



Bridging Culture and Mathematics: Exploring Teachers' Needs for Culturally Relevant Digital Resources in Primary Schools

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Abstract: This study aims to evaluate the feasibility and user acceptance of the Matematika Berbudaya e-book as a culturally responsive digital resource for primary mathematics learning in the Special Region of Yogyakarta, Indonesia. This study used a design and development research method with a field trial evaluation to assess the feasibility, acceptability, and perceived pedagogical value. A field trial involved 10 teachers and school leaders who completed a 26-item five-point questionnaire with an open-ended comment, and 89 students who completed a 20-item four-point questionnaire after using the e-book. Descriptive statistics were used to summarize item-level means and response distributions, and internal consistency was examined with Cronbach's alpha. Teachers reported strong endorsement of value integration and meaningful learning ($M = 4.80$ and 4.70), contextual and cultural integration (highest $M = 4.90$), and perceived usefulness and access (M from 4.50 to 4.60). Students also responded positively, with an overall mean of 3.3494 and responses concentrated in the upper categories (scores 3 and 4). The combined results indicate that the e-book is perceived as culturally meaningful, practically usable, and supportive of engaging learning experiences. These findings provide an empirical basis for refining instructional wording, layout cues, and navigation, and for informing the development of culturally grounded digital materials that align with Kurikulum Merdeka and principles of culturally responsive teaching.

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Introduction

Indonesia is a country rich in cultural diversity. However, in the field of education, this diversity is often not reflected in teaching materials (Kotluk & Kocakaya, 2018), including learning e-books. Although previous studies have shown that e-books can enhance students' learning interest and critical thinking skills (Mursalin, 2019; Ormancı & Çepni, 2020), most available e-books have yet to consider students' cultural backgrounds. As a result, when learning materials are disconnected from students' contexts, students' motivation and classroom participation may be reduced (Harni & Yustitia, 2025).

Several studies have explored interactive e-books based on local wisdom (Syafani & Tressyalina, 2023) and mathematics learning media (Fajarwati & Irianto, 2021). However, they have not adequately addressed how cultural integration can foster deeper thinking processes (Mouta et al., 2024). This gap often leaves students feeling disconnected from the material, making the learning experience less meaningful. Furthermore, mathematics teaching materials remain largely abstract and insufficiently contextualized (Syarifudin et al., 2021),



which makes it difficult for students to grasp concepts that do not align with their lived experiences.

In the post-pandemic era, e-books have emerged as an effective solution for distance learning (Temel & Gür, 2022; Us & Mahdayeni, 2019). Nevertheless, many existing e-books still fail to incorporate content that promotes meaningful learning (Malau, 2021). While the adoption of e-books in education is increasing, a gap persists in their practical application. This highlights the urgent need for e-books that not only focus on academic content but also integrate cultural elements and foster deep learning, thereby improving students' conceptual understanding and critical thinking skills.

This study seeks to bridge that gap by developing an e-book that is not only academically sound but also culturally relevant, designed to enhance student engagement and learning outcomes. In addition, this research contributes to the advancement of inclusive pedagogy in mathematics education, complementing previous studies that emphasize more inclusive teaching approaches (Sari et al., 2021; Subekti & Prahmana, 2021; Wahiddah et al., 2022).

Culturally Responsive Teaching (CRT) functions as a framework that enables educators to recognize and leverage students' cultural backgrounds in the learning process. CRT has emerged as a transformative tool for understanding the complexities of race in education, and the importance of applying its principles in educational practice cannot be overlooked (K. Madiratta, 2024). By integrating CRT, educators can create a more inclusive and relevant learning environment, which in turn enhances students' engagement and academic outcomes (Aisah et al., 2023). CRT emphasizes the recognition and appreciation of students' cultural backgrounds in pedagogy (Kong & Zou, 2022), aiming to connect instructional materials with students' cultural experiences to foster inclusivity (Gay, 2021). A fundamental principle of CRT is the integration of culture into the curriculum by linking it to the lived experiences of both students and teachers.

This issue is particularly relevant in Indonesia, where students' mathematical literacy remains relatively low. Results from the Programme for International Student Assessment (PISA) 2022 showed that Indonesia scored 366 in mathematics, which is significantly below the OECD average and indicates persistent challenges in students' ability to apply mathematical concepts in real-life situations (OECD, 2023). One of the contributing factors is the dominance of overly abstract and procedural teaching approaches in mathematics classrooms. Mathematics instruction in many schools still emphasizes memorization of formulas and routine problem-solving rather than conceptual understanding, contextual application, and higher-order thinking skills (Rakhmawati & Mustadi, 2022). As a result, students often struggle to connect mathematical concepts with everyday experiences, limiting their mathematical literacy and problem-solving abilities. In this context, interactive mathematics e-books that integrate contextual learning, visual representations, and real-world applications have the potential to address these challenges by making mathematics learning more meaningful, engaging, and accessible for elementary school students.

In the context of mathematics education, research has demonstrated that e-books can improve mathematical literacy as well as students' entrepreneurial spirit (Amalia et al., 2021). Well-designed e-books facilitate mathematical understanding by presenting content in an engaging and accessible manner (Pujiastuti et al., 2021). They also serve as an interactive medium for revisiting content, which is critical for supporting deep learning. Furthermore, e-books provide flexible accessibility, allowing students to learn anytime and anywhere an increasingly relevant feature in technology-driven education (Ormancı & Çepni, 2020; Roslina et al., 2013). Mathematics e-books are often equipped with interactive and



multimedia elements, making them valuable digital resources that bridge traditional instruction with modern learning practices (Sari et al., 2021).

Deep learning in education refers to the ability to understand concepts thoroughly and apply knowledge in diverse contexts (Bozkurt, 2023). It involves critical thinking skills and the capacity to connect learned concepts with real-life situations (Topping et al., 2025). In mathematics, deep learning emphasizes not only the mastery of abstract concepts but also their meaningful application in practical contexts (Borke, 2021). This process encourages students to reflect on learning, connect new ideas with what they already know, and apply understanding across context (Stigberg et al., 2022; Winje & Løndal, 2020). Such an approach encourages students to move beyond rote memorization, fostering both conceptual understanding and reflective engagement (Sidik et al., 2021).

CRT, mathematics e-books, and deep learning represent three interrelated components that can enhance educational effectiveness by making learning more inclusive, interactive, and profound (Madiratta, 2024). CRT provides the pedagogical foundation by emphasizing the integration of students' cultural backgrounds into instruction, creating a more meaningful and engaging environment. Mathematics e-books serve as a medium that enables interactive and accessible delivery of content, supporting students in developing critical conceptual understanding (Saleh et al., 2018). Meanwhile, deep learning ensures that students can apply mathematical concepts in reflective and real-life contexts. The integration of CRT into mathematics e-books oriented toward deep learning presents an innovative solution that not only makes mathematics instruction more contextualized but also promotes active, engaged, and reflective participation from students.

Yogyakarta was selected as the research locus because it possesses rich cultural (Diana, 2022) and ethnomathematical resources that are highly relevant to mathematics learning. Cultural elements such as the geometric patterns of batik, the architectural structures of temples such as Prambanan Temple, and traditional culinary practices reflect various mathematical concepts including symmetry, geometry, measurement, and patterns. However, these local cultural potentials are still rarely integrated into mathematics textbooks and classroom instruction, which tend to emphasize abstract and decontextualized learning. Therefore, Yogyakarta provides a strategic context for developing CRT-based mathematics e-books that connect mathematical concepts with students' cultural experiences and daily lives.

This study aims to examine how the integration of CRT, mathematics e-books, and deep learning can support more meaningful mathematics learning by connecting mathematical concepts with students' cultural experiences and real-life contexts. The study also seeks to investigate the role of culturally relevant and technology-based learning in improving students' mathematical literacy, conceptual understanding, engagement, and reflective thinking in elementary mathematics education. The urgency of this study emerges from the persistent problem of low mathematical literacy and the continuing dominance of abstract, procedural, and teacher-centered mathematics instruction that often disconnects mathematics from students' everyday lives. As a result, many students perceive mathematics as difficult, irrelevant, and limited to memorizing formulas rather than understanding concepts and solving authentic problems. At the same time, the rapid growth of digital learning demands innovative educational approaches that are not only technologically accessible but also culturally meaningful and cognitively engaging. However, many existing digital mathematics resources still emphasize content delivery rather than reflective understanding, contextual learning, and cultural relevance. Therefore, this study is important because it addresses the need for mathematics learning that is more human-centered,

contextualized, interactive, and capable of fostering deeper conceptual understanding and meaningful student participation in contemporary education.

Research Method

This study used a design and development research orientation with a field trial evaluation to assess the feasibility, acceptability, and perceived pedagogical value of the Matematika Berbudaya e-book for primary mathematics learning (Richey & Klein, 2020). The field trial was conducted in primary schools in the Special Region of Yogyakarta, Indonesia, and the procedure is summarized in Figure 1. Participants consisted of two groups. The teacher group included 10 respondents, namely Grade 6 teachers and school leaders from five schools. The teacher group included 10 respondents, namely Grade 6 teachers, selected using purposive sampling. This sampling technique was employed because Grade 6 teachers possess direct experience in teaching mathematics at the upper elementary level and are familiar with students' mathematical literacy development, learning challenges, and the use of digital learning resources in classroom instruction.

Grade 6 students were specifically selected because they are considered to have more mature cognitive and mathematical abilities compared to lower-grade students, enabling them to engage more effectively with reflective, contextual, and deep learning-oriented mathematics activities. In addition, Grade 6 students are at an important stage of elementary education where mathematical literacy, problem-solving skills, and conceptual understanding become increasingly essential in preparation for higher levels of education. The student group included 89 students from five schools who provided complete questionnaires across all items and were therefore included in the analysis.

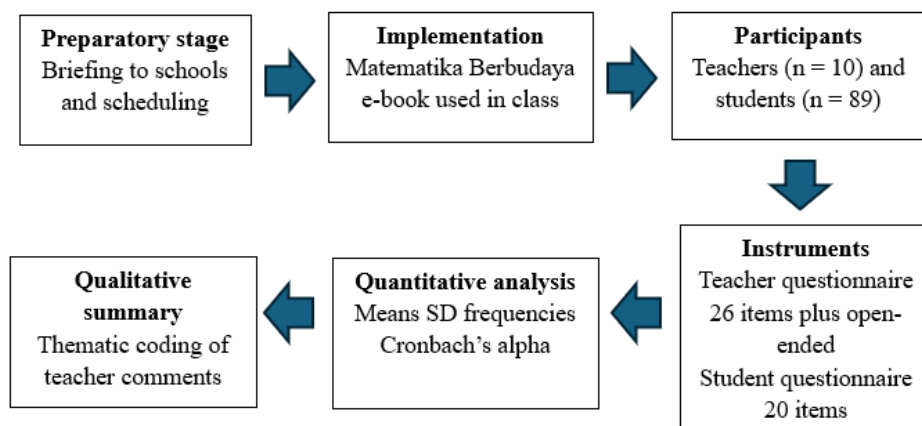


Figure 1. Field Trial Evaluation Procedure

Two instruments were administered after the e-book was implemented. The questionnaire instruments used in this study underwent an expert judgment validation process to ensure their validity, clarity, and suitability for the research objectives. The validation involved several experts in the fields of mathematics education, educational technology, and culturally responsive pedagogy, who carefully evaluated each questionnaire item in terms of content relevance, language appropriateness, and construct representation. Feedback and recommendations provided by the experts were subsequently used to revise and refine the instruments, ensuring that the questionnaires were capable of accurately capturing participants' perceptions and responses related to culturally responsive mathematics learning, mathematics e-books, and deep learning implementation.

Teachers completed a structured questionnaire consisting of 26 five-point Likert-type items followed by one open-ended question for general feedback. Students completed a 20-item four-point questionnaire to capture their responses after using the e-book. The evaluation also reflected culture-based mathematical contexts embedded in the learning tasks, including Alun-Alun Kidul, Wayang Gunung, Batik Kawung, traditional market transactions, traditional measurement contexts, and recipe ratio situations.

Data analysis focused on descriptive statistics and thematic summarization of open-ended feedback. For teacher data, item-level means and standard deviations were calculated and reported as grouped indicators representing value integration, contextual and cultural integration, usefulness and access, and mindful, meaningful, and joyful learning indicators. For student data, a student's average score was computed as the mean of the 20 items for each student. School-level summaries were generated using the mean and standard deviation of student average scores within each school. Overall response tendencies were examined using the overall mean and standard deviation across all item responses and the frequency distribution of response categories across the total number of item responses. Internal consistency was assessed using Cronbach's alpha. Open-ended teacher feedback was coded into themes reflecting strengths and revision priorities. One response could contribute to more than one theme, and theme frequencies were summarized. Permission was obtained from participating schools. Participation was voluntary, and responses were reported in anonymized form.

Results and Discussion

Field Trial Overview

Results are presented from an evaluation conducted in five primary schools in the Special Region of Yogyakarta, Indonesia. Two respondent groups contributed data, including teachers and students, as summarized in Table 1.

Table 1. Field Trial Respondents

Group	Description	n
Teachers	Grade 6 teachers and school leaders from five schools	10
Students	Students from five schools with complete questionnaires	89

To provide an overview of students' responses by school, Table 2 presents school-level summaries based on student average scores, calculated as the means of the 20 questionnaire items for each student. The school means ranged from 3.1536 to 3.6393 on a four-point scale, indicating generally positive student responses across schools.

Table 2. Student Mean Scores by School

School	n	Mean of student average score	Standard deviation
SD Negeri Tahunan	24	3.4188	0.2549
SD Muhammadiyah Kayen	22	3.1727	0.1638
SD Negeri Ambarukmo	15	3.4100	0.2923
SD Pedagogia	14	3.1536	0.2406
SD Negeri Pandeyan	14	3.6393	0.2528

Teacher Evaluation

Teacher perceptions were collected using a 26-item five-point Likert-type questionnaire followed by one open-ended question. Internal consistency of the teacher questionnaire was high, with Cronbach's alpha of 0.8958. Teacher ratings are presented below as grouped indicators aligned with the evaluation dimensions. Teacher ratings related to value integration are presented in Table 3. Both indicators were rated highly, indicating strong teacher endorsement of the e-book's value-oriented contribution.

Table 3. Teacher Ratings on Value Integration

Indicator	Mean	Standard Deviation
The e-book improves character through moral messages	4.80	0.42
The e-book helps students learn meaningfully	4.70	0.48

Teacher ratings related to contextual and cultural integration are presented in Table 4. The highest rating was observed for the indicator on contextual mathematical understanding, followed by students' understanding of local culture. Ratings for cultural visuals and links to prior learning experiences were also consistently high.

Table 4. Teacher Ratings on Cultural Contextualization

Indicator	Mean	Standard deviation
Potential to improve contextual mathematical understanding	4.90	0.32
Improves students' understanding of local culture	4.80	0.42
Cultural visuals encourage focused attention on concept meaning	4.50	0.71
Links new concepts with prior learning experiences	4.50	0.53

The evaluation instrument also reflected culture-based mathematical contexts embedded in the learning tasks. Table 5 summarizes examples of these contexts and their mathematics focus, indicating how cultural elements were linked to specific mathematical ideas.

Table 5. Culture-Based Task Context

Culture-based context	Mathematics focus
Alun-Alun Kidul and shaded circle areas	Area of plane figures and composite area
Wayang Gunung with triangle and circle	Area and subtraction of regions
Batik Kawung motif	Symmetry
Traditional market transactions	Arithmetic operations and multi-step reasoning
Traditional measurement units and daily trade	Unit conversion and proportional reasoning
Traditional recipes and ratios	Ratio and proportion

Teacher ratings on usefulness and access are presented in Table 6. Mean ratings were high across all indicators, suggesting that teachers viewed the e-book as a practical learning support resource, a motivational resource, and an accessible medium

Table 6. Teacher Ratings on Usefulness and Access

Indicator	Mean	Standard Deviation
Supports mathematics learning	4.60	0.52
Increases students' motivation to learn mathematics	4.50	0.71
Ease of access to the media	4.60	0.52

Teacher ratings aligned with mindful, meaningful, and joyful learning indicators are presented in Table 7. Ratings were consistently high across indicators related to attention, curiosity, personal connection, connections to prior learning, and meaningful learning support.

Table 7. Teacher Ratings on Deep Learning Indicators

Indicator	Mean	Standard deviation
Cultural visuals support focused attention on concept meaning	4.50	0.71
Activities foster curiosity through enjoyable learning experiences	4.60	0.52
Promotes deep lasting understanding through personal connection	4.40	0.70
Links new concepts with prior learning experiences	4.50	0.53
The e-book helps students learn meaningfully	4.70	0.48

Open-ended feedback provided additional detail on perceived strengths and revision priorities. Table 8 summarizes themes and frequencies. A single response could reflect multiple themes, therefore the total frequency is not expected to equal the number of teacher respondents.

Table 8. Themes in Teachers' Open-Ended Feedback

Theme	Frequency	Representative evidence
Feasibility and overall quality	6	Suitable for elementary students, feasible for publication, worthy to be developed
Cultural relevance and literacy	4	Helps students understand mathematics and culture, adds cultural literacy
Instructional language	2	Improve wording of prompts to be more appropriate
Layout and page structure	2	Simplify the cover, add topic or chapter cues on each page
Navigation usability	2	Enlarge navigation buttons, provide more practical navigation
Device accessibility	1	Easy to access across devices

Student Responses

Student perceptions were collected using a 20-item four-point questionnaire. Table 9 presents the overall student summary across all item responses. The overall mean was 3.3494 with an overall standard deviation of 0.5982. Internal consistency was strong, with Cronbach's alpha of 0.8349.

Table 9. Student Questionnaire Summary

Statistic	Value
Overall mean	3.3494
Overall standard deviation	0.5982
Cronbach's alpha	0.8349
Total item responses	1780

To describe response tendencies across the four-point scale, Table 10 presents the distribution of student responses across all 1,780 item responses. Responses were concentrated in the upper categories, with scores 3 and 4 accounting for most responses.

Table 10. Distribution of Student Responses

Score	Frequency	Percentage
1	6	0.34
2	98	5.51
3	944	53.03
4	732	41.12

The field trial results indicate that the Matematika Berbudaya e-book was perceived as feasible, and acceptable for classroom use. Teacher ratings were consistently high across the evaluated dimensions and student responses were concentrated in the upper categories. The "Potential to Improve Contextual Mathematical Understanding" aspect obtained the highest mean score ($M = 4.90$, $SD = 0.32$) because teachers perceived that the integration of cultural elements within the mathematics e-book successfully helped students connect abstract mathematical concepts with familiar real-life contexts. Visual representations derived from cultural artifacts, such as Batik patterns, Wayang figures, and other local cultural objects, enabled students to concretize mathematical ideas such as geometry, symmetry, patterns, fractions, and spatial reasoning that are often difficult to understand through conventional symbolic explanations alone. By relating mathematical concepts to cultural

experiences that students encounter in their daily lives, learning became more meaningful, relevant, and easier to comprehend (Saputra & Fahrizal, 2019).

The interaction between digital and cultural elements created new cognitive pathways that supported deeper conceptual understanding. The multimedia features embedded in the e-book, including interactive visuals, animations, and contextual illustrations, allowed students to simultaneously process visual, cultural, and mathematical information in an integrated manner (Rahman et al., 2018). This process encouraged students not only to memorize formulas procedurally but also to construct meaning through observation, interpretation, and reflection on culturally familiar representations. As a result, the mathematics learning experience became more engaging and cognitively connected, helping students bridge prior cultural knowledge with new mathematical concepts more effectively.

The indicator “The e-book helps students learn meaningfully” obtained the highest score ($M = 4.70$, $SD = 0.48$), indicating that teachers strongly perceived the e-book as effective in supporting contextual and understandable mathematics learning. The integration of cultural contexts, interactive activities, and visual representations helped students connect mathematical concepts with real-life situations, making learning more engaging and easier to comprehend. In contrast, the indicator “Promotes deep lasting understanding through personal connection” received a slightly lower mean score ($M = 4.40$, $SD = 0.70$) because establishing personal connection in learning is a more complex and individualized process. Although the cultural elements embedded in the e-book were generally familiar and meaningful, not all students may have experienced the same level of emotional, cultural, or experiential attachment to the contexts presented. Personal connection depends not only on exposure to cultural content but also on students’ individual backgrounds, experiences, interests, and reflections. Therefore, while the e-book successfully facilitated meaningful learning at a broader classroom level, achieving deeper personal resonance for every student required more individualized interaction, discussion, and reflection beyond the digital learning experience itself.

A prominent pattern concerns cultural and contextual integration. Teachers’ strong endorsement of contextual understanding and local culture, together with the culture-based task contexts, suggests that cultural elements were perceived as instructionally meaningful for mathematical learning. This interpretation is consistent with culturally responsive teaching, which emphasizes the use of learners’ cultural experiences as resources for relevance, inclusion, and engagement (Aisah et al., 2023; Gay, 2021). It also aligns with ethnomathematics perspectives that view cultural practices as legitimate sources of mathematical ideas and as bridges between community knowledge and school mathematics (D’Ambrosio, 2019; Rosa & Orey, 2020).

The results also suggest that value integration can be strengthened through structured learning media. Teachers’ high endorsement of moral messaging and meaningful learning indicates that the e-book was perceived as supporting character-oriented dimensions within mathematics instruction. This aligns with scholarship arguing that mathematical activity is not value-neutral and can be designed to cultivate ethical and social dispositions alongside cognitive development (Bishop, 1991; Noddings, 2005). It also resonates with whole-child and social-emotional learning perspectives that connect academic development with ethical orientation and emotional competence (CASEL, 2020; Darling-Hammond & Flook, 2021; Elias, 2009).

In addition, teachers’ positive ratings on usefulness and access, together with students’ favorable response tendencies, suggest that cultural relevance was accompanied by perceived practicality of use. This matters because digital resources are more likely to be



adopted when they are accessible and instructionally clear, not merely available as technology (Ormançı & Çepni, 2020; Temel & Gür, 2022). The open-ended feedback further clarifies implementation conditions that can influence classroom uptake, including improvements to wording, layout cues, and navigation. These points imply that culturally rich content must be matched by usability-focused design decisions to remain classroom-ready.

Finally, the mindful, meaningful, and joyful indicators provide a coherent lens for interpreting the overall reception. Teachers' endorsement of focused attention, curiosity, personal connection, and meaningful learning suggests that the e-book was perceived as supportive of learning conditions associated with deeper engagement. This is consistent with deep learning perspectives that emphasize conceptual understanding, meaningful connections, and the ability to relate learning to authentic contexts rather than relying on rote procedures (Stigberg et als., 2022) . In combination, the field trial provides an integrated feasibility picture in which cultural contextualization, value orientation, digital practicality, and deep learning conditions are perceived as aligned within one learning medium. Future research should extend this feasibility evidence by examining implementation consistency and learning outcomes in larger trials.

Conclusion

This study indicates that the Matematika Berbudaya e-book is perceived as a culturally meaningful and practically usable learning resource for primary mathematics in the participating schools. Teacher evaluations consistently support the integration of educational values and culture-based contexts within mathematics learning and indicate that the e-book is viewed as accessible and useful for classroom implementation. Student responses further reflect a broadly positive reception and strong internal consistency, suggesting that the e-book design is well aligned with learners' engagement in the trial setting.

The study affirms the value of integrating culturally responsive principles into digital mathematics learning materials to support learning experiences that are perceived as meaningful, engaging, and classroom-ready. This study contributes to the digital learning literature by showing that Culturally Responsive Teaching (CRT) can be implemented not only through face-to-face interactions or printed materials, but also through interactive digital learning environments such as mathematics e-books. The integration of cultural elements into the e-book format provides a new dimension to CRT because multimedia features, including visuals, animations, and interactive activities, enable students to engage with cultural and mathematical concepts simultaneously in more meaningful and contextual ways. In this sense, culture functions not merely as supplementary content but as an interactive pathway that supports students' conceptual understanding, engagement, and reflective learning within digital mathematics education. The results highlight the importance of aligning cultural authenticity with instructional clarity and usability so that digital resources can be readily implemented and sustained in everyday classroom practice.

Recommendation

Given the findings, several recommendations emerge for enhancing the application and development of CRT in the context of primary education:

1) Enhancing Teacher Professional Development

It is crucial to expand teacher professional development programs that focus on integrating CRT principles into the classroom. These programs should emphasize not only the theoretical foundations of CRT but also practical strategies for embedding cultural awareness into daily teaching practices. Future workshops could also include

training in designing culturally responsive digital learning resources, especially e-books, which can bridge the gap between classroom instruction and students' lived experiences.

2) Development and Scaling of Culturally Relevant Learning Materials

The study highlights the potential benefits of culturally responsive digital materials in engaging students and improving learning outcomes. To maximize this potential, educational authorities and content developers should collaborate on creating more resources that integrate local culture and context into the curriculum. This initiative could be extended through the development of a repository of culturally enriched e-books that are easily accessible to teachers across diverse regions.

3) Strengthening Educational Policy Support

Policymakers should prioritize the integration of CRT within national education frameworks, particularly in the context of Kurikulum Merdeka. This could involve revising curriculum standards to explicitly incorporate culturally responsive practices and ensuring that both teachers and students are equipped to engage with a more diverse and inclusive educational experience.

4) Improving Access to Technology

Despite the positive feedback on digital resources, disparities in access to technology remain a challenge in some regions. Therefore, the government should focus on ensuring equitable access to digital tools and resources across urban, suburban, and rural schools. This could involve offering support for schools to integrate digital technologies into their infrastructure and curricula effectively.

5) Further Research on Long-Term Impact

Future research should explore the long-term effects of CRT-based pedagogies on student outcomes, particularly their conceptual understanding and critical thinking skills. Longitudinal studies and experimental trials can provide valuable insights into how these educational approaches affect students' academic trajectories and their ability to apply knowledge in real-world contexts.

By addressing these areas, education systems can create a more inclusive, culturally responsive, and effective learning environment for all students, fostering not only academic excellence but also social equity.

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