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Culturally Responsive Teaching as a Strategy to Improve Students' Science Literacy in Higher Education

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Abstract: The problem in this research is the low level of science literacy among students caused by learning that is less responsive to cultural contexts. The objective of this research is to examine the application of culturally responsive teaching in improving science literacy among university students in higher education. The method used is a systematic literature review of 40 scientific articles published between 2019 and 2025, obtained from the Scopus and Google Scholar databases. Data analysis was conducted through the stages of planning, implementation, and reporting, referring to PRISMA guidelines, and identifying patterns, themes, and key findings from each article. The research results show that a culturally responsive learning approach, such as the integration of local cultural values, the use of socio-cultural contexts in learning, and the creation of inclusive relationships between lecturers and students, can enhance students' science literacy. Improvements occurred in critical thinking skills, contextual understanding of science concepts, and learning motivation. The conclusion of this study is that culturally responsive teaching significantly contributes to the enhancement of science literacy and has the potential to be an inclusive and transformative pedagogical strategy in higher education settings.

Keywords: Culturally Responsive Teaching; Science Literacy; Higher Education

Introduction

Efforts to improve the quality of higher education cannot be separated from attention to students' science literacy skills (Sholahuddin et al., 2021). Scientific literacy is not only related to the ability to understand scientific concepts theoretically, but also includes critical thinking skills, the ability to make decisions based on scientific data, and an understanding of the impact of science on social and cultural life (Fortus et al., 2022; Valladares, 2021b). In today's complex global era, students are expected to think scientifically in solving real-world problems that are multidimensional. However, various studies indicate that the level of science literacy among students in Indonesia is still relatively low, as evidenced by their limited ability to contextualize scientific information and the restricted application of scientific knowledge in daily life.

The low level of science literacy among students can also be linked to a learning approach that is not yet fully adaptive to the cultural context, socio-economic background, and diverse learning experiences of the students (Chen et al., 2021; Smith et al., 2022). Learning in many universities is still oriented towards a traditional, homogeneous approach, lacking in empowering cultural diversity as an educational potential, and not sufficiently responsive to learners' needs (Aasebø & Willbergh, 2022). In Indonesia's multicultural society, neglecting students' cultural backgrounds has the potential to create disparities in the

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learning process, weaken motivation, and hinder students' active engagement in understanding and constructing scientific knowledge.

Along with these challenges, culturally responsive teaching has emerged as an innovative approach that emphasizes the importance of integrating cultural context into the learning process (Chang & Viesca, 2022; Kondo, 2022; Markey et al., 2021). Culturally responsive teaching is based on the principle that cultural diversity is not an obstacle, but rather a source of wealth that can strengthen the learning process (Kotluk & Aydin, 2021). Through culturally responsive teaching, lecturers are expected to understand students' cultural identities, build meaningful relationships, and connect learning materials with values, practices, and social realities that are close to students' lives (Berlian & Huda, 2022). In this case, culturally responsive teaching not only enhances the social sensitivity of lecturers but also strengthens the relevance of science education in the eyes of students.

Research Affuso et al. (2023); Alhanachi et al. (2021); Tanase (2022); Yeh et al. (2021) shows that the implementation of culturally responsive teaching has a positive impact on increasing student motivation, class participation, and academic achievement.In science education, culturally responsive teaching contributes to bridging scientific concepts with students' socio-cultural contexts, making learning more meaningful and contextual. culturally responsive teaching also encourages deeper cognitive engagement among students because they feel valued and understood in their unique backgrounds (Anyichie et al., 2023). Thus, culturally responsive teaching has strategic potential in enhancing science literacy through a more inclusive and humanistic learning approach.

However, despite the numerous studies addressing the effectiveness of culturally responsive teaching across various educational levels, research specifically examining the implementation of culturally responsive teaching in enhancing science literacy at the college level remains limited, particularly in the form of systematic literature reviews. A systematic literature review is needed to critically summarize previous research findings, identify trends, gaps, and opportunities for further research, and provide a strong conceptual foundation for the development of future learning strategies. This study is important considering the role of higher education institutions as producers of a scientifically literate and globally competitive generation.

Based on that background, this study aims to conduct a systematic literature review on the application of culturally responsive teaching in improving science literacy among university students. This research will specifically identify the approaches of culturally responsive teaching used in science education, evaluate their effectiveness based on previous studies, and analyze the factors that support or hinder the implementation of culturally responsive teaching in the context of higher education. Thus, the results of this research are expected to contribute both theoretically and practically in designing science teaching strategies that are more adaptive, inclusive, and based on cultural justice.

This research seeks to answer the main question: how can the implementation of culturally responsive teaching improve science literacy among college students? With a systematic literature review approach, this study will compile, critically assess, and synthesize various relevant research to provide a comprehensive overview of the relationship between culturally responsive teaching and science literacy. The findings of this research are expected to not only enrich academic studies but also serve as practical guidelines for lecturers, curriculum developers, and policymakers in building an inclusive and transformative science learning ecosystem in higher education environments.

Method

Research Methods

This research uses the systematic literature review approach. systematic literature review is a research approach designed to identify, critically assess, and synthesize all relevant research related to a specific research question, topic, or phenomenon under study, using systematic, transparent, and replicable procedures (Dekkers et al., 2022; Sugiyono, 2022). Unlike regular literature reviews that are narrative and often subjective, a systematic literature review is conducted through structured stages to identify, select, evaluate, and synthesize literature relevant to the research question (Machi & McEvoy, 2021; Morin et al., 2021). In this study, a systematic literature review is used to comprehensively examine how the implementation of culturally responsive teaching contributes to improving science literacy among college students.

Planning Stage

At this stage, the researcher formulates the research objectives and develops a literature search strategy. The focus of the study is directed towards the relationship between the culturally responsive teaching approach and the improvement of students' science literacy. The main question to be answered is how the application of culturally responsive teaching can enhance science literacy among college students. In this stage, inclusion and exclusion criteria for articles are also established. The articles included in the study are scientific articles published between 2019 and 2025, available in Indonesian or English, sourced from journals indexed in

the scopus and google scholar databases, and discussing topics related to culturally responsive teaching, science literacy, students, and higher education. Articles that do not meet these criteria, such as non-peer-reviewed articles, unpublished conference papers, and articles that are not relevant to the context of higher education, are excluded from the analysis. To obtain relevant articles, the researchers used keywords such as "Culturally Responsive Teaching," "Science Literacy," "Students," and "Higher Education," as well as Boolean combinations like AND and OR to filter the search results more precisely.

Implementation Stage

The next stage is the implementation phase, where researchers systematically conduct the process of searching and selecting articles. The search is conducted through two main databases, namely scopus and google scholar. After the articles were collected, an initial screening process was conducted based on the title and abstract to identify relevance to the topic. Next, a full reading of the articles is conducted to further filter them based on the predetermined inclusion criteria. From the entire search results, 40 articles were obtained that met the criteria for further analysis. After the selected articles, a data extraction process was carried out, which included important information such as the author's identity and publication year, research objectives, the approach or strategy of culturally responsive teaching used, research results, and relevance to students' science literacy. The results of the extraction were analyzed using a thematic approach, which involved grouping the data into recurring themes from various studies, such as culturally responsive teaching strategies, the impact of implementing culturally responsive teaching on science literacy, and the supporting and inhibiting factors of implementing culturally responsive teaching in the context of higher education.

Reporting Stage

The final stage in this research is the reporting stage, where the results of the data synthesis are systematically organized in the results and discussion sections. In this stage, the researcher presents the main findings from the reviewed previous studies, as well as the general patterns and trends that emerge from the analyzed literature. The report is structured in a narrative form and supplemented with summary tables to facilitate readers in understanding the contributions and relevance of each study. In addition, at this stage, the researchers also conduct a critical analysis of the contributions, limitations, and development opportunities of previous studies.

Result and Discussion

The Culturally Responsive Teaching Approach in Science Education at the Higher Education

The culturally responsive teaching approach in science education at the university level begins with efforts to integrate local cultural values into the teaching materials (Min et al., 2022; Oladejo et al., 2022). This strategy aims to ensure that learning is not abstract and detached from the realities of students' lives, but rather close to the cultural experiences they encounter daily. Derlina et al. (2019) shows that Javanese culture-based physics learning tools can enhance student engagement and absorption of abstract physics concepts.In the study, the concepts of force and motion were explained using wayang and gamelan, making it easier for students to understand the material due to its high cultural relevance.

The culturally responsive teaching approach not only integrates local culture into the material but also relies on using students' socio-cultural contexts in class discussions (Anlimachie et al., 2025; Eun, 2023; Kumi-Yeboah & Amponsah, 2023; Meléndez-Luces & Couto-Cantero, 2021). This involves selecting topics relevant to the social backgrounds of students and encouraging them to connect science with real problems they face. Aoki et al. (2022); Brooks et al. (2021); Lubis et al. (2022); Ting et al. (2021) by applying the problem-based learning model based on culturally responsive teaching to discuss environmental issues in the student community. The results show that students not only became more active in discussions but also experienced an increase in science literacy, particularly in understanding contextual scientific concepts.

The culturally responsive teaching strategy is also evident in how professors build inclusive learning relationships by considering the differences in language, norms, and learning styles of students from diverse cultural backgrounds (Abdulah & Mahmud, 2025; Fatmawaty et al., 2024; Nguyen & Huynh, 2023; Peng et al., 2023). In a study by Lau & Shea (2024); Li (2025); Rachamim & Orland-Barak (2024), it was found that lecturers who build empathetic interpersonal communication, appreciate regional languages in informal discussions, and provide space for students' cultural expressions, significantly increased class participation. The relationship between lecturers and students, based on mutual respect, becomes a strong foundation for creating a conducive and enjoyable learning atmosphere.

The learning models widely adopted within the framework of culturally responsive teaching include project-based learning, problem-based learning, and think-talk-write, which have been modified to incorporate local values (Aldi et al., 2025; Hujjatusnaini

et al., 2022). Ogegbo and Ramnarain (2024) developing chemistry learning based on local comics and the think talk write model, which effectively enhances students' understanding of basic chemistry laws. This project involves local stories in the learning media, making the learning experience more contextual and engaging. These models not only teach science but also build cultural awareness and student identity.

The culturally responsive teaching approach in science education is not limited to one method, but rather encompasses various pedagogical strategies that strengthen the connection between science content and students' cultural lives (Hammond, 2021; Kondo, 2022). Active student engagement in science learning occurs when they feel recognized and culturally valued (Cian et al., 2022; Garzón-Díaz, 2021). This is in line with the findings Banwo et al. (2022); Berlian & Huda (2022); Comstock et al. (2023); Min et al. (2022), which shows that strengthening students' cultural identity through the culturally responsive teaching approach positively correlates with the improvement of their critical thinking skills and understanding of scientific concepts. Therefore, the integration of this approach is important to address the challenges of science education in a multicultural society.

The Effectiveness of Implementing Culturally Responsive Teaching on Improving Students' Science Literacy

The effectiveness of implementing culturally responsive teaching in science education has been empirically proven to enhance students' science literacy in higher education. Science literacy, which includes the ability to understand scientific concepts, think critically, and apply science in real life, is greatly influenced by teaching approaches that align with students' cultural backgrounds (Baltikian et al., 2024; Sutiani et al., 2021; Suwono et al., 2023). Cameron et al. (2024); Cheng et al. (2024); Magee & Willey (2024); Ogodo (2024) explaining that culturally responsive teaching creates a pedagogical bridge between academic material and students' life experiences, allowing them to more easily connect scientific concepts with their social and cultural realities. In this case, culturally responsive teaching not only enhances cognitive understanding but also builds a deeper affective and social meaning of learning.

Research by Derlina et al. (2019) In javanese culture-based physics education, there is a significant improvement in students' understanding of the concepts of motion and force after they study material contextualized with local culture such as gamelan and wayang. According to Guo et al. (2022); Howell & Brossard (2021); Ke et al. (2021) that students' science literacy has increased because they are able to see the connection between physical laws and cultural practices they have known since childhood. These results are in line with the study Adam et al. (2024, 2025); Koirala (2023) which emphasizes that the use of local wisdom in science education not only enhances cognitive engagement but also strengthens students' ability to evaluate scientific information within their socio-cultural context.

The effectiveness of culturally responsive teaching is also evident in its success in building students' motivation and confidence in openly expressing their understanding of science. Lubis et al. (2022); Papilaya & J. Tuapattinaya (2022) implementing a problem-based learning model based on local cultural context for biology education students to discuss environmental issues in their community. Students showed significant improvement in their ability to identify scientific problems, analyze contextual data, and propose scientific solutions based on local values. These findings reinforce the opinion Cobian et al. (2024); Polleck et al. (2022) that culturally responsive teaching not only transfers knowledge but also empowers students as agents of change in their own communities.

From the perspective of critical literacy, the culturally responsive teaching approach enables students to develop higher-order thinking skills that are greatly needed in facing the challenges of the 21st century. Anyichie et al. (2023); Chang & Viesca, (2022); Jeong et al. (2021); Valladares, 2021a) In her research on the relationship between Culturally Responsive Teaching and science literacy, she found that students who learn in an environment that acknowledges and values their cultural backgrounds perform better in science literacy, including the ability to read graphs, analyze scientific arguments, and convey ideas in the form of scientific writing. This shows that culturally responsive teaching supports the development of a scientific mindset rooted in students' real experiences and cultural identities.

The implementation of culturally responsive teaching has proven effective in improving students' science literacy because it combines three important aspects of learning: cognitive, affective, and cultural. When students feel valued and recognized in the learning process, they will be more motivated to understand and apply scientific knowledge. This finding is supported by Brown et al. (2022); Doucette et al. (2021); Snyder & Fenner (2021) which emphasizes the importance of multicultural education in creating equitable and culturally relevant learning opportunities. Therefore, the integration of Culturally Responsive Teaching in higher education science education is not only important for academic achievement but also for shaping students who are scientifically literate and sensitive to socio-cultural diversity.

Obstacles and Challenges of Implementing Culturally Responsive Teaching in Higher Education

The implementation of culturally responsive teaching in higher education often faces obstacles from the teaching staff, particularly the resistance of lecturers towards pedagogical approaches that are considered new and unconventional. Lecturers who are accustomed to using lecture-based or traditional methods tend to show skepticism towards the effectiveness of culturally responsive teaching, especially when it comes to integrating cultural dimensions that they have not yet mastered.According to research Brown et al. (2022); Koch et al. (2021), many lecturers have low confidence in their ability to implement culturally responsive teaching strategies, even though they acknowledge the importance of diversity in the classroom. This is exacerbated by the lack of multicultural-based pedagogical training at the higher education level, so lecturers do not have the conceptual or practical foundation to effectively develop culturally responsive teaching strategies.

Besides personal resistance, the limited conceptual understanding of culturally responsive teaching also poses a significant barrier to its implementation. Some lecturers equate culturally responsive teaching merely with "appreciating cultural differences," without understanding that culturally responsive teaching demands structural changes in planning, processes, and evaluation of learning. Genao (2021) and Mburu (2022) emphasizing that culturally responsive teaching is not just about cultural representation in teaching materials, but about restructuring the entire teaching strategy to align with the cultural values of the students. In Indonesia, Ikawati et al. (2024) and Rahmawati et al. (2023) expresses that the lack of Indonesian-language literature and limited academic discussions on culturally responsive teaching lead to misconceptions among lecturers about what and how culturally responsive Teaching is actually applied in science education.

On the other hand, administrative pressure and bureaucratic demands in the higher education system often force lecturers to continue using conventional approaches. The tight class schedules, strict curriculum targets, and number-based evaluation system make it difficult for lecturers to find time to design culturally contextual and reflective learning. This is reinforced by research findings Cardino & Ortega-Dela Cruz (2020); Hanaysha et al. (2023), which states that lecturers often feel they are not given enough space by the institution to explore alternative teaching approaches, especially those that require adjustments to materials and methods to align with students' social backgrounds. As a result, the implementation of culturally responsive teaching becomes limited to superficial aspects, such as cultural case studies, without touching the transformational essence of the approach.

The lack of institutional support in the form of training and cross-cultural collaboration also presents its own challenges. The study conducted by Hackett et al. (2023); Huang et al. (2023); Pryshliak et al. (2020) emphasizing the importance of diversity training for educators in higher education environments to build intercultural competence. However, in many universities in Indonesia, pedagogical training still focuses on curriculum or technology updates, while the aspect of cultural diversity has not yet become a priority. This condition causes lecturers to work individually in exploring the culturally responsive teaching approach, without systematic support from the institution, which ultimately leads to inconsistency and doubt in its implementation.

The challenge of implementing culturally responsive teaching also comes from the diverse perceptions of students towards this approach. Some students from dominant cultural backgrounds might feel unfamiliar or even uncomfortable when minority cultures receive more attention in class. This has the potential to create horizontal resistance among students that can hinder intercultural dialogue. Research Kumi-Yeboah & Amponsah (2023); Kurian (2024); Markey et al. (2021) shows that the implementation of culturally responsive teaching without an inclusive and reflective approach can create identity tensions in multicultural classrooms. Therefore, lecturers are required to have high cultural sensitivity and be able to facilitate a learning environment that is not only culturally responsive but also socially and emotionally equitable. Without this competence, culturally responsive teaching can actually create new gaps in the learning process.

Conclusion

Based on the findings and studies conducted, it can be concluded that the Culturally Responsive Teaching approach has been implemented in science education at the university level through various strategies such as the integration of local cultural values, the utilization of students' socio-cultural contexts, and the strengthening of inclusive relationships between lecturers and students. The implementation of this approach has proven effective in enhancing students' science literacy, particularly in aspects of conceptual understanding, active engagement, and critical thinking. However, the implementation of Culturally Responsive Teaching is not without challenges, including faculty resistance to new approaches, limited pedagogical understanding of cultural diversity, and administrative pressures that still promote the dominance of conventional approaches in the learning process. Therefore, institutional support,

continuous training, and curriculum updates that favor diversity are key to expanding and strengthening the practice of Culturally Responsive Teaching in higher education settings.

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