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Development of Microlearning Modules based on Candi Singasari as a Culturally Responsive Teaching to Enhance Problem-Solving Ability

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Abstract

The aim of this research is to find out how the implementation of the development of a microlearning module containing Culturally Responsive Teaching at Candi Singasari can improve students' problem solving abilities. The development model in this study refers to the ADDIE development model. The study involved one media expert, one material expert, and the research subjects taken came from class X students in Malang class X students. Data collection was carried out through observation, interviews, and questionnaires analyzed using qualitative and quantitative methods. The average total validation score from experts is 91.4%, which indicates that the Containing Culturally Responsive Teaching loaded microlearning module is very valid. The overall average product trial results reached 83.8% which is included in the valid category. The results of the Paired Sample t-test and Post test were 0.000 <0.05, so there is an effect of the microlearning module containing Containing Culturally Responsive Teaching on improving mathematical problem solving abilities and an increase in mathematical problem solving abilities before and after the use of the microlearning module containing Containing Culturally Responsive Teaching by looking at the average value of the pre-test 6.1694 and post-test 24.2788. So it can be concluded that the Containing Culturally Responsive Teaching loaded microlearning module has been successfully developed and validated so that it is suitable for use to improve mathematical problem solving abilities in the material of trigonometry comparisons in right triangles.

Keywords: Microlearning modules, ethnomathematics, problem solving abilities, trigonometry

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INTRODUCTION

The industrial revolution 4.0 has had a significant impact on various fields including the world of education. In Indonesia, the changes caused by the industrial revolution 4.0 are clearly felt in the way of accessing information and the learning process (Ahdar et al., 2021; Anissi & Darmansyah, 2024; Utami. et al., 2023). The development of digital technology in the world of education opens up great opportunities for the world of education to improve quality amidst new challenges in preparing students to face an increasingly complex world. Amidst the changes,

the characteristics of 21st-century students are increasingly diverse, such as preferring freedom in learning, liking new things, being more comfortable with an environment connected to the internet network, being more interested in visual content than in long texts, having a short attention span, and being able to interact in a complex manner in the media, and being independent and critical in assessing the credibility of information, resulting in the need for students to have the ability to communicate, share, and use information to solve problems. (MacDonald, 2017; Md, 2019; Tambunan, 2019; Yapatang & Polyiem, 2022). So that education today does not just provide knowledge, but also equips students with the ability to solve problems and adapt to change.

In response to the challenges, Indonesia launched the Merdeka curriculum which gives teachers the freedom to design learning that suits the needs and potential of students. In addition to mastering the material, the Independent Curriculum aims to focus on developing student competencies so that the learning approach taken is more flexible and adaptive. In this context, mathematics learning is one of the areas that is receiving great attention in improving students' abilities to solve more complex mathematical problems.

One of the materials studied in grade ten of high school is trigonometric comparisons in right triangles which is often a challenge for students because it requires a deep understanding of basic mathematical concepts and their applications. This requires effective and interesting learning modules. The mathematics learning modules used need to be designed to adapt to the needs of the times and characteristics of 21st-century students so that they can convey concepts clearly and contextually by involving relevant local culture so that students can see directly the relationship between mathematics and their daily lives. (Flesia et al., 2020; Md, 2019; Nouri et al., 2020; Yapatang & Polyiem, 2022).

Mathematics is closely related to culture, for example, the Singasari Temple in Malang, East Java province. Which is one of Indonesia's cultural heritages. Singasari Temple contains mathematical elements in its design and construction so that it can be used to teach trigonometric comparisons of right triangles. Learning using Singasari Temple which is a culture is included in learning with the CRT approach. CRT stands for Culturally Relevant Teaching which is defined as a pedagogy that empowers students both intellectually, socially, emotionally, and politically by using cultural references to provide knowledge, skills, and attitudes (Abdulrahim & Orosco, 2020; Brown et al., 2019; Gorski, 2016; Neri et al., 2019). In CRT, there must be three parts: academic success, cultural competence, and critical awareness. By implementing all three, teachers can engage learners from all cultures to help them build self-confidence through academic success with their culture intact (Parwati et al., 2018). For students to learn sequentially, mathematics teaching with the CRT approach can be packaged in a module. A module is a set of learning materials that students can study independently. The module contains clear components and instructions so that students can follow them sequentially without teacher intervention. So that the microlearning module containing CRT is packaged systematically and interestingly with material, methods and evaluation coverage that can be used independently with cultural content, namely the Singasari Temple so that students can learn independently so that the expected learning outcomes will be achieved.

One modern approach that suits the characteristics of 21st-century students is microlearning. Microlearning is a learning method that breaks down material into small pieces so that the material being studied is easy to understand in a short time. This supports current learning due to students' limited memory and students being easily distracted by other things (Dessì et al., 2019; Diaz Redondo et al., 2020; Shail, 2019; Yin et al., 2021). This approach is very effective because it reduces cognitive load and provides opportunities for students to learn gradually at their own pace. In the context of mathematics, microlearning can be applied to CRT-based mathematics modules which present material in a clear, concise and structured manner so that it is hoped that students will gain a better understanding of the material on trigonometric comparisons in right triangles and improve their ability to solve mathematical problems..

Even though the education system in Indonesia has developed, the results of achieving mathematical problem-solving abilities still show low figures in various international surveys (OECD, 2023). This shows that there is a gap in mathematics learning that needs to be fixed. One way that can be done is by developing a microlearning module containing the Candi Singasari CRT which is expected to not only help students master concepts but be effective in improving their mathematical problem-solving abilities in a structured and fun way. Thus, the purpose of this study is to determine the effectiveness of the development of a microlearning module containing CRT Candi Singasari on mathematical problem-solving abilities (Rakasiwi & Muhtadi, 2021).

Based on this introduction, this research aims to find out how the implementation of the development of a microlearning module containing Culturally Responsive Teaching at Singasari Temple can improve students' problem-solving abilities. To achieve this aim, this research asks the following questions: 1) What is the process of developing microlearning modules that integrate teaching with ethnomathematics? 2) Can microlearning modules with ethnomathematics content improve students' problem-solving abilities?

METHODS

The development model in this study refers to the ADDIE development model using five stages of development, namely 1) Analysis, at this stage the identification of learning needs, problems faced, and student profiles is carried out. The analysis carried out includes determining learning objectives, competencies to be achieved, and learning contexts; 2) Design, this stage is carried out with instructional design planning including the selection of teaching methods, media to be used, and learning evaluation. This stage aims to make the learning design interesting, relevant, and able to achieve the predetermined goals; 3) Development, at this stage learning materials and media begin to be produced according to the design that has been formulated. Development involves testing materials to ensure that all components run according to plan and get the expected results; 4) Implementation, namely the implementation of the learning process. At this stage, students use materials and media that have been designed and developed. The teacher uses the developed learning design and ensures that the learning process

runs smoothly and provides support to students according to their needs; and 5) Evaluation which is used to assess the effectiveness of the entire learning process. Evaluation is carried out during the learning process with formative evaluation and after learning with summative evaluation. The results of the evaluation are used to improve the material, media, and learning methods to better suit the needs of students.

The development procedure with the ADDIE development model consists of five stages including Analysis, Design, Development, Implementation, and Evaluation. The ADDIE stages are presented in Figure 3.1

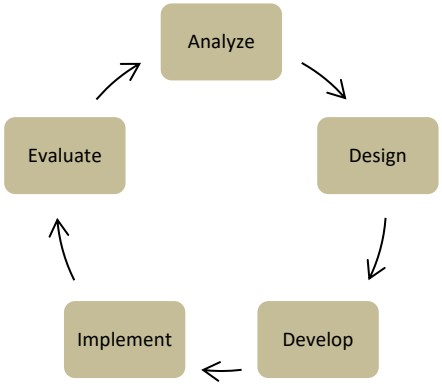


Figure 1. ADDIE Models

The subject of this study is one of the lecturers of Educational Technology who is an expert in the field of learning media at the Universitas Negeri Malang and expert in mathematics learning materials at the Universitas Sarjanawiyata Tamansiswa Yogyakarta, while the object is a development product in the form of a microlearning module containing ethnomathematics. Data collection was carried out using a questionnaire and data analysis techniques were carried out using quantitative descriptive analysis techniques, namely by analyzing quantitative data obtained from the questionnaire with the following formula:

$$V_a = \frac{TS_a}{TS_h} \times 100\% \ldots(1)$$

With V_a is the validation score percentage, TS_a Is the total score received, TS_h Is the highest possible total score that can be obtained with the validation analysis criteria presented in Table 1 below.

Table 1. Criteria for Validation

Interval	Category
$85{,}00\% < V_a \leq 100{,}00\%$	Very good
$70{,}00\% < V_a \leq 85{,}00\%$	Good
$50{,}00\% < V_a \leq 70{,}00\%$	Fair
$1{,}00\% < V_a \leq 50{,}00\%$	Poor

The feasibility value of a learning media product in the form of a microlearning module with ethnomathematics content is declared suitable for use if it meets the specified criteria with a minimum indicator of very good.

To determine the effectiveness of the product, a summative evaluation was carried out regarding the problem-solving abilities of class X students at one of the SMA Negeri at Malang on trigonometry material in Table 2.

Table 2. Mathematics Problem Solving Ability Question Grid

Learning Goals	Indicators of Learning Achievement	Level	Question Number
Solve contextual problems related to trigonometric comparisons in right triangles.	Students can solve contextual problems related to trigonometric ratios in right triangles	C4	1,2,3

With the following problem-solving in Table 3.

Table 3. Criteria for Problem Solving Process

Polya's Steps	Indicators of the Mathematical Problem-Solving Process	Score
See	Write down what you know and ask correctly	3
	Write down what you know and what you ask but one of them is wrong	2
	Write down what is known and what is asked but both are wrong	1
	Do not write down what is known and asked	0
Plan	Write down the settlement plan correctly	3
	Write a resolution plan, but only partially correct	2
	Menuliskan rencana penyelesaian, tetapi semuanya tidak tepat	1
	No plans at all	0
Do	Complete the steps and correct the answers	4
	Problem-solving steps are incomplete and the answer is correct	3
	Complete solution steps and partially correct answers	2
	The solution steps are incomplete and all answers are wrong	1
	Not a problem-solving process at all	0
Check	There is a check on the results of solving problems that are relevant and correct	3
	There is an examination of the results of problem-solving, but not all of them are relevant.	2
	There is an examination of the results of solving the problem, but not all of them are relevant.	1
	There is no checking of settlement results	0

$$\text{Grade} = \frac{\text{The scores obtained}}{\text{maximum score}} \times 100 \quad ...(2)$$

RESULTS & DISCUSSION

To improve mathematical problem-solving abilities on trigonometry comparison material that is by the characteristics of students in the 21st century, namely liking freedom to learn, being comfortable in an internet-connected environment, and having a short attention span, it is necessary to develop a CRT (Culturally Relevant) microlearning module. Teaching) Singasari Temple. The Ministry of Education, Culture, Research, and Technology stated that teachers need to understand the strategies, methods, and ways of delivering knowledge to students according to the needs of each student. With this module, it is hoped that it can adjust to the needs of students. The steps taken to develop this product are as

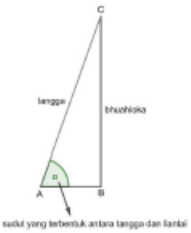
follows:

1. Analysis. Based on the results of observations and interviews with teachers and students conducted from February to June 2024, the following results were obtained: 1) teachers: a) books provided by the government have not fully facilitated the achievement of Learning Outcomes so that teachers must look for other references either through Google or other relevant mathematics books, b) exercises are needed that can cover students' abilities because the material presented in the book is still the same as the previous format and is even confusing to learn, c) schools have provided learning support books but students do not want to study them on the grounds that there is too much material to study so that it makes them dizzy, d) a contextual learning module is needed that facilitates students' abilities and learning styles so that they can improve their ability to solve mathematical problems, e) a module is needed that directly integrates cultural values because students are more familiar with foreign culture than with regional culture; 2) students: a) lack of critical thinking, creative, and opinion-giving skills so that a module is needed to accommodate this, b) the books studied are still monotonous and have not been touched by technology, c) students lack learning independence so that practice questions are needed that can guide students to learn independently, d) students feel distracted if learning is done by surfing on Google or YouTube, e) students still feel better using paper-based but the material presented is not too long-winded, f) students want to explore the surrounding environment not just studying the material so that they are trained to solve problems. From this analysis, a microlearning learning module is needed that adapts to the needs of teachers and students so that it is hoped that it can improve problem-solving abilities.
2. Design, The main focus of the design stage is to design specific and appropriate learning modules based on the results of the needs analysis which is carried out in the following steps: a) determine the learning objectives, namely improving mathematical problem solving abilities, namely after studying trigonometry comparison material, it is hoped that students will be able to solve contextual problems relating to trigonometric ratios in right triangles, b) compiling the structure and content of microlearning-based and culturally charged modules, namely the Singasari Temple, the involvement of technology through the provision of QR scans that link to short videos of learning material thereby facilitating various learning styles, and providing two practice questions are practice questions guided which aims to make students better understand the concepts being studied by paying attention to the directions at each step and for students who have higher abilities they can continue with the let's try activity which contains practice questions to be done independently which aims to measure the level of students' mathematical problem solving students, c) provided discussion space to develop critical and creative thinking skills, and provide feedback
3. Development, The development of the CRT (Culturally Relevant Teaching) microlearning module for Singasari Temple was carried out by creating learning materials that were presented briefly, concisely, and clearly with the help of Singasari Temple which is presented in Figure 2.

Gambar 1. Proses Perawatan Candi Singosari.

Sumber: https://tinyurl.com/42fvrsrv

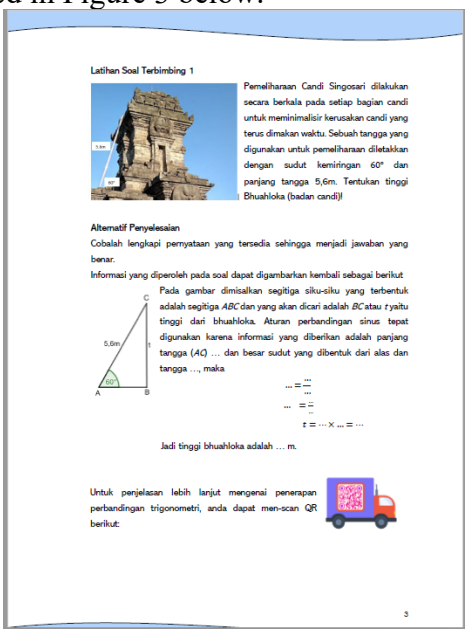
Perawatan Candi Singasari dilakukan secara berkala agar bangunan tidak mengalami kerusakan. Pada Gambar 1 terlihat sebuah tangga yang bersandar pada bhuahloka, apabila digambarkan maka akan terlihat seperti gambar 2 berikut:



Dengan mengetahui minimal dua bagian dari gambar, kita dapat menentukan bagian yang lainnya. Misalnya dengan diketahui besar sudut yang terbentuk antara tangga dengan lantai dan jarak antara tangga dengan lantai maka dapat dicari tinggi dari bhuahloka.

Figure 2. Trigonometric Comparison Material

After the learning material is presented, it is continued by providing guided practice questions to determine the level of student ability. Guided practice questions are presented in Figure 3 below.



Latihan Soal Terbimbing 1

Pemeliharaan Candi Singosari dilakukan secara berkala pada setiap bagian candi untuk meminimalisir kerusakan candi yang terus dimakan waktu. Sebuah tangga yang digunakan untuk pemeliharaan diletakkan dengan sudut kemiringan 60° dan panjang tangga 5,6m. Tentukan tinggi Bhuahloka (badan candi)!

Alternatif Penyelesaian

Cobalah lengkapi pernyataan yang tersedia sehingga menjadi jawaban yang benar.

Informasi yang diperoleh pada soal dapat digambarkan kembali sebagai berikut

Pada gambar dimisalkan segitiga siku-siku yang terbentuk adalah segitiga *ABC* dan yang akan dicari adalah *BC* atau *t* yaitu tinggi dari bhuahloka. Aturan perbandingan sinus tepat digunakan karena informasi yang diberikan adalah panjang tangga (*AC*) … dan besar sudut yang dibentuk dari alas dan tangga …, maka

$\ldots = \frac{\ldots}{\ldots}$

$\ldots = \frac{\ldots}{\ldots}$

$t = \ldots \times \ldots = \ldots$

Jadi tinggi bhuahloka adalah … m.

Untuk penjelasan lebih lanjut mengenai penerapan perbandingan trigonometri, anda dapat men-scan QR berikut:

Figure 3. Guided Question Practice

If students have difficulty understanding and working with the material, students can use a QR scan to connect to a short video related to the material. Students who can understand the material and can do guided practice questions can continue with exploration activities, namely, let's solve the problems presented in Figure 4 below.

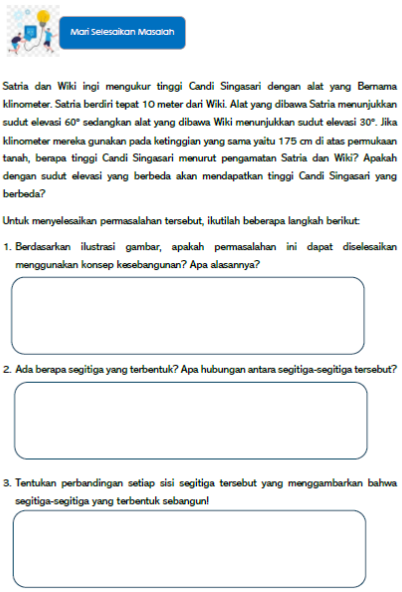


Figure 4. Let's Solve the Problem

This activity is expected to improve students' problem-solving abilities, critical thinking abilities, and creative thinking abilities. After completing the activity, able students can continue to the evaluation questions presented in Figure 5 below.

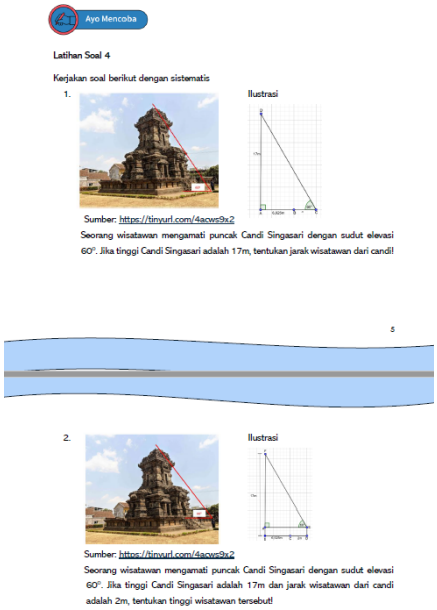


Figure 5. Let's Try Activities

The questions presented in the activity let's try to train students to practice mathematical problem solving, and critical and creative thinking skills because the answers given give students the opportunity to provide opinions regarding the logic of the answers.

4. Implementation of, microlearning module containing CRT (Culturally Relevant Teaching) Candi Singasari was conducted in one of the SMA Negeri in Malang, class X who studied trigonometric comparison material. This was done so as not to interfere with the learning plan that had been arranged by the teacher.
5. Evaluation at this stage aims to ensure that the needs analysis conducted is correct, as well as to identify problems that need to be resolved through learning. Evaluation is carried out using a validation sheet involving the Validation of learning media experts, and mathematics material experts., with the results presented in Table 4

Table 4. Results of Expert Validation

Validator	Percentage Score	Criteria
Media expert	90,7%	Sangat valid
Material expert	92,1%	Sangat valid
Average total expert test result	91,4%	Sangat valid

Media experts gave a percentage score of 90.7% included in the very valid category and material experts gave a percentage score of 92.1% included in the very valid category. The average total validation score from the experts was 91.4%, indicating that the CRT-loaded microlearning module met the criteria needed to be considered a very valid educational resource. These results indicate that the CRT-loaded microlearning module has met the required standards in terms of media, namely the size of the learning material, the design of the learning material, the design of the content of the learning material; and the feasibility of the material, namely the feasibility of the content, the feasibility of the test, the feasibility of the language, the suitability of the module to the learning strategy, and the effectiveness of the module to learning.

After evaluation by experts, the product undergoes a testing phase involving students, who represent potential media users. The pilot test was conducted in three stages: individual pilot test with three learners (1 high ability, 1 medium ability, and 1 low ability), small group pilot test with nine learners (3 high ability, 3 medium ability, and 3 low ability), and field trial test with thirty students. The purpose of the pilot test was to identify problems in the use of the media from the student's perspective. The findings from the pilot test provided valuable information about the suitability and ease of use of the media in improving mathematical problem-solving skills. Detailed results of the pilot test are presented in Table 5

Table 5. Product Result by Student

Validator	Percentage Score	Criteria
One-to-one test	82,5%	valid
Small group test	84,4%	valid
Field trial	84,7%	valid
Average total expert test result	83,8%	valid

Based on the results of the product trial by students presented in Table 5, the microlearning module containing CRT was declared valid. In the one-to-one test, it obtained a score of 82.5%, followed by a small group trial with a score of 84.4%, and a field trial with a score of 84.7%. The average result of the overall product trial reached 83.8% which is included in the valid category. These results show that the CRT-loaded microlearning module is consistently assessed as appropriate by

students at various stages of testing, thus strengthening the conclusion that this media is ready to be implemented in mathematics learning on trigonometry comparison material in class X high school as one of the module options to improve mathematical problem-solving abilities.

Field trials are also used as an effectiveness test of the microlearning module containing CRT. The test conducted is a paired sample t-test and post-test using SPSS and the questions used are mathematical problem-solving questions. Before conducting a paired sample t-test and post-test, a normality test is required with the following results.

Table 6. Test of Normality

	Kolmogorov-Smirnov			Shapiro-Wilk		
	statistic	df	Sig.	statistic	df	Sig.
Pre-test	.143	32	.097	.941	32	.077
Post-test	.126	32	.200	.936	32	.056

Based on the results of the normality test with Shapiro-Wilk, it can be seen that the significance value of the pre-test is 0.07 and the post-test is 0.056. Because the significance value is greater than 0.05, the data is normally distributed. Furthermore, a paired sample t-test and post-test were conducted with the following results.

Table 7. Paired Sample t-test and Post-test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Pre-test-post test	-18,109	14.386	2.543	-23.296	12.923	-7.121	31	.000

From the results of the Paired Sample t-test and Post-test in Table 6, it can be seen that the significance value of 2-tails is 0.000 <0.05, so there is an influence of the CRT-laden microlearning module on improving mathematical problem-solving skills. This is explained in the following table 7.

Table 8. Result Pre-Test dan Post Test

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre-test	6.1694	32	3.67693	.65000
	Post-test	24.2788	32	14.77942	2.61266

From the results of Table 8, it can be seen that there is an increase in mathematical problem-solving ability before and after using the CRT-based microlearning module by looking at the average pre-test and post-test scores.

Discussion

The results of the data analysis show that the CRT-loaded microlearning module is valid and feasible to be used as a learning medium for trigonometric comparison material to improve mathematical problem-solving ability. The CRT-loaded microlearning module supports the characteristics of 21st-century students,

namely liking the freedom to learn, being comfortable with an environment connected to the internet, and having a short attention span and also supports learning because it is adjusted to the learning style and ability level of students (Giurgiu, 2017; Ma et al., 2023; Nikou & Economides, 2018; Shail, 2019; Zarshenas et al., 2022). The CRT-based microlearning modules have undergone a validation process to ensure their suitability (Díaz Redondo et al., 2021; Fidan, 2023; Ma et al., 2023; Zarshenas et al., 2022). Validation is an important step taken in the development of learning media including modules, because it is related to the quality of the module. The validation process is carried out by evaluating media and materials which aims to ensure alignment between materials, learning objectives, and competency achievements stated in the module Government policy as stated in BSKAP Nomor 032/H/KR/2024 on Learning Achievements in Early Childhood Education, Elementary Education Level, and Secondary Education Level in the Merdeka Curriculum.

Research on the use of ethnomathematics learning modules is supported by research. Finariyati (2020) and Dwi (2020) Which states that the use of ethnomathematics modules improves mathematical problem-solving skills. This finding underline that the ethnomathematics learning module can improve mathematical problem-solving abilities in this research. Likewise, with microlearning, research on microlearning was carried out by (Pebriantika et al., 2025; Simanjuntak & Haris, 2023) Shows that learning with microlearning can improve learning outcomes.

Based on the results of data analysis, it was found that collaborating microlearning and ethnomathematics modules which became CRT-loaded microlearning modules could improve students' mathematical problem-solving abilities, especially in the material of trigonometry comparisons in right triangles. From this research, it is hoped that there will be further development of microlearning modules for mathematics material or other materials that contain local culture so that students can better appreciate, love, and participate in preserving local culture.

CONCLUSION

This research was successful in developing a microlearning module that integrates Culturally Responsive Teaching with Singasari Temple material. This module proved effective in improving students' problem-solving abilities and was well received by students. Integration of local culture helps students link learning to relevant contexts, thereby strengthening student engagement and understanding. The results of this study show that the use of microlearning modules based on culturally responsive teaching can improve the quality of learning. Practically, this module can be a reference for teachers in designing contextual and relevant teaching materials for local culture. Theoretically, this research enriches the literature regarding culturally responsive teaching and the development of microlearning in learning. Integrating local culture into learning can be a strategy for improving students' problem-solving abilities, especially in the context of history and cultural heritage. This study has several limitations. First, the scope of the study was limited

to students in one school so the results may not be fully generalizable to a wider context. Second, measuring the effectiveness of the module is only carried out over a certain period, so the long-term impact cannot yet be evaluated. Third, this research focuses on one topic of local Malang culture, namely Singasari Temple, so its development may not be relevant to other regions or cultural contexts.

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