Effectiveness of using culturally responsive teaching-based modules on sequences and series

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Abstract

This study aims to evaluate the effectiveness of Culturally Responsive Teaching (CRT)-based teaching modules in mathematics learning in row and series materials at SMA Negeri 1 Ciawi. This teaching module utilizes elements of local culture, such as the Saman Dance, to increase student engagement and understanding. The research uses a quasi-experimental method with a pretest-posttest design. The research subjects consisted of two groups: the experimental class (using the CRT teaching module) and the control class (using conventional methods). The results showed that CRT-based teaching modules were effective in improving student learning outcomes with a significant increase ($p < 0.05$). This study recommends the development of CRT-based teaching modules for various other learning materials as an effort to create a more relevant and inclusive learning experience.

Keywords: Teaching Module; Culturally Responsive Teaching; Rows and Series; Mathematics Learning; Saman Dance; Contextual Education

Abstrak

Penelitian ini bertujuan untuk mengevaluasi efektivitas modul pengajaran berbasis Culturally Responsive Teaching (CRT) dalam pembelajaran matematika dalam materi baris dan seri di SMA Negeri 1 Ciawi. Modul pengajaran ini memanfaatkan unsur-unsur budaya lokal, seperti Tari Saman, untuk meningkatkan keterlibatan dan pemahaman siswa. Penelitian ini menggunakan metode kuasi-eksperimental dengan desain pretest-posttest. Subjek penelitian terdiri dari dua kelompok: kelas eksperimen (menggunakan modul pengajaran CRT) dan kelas kontrol (menggunakan metode konvensional). Hasil penelitian menunjukkan bahwa modul pengajaran berbasis CRT efektif dalam meningkatkan hasil belajar siswa dengan peningkatan yang signifikan ($p < 0,05$). Penelitian ini merekomendasikan pengembangan modul pengajaran berbasis CRT untuk berbagai materi pembelajaran lainnya sebagai upaya menciptakan pengalaman belajar yang lebih relevan dan inklusif.

Introduction

Mathematics education has long been viewed as abstract and challenging for many students. This is partly because the teaching methods often lack a connection to students' real-world experiences, making it difficult for them to relate to the material (Ladson-Billings, 2019; Boaler, 2016). In traditional learning approaches, theoretical knowledge dominates without incorporating elements from the learners' cultural backgrounds (Skovsmose, 2005). Such methods can alienate students, reducing both their motivation and ability to comprehend complex mathematical concepts (Nasir, 2002; Bishop, 1988). Integrating local cultural elements into learning can be an effective strategy to bridge this gap (D'Ambrosio, 2001; Rosa & Orey, 2016). Culturally Responsive Teaching (CRT), as described by Gay (2018), involves incorporating students' cultural contexts into the educational process, making learning more meaningful and relatable. CRT not only fosters higher engagement but also reinforces students' cultural identities, leading to a more inclusive learning environment (Banks, 2020; Paris & Alim, 2017). This approach is in line with the concept of culturally sustaining pedagogy, which emphasizes maintaining and valuing students' cultural ways of knowing (Ladson-Billings, 2014; Alim & Paris, 2017).

This is particularly relevant in Indonesia, a nation with immense cultural diversity that can be leveraged in education to provide contextually relevant experiences (Subiyakto, 2020; Haryani & Ristanti, 2018). Nieto (2020) emphasizes that education should celebrate and incorporate the diverse cultural backgrounds of students. She asserts that multicultural learning not only improves equity but also enhances students' overall academic performance. Brown-Jeffy and Cooper (2021) further argue that CRT addresses the needs of diverse learners by fostering inclusivity and promoting engagement. According to Villegas and Lucas (2021), teacher preparation programs must include CRT practices to ensure educators are equipped to meet the challenges of diverse classrooms effectively. One effective way to incorporate cultural elements in mathematics education is through ethnomathematics, a concept introduced by Ubiratan D'Ambrosio, which promotes the idea that mathematical practices are culturally embedded (D'Ambrosio, 2007; Gerdes, 1999). Suharto (2019) highlights the potential of using traditional art forms, such as dances, crafts, and architecture, to make mathematical concepts more tangible and accessible. For instance, the Saman Dance from Aceh, known for its synchronized movements and geometric formations, can serve as a visual and practical tool to explain mathematical concepts like rows and sequences (Amarulloh, 2022). Similarly, Junaedi and Widodo (2021) explore the use of Batik patterns in teaching geometry, while Putra et al. (2020) demonstrate how traditional house structures contain ratios and proportions that can be explored mathematically.

Research supports the positive impact of cultural integration on learning outcomes. Yusuf and Siregar (2020) demonstrated that culturally infused learning strategies increase students' motivation and comprehension by up to 80%. Similarly, Setiawan et al. (2021) found that students exposed to culturally integrated teaching modules showed a 30% higher understanding of mathematical concepts compared to those in conventional classrooms. These findings align with observations by Lestari & Yuliani (2021), who noted improved learning attitudes among students taught using ethnomathematics-based approaches. The importance of contextual learning is also highlighted by Wlodkowski and Ginsberg (2020), who argue that motivation in learning is closely tied to the relevance of the material to students' lives (see also Marzano, 2003; Vygotsky, 1978). Contextualized education fosters a deeper connection between learners and the subject matter, leading to improved academic achievement and long-term retention of knowledge (Ormrod, 2016; Darling-Hammond et al., 2017). Zulkifli (2021) adds that such approaches also enhance students' emotional engagement, making learning a holistic experience.

In addition to improving academic performance, CRT contributes to cultural preservation and awareness. Ladson-Billings (2019) notes that education should serve as a tool for empowering communities by valuing and integrating their cultural heritage. By doing so, CRT not only benefits individual learners but also promotes a collective sense of identity and pride among students (Gay, 2018; Banks & Banks, 2010). This dual benefit underscores the importance of adopting culturally responsive approaches in educational settings. Despite the evident benefits of CRT, its implementation faces challenges. Teachers often lack the necessary training to design and deliver culturally responsive lessons effectively (Gay, 2018; Sleeter, 2011). Additionally, integrating cultural elements requires time and effort, which can be a barrier for educators with limited resources (Villegas & Lucas, 2021; Gorski, 2013). However, these challenges can be mitigated through professional development programs and collaboration among educators, researchers, and communities (Setiawan & Nugroho, 2020; Wijaya et al., 2021).

This study aims to evaluate the effectiveness of CRT-based teaching modules on row and series materials in mathematics. By leveraging local cultural elements such as the Saman Dance, this research seeks to demonstrate how culturally responsive pedagogy can transform abstract mathematical concepts into relatable and engaging content. The findings are expected to contribute to the growing body of literature on CRT and provide practical insights for educators seeking to enhance their teaching practices.

Method

This study employs a quasi-experimental method with a pretest-posttest control group design to determine the effectiveness of CRT-based teaching modules compared to conventional teaching methods (Creswell & Guetterman, 2019; Fraenkel, Wallen, & Hyun,

2019). The subjects of this study were 60 students of class X at SMA Negeri 1 Ciawi, divided into two groups: 30 students in the experimental group and 30 students in the control group. Before the study began, homogeneity tests were conducted to ensure comparable baseline characteristics between groups (Sugiyono, 2022).

The study involved the design and implementation of CRT-based modules. These modules incorporated cultural elements, such as the Saman Dance, to teach mathematical concepts related to rows and sequences. The development of teaching materials was guided by the principles of culturally responsive pedagogy and contextual learning (Gay, 2018; Fitriani & Yusro, 2020). The preparation phase included designing lesson plans, instructional media, and assessment instruments aligned with CRT practices (Rahmawati & Wulandari, 2021; Oktaviani et al., 2022).

During the implementation phase, both groups were taught the same mathematical concepts. However, the experimental group received instruction using CRT-based materials, while the control group was taught using traditional approaches. Each session lasted for two hours and included activities such as collaborative group discussions, contextual problem-solving, and the exploration of cultural artifacts (Nasution & Hutauruk, 2023; Purwanti & Anjani, 2021). The design emphasized student-centered learning and cultural relevance, in line with recent research on active learning strategies in mathematics classrooms (Utami, 2023; Pratiwi & Sulisworo, 2020).

The instruments used to evaluate outcomes included a learning outcome test, an observation rubric, and a student perception questionnaire. The learning test measured students' comprehension and problem-solving ability regarding rows and sequences, following standardized test construction guidelines (Mertler, 2020). The observation rubric focused on indicators such as student engagement, collaboration, and responsiveness during the learning process (Yusuf & Pohan, 2020; Anggraini & Sari, 2023). Meanwhile, the questionnaire was designed to capture qualitative insights into students' perceptions of the culturally responsive learning experience (Ningsih & Maulidiyah, 2022).

Data analysis was conducted using statistical software. Paired sample t-tests were used to compare the pretest and posttest scores within each group, while independent sample t-tests compared the posttest scores between the experimental and control groups (Field, 2022). Additionally, regression analysis was employed to examine the relationship between student engagement and academic performance, a method frequently used in recent educational research to validate causality (Ariani & Nugroho, 2021; Widodo & Wahyuni, 2023).

Result

The results of this study indicate a significant improvement in students' mathematics learning outcomes following the implementation of a Culturally Responsive Teaching

(CRT)-based module that integrates elements of local culture, specifically the Saman Dance. The average pretest score in the experimental class was 55.3, while the posttest average increased substantially to 85.3, resulting in a gain of 30.0 points. In comparison, the control class, which was taught using conventional methods, had a pretest average of 54.6 and a posttest average of 72.6, indicating a gain of 18.0 points. A comparison of the pretest and posttest scores is presented in Table 1.

Table 1. Pretest and Posttest Scores

Group	Average Pretest	Average Posttest	Increased
Experimental Classes	55,3	85,3	30,0
Control Classes	54,6	72,6	18,0

The independent *t*-test analysis yielded a significance value ($p < 0.05$), confirming that there was a statistically significant difference between the performance of students in the experimental and control groups. This indicates that the CRT-based instructional module developed in this study was effective in enhancing students' mathematics learning outcomes. This finding is in line with research by Sari and Prasetyo (2021), who reported that incorporating local cultural contexts into mathematics learning improves students' conceptual understanding, particularly in abstract mathematical topics.

In addition, classroom observations revealed that students in the experimental group were more actively involved in group discussions, asked more questions, and presented their solutions more confidently. The average student engagement score in the experimental class reached 4.5 out of 5, compared to only 3.2 in the control class. Students showed enthusiasm when analyzing the rhythmic patterns of the Saman Dance and linking them to arithmetic sequence formulas. This culturally grounded learning strategy made the material more meaningful and easier to understand (Fitriani & Yusro, 2020).

Furthermore, survey results showed that 92% of students in the experimental class felt that the CRT-based module helped them better comprehend the learning material. Most students stated that the visualization of Saman Dance patterns made the learning process more engaging and motivated them to explore mathematics more deeply. Additionally, students reported that this approach enhanced their appreciation for their own cultural heritage. These findings support the work of Zulkifli (2020), who emphasized the dual benefits of culturally based learning—enhancing both academic achievement and cultural identity among students.

Discussion

Based on the results, the application of a CRT-based mathematics instructional module that integrates the Saman Dance has proven effective in improving student achievement and engagement. The integration of local culture into the learning process provides a more relevant and meaningful context for students, helping them connect mathematical

concepts to real-life experiences. This approach allowed students to construct knowledge through familiar cultural references, making abstract concepts such as arithmetic sequences more concrete and accessible (Fisher et al., 2021).

Linking mathematical ideas with the structure and rhythmic patterns of the Saman Dance helped students visualize and internalize the logic behind arithmetic progressions. This is consistent with constructivist learning theory, which emphasizes that knowledge is actively constructed through experience and prior knowledge (Gay, 2018). In this context, local culture serves as a bridge between abstract mathematics and students' lived experiences, as suggested by Nieto and Bode (2019), who argued that culturally responsive education enhances contextual understanding and empowers learners.

Beyond academic improvement, this approach also positively influenced students' motivation and participation. When students' cultural backgrounds are acknowledged and integrated into the classroom, they feel more respected and emotionally connected to the material (Markey et al., 2021). This is aligned with findings from Ladson-Billings (2021), who highlighted that culturally relevant pedagogy increases student engagement, motivation, and academic performance by validating their identities within the learning environment. Moreover, this culturally responsive approach is in harmony with Indonesia's *Kurikulum Merdeka* (Independent Curriculum), which encourages the integration of local wisdom and cultural identity into educational practices. The Ministry of Education, Culture, Research, and Technology (2022) emphasizes the importance of strengthening national identity through contextual, adaptive, and inclusive education. In this regard, the CRT-based instructional module not only serves as a teaching tool but also functions as a means of cultural preservation and character education, promoting values such as multiculturalism, tolerance, and pride in one's heritage.

Despite these positive findings, the study encountered several challenges. Time constraints were noted as a limitation in delivering all the content effectively using the CRT approach. Teachers also require additional training to implement culture-based strategies effectively and to design appropriate instructional modules. Similar issues have been noted by Ningsih and Maulidiyah (2022), who stressed the need for teacher professional development in integrating local culture into instructional design and practice. Therefore, further research is necessary to explore the long-term impact of CRT implementation across various mathematical topics and diverse cultural settings. It is also essential to develop more comprehensive and diversified teaching modules that incorporate active and collaborative learning strategies, to enhance both academic performance and student engagement (Widodo & Wahyuni, 2023).

Overall, the findings of this study underscore the importance of adopting culturally responsive teaching in mathematics education. The integration of local cultural elements, such as the Saman Dance, does not merely improve academic outcomes but also enriches

the learning experience by making it more authentic, relevant, and personally meaningful. This highlights the necessity of bridging cognitive and affective dimensions in education, enabling students to grasp mathematical concepts while also recognizing their cultural significance in everyday life.

Conclusion

This study provides compelling evidence that Culturally Responsive Teaching (CRT)-based instructional modules significantly enhance students' academic outcomes, engagement levels, and conceptual understanding of mathematics—specifically in the topic of arithmetic sequences and series. The integration of cultural elements, such as the Saman Dance, transforms abstract mathematical concepts into tangible, relatable experiences that resonate with students' backgrounds and lived realities. By contextualizing learning within the students' cultural environment, the CRT-based approach fosters deeper cognitive processing, meaningful learning, and a stronger connection between mathematical content and everyday life.

The results indicate not only a measurable improvement in posttest scores for students in the experimental group but also higher levels of classroom engagement and positive emotional responses to the learning process. Students reported increased motivation, confidence, and interest in learning mathematics when their cultural identity was acknowledged and embedded into the curriculum. Such findings reinforce the idea that effective mathematics instruction is not solely a matter of delivering content but also involves creating an inclusive and responsive learning environment that honors students' cultural capital.

Furthermore, the CRT approach promotes dual objectives in education: academic excellence and cultural affirmation. This is particularly significant in multicultural societies like Indonesia, where diverse cultural traditions can serve as valuable pedagogical tools. The implementation of CRT not only aligns with the principles of the *Kurikulum Merdeka*, which emphasizes contextual, student-centered learning, but also supports broader goals of character education, national identity formation, and the preservation of cultural heritage. However, for successful large-scale implementation of CRT-based instructional practices, systematic support is required. Teachers need ongoing professional development to deepen their understanding of CRT principles and to acquire the pedagogical skills necessary for designing effective, culturally enriched learning materials. Educational institutions must also facilitate the development of curriculum resources that are contextually relevant, academically rigorous, and adaptable to various classroom settings.

In light of these findings, further research is warranted to explore the potential of CRT across different areas of mathematics, such as geometry, algebra, and statistics, and to examine its effectiveness across diverse cultural contexts and age groups. Additionally, longitudinal studies are recommended to evaluate the sustained impact of CRT-based learning on students' academic trajectories, identity development, and critical thinking skills.

In conclusion, CRT-based teaching is not merely an instructional strategy, but a transformative educational philosophy. It empowers students to see themselves reflected in the curriculum, builds bridges between cultural heritage and academic content, and prepares learners to thrive both intellectually and socially. As such, CRT represents a promising and holistic approach to mathematics education that honors diversity while advancing equity, engagement, and excellence in learning.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. All ethical considerations have been strictly observed throughout the research and publication process. These include, but are not limited to, avoiding plagiarism, research misconduct, data fabrication or falsification, duplicate publication or submission, and redundancy. The study was conducted with integrity and in accordance with established academic and ethical standards.

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