulate, represent, and solve problems is more crucial than mere procedural fluency (Mohamed Elsayed, 2022). At the same time, research in various contexts has shown that instructional models that explicitly incorporate problem solving can strengthen critical thinking dimensions such as interpretation, analysis, and evaluation, which are recognized as key components of twenty-first century skills (Utami et al., 2026).

Despite these global expectations, empirical evidence indicates that students in many countries, including Indonesia, continue to struggle with mathematical tasks requiring higher-order thinking and problem solving. Reports from PISA 2018 show that Indonesian students' performance in mathematics remains below the OECD average, particularly in items assessing reasoning and application of concepts in unfamiliar contexts, signaling persistent weaknesses in conceptual understanding and flexible problem solving.

Research on students' thinking processes in solving mathematical problems reveals that learners with lower mathematical ability tend to rely on computational rather than conceptual strategies, which limits their capacity to transfer knowledge to new situations and hampers the development of reflective thinking (Sinaga et al., 2023). Other studies similarly indicate that conventional, teacher-centered approaches and low-level cognitive questioning still dominate many classrooms, resulting in insufficient opportunities for learners to engage in non-routine problems, argumentation, and self-regulation in mathematical reasoning (Oliver, 2024 ; Kasinta, 2025).

One critical factor underlying this gap is the disconnection between mathematics instruction and students' socio-cultural backgrounds. In numerous classrooms, mathematics is presented as a set of abstract symbols and procedures detached from learners' lived experiences, community practices, and cultural knowledge systems. This disconnect is particularly problematic in multicultural settings such as Indonesia, where students come from diverse ethnic, linguistic, and socio-economic backgrounds that shape their ways of knowing and reasoning. Evidence from various subject areas shows that learning becomes more meaningful and motivating when instructional designs connect content to familiar contexts and experiences. For instance, project-based learning supported by animated video media has been found to improve elementary students' learning outcomes by situating tasks in meaningful, contextualized projects (Puspitaningrum et al., 2025).

Similarly, the use of contextual problem-based environments and simulations helps students construct deeper understanding and transfer cognitive skills beyond rote procedures (Rosário et al., 2025). These findings imply that culturally and contextually grounded approaches may be crucial for fostering mathematical problem solving that is both cognitively demanding and personally relevant. In response to these challenges, Culturally Responsive Teaching (CRT) has emerged as a promising pedagogical framework for bridging the gap between formal mathematics and students' cultural experiences (Msomi & Rzyankina, 2024).

CRT emphasizes validating and leveraging learners' cultural identities, languages, and community practices as resources for instruction, thereby making learning more meaningful, engaging, and equitable in mathematics, this can involve embedding tasks in local cultural artefacts such as batik patterns, traditional architecture, indigenous games, or community economic activities to illustrate mathematical ideas and invite problem solving grounded in familiar contexts. Empirical studies in broader subject domains show that when students engage in inquiry and problem-based activities that build on their prior experiences, their critical thinking, creativity, and independence increase significantly (Widiastuti et al., 2023). Cooperative and game-based learning environments that are responsive to learners preferences and social interaction patterns also demonstrate positive effects on cognitive outcomes, motivation, and numeracy skills (Mahmud Muhammad Sofwan, 2023).

Although a growing body of research has examined innovative learning models such as problem-based learning, guided inquiry, discovery learning, and project-based learning to promote higher order thinking and problem solving, the evidence related specifically to CRT in mathematics remains dispersed and partially documented. For example, studies show that problem-based learning supported by digital tools can improve students critical thinking and learning outcomes across various science and language topics (Razak et al., 2022), Cooperative structures like STAD and TGT, often combined with digital games, have also been reported to enhance students cognitive outcomes and motivation.

However, these studies rarely foreground cultural responsiveness as an explicit theoretical lens, and their findings are scattered across different grade levels, subjects, learner characteristics, and local contexts. As a result, there is still limited synthesized knowledge regarding how, and to what extent, culturally responsive approaches in mathematics specifically contribute to students' problem-solving competence, particularly at the lower secondary level (Ntumi et al., 2026).

Given this situation, a systematic literature review (SLR) is needed to organize and critically evaluate the existing empirical evidence on students' mathematical problem-solving abilities within culturally responsive teaching environments. An SLR offers a rigorous and transparent procedure for identifying, appraising, and synthesizing relevant studies, thereby reducing bias and providing a coherent picture of what is known and where gaps remain. By focusing on research that explicitly or implicitly incorporates CRT principles in mathematics instruction, this review aims to clarify the characteristics of effective culturally responsive practices, the types of mathematical problem-solving tasks used, and the learning outcomes most frequently impacted.

Therefore, the present study is designed as a Systematic Literature Review with the specific purpose of evaluating the contribution of culturally responsive teaching approaches to improving junior secondary students' mathematical problem-solving abilities. The findings are expected to provide theoretical insights into the intersection of CRT and mathematical problem solving, as well as practical guidance for teachers and curriculum developers in designing inclusive,

context-rich learning experiences that promote equitable participation and higher order thinking in mathematics (Santos-Trigo, 2024).

2. Methodology

This study employed a Systematic Literature Review (SLR) design to investigate research on the implementation of Culturally Responsive Teaching (CRT) for enhancing junior high school student's mathematical problem-solving skills. As a secondary study, the SLR synthesizes findings from primary empirical research rather than collecting data directly from participants. This design was selected because structured reviews are widely used to map existing evidence, identify effective pedagogical approaches, and inform the development of instructional innovations such as teaching modules and digital learning resources in diverse educational contexts. By adopting an SLR, the present research aims to provide a rigorous evidence base to support both theoretical development and classroom practice in mathematics education (Syahar et al., 2025).

SLR in this study is understood as a research approach that systematically identifies, evaluates, and synthesizes available empirical studies following explicit, replicable procedures. This approach is characterized by clearly formulated research questions, predefined search strategies, transparent inclusion and exclusion criteria, and documented steps of data extraction and synthesis. Such rigor distinguishes SLR from traditional narrative reviews and strengthens the reliability of its conclusions for guiding curriculum and material development, as can also be seen in review-based or needs-analysis studies used to design instructional multimedia, e-modules, and problem-based learning resources. In this context, SLR functions not only as a summarizing tool but also as an analytical framework to trace trends, gaps, and methodological patterns in CRT-oriented mathematics research (Penelitian et al., 2026)

The subjects of this research are scientific articles and conference papers that report primary empirical studies on the application of CRT, culturally relevant pedagogy, or ethno mathematics in mathematics learning at the junior high school or equivalent level (approximately 12–15 years old). The objects of investigation are the characteristics and outcomes of these studies, particularly the influence of culturally responsive approaches on student's mathematical problem-solving abilities, including related constructs such as reasoning, representation, and self-efficacy. This focus aligns with previous development studies that target specific cognitive or affective outcomes such as conceptual understanding, critical thinking, or scientific attitudes as the main objects of evaluation when designing and testing instructional modules and learning media (Amulraj & Al-Hidabi, 2024).

Data collection was carried out through a systematic online search of reputable scholarly databases. Search strings combined keywords related to CRT, mathematics education, problem solving, and lower secondary schooling using Boolean operators (AND, OR) to maintain a balance between breadth and specificity. Additional filters were applied to limit results to Indonesian and English

language publications, peer-reviewed journal articles, and full-text accessibility. These procedures mirror the search strategies adopted in development and effectiveness studies of e-modules and interactive multimedia, which rely on high quality, up to date literature as a conceptual and empirical foundation (Alyus fitri et al., 2024). All records were then imported into reference-management software to organize citations, remove duplicates, and facilitate screening.

To ensure data validity, a set of inclusion and exclusion criteria was established prior to screening. Eligible studies had to (1) examine CRT, culturally relevant pedagogy, or ethnomathematics within mathematics instruction; (2) involve junior high school students or learners in the corresponding age range; (3) report outcomes related to mathematical problem-solving skills or closely associated competencies; and (4) present primary empirical findings published in reputable journals during the 2019 - 2024 period. The overall article selection process is visualized through the PRISMA 2020 diagram in Figure 1.

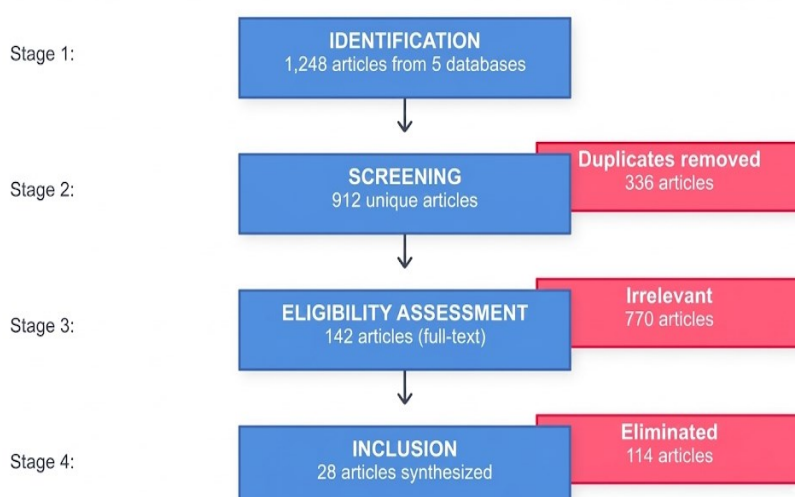


Figure 1. PRISMA Diagram of the Article Selection Process

Excluded were non-systematic reviews, studies outside mathematics, non peer-reviewed proceedings, and publications without accessible full text. The screening process, consisting of title abstract assessment followed by full-text review, was conducted by two independent reviewers to minimize subjectivity, reflecting quality control practices commonly used in validation and usability studies of instructional modules and e-learning resources (Gusenbauer & Gauster, 2025).

Data analysis employed a narrative synthesis technique. Each included article was coded according to bibliographic information (author, year), research methodology, educational setting, and description of CRT implementation, target mathematical content, and reported effects on problem-solving or related skills. The coded data were then compared and grouped to reveal convergent and divergent findings, as well as thematic patterns across different cultural contexts, instructional designs, and learner characteristics. This iterative process of reading, interpreting, and

cross-checking results is consistent with analytical procedures used when evaluating the effectiveness, practicality, and validity of educational modules and media in prior research (Muti, 2026). Through this synthesis, the study generates an integrated overview of how CRT has been applied in mathematics classrooms and the extent to which it contributes to improving junior high school students' mathematical problem-solving performance.

3. Results and Discussion

A literature search conducted through five reputable scientific databases: Scopus, ScienceDirect, SpringerLink, Taylor & Francis Online, and Google Scholar, yielded 1,248 articles initially deemed potentially relevant to the research topic. After an initial screening process based on title and abstract, 1,121 articles were eliminated because they did not specifically discuss the application of *Culturally Responsive Teaching* (CRT) in mathematics learning. The next stage involved reviewing the full text of the remaining 127 articles. Of these, 99 articles were excluded because they did not meet established methodological or substantive standards, including not explicitly applying CRT ($n = 42$), not highlighting mathematical problem-solving skills ($n = 33$), using research subjects other than junior high school level ($n = 15$), and not undergoing peer review ($n = 9$). The final results of the overall selection produced 28 articles that met the inclusion criteria and were used as analysis material for this research, the flow of which is visualized through the PRISMA 2020 diagram including the stages of identification, screening, eligibility, and inclusion of articles.

Based on the results of the synthesis of the 28 articles, three main tendencies were found that indicate a relationship between the application of *Culturally Responsive Teaching* (CRT) and the improvement of students' mathematical problem-solving abilities, namely the implementation of CRT in mathematics learning, the integration of CRT with problem-based learning models, and the influence of CRT on increasing students' *self-efficacy* and learning motivation. A summary of all articles that have been analyzed is presented in Table 1 below.

Table 1. Summary of Articles Based on SLR Results

No	Author & Year	Research methods	Research Context	Key Results
1	Gay (2018)	Descriptive qualitative	Multicultural education	CRT increases the relevance of learning and student participation.
2	Ladson-Billings (1995)	Conceptual study	Primary and secondary education	CRT links academic content to students' cultural identities.
3	Ladson-Billings (2021)	Conceptual study	Post-pandemic education	CRT strengthens students' social justice and academic identity.
4	Banks (2020)	Theoretical study	Global education	CRT fosters multicultural awareness

				and character in students.
5	Rosa & Orey (2021)	Qualitative case study	Ethnomathematics in Brazilian Middle School	Integration of local culture improves understanding of geometric concepts.
6	D'Ambrosio (2020)	Literature review	Global (Ethnomathematics)	Local culture serves as a bridge in understanding mathematical concepts.
7	Aydin & Ubuz (2020)	<i>Quasi-experimental</i>	Turkish Junior High School	Culture-based PBL improves problem-solving skills.
8	Rahmawati & Santoso (2020)	<i>Systematic Review</i>	Indonesia	The PBL model effectively improves students' critical and collaborative thinking.
9	Fitriani, Wulandari, & Rahmawati (2022)	<i>Mixed methods</i>	Indonesian Junior High School	Local culture-based learning increases students' <i>self-efficacy</i> .
10	Sardin, Kusumah, & Martadiputra (2025)	<i>Systematic Literature Review</i>	Mathematics education	PBL and RME are most effective in increasing <i>self-efficacy</i> .
11	Schunk & DiBenedetto (2021)	Theoretical study	Educational psychology	Self-efficacy influences motivation and academic performance.
12	Nasir & Hand (2020)	Qualitative	Urban cultural context	Teaching that does not take culture into account reduces participation.
13	Wulandari, Pratama, & Susilo (2021)	Field study	Indonesian multicultural school	Teachers have difficulty implementing CRT without training and contextual media.
14	Raharjo & Fitriyani (2020)	<i>Quasi-experimental</i>	Indonesian Junior High School	The integration of CRT and PBL enhances reflective thinking skills.
15	Setiawan & Hanifah (2021)	<i>Action research</i>	Central Java Middle School	The use of batik motifs as a context increases interest in learning mathematics.
16	Arifin et al. (2021)	<i>Case study</i>	Islamic boarding school	Religious cultural values support the formation of mathematical character.
17	Santosa & Dewi (2022)	<i>Experimental</i>	Bali Junior High School	The local culture-based RME model enhances critical thinking skills.
18	Kurniasih & Yuliani (2021)	<i>Survey research</i>	Indonesian junior high school math teacher	Teachers understand CRT but are not yet able to implement it fully.

19	Purwanti & Rahmad (2020)	<i>Action research</i>	Kalimantan Middle School	The use of traditional games strengthens arithmetic concepts.
20	Nugraha & Fitri (2022)	<i>Qualitative case study</i>	Sundanese culture-based school	Local cultural activities help students understand patterns and geometry.
21	Sari & Ningsih (2021)	<i>Quantitative experimental</i>	West Sumatra Middle School	CRT has a significant influence on student learning outcomes and activity.
22	Fauzan et al. (2023)	<i>Mixed methods</i>	Indonesian mathematics education	The integration of CRT and RME enhances creative thinking skills.
23	Handayani & Yusuf (2022)	<i>Qualitative phenomenology</i>	East Java Middle School	Students are more confident learning mathematics in their cultural context.
24	Prasetyo & Nurhadi (2021)	<i>Action research</i>	Yogyakarta Junior High School	Culture-based learning activities foster collaboration and participation.
25	Rini & Taufiq (2023)	<i>Experimental study</i>	Indonesian high school	CRT improves learning outcomes and reduces mathematical anxiety.
26	Lestari & Hidayat (2023)	<i>Correlational study</i>	West Java Middle School Students	<i>Self-efficacy</i> is positively related to problem-solving ability.
27	Hanifah & Rohmad (2024)	<i>Systematic mapping review</i>	Culture-based mathematics learning	CRT research trends show the dominance of the local Southeast Asian context.
28	Xiao & Watson (2019)	Methodological guide	SLR Research	Provides guidance for replicating the steps of a systematic review.

An analysis of the entire article shows that the implementation of *Culturally Responsive Teaching* consistently has a positive impact on students' mathematical problem-solving, learning motivation, and *self-efficacy*. This approach encourages learning that is relevant to real life, fosters self-confidence, and increases active student participation. emphasize that learning aligned with cultural identity allows students to feel socially valued, thus increasing their enthusiasm for learning mathematical concepts previously considered abstract (Worlds, 2022).

Research conducted in Indonesia also supports these findings, demonstrated that using batik as a context can increase students' interest in mathematics, demonstrated that traditional games can strengthen arithmetic comprehension. Globally illustrate that local culture can be an effective medium for connecting formal mathematical concepts with students' everyday experiences. Furthermore, CRT also makes a significant contribution to students' affective aspects, particularly *self-efficacy*.

Research by Guerrero et al., (2024), suggests that students' self-efficacy increases when they learn through a familiar cultural context, as prior successful experiences

strengthen their self-confidence. who demonstrated that culture-based learning can reduce math anxiety and increase students' intrinsic motivation (Zuliana et al., 2025), The integration of CRT with problem-based learning models such as *Problem-Based Learning* (PBL) and *Realistic Mathematics Education* (RME) has also been proven effective in improving critical thinking skills and contextual problem-solving abilities (Anugraheni et al., 2025). These models enable students to explore real-world issues within their own culture, making the learning process more reflective, relevant, and meaningful.

However, several studies have also noted challenges in implementing CRT in Indonesian schools, particularly related to limited teacher training and the availability of culture-based learning tools (Patras et al., 2023). Teachers often understand the concept of CRT but struggle to implement it consistently in culturally heterogeneous classrooms. Therefore, institutional support and ongoing training are needed to enable teachers to more systematically integrate local cultural elements into mathematics learning. Overall, the results of this *Systematic Literature Review* demonstrate that *Culturally Responsive Teaching* functions not only as a pedagogical strategy to improve mathematics learning outcomes but also as a means of strengthening cultural identity, social empathy, and equity in education. With appropriate implementation, mathematics learning can be a medium that accommodates cultural diversity while encouraging the development of higher-order thinking skills, which are essential in today's global era.

4. Conclusion

Based on the results of a systematic review of 28 analyzed articles, it can be concluded that the application of Culturally Responsive Teaching (CRT) and ethnomathematics contributes significantly to improving junior high school students' mathematical problem-solving abilities and self-efficacy. Culturally responsive learning helps students connect abstract mathematical concepts with their cultural experiences, thereby improving conceptual understanding, active participation, and self-confidence in learning mathematics. The integration of CRT with problem-based learning models such as Problem-Based Learning (PBL) and Realistic Mathematics Education (RME) has been shown to strengthen critical and reflective thinking skills and foster successful learning experiences that positively impact student self-efficacy . This demonstrates that culture-based learning is not only effective cognitively but also strengthens students' affective aspects by increasing motivation and self-confidence. However, research also reveals challenges in implementing CRT in Indonesia, particularly limited teacher training and the availability of culture-based learning tools. Therefore, institutional support and ongoing training are needed to enable teachers to implement CRT consistently and contextually, according to students' cultural characteristics. Thus, the CRT and ethnomathematics approaches can be recommended as effective and relevant pedagogical strategies to improve the quality of mathematics learning at the junior high school level, both from a cognitive, affective, and socio-cultural perspective

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