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LOCAL CULTURE-BASED ETHNOMATICS DEVELOPMENT IN MATHEMATICS DEVELOPMENT IN MATHEMATICS LEARNING TO IMPROVE CRITICAL THINKING SKILLS

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ABSTRACT
Integration of cultural elements into the learning process, especially in mathematics, functions as a strategic approach to create a contextual and interesting classroom environment. This study aims to develop ethnomatics-based mathematics learning media that integrates local culture to improve critical thinking skills of 5th grade elementary school students. This study is a type of research and development that refers to three stages: preliminary study, model development, and trial. The subjects of this study consisted of 66 fifth grade elementary school students in Klaten Regency, Central Java who were selected using purposive sampling techniques. The data collected quantitatively to determine the average score, by categorizing based on the evaluation table referred to by the criteria, then analyzed qualitatively. The preliminary study was conducted through observations related to local culture that is relevant to the concept of mathematics and a needs questionnaire. The product developed is a plasticine learning media in the form of traditional cakes as an aid in understanding the concept of geometry. The trial results showed significant improvements in four aspects of learning: conceptual understanding (from 70 to 90), critical thinking skills (from 74 to 89), collaboration (from 75 to 95), and local cultural knowledge (from 70 to 95). These findings suggest that local culture-based ethnomatics can enhance students' academic abilities and strengthen cultural understanding and collaborative skills.

INTRODUCTIONS

Mathematics is a very important basic subject in the world of education because it plays a role in developing logical, systematic, and critical thinking patterns (Adillaningtyas & Syamsuri, 2024). However, in practice,

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mathematics is often considered a difficult and uninteresting subject by most students, especially at the elementary school level (Andriani & Sari, 2024). This is because the material taught is abstract and less related to the context of students' daily lives (Andriyani, 2017). The disconnection between mathematical concepts and real experiences causes a lack of motivation and low critical thinking skills in students in solving math problems (Ardiansyah & Nulhakim, 2023).

In response to these problems, the contextual learning approach is one alternative that is believed to be able to improve students' understanding and participation in learning. One relevant approach is ethnomatics, which is an approach to learning mathematics that integrates local cultural elements into the context of learning. Ethnomatics provides opportunities for students to see that mathematical concepts actually exist and develop in their own culture (Zaenuri & Dwidayati, 2018). Ethnomathematics encompasses mathematical practices in various cultural groups, from urban to rural, including indigenous peoples, workers, and children According to (Pirma & Caswita, 2023), ethnomathematics is a form of mathematics that develops in a particular community in response to its needs.

Ethnomathematics helps students understand mathematical concepts by encouraging exploration and understanding of the culture in their surrounding environment (Febrina et al., 2022; Mulyatna et al., 2022). Integrating culture into the learning process can facilitate the development of students' critical thinking skills more easily. It is time to integrate ethnomathematics into the national mathematics education curriculum to ensure that all students, regardless of their cultural background, can connect mathematics to their life experiences and cultural heritage. Culture is one aspect of students' daily environment that can be interconnected with mathematics subjects ((Febriyanti & Ain, 2021; Putri & Agustika, 2022).

Indonesia as a country rich in local culture has great potential to be developed as a learning resource (Yuliani et al., 2022). Batik patterns, traditional number systems, regional games, traditional house architecture, and measurement systems in traditional agricultural and trade activities are real examples of the application of mathematical concepts in local culture (Xia, 2022). If these elements are raised in mathematics learning, there will be a more contextual transfer of knowledge and strengthening of cultural identity in students.

Integration of local culture in mathematics learning not only serves to link material to students' realities but can also develop critical thinking skills (A. Twiningsih et al., 2019). Students will be invited to analyze, evaluate, and construct knowledge from the cultural context they understand. Critical thinking skills are very important in 21st century learning because they help students make decisions, solve problems, and develop a reflective attitude towards the information obtained (A. T. Twiningsih, 2020). Critical thinking is an attitude of thinking deeply about problems and things that are within the scope of one's experience (Susanto et al., 2021).Critical thinking requires students to make decisions that are reasonable and logical.

However, the application of ethnomatics in mathematics learning in elementary schools has not been done systematically. The majority of teachers still use conventional approaches and have not utilized local cultural wealth as a source of learning. Therefore, an effort is needed to develop learning tools that explicitly integrate local cultural elements in the context of mathematics learning to improve the quality of the process and student learning outcomes.

Previous studies have been conducted on the application of ethnomathematics in mathematics learning using various approaches, including the effectiveness of ethnomathematics-based teaching materials (Imswatama & Lukman, 2018), exploration of Bugis ethnomathematics as a source of mathematics learning (Pathuddin & Nawawi, 2021), realistic mathematics learning based on ethnomathematics (Payadnya et al., 2024), and problem-solving skills through realistic mathematics learning based on ethnomathematics (Lubis et al., 2021). In addition, research (Akmal Wildan et al., 2024) revealed that ethnomathematics-based mathematics education can help students simplify previously difficult-to-understand mathematical concepts. However, most of these studies focus more on the development of media or methods without specifically discussing how students respond to ethnomathematics problems in a particular cultural context in the digital era.

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The novelty of this approach lies in the combination of local culture and critical thinking skills learning. Research on the integration of cultural elements, such as: Batik patterns, traditional number systems, regional games, traditional house architecture, to measurement systems in traditional agricultural and trade activities in mathematics learning provides a new perspective that has not been widely studied in various countries. This opens up opportunities to utilize cultural heritage as an innovative learning medium that is relevant to the needs of today's students (David et al., 2024; Kogoya et al., 2023).

Based on this background, this study aims to develop ethnomatics-based mathematics learning tools that are contextualized with local culture. This research provides a significant contribution to identifying the gap between students' critical thinking skills towards ethnomathematics and their ability to apply mathematical concepts and cultural contexts. Furthermore, this study offers pedagogical insights to develop learning strategies that integrate cultural contexts with digital technology to enhance engagement and problem-solving skills.

RESEARCH METHODS

This research is a type of research and development that aims to develop ethnomatics-based mathematics learning tools integrated with local culture to improve critical thinking skills of 5th grade elementary school students. This research was conducted at an elementary school in Klaten Regency, Indonesia. The research subjects used were 66 fifth grade students. Samples were taken using random sampling techniques. Proportional random sampling is a method used to obtain samples by taking them randomly which is proportional to the size of each sampling unit (Etikan, 2017; Mweshi & Sakyi, 2020).

This development research refers to the development model according to Sukmadinata (2007), which includes three main stages, namely: (1) preliminary study, (2) model development, and (3) model testing (validation testing).

1. Preliminary Study Stage
   At this stage, the researcher conducted a theoretical study and field study to obtain an overview of the needs of students and teachers for contextual mathematics learning devices. Activities in this stage include:
   - Literature study related to ethnomatics, local culture, and critical thinking.
   - Observation of mathematics learning in grade 5 of elementary school.
   - Interviews with class teachers and local cultural figures.
   - Analysis of the curriculum and mathematics materials relevant to local cultural elements.

   The results of this preliminary study are used as a basis for designing the initial design of the learning devices to be developed.
2. Model Development
   This stage aims to design and compile ethnomatics learning devices based on local culture. The devices developed include:
   - Syllabus and RPP based on ethnomatics
   - Student worksheets (LKS)
   - Learning media (visual or manipulative based on local culture)
   - Critical thinking skills assessment instruments
   - This initial product is then validated by material experts, media experts, and education practitioners. Validation is carried out to obtain input to revise the product before being tested in the field. Validation is carried out using an assessment sheet with a Likert scale.

3. Model testing (Validation testing)

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The model trial was conducted in two stages: limited trial and extensive trial.

- A limited trial was conducted in one 5th-grade elementary school classroom with approximately 25–30 students. The purpose of this limited trial was to assess the initial student and teacher responses to the device.
- Extensive trials were conducted in two different schools with fifth-grade students as subjects. At this stage, researchers measured improvements in students' critical thinking skills using a pretest-posttest design.

Questionnaires and observations were used as instruments to collect research data. According to Moser & Korstjens (Moser & Korstjens, 2018) a questionnaire is a tool used to collect data consisting of a series of questions that require responses from participants that are closed. The first instrument is a questionnaire on teacher needs for the product being developed. The second instrument is a questionnaire designed to measure the level of feasibility of media and materials. Validation questionnaires were also given to practitioners and students. The questionnaire measurement uses a Likert scale reference of 1-5 (Aithal & Aithal, 2020).

Meanwhile, observations were carried out to determine the problems in the preliminary research (Hanif, 2020). The method used is non-participant and structured observation. The results of the observations contain what can be learned from the content of developing ethnomathematics based on local culture in mathematics learning to improve students' critical thinking skills.

The use of techniques in analyzing data in this development uses quantitative and qualitative descriptive techniques. Quantitative analysis involves data from expert team validation (material, media, and language) to find out the average score, then analyzed qualitatively. All results in the form of comments, suggestions, and feedback are explained in descriptive descriptions. The measurement scale used in this study is a Likert scale. The amount of each data is also changed into a percentage, with the formula:

$$P = \frac{f}{N} \times 100\%$$

P = percentage
F = total value of collected results data
N= maximum score

RESEARCH RESULTS AND DISCUSSION

Results

This research is a type of research and development that aims to develop ethnomatics-based mathematics learning tools integrated with local culture to improve critical thinking skills of 5th grade elementary school students. This research was conducted at an elementary school in Klaten Regency, Indonesia. The research subjects used were 66 fifth grade students. Samples were taken using random sampling techniques. Proportional random sampling is a method used to obtain samples by taking them randomly which is proportional to the size of each sampling unit (Etikan, 2017; Mweshi & Sakyi, 2020).

This development research refers to the development model according to Sukmadinata (2007), which includes three main stages, namely: (1) preliminary study, (2) model development, and (3) model testing (validation testing).

1. Preliminary Study Stage

   The preliminary study stage is the initial step in the development process which aims to dig up in-depth information related to the needs, potentials, and problems in the field. This information becomes the basis for designing the initial design of the learning device to be developed. In the context of this research, the

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preliminary study was conducted through three main activities: literature review, field study, and needs analysis.

2. Model Development

This research resulted in the development of media in the form of ethnomatics-based mathematics learning media by preserving local cultural wisdom. The development of learning media produced in the form of media made from plasticine as a replica of traditional cakes to recognize geometry, especially in various types of solid and flat shapes.

Figure 1, Replica of traditional cakes

The enthusiastic response shown by the students was not in line with their skills in solving ethnomathematics problems. Most students had difficulty when faced with ethnomathematics problems rooted in the material of solid and flat shapes. Many students had difficulty understanding the ethnomathematics problems given and failed to translate the cultural context into mathematical concepts. The following is an example that illustrates the students' responses.

In answering the following questions, students often show a lack of understanding of the questions, which leads to errors in calculations. In addition, students have difficulty identifying relevant information from the questions given. Here is an example of a student response.

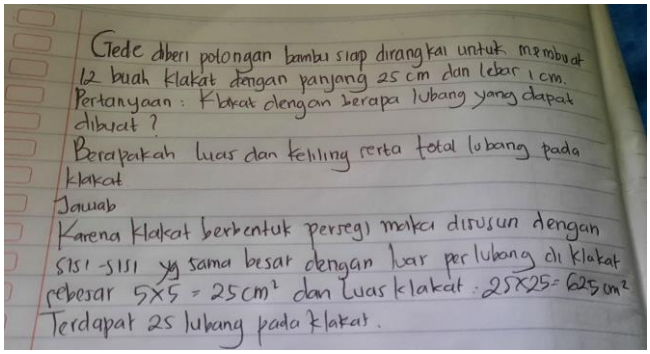

Figure 2, Example of student answers

The image above shows that students do not fully understand the information presented in the question. From the “knowing” part of the student’s answer, it appears that the student understands the dimensions of the bamboo sticks (25 cm x 1 cm) but mistakenly assumes that the number of bamboo sticks given (12 pieces) corresponds to the number of klakats to be made. In addition, the student concludes that the size of

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the hole in the Klakat is 5 x 5 cm without providing any reason for this choice. Although students understand the purpose of the question, they have difficulty fully understanding the information provided.

3. Model testing (Validation testing)
   Berdasarkan hasil uji coba lapangan hasil implementasi pengembangan media etnomatika hasil belajar siswa dapat disajikan dalam grafik beikut.

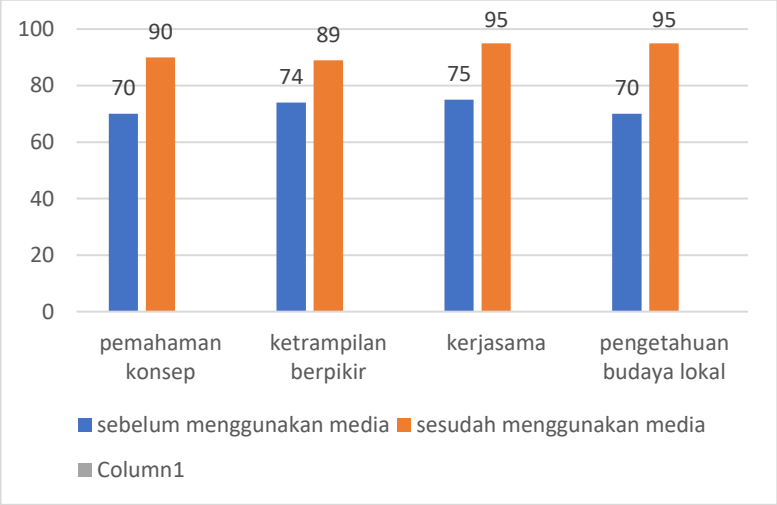

Table 1, Average class mathematics learning outcomes before and after using ethnomatics media development

The bar chart above presents comparative data on student learning outcomes in four main aspects, namely conceptual understanding, thinking skills, cooperation, and local cultural knowledge, which were measured before and after using learning media. In general, there was a significant increase in all aspects after the media was applied. In the conceptual understanding aspect, students' scores increased from 70 to 90, indicating that learning media were able to help students understand the material better and more deeply.

The thinking skills aspect also increased from 74 to 89. This shows that the use of media is able to stimulate students' critical and logical thinking skills in the learning process. An increase was also seen in the cooperation aspect, from 75 to 95. This indicates that the media used was able to facilitate group work and collaboration between students more effectively, so that they were more active in joint activities.

The most significant increase occurred in the local cultural knowledge aspect, from an initial score of 70 to 95 after using the media. These data show that the learning media used not only helped students understand the subject matter, but also enriched their insight into local culture. Overall, the use of learning media has been shown to have a positive impact on improving various aspects of students' abilities as a whole.

Discussion

The enthusiastic response shown by the students showed a positive acceptance of the concept of ethnomathematics in colorful traditional cake replicas. Ethnomathematics not only attracts students' interest but also stimulates and improves critical thinking skills. Students view ethnomathematics, especially in the context of

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traditional cake shapes that fulfill the elements of flat and spatial shapes, as an interesting and fun way to learn and solve problems (Darmayasa et al., 2019).

Ethnomathematics-based learning has the potential to improve students' understanding of mathematics and the environment (Mania & Alam, 2021). A strong understanding of realistic mathematics is essential for developing critical thinking skills and problem-solving abilities. Through ethnomathematics, students can gain insight into their environmental conditions and utilize their mathematical skills to address real-world challenges.

The media developed in the form of replicas of traditional cakes made of plasticine is a concrete means of introducing the concept of spatial and flat shapes (Andriani & Sari, 2024). This innovation shows that mathematics learning does not have to be limited to numbers and symbols, but can be associated with meaningful cultural objects. The increase in scores on the conceptual understanding aspect from 70 to 90 reflects the success of the media in visualizing complex material to be simpler and easier for students to understand. In addition, the aspect of critical thinking skills which increased from 74 to 89 strengthens the finding that students are able to explore, analyze, and draw conclusions from the cultural phenomena they learn.

Ethnomatics-based learning also contributes greatly to improving students' ability to work together in groups. The increased cooperation score from 75 to 95 shows that this media not only stimulates students' cognition, but also their social-emotional aspects. Local cultural exploration activities in groups encourage discussion, collaboration, and mutual learning between students. Thus, this media is able to create a participatory and enjoyable learning atmosphere.

The last aspect that shows the most significant increase is students' local cultural knowledge, from 70 to 95. This proves that ethnomatics not only strengthens mathematical understanding, but also forms cultural awareness in students. Strengthening cultural identity is very relevant to the goals of 21st century education which not only emphasizes academic competence, but also the preservation of local values and national character. Thus, the ethnomatics approach has proven to be able to bridge meaningful mathematics learning with contextual cultural preservation,

However, the current study is limited to focusing only on one mathematical topic in the form of flat and spatial figures and with a simple number of samples. As noted by (Alhusna et al., 2025)that future research needs to expand the application of ethnomathematics in a wider range of mathematics content with larger and more demographically diverse populations. In addition, longitudinal studies can provide insights into the ongoing cognitive and cultural benefits of the tool over time, including its impact on academic achievement and character formation.

This finding supports the view (A. T. Twiningsih, 2020) which shows that the development of ethnomatics learning media that integrates local cultural elements has a positive impact on improving student learning outcomes, especially in terms of critical thinking skills. This approach is able to overcome the problem of the abstractness of mathematics material which has been an obstacle for elementary school students. By presenting material through media that is familiar in everyday life, students find it easier to understand mathematical concepts contextually and comprehensively. This is in line with the theory of contextual learning which suggests that learning will be more effective when linked to students' real experiences (Alagan et al., 2020). Research conducted by (Wijayanto, 2017) that the developed teaching module has met the criteria of being valid, practical, and effective. According to (Simbolon, 2024) shows how ethnomathematics-based worksheets not only improve learning outcomes but also students' abilities in solving mathematical problems. The study concluded that integrating culture into learning materials encourages students to think more critically and creatively, especially when faced with problems that require logical reasoning and pattern recognition.

CONCLUSION

Based on the research results, it can be concluded that the development of ethnomatics-based mathematics learning media integrated with local culture has been proven to have a positive impact in improving various aspects

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of students' overall abilities. The developed media utilizes replicas of traditional cakes made of plasticine to visualize geometric concepts in a contextual and interesting way. The use of this media not only helps students understand mathematical concepts more deeply, but also improves critical thinking skills, collaboration, and insight into local culture. The significant improvement in learning outcomes in these four aspects shows that the ethnomatics approach is able to make learning more meaningful, contextual, and oriented towards strengthening character and preserving culture. Overall, the integration of cultural elements in mathematics education has the potential to create a more inclusive, culturally relevant society and foster a deeper connection between mathematical concepts and diverse cultural perspectives.

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