Jurnal Pendidikan Matematika Universitas Lampung
Vol. 13, No. 2, 2025, pp. 76 - 93
https://jurnal.pbs.fkip.unila.ac.id/index.php/jpm/
ISSN: 2715-856X

Development of Electronic Modules with Culturally Responsive Teaching and Augmented Reality based on Jambi Culture for Mathematical Literacy

Salsabila Putri Deska[1], Feri Tiona Pasaribu[2]*, Tria Gustiningsi[3], Duano Sapta Nusantara[4]

[1,2,3,4] Universitas Jambi, Jl Jambi-Ma Bulian, Jambi 36361, Indonesia
[1]salsabiladeska25@gmail.com; [2]feri.tiona@unja.ac.id*; 3 triagustiningsi@unja.ac.id; 4 duanosaptanusantara@unja.ac.id

*corresponding author

ARTICLE INFO

Article history
Received: 21 June, 2025
Revised: 10 July, 2025
Accepted: 27 July, 2025
Published: 29 July, 2025

Keywords
Augmented Reality
Culturally Responsive Teaching
Electronic Modul
Jambi Culture
Mathematical Literacy

ABSTRACT

The purpose of this study is to develop and evaluate the feasibility and quality of an electronic module based on Culturally Responsive Teaching (CRT) and Augmented Reality (AR), incorporating Jambi culture to enhance students' mathematical literacy skills in the topic of similarity. This research adopts a Research and Development (R&D) approach using the ADDIE development model. The participants were 35 seventh-grade students from class VII G at SMP Negeri 6 Kota Jambi. The instruments used in this study included validation questionnaires, practicality questionnaires, and effectiveness questionnaires. The e-module was considered valid based on assessments by subject matter and design experts, obtaining a validity score of 86.25%, which falls into the "valid" category. This indicates that the e-module integrates similarity material with CRT components and contextual problems related to Jambi culture, along with AR features aligned with indicators of mathematical literacy. The practicality test, based on evaluations from both teachers and students, yielded a score of 85.97%, categorized as "very practical." Additionally, the students' n-gain score reached 79.04%, indicating the effectiveness of the e-module in improving mathematical literacy skills. These findings support the integration of local culture and AR technology in instructional material development, offering a practical and engaging approach for educators to promote mathematical literacy through contextualized learning experiences.

How to Cite: Deska, S. P., Pasaribu, F. T., Gustiningsi, T., & Nusantara, D. S. (2025). Development of electronic modules with culturally responsive teaching and augmented reality based on jambi culture for mathematical literacy. *Jurnal Pendidikan Matematika Universitas Lampung*, 13(2), 76-93. http://dx.doi.org/10.23960/mtk/v13i2.pp76-93

INTRODUCTION

In the 21st century, six types of literacy are considered essential for every individual as key indicators in assessing the quality and excellence of human resources. These include reading and writing literacy, numeracy literacy, digital literacy, financial literacy, scientific literacy, and cultural literacy (Pasaribu et al., 2022, p. 1980). One of the most important skills in mathematics education is mathematical literacy, defined as the ability to formulate, apply, and interpret mathematics in a variety of real-life contexts (OECD, 2023b, p. 22). Mathematical literacy involves the ability to understand problems, plan, analyze, and use mathematics in daily life (Isnaniah et al., 2021, p. 1). Therefore,

mathematical literacy is essential, as it enables students to use mathematics to solve various real-world problems.

The Programme for International Student Assessment (PISA) is a major international study in mathematics that focuses on mathematical literacy (Stacey, 2011, p. 96). Indonesia, as a regular participant in the PISA program, uses the results of these assessments as a tool to evaluate students' mathematical literacy (Fadillah & Munandar, 2021, p. 16). Over the past two decades, PISA results have shown that Indonesian students' performance has been inconsistent (Nusantara et al., 2021, p. 1), with a score of 379 in 2018 (OECD, 2019, p. 18) declining to 366 in 2022 (OECD, 2023a, p. 29).

Research by Islami et al. (2019, p. 168) found that students faced significant difficulties in solving problems related to congruence and similarity, particularly in applying concepts and performing calculations, with a difficulty rate reaching 60%, categorized as low. This aligns with findings by Masfufah and Afriansyah (2021, p. 199), who reported through PISA-based analysis that students' mathematical literacy remains in the low category. A preliminary study conducted by the researchers at SMP Negeri 6 Kota Jambi revealed similar findings, with students in the targeted class achieving an average mathematical literacy score of only 0.32, which falls significantly below the expected proficiency standards.

To improve students' mathematical literacy skills, appropriate teaching materials are essential to help students better understand the subject matter. These materials should also be aligned with current educational developments (Rizqiyani et al., 2022, p. 956). A variety of learning media are available to support this goal, one of which is the electronic module (e-module) (Yanindah & Ratu, 2021, p. 609). E-modules are systematically organized instructional materials designed to optimize learning outcomes. They are intended for independent study and are presented in an electronic format that is self-instructional, self-contained, standalone, and user-friendly, typically focusing on a single learning topic (Simbolon et al., 2023, p. 84). This format supports student learning due to its flexibility and accessibility, allowing use anytime and anywhere (Buchori & Prasetyowati, 2021, p. 328).

In addition to e-modules, an innovation that can significantly enhance student engagement and facilitate experiential learning is the use of Augmented Reality (AR)-based instructional media (Meilindawati et al., 2023, p. 59). AR is a technology that allows virtual objects—whether two-dimensional or three-dimensional—to be visualized in three dimensions within a real-world environment (Pasaribu & Ramalisa, 2022, p. 69). In practice, all relevant information can be integrated and rendered in real time, making the learning experience interactive and lifelike (Setiawan et al., 2021, p. 148). AR technology allows specific information to be integrated into a virtual environment and

displayed in the real world using devices such as webcams, computers, and smartphones (Saputri & Sibarani, 2020, p. 16). AR can enrich the learning experience by presenting interactive visual content that enhances understanding (Fauziyah et al., 2024, p. 937). Despite its potential, the implementation of AR in schools remains limited (Pasaribu et al., 2024, p. 1589). Thus, integrating AR into mathematics instruction is crucial to improving students' skills.

Beyond teaching materials and media, the choice of instructional models or approaches plays a vital role in the learning process (Pasaribu & Ramalisa, 2020, p. 57). One effective approach is Culturally Responsive Teaching (CRT), which can be used to enhance students' mathematical literacy. Afiani et al. (2024, p. 275) state that the CRT approach is a key factor in the success of mathematics learning. By incorporating students' cultural backgrounds, CRT contextualizes mathematical concepts, making them more accessible and relevant, and fostering deeper conceptual understanding (Enjelina et al., 2024, p. 40). This aligns with Bahari et al. (2025, p. 58), who assert that implementing CRT improves learning outcomes and motivation and encourages students to become more active and engaged. Similarly, Ghifari et al. (2023, p. 138) argue that CRT closely aligns with the principles of mathematical literacy, as both emphasize the integration of mathematical concepts with real-world experiences. Several prior studies have reported the effectiveness of CRT: Rokhman et al. (2024, p. 7950) found that CRT improves student learning outcomes, and Wardana et al. (2024, p. 4963) noted that CRT, when supported by E-LKPD, positively impacts the learning process.

A key component of the CRT approach is the integration of contexts that are closely related to students' cultural and personal experiences. This helps students make connections between concepts and real-life applications (Manurung, 2020, p. 4). Similarly, Mardiyah et al. (2021, p. 15) emphasize that using local contexts allows students to understand mathematical phenomena through their own life experiences, thereby enhancing the relevance and meaningfulness of the learning process.

Numerous studies have explored teaching materials developed based on CRT principles. For example, Zakiyatul et al. (2023) developed e-modules grounded in CRT. The novelty of the present study lies in combining CRT-based e-modules with Augmented Reality (AR) and contextual problems rooted in Jambi culture. Accordingly, this research aims to develop a CRT-AR e-module based on Jambi culture that is valid, practical, and effective in enhancing students' mathematical literacy skills.

METHOD

Research Design

This study employed a development research design, specifically the Research and Development (R&D) approach, using the ADDIE model. The ADDIE model consists of five systematic phases: Analysis, Design, Development, Implementation, and Evaluation.

Research Subjects

The subjects of this study were students from classes VII F and VII G at SMP Negeri 6 Kota Jambi. During the small-group trial phase, six students from class VII F were selected based on teacher recommendations and group classifications derived from daily test scores. In the subsequent field test phase, 35 students from class VII G participated. In total, 41 students were involved in the study.

Development Procedures

The development procedure, based on the ADDIE model, is illustrated in Figure 1.

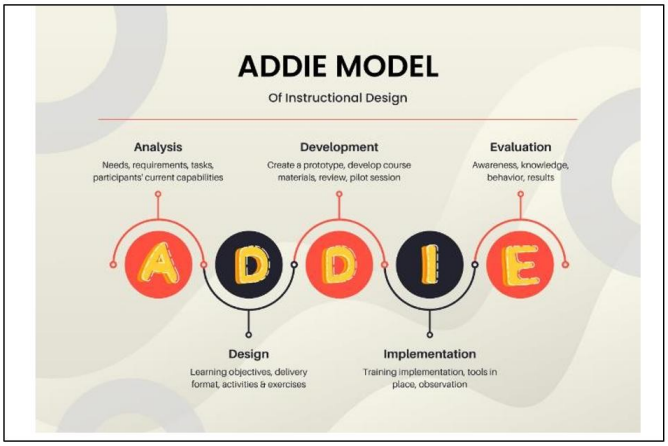

Figure 1. ADDIE Development Procedures

Figure 1 illustrates the research development procedure based on the ADDIE model, which is described in detail below.

1. Analysis Stage

In this stage, the researchers conducted a comprehensive analysis, starting with the identification of performance gaps observed at SMP Negeri 6 Kota Jambi. Subsequently, they examined the instructional objectives, student characteristics, curriculum content, and available resources, and formulated a detailed work plan.

2. Design Stage

In the design stage, the initial product was developed and planned. The process began with the creation of a storyboard, followed by the design of the instructional product structure and components.

3. Development Stage

During the development stage, the researchers validated the research instruments and assessed the quality of the e-module through several phases. These included content and design validation by a team of experts, as well as practicality testing conducted by a seventh-grade mathematics teacher at SMP Negeri 6 Kota Jambi and six students. The student participants were selected by the teacher based on test scores and categorized into three ability levels: two high-ability students, two medium-ability students, and two low-ability students.

4. Implementation Stage

At this stage, the e-module—previously validated by experts and assessed for practicality by both the teacher and students—was implemented in the teaching and learning process as part of the field testing phase. This phase was conducted in Class VII G at SMP Negeri 6 Kota Jambi, involving 35 students.

5. Evaluation Stage

In the final stage, the researchers conducted a comprehensive evaluation of the entire development process, encompassing all phases from the initial analysis through to implementation.

Data Collection

Data collection in this study was conducted through interviews, questionnaires, and mathematical literacy tests. Interviews were carried out during the analysis phase to identify specific needs relevant to the study. In the development phase, validity and practicality questionnaires were distributed to evaluate the quality and feasibility of the e-module prior to its implementation in the learning process through field testing. During the implementation phase, effectiveness questionnaires and mathematical literacy tests were administered to assess the impact of the e-module based on student feedback and learning outcomes.

The data collected aimed to measure the validity, practicality, and effectiveness of the culturally responsive teaching (CRT) e-module enhanced with augmented reality (AR) and contextualized in Jambi culture. Validity data were obtained from assessments conducted by subject matter experts and instructional design experts. Practicality data were collected through questionnaires completed by both teachers and students.

The questionnaires used to assess the validity, practicality, and effectiveness of the e-module employed a five-point Likert scale, as follows: 5 = Strongly Agree, 4 = Agree, 3 = Somewhat Agree, 2 = Disagree, and 1 = Strongly Disagree. Further details regarding the questionnaire instruments can be accessed via the following link: https://bit.ly/AngketEModulCRTAR.

The results of the validity and practicality assessments are presented as percentages, calculated using the following formula:

$$Percentage = \frac{Number\ of\ scores\ per\ validator/respondent}{Maximum\ indicator\ score} \times 10$$

Subsequently, the level of validity achievement for the e-module is classified according to the criteria presented in Table 1.

Table 1. Criteria for the Validity Percentage of CRT-AR E-Modules

Validity Level	Validity Criteria Description
$85{,}01\% \leq V_S \leq 100{,}00\%$	Valid or usable without revision
$70{,}01\% \leq V_S \leq 85{,}00\%$	Valid or usable but needs revision
$50{,}01\% \leq V_S \leq 70{,}00\%$	Invalid or not recommended for use due to numerous Revisions
$01{,}00\% \leq V_S \leq 50{,}00\%$	Invalid or cannot be used

(Sugiyono, 2013)

The criteria for determining the validity percentage of the e-modules, as evaluated by expert reviewers, are presented in Table 1. In addition, the classification levels used to interpret the practicality percentage of the e-modules are outlined in the criteria shown in Table 2.

Table 2. Practicality Percentage Criteria for CRT-AR E-Modules

Practicality Level	Criteria
$80\% \leq V_p \leq 100\%$	Very practical, can be used without modification
$60\% \leq V_p \leq 80\%$	Quite practical, can be used with minor improvements
$40\% \leq V_p \leq 60\%$	Not very practical, not recommended for use
$20\% \leq V_p \leq 40\%$	Impractical, should not be used
$0\% \leq V_p \leq 20\%$	Very impractical, cannot be used

(Sugiyono, 2013)

The practicality criteria, based on percentage scores derived from questionnaires completed by teachers and students, are presented in Table 2. For instance, the classification "Very Impractical – Cannot Be Used" may be assigned to the lowest score range. Furthermore, the levels of achievement or categories used to interpret the effectiveness percentage of the e-module are outlined in the criteria shown in Table 3.

Table 3. Criteria for the Effectiveness Percentage of CRT-AR E-Modules

Effectiveness Level	Criteria
$80\% \leq V\mathrm{e} \leq 100\%$	Very effective
$60\% \leq V_{\mathrm{e}} \leq 80\%$	Effective
$40\% \leq V_{\mathrm{e}} \leq 60\%$	Quite effective
$20\% \leq V_{\mathrm{e}} \leq 40\%$	Ineffective
$0\% \leq V_{\mathrm{e}} \leq 20\%$	Very Ineffective

(Sugiyono, 2013)

Table 3 presents the criteria for interpreting the effectiveness percentage of the e-modules, based on student responses to the effectiveness questionnaire administered after the use of the e-modules during the learning process. To evaluate improvements in students' mathematical literacy skills, assessments were conducted both at the beginning (pre-test) and at the end (post-test) of the program. The resulting data on students' performance were analyzed using the normalized gain (N-Gain) formula to determine the extent of improvement, as shown below.

$$N - Gain = \frac{Posttest\ Score - Pretest\ Score}{Maximum\ Score - Pretest\ Score} \times 10$$

Subsequently, the level of achievement or category of students' mathematical literacy, based on the N-Gain percentage, is classified according to the criteria presented in Table 4.

Table 4. Criteria for Improving Mathematical Literacy Skills

Interval	Criteria
$g \geq 0{,}7$	High
$0{,}3 < g < 0{,}7$	Medium
$g \leq 0{,}3$	Low

After calculating the N-Gain scores of students' mathematical literacy skills, the criteria for categorizing the improvement in these skills—following the use of CRT-AR- based e-modules contextualized in Jambi culture during the learning process—are presented as follows.

RESULTS AND DISCUSSION

The outcome of this study is a Culturally Responsive Teaching and Augmented Reality (CRT-AR)-based electronic module, contextualized within Jambi culture, and developed to enhance students' mathematical literacy skills on the topic of similarity. The development process followed the ADDIE model, which consists of five systematic stages: Analysis, Design, Development, Implementation, and Evaluation.

Analysis Stage

The initial phase of the development process focused on validating the performance gap and conducting a student needs analysis. These steps were informed by an interview with a seventh-grade mathematics teacher at SMP Negeri 6 Kota Jambi. The interview revealed that students faced difficulties in understanding the lesson content and demonstrated low engagement during the learning process. This lack of engagement was attributed to the continued use of conventional, teacher-centered instructional methods.

Additionally, the existing learning materials were reported to be insufficiently interactive and failed to capture students' interest.

The school implements the Merdeka Curriculum, which emphasizes student-centered learning and contextual understanding—further highlighting the need for improved instructional approaches and resources. To complement the interview data, researchers administered a preliminary mathematical literacy test consisting of three questions aligned with key indicators of mathematical literacy. The results showed that students' mathematical literacy skills were generally low. An analysis of the available resources at SMP Negeri 6 Kota Jambi indicated adequate infrastructure to support the development and implementation of a digital learning product. These resources included:

1. Content resources, such as teacher and student textbooks aligned with the *Merdeka Curriculum* for seventh-grade mathematics;
2. Technological resources, including student-owned smartphones and reliable internet access; and
3. Human resources, including the researcher, mathematics teachers, and seventh-grade students.

Based on these findings, the development of a Culturally Responsive Teaching (CRT) and Augmented Reality (AR)-based e-module contextualized within Jambi culture was deemed necessary to enhance students' mathematical literacy and to promote a more interactive and engaging learning experience.

Design Stage

The design process began with the creation of a storyboard outlining detailed explanations for each page of the e-module. This storyboard served as the blueprint for developing the module, which integrates three key components: Culturally Responsive Teaching (CRT), Augmented Reality (AR), and indicators of mathematical literacy. A more detailed view of the storyboard and the initial design can be accessed at: https://bit.ly/StoryboardEMODULCRTARJAMBI

Development Stage

The validity of the e-module was evaluated by a panel of experts, while its practicality was assessed through questionnaires completed by mathematics teachers and six students selected based on varying levels of academic ability.

1) Validility Test

The results of the content validation of the e-module, as assessed by subject matter experts, are presented in Table 6.

Table 6. E-Module Material Validation Results

No	Validator	Total Score	Max Score	Percentage (%)
1.	Validator 1	109	130	83,8%
2.	Validator 2	118	130	90,7%
Total Percentage				**87,25%**

Table 6 presents the results of the content validity assessment conducted by subject matter experts, which yielded a score of 87.25%, categorized as “valid.” This suggests that the e-module is appropriate for further implementation, although minor revisions are recommended. In addition to the quantitative results, the experts also provided qualitative feedback in the form of comments and suggestions aimed at improving the module’s quality. The results of the design validity assessment are presented in Table 7.

Table 7. E-Module Design Validation Results

No	Validator	Total Score	Max Score	Percentage (%)
1.	Validator 1	82	95	86,3%
2.	Validator 2	80	95	84,2%
Total Percentage				**85,25%**

Based on the results of the e-module design validation conducted by experts, the module achieved a score of 85.25%, which falls within the "valid" category, as shown in Table 8. This indicates that the e-module is eligible for further testing, although some revisions are recommended. The validators also provided comments and suggestions that serve as a basis for refinement by the researchers. Considering the evaluations of both content and design, the overall average validity of the e-module is summarized in Table 8.

Table 8. Validity Results of the CRT-AR E-Module by Experts

No	Validator	Total Score	Max Score	Percentage (%)
1.	Material	227	260	87,25%
2.	Design	162	190	85,25%
Total Pecentage				**86,25%**

Based on the validation assessments of both the content and design aspects, the overall results of the e-module validation are presented in Table 10. As shown in the table, the CRT-AR e-module achieved a validity score of 86.25%, which falls into the "valid" category. This indicates that the e-module is suitable for further testing in the subsequent stage—namely, the one-to-one trial—following revisions made in accordance with the comments and suggestions provided by the expert reviewers.

2) Practically Test

Following the validation of the e-module by a panel of experts, a practicality test was conducted using a structured questionnaire. This practicality evaluation was carried

out in two phases: the one-to-one stage and the small group stage. he results of the practicality assessment conducted by mathematics teachers during the one-to-one stage are presented in Table 9.

Table 9. Practicality of E-Modules by Teachers

No	Respondent	Total Score	Max Score	Percentage (%)
1.	Material	85	67	78,82%
Total Percentage				**78,82%**

The practicality assessment of the e-module, conducted by a seventh-grade mathematics teacher at SMP Negeri 6 Kota Jambi, resulted in a score of 78.82%, which falls into the "practical" category, as shown in Table 9. This indicates that the e-module is suitable for testing in the next phase, namely the small group stage. The results of the practicality assessment conducted by six seventh-grade students from SMP Negeri 6 Kota Jambi during the small group phase are presented in Table 10.

Table 10. Practicality of E-Modules by Students

No	Respondent	Total Score	Max Score	Percentage (%)
1.	MAFP	79	85	92,94%
2.	RAB	76	85	89,41%
3.	JFP	75	85	88,23%
4.	HN	71	85	95,29%
5.	CR	81	85	95,29%
6.	AFN	83	85	97,64%
Total Percentage				**93,13%**

The practicality assessment of the e-module, as evaluated by students using the practicality questionnaire, is presented in Table 10. The results showed a score of 93.13%, which falls into the "very practical" category. This indicates that the e-module is highly suitable for use and can proceed to the next stage of development, namely field testing.

Implementation Phase

During the field trial stage, students utilized the e-module and engaged in all instructional activities included within it. The following images provide documentation of the learning activities conducted throughout this phase.

Figure 2. Documentation of Learning Activities Using E-Modules

Figure 2 illustrates the implementation of the CRT-AR-based e-module contextualized within Jambi culture during the learning of similarity material. Throughout the learning process, students actively engaged with the activities provided in the e-module. The following section highlights several examples of learning activities included in the e-module.

Figure 3. CRT-AR E-Module Activities

The CRT-AR-based e-module includes group discussion activities that were implemented by students during the learning process. Figure 3 depicts one such activity from the sub-topic on similarity. Presented below is one of the practice questions included in the e-module during the field trial, along with a sample response from a student.

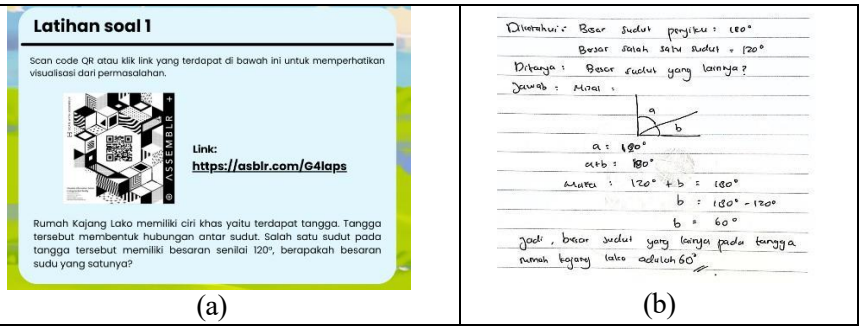

Figure 4. Student Questions and Answers in the E-Module

Figure 4 presents student engagement with the e-module. Figure 4 (a) displays a sample practice question from the sub-topic on angle relationships, while Figure 4 (b) shows one of the students' responses to the question. Following the learning process using the e-module, students were asked to complete an e-module effectiveness questionnaire. The results of this assessment, based on responses from Grade VII G students at SMP Negeri 6 Kota Jambi, are presented below.

Table 11. Results of the E-Module Effectiveness Survey

No	Instrument	Total Score	Max Score	Percentage (%)
1.	E-Module Effectiveness Questionnaire	67	85	78,82%
	Total Percentage			**89,74%**

Table 11 presents the results of the effectiveness questionnaire completed by students after using the e-module during the learning process. The questionnaire yielded a score of 89.74%, which falls into the "very effective" category. This result suggests that the e-module effectively supported students in understanding the concept of similarity. Following the questionnaire, students completed a post-test consisting of three questions related to similarity, designed to assess their mathematical literacy skills after interacting with the e-module. The outcomes of the N-Gain analysis, which measured students' improvement in mathematical literacy, are summarized in Table 12.

Table 12. Student N-Gain

No	Instrument	Average Pretest	Average Posttest	N-Gain
1.	Mathematical Literacy Test	32,31	85,39	0,7842
	N-Gain (%)			**78,42%**

The results of the students' N-Gain calculations can be seen in Table 12, which shows that the average score was 0.7842, with a percentage of 78.42% falling into the "high" category, indicating a significant improvement in students' mathematical literacy

skills after using the e-module during learning activities. Therefore, based on the survey results and mathematical literacy tests, the e-module is able to achieve results consistent with the expected learning objectives.

Evaluation Stage

Each stage of the development process—from analysis to implementation—was systematically evaluated to enhance and refine the quality of the CRT-AR-based e-module. Revisions were made based on feedback and suggestions provided by experts, teachers, and students. As a result, the final product met the established criteria for validity, practicality, and effectiveness.

The findings of this study indicate that the e-module, developed using the ADDIE model, fulfills the quality standards expected of instructional products. Based on content validation by subject matter experts, the e-module achieved a score of 87.25%, which falls into the "highly valid" category. This evaluation covered three key aspects: (1) content suitability, including the relevance and accuracy of the material; (2) language quality; and (3) content structure, focusing on clarity of presentation, supportive components, and alignment with Culturally Responsive Teaching (CRT) principles.

Additionally, the design validity assessment, conducted by instructional design experts, yielded a score of 85.25%, also categorized as "highly valid." This assessment examined three dimensions: writing style, visual and physical layout, and the technical characteristics of the e-module. Together, the content and design validation results confirm that the e-module meets the overall validity criteria.

The practicality of the e-module was evaluated through teacher and student assessments. During the one-to-one stage, a teacher completed a practicality questionnaire covering three aspects: ease of use, time efficiency, and functional performance of the e-module. The results produced a score of 78.82%, indicating that the module is "practical." In the small-group stage, six students—consisting of two high-ability, two medium-ability, and two low-ability students (selected based on test results)—participated in a practicality evaluation using the same criteria. The results showed a practicality score of 93.13%, categorized as "very practical," demonstrating strong usability and learner engagement.

The effectiveness of the e-module was assessed during a field trial involving 35 students from Class VII G at SMP Negeri 6 Kota Jambi. This phase involved both an effectiveness questionnaire and a post-test of mathematical literacy skills. The questionnaire measured three dimensions: content, language, and the functionality and impact of the e-module. The results yielded a score of 89.74%, placing it in the "very effective" category. In addition, a mathematical literacy post-test was administered, and the students' results were analyzed using the Normalized Gain (N-Gain) formula. The

analysis produced an N-Gain score of 79.03%, categorized as "moderate," confirming that the e-module effectively supports the development of students' mathematical literacy.

Overall, the CRT-AR-based e-module, contextualized within Jambi culture, was found to meet the criteria for validity, practicality, and effectiveness, particularly in enhancing students' mathematical literacy in the topic of similarity. These findings are supported by previous studies. For instance, Nanthi and Mutaqin (2023) concluded that e-modules developed using effective design principles can significantly improve students' mathematical literacy. Similarly, Prayitno et al. (2025, p. 566) reported gains in mathematical literacy following the use of e-modules during classroom instruction. Tamur and Pantaleon (2023, p. 141) also demonstrated that interactive e-modules can effectively support the development of students' mathematical literacy.

Further support is provided by Gradini and Firmansyah (2020, p. 240), who found that the application of Culturally Responsive Teaching (CRT) leads to significantly greater improvements in students' mathematical literacy compared to conventional teaching methods. Afiani et al. (2024, p. 275) emphasized that CRT enhances students' mathematical literacy by incorporating culturally relevant contexts drawn from their daily lives. Similarly, Kurniawan et al. (2024, p. 65) reported positive learning outcomes among students who used modules developed based on CRT principles.

Moreover, Hilaliyah et al. (2019, p. 133) found that culturally-based learning modules are effective in enhancing students' mathematical literacy, achieving an improvement rate of 93%. The importance of cultural integration in mathematics learning is also underscored by Mahpudin and Yuliati (2019, p. 291), who argue that incorporating cultural values into instruction enables students to better understand the relevance of mathematics in everyday life, thereby fostering mathematical literacy. This is consistent with the findings of Mutiasari et al. (2024, p. 849), who reported that the use of culturally contextualized learning models positively influences students' mathematical literacy development.

Previous studies have also demonstrated that the use of e-modules, the CRT approach, and Augmented Reality (AR) technology—each implemented independently—has a significant positive impact on learning outcomes and student engagement. E-modules promote flexibility and learner autonomy; CRT fosters deeper, more meaningful connections between students and instructional content through the integration of cultural values; and AR enhances students' conceptual understanding and learning motivation through immersive and interactive visual experiences.

This study integrates all three components—CRT, AR, and e-modules—into a unified and innovative CRT-AR-based electronic module, contextualized within local

Jambi culture. The integration of these elements produces a more interactive, culturally relevant, and pedagogically robust learning tool aimed at improving students' mathematical literacy skills.

CONCLUSION

This study resulted in the development of a culturally contextualized electronic module—rooted in Jambi culture and integrating Culturally Responsive Teaching (CRT) with Augmented Reality (AR)—designed to improve junior high school students' mathematical literacy on the topic of similarity. The e-module demonstrated strong validity, with a content validation score of 87.25% and a design validation score of 85.25%, both categorized as highly valid. Furthermore, the N-Gain score of 79.03%, also classified as high, indicates that the e-module is effective in enhancing students' mathematical literacy skills.

These findings suggest that the CRT-AR-based e-module serves as an innovative and effective instructional resource that can contribute to improving the quality of mathematics education, particularly within culturally diverse learning environments.

However, this study was limited to the topic of similarity and the cultural context of Jambi. Future research is recommended to expand upon this work by developing similar e-modules for other mathematical topics and by incorporating cultural elements from various regions, given Indonesia's rich and diverse cultural heritage. Such efforts would further promote the development of mathematical literacy through culturally relevant and engaging learning experiences.

REFERENCE

Afiani, A. N. A., Adamura, F., & Maduretno, W. (2024). Peningkatan kemampuan literasi matematis peserta didik melalui penerapan model pembelajaran PBL dan pendekatan CRT di SMP N 1 Takeran. *Seminar Nasional Sosial Sains, Pendidikan, Humaniora (SENASSDRA)*, 3(3), 271–278.

Bahari, P. K., Dewi, R. S. I., & Ekawati, R. (2025). Optimalisasi pendekatan culturally responsive teaching (CRT) dalam pembelajaran abad 21. *Jurnal pendidikan dan pembelajaran*, 4(1), 52–60. https://doi.org/10.54259/diajar.v4i1.3901

Buchori, A., & Prasetyowati, D. (2021). Pengembangan e-modul matematika interaktif berbasis augmented reality pada materi bangun ruang. *Widya Balina*, 6(2), 325–338. https://doi.org/10.53958/wb.v6i2.195

Enjelina, F. R., Damayanti, R., & Dwiyanto, M. (2024). Penggunaan pendekatan *culturally responsive teaching* (CRT) untuk meningkatkan hasil belajar matematika siswa kelas V SD mempengaruhi hasil belajar siswa. *Edutama: Jurnal Ilmiah Penelitian Tindakan Kelas*, 1(1), 39–51. https://doi.org/10.69533/t35nhb59

Fadillah, F., & Munandar, R. D. (2021). Analisis kemampuan literasi matematis siswa pada soal PISA di SMPN 2 karawang barat. *Wahana Matematika dan Sains*: *Jurnal Matematika, Sains, dan Pembelajarannya*, 15(3), 15–25. https://doi.org/10.23887/wms.v15i3.32118

Fauziyah, Sugiman, & Munahefi. (2024). Transformasi pembelajaran matematika melalui media augmented reality: keterlibatan siswa dan pemahaman konseptual. *PRISMA, Prosiding Seminar Nasional Matematika*, 7, 936–943.

Gradini, E., & Firmansyah, F. (2020). Measuring students' mathematical literacy in culturally responsive mathematics classroom. *Al-Ta Lim Journal*, 26(3), 233–242. https://doi.org/10.15548/jt.v26i3.551

Hilaliyah, N., Sudiana, R., & Pamungkas, A. S. (2019). Pengembangan modul *realistic mathematics education* bernilai budaya banten untuk mengembangkan kemampuan literasi matematis siswa. *Jurnal Didaktik Matematika*, 6(2), 121–135. https://doi.org/10.24815/jdm.v6i2.13359

Islami, A. N., Rahmawati, N. K., & Kusuma, A. P. (2019). Analisis kesulitan siswa dalam menyelesaikan soal matematika pada materi kekongruenan dan kesebangunan. *Simposium Nasional Ilmiah*, 158. https://doi.org/10.30998/simponi.v0i0.444

Isnaniah, I., Imamuddin, M., Charles, C., Syahrul, S., & Zulmuqim, Z. (2021). Kemampuan Literasi Matematika Siswa Berdasarkan Gender. Lattice Journal : Journal of Mathematics Education and Applied, 1(2), 131. https://doi.org/10.30983/lattice.v1i2.5088

Kurniawan, D., Madawistama, S. T., & Heryani, Y. (2024). Pengembangan modul ajar melalui culturally responsive teaching berbasis soft skills materi bangun datar di SMPN 8 Banjar. *Prossiding Galuh*, 4(1), 56–67. https://jurnal.unigal.ac.id/GAMMA-NC/article/view/14858

Mahpudin, M., & Yuliati, Y. (2019). Peran budaya lokal terhadap literasi matematika siswa sekolah dasar di cirebon. *Proceedings of The ICECRS*, 2(1), 287–292. https://doi.org/10.21070/picecrs.v2i1.2402

Manurung, A. S. (2020). Pengaruh model pembelajaran contextual teaching dan learning (CTL) terhadap hasil belajar matematika siswa kelas XI IPA SMA negeri 31 jakarta. *Jurnal Guru Kita PGSD*, 4(3). https://doi.org/10.24114/jgk.v4i3.19454

Mardiyah, N., Nabilah, N. A., Billah, K. I. A. A., Jannah, W., & Septiadi, D. D. (2021). Pengembangan soal matematika model pisa pada materi transformasi geometri kelas XI SMA. *Aritmetika: Jurnal Riset Pendidikan Matematika*, 2(1). https://doi.org/10.35719/aritmatika.v2i1.10

Masfufah, R., & Afriansyah, E. A. (2021). Analisis kemampuan literasi matematis siswa melalui soal PISA. *Mosharafa: Jurnal Pendidikan Matematika*, 10(2), 291– 300. https://doi.org/10.31980/mosharafa.v10i2.662

Meilindawati, R., Zainuri, Z., & Hidayah, I. (2023). Penerapan media pembelajaran augmented reality (AR) dalam pembelajaran matematika. *Jurnal E-DuMath*, 9(1), 55–62. https://doi.org/10.52657/je.v9i1.1941

Mutiasari, F., Susanta, A., & Muchlis, E. E. (2024). Pengaruh model pembelajaran problem based learning konteks budaya bengkulu terhadap kemampuan literasi

matematika siswa SMPI Al-Azhar 52 Kota Bengkulu. *Jurnal Lebesgue: Jurnal Ilmiah Pendidikan Matematika, Matematika dan Statistika*, 5(2), 844–850. https://doi.org/10.46306/lb.v5i2.621

Nanthi, B. D., & Mutaqin, A. (2023). Pengembangan e-modul dengan berbantuan pendekatan STEM untuk meningkatkan literasi matematis siswa SMP. *Jurnal Ilmiah Pendidikan Dasar*, 8(3), 1–12.

Nusantara, D. S., Zulkardi, & Putri, R. I. I. (2021). Designing Pisa-like mathematics problem using a Covid-19 transmission map context. *AIP Conference Proceedings, 2438(October)*. https://doi.org/10.1063/5.0071596

OECD. (2019). PISA 2018 Results (Volume I): What Students Know and Can Do (Vol. I).

OECD. (2023a). PISA 2022 Results (Volume I): The State of Learning and Equity in Education. Factsheets (Vol. I).

OECD. (2023b). Program For International Student (PISA) 2022 Assessment and Analytical Framework. OECD (Organisation for Economic Co-operation and Development) Publishing.

Pasaribu, F. T., Gustiningsi, T., Syafmen, W., Roseli, T., Nusantara, D. S., & Sainuddin, S. (2023). Pendampingan pembuatan media pembelajaran berbasis AR untuk guru SMP di kota jambi. *Abdimas Indonesia*, 1(2), 1588–196. https://doi.org/10.53769/jai.v4i4.1061

Pasaribu, F. T., & Ramalisa, Y. (2020). Desain media pembelajaran geometri SMP menggunakan 3D pageflip professional berbasis RME terintegrasi STEM. *Logaritma: Jurnal Ilmu-Ilmu Pendidikan dan Sains*, 8(01), 55–66. https://doi.org/10.24952/logaritma.v8i01.2374

Pasaribu, F. T., & Ramalisa, Y. (2022). Quizizz's augmented reality (AR) based mathematics digital pocketbook design using gold (guided, organizing, leaflet, discovery) learning model. *Logaritma: Jurnal Ilmu-Ilmu Pendidikan dan Sains*, 10(01), 67–80. https://doi.org/10.24952/logaritma.v10i01.4567

Pasaribu, F. T., Saputra, W., Agustinawati, P. L., & Afifah, N. (2022). Desa cendekia sebagai program pengembangan kemampuan literasi masyarakat desa rantau puri. *Community Development Journal: Jurnal Pengabdian Masyarakat*, 3(3), 1979–1986. https://doi.org/10.31004/cdj.v3i3.9549

Prayitno, A. T., Ismalia, I., & Taufik, A. (2025). Pengembangan modul matematika berbasis problem based learning untuk meningkatkan kemampuan literasi matematis. *JagoMIPA: Jurnal Pendidikan Matematika dan IPA*, 5(2), 556–569. https://doi.org/10.24036/pmat.v12i1.14295

Rizqiyani, Y., Anriani, N., & Pamungkas, A. S. (2022). Pengembangan e-modul berbantu kodular pada smarthphone untuk meningkatkan kemampuan literasi matematis siswa SMP. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 6(1), 954–969. https://doi.org/10.31004/cendekia.v6i1.1172

Rokhman, F. A., Susanti, & Lestariningsih, A. R. (2024). Penerapan pendekatan culturally responsive teaching (CRT) untuk meningkatkan hasil belajar peserta

didik kelas VII SMP negeri 4 madiun pada materi penyajian data. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, 9(2), 7950–7960.

Saputri, S., & Sibarani, A. J. P. (2020). Implementasi augmented reality pada pembelajaran matematika mengenal bangun ruang dengan metode marked based tracking berbasis android. *Komputika: Jurnal Sistem Komputer*, 9(1), 15–24. https://doi.org/10.34010/komputika.v9i1.2362

Setiawan, H., Aji, S. M. W., Oktaviyanti, I., Jiwandono, I. S., Rosyidah, A. N. K., & Gunayasa, I. B. K. (2021). Pemanfaatan sumber bacaan berbasis augmented reality untuk gerakan literasi di sekolah dasar. *Briliant: Jurnal Riset Dan Konseptual*, 6(1), 146. https://doi.org/10.28926/briliant.v6i1.554

Simbolon, N., Sitohang, R., & Mailani, E. (2023). Pengembangan e-modul berbasis pendekatan problem based learning untuk meningkatkan pemahaman siswa pada pembelajaran tematik kelas V tema 9 subtema 3 SDN 107418 bangun sari baru T.A 2022/2023. *Journal of Student Developement Information System (JoSDIS)*, 3(2), 189–198.

Stacey, K. (2011). The PISA view of mathematical literacy in Indonesia. Journal on Mathematics Education, 2(2), 95–126. https://doi.org/10.22342/jme.2.2.746.95-126

Sugiyono. (2013). *Metode Penelitian dan Pengembangan Pendekatan Kualitatif, Kuantitatif, dan R&D*. Bandung: Alfabeta,

Tamur, M., & Pantaleon, K. V. (2023). Pengembangan e-modul matematika interaktif terintegrasi kahoot! untuk mendukung literasi matematis siswa SMP. *Suska Journal of Mathematics Education*, 9(2), 135. https://doi.org/10.24014/sjme.v9i2.24932

Tareq Ghifari, M. E. F. H. R. (2023). Pasundan Journal of Mathematics Education : Jurnal Pendidikan Matematika. Pasundan Journal of Mathematics Education: Jurnal Pendidikan Matematika, 13(2), 134–150. https://doi.org/10.23969/pjme.v13i2.10020

Wardana, J. W., Sugiyanti, Ariyanto, L., & Purwanto. (2024). Efektivitas pendekatan culturally responsive teaching berbantuan e-lkpd dalam meningkatkan hasil belajar matematika siswa SMP. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, 9(2), 4955–4965.

Yanindah, A. T. C., & Ratu, N. (2021). Pengembangan e-modul sugar berbasis android. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 5(1), 607–622. https://doi.org/10.31004/cendekia.v5i1.445

Zakiyatul Miskiyyah, Z. M., & Achmad Buchori. (2023). Pengembangan E-Modul Dengan Pendekatan Culturally Responsive Teaching Pada Materi Sistem Persamaan Linear Dua Variabel. *ENGGANG: Jurnal Pendidikan, Bahasa, Sastra, Seni, dan Budaya*, 3(2), 281–289. https://doi.org/10.37304/enggang.v3i2.9039