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Development of Geometry Learning Tools Integrated Transformation of Ethnomathematics of Jambi Batik

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Abstract: This research was motivated by low student learning outcomes, learning tools that did not provide a positive relationship to students' mathematical abilities, and learning tools that did not include the surrounding culture. This research aims to produce an integrated learning tool for Jambi Batik ethnomathematics that meets the valid, practical, and effective criteria for transforming geometry material in class IX junior high schools. The method used in this research is a combination of ethnographic research and development research with the Plomp model which consists of the Preliminary, Prototyping, and Assessment Phases. The subjects of this research were class IX students of SMP Negeri 21 Batanghari. The results of this research show that the Jambi Batik Ethnomathematics integrated Transformation Geometry learning tool in Class IX Middle School is valid. The device also meets practical criteria based on the results of questionnaires and interviews. Based on the final tests carried out, it shows that the device is in the effective category. So, it can be concluded that the resulting device is valid, practical, and effective.

Keywords: Ethnomathematics; Jambi batik; Learning tools

Introduction

Mathematics and culture are two inseparable elements in people's daily lives. Mathematics, as a science, is an integral part of solving various problems in everyday life (Thanheiser, 2023; Turmuzi et al., 2023). On the other hand, culture, as a unity that covers various aspects of society, is also related to mathematics (Bishop, 1994; Rajapathirana & Hui, 2018; Ernest, 2021). Ethnomathematics emerged as an approach that connects mathematics with culture, aiming to increase students' understanding of cultural values and the benefits of mathematics in cultural terms (Rosa & Orey, 2016; Johnson et al., 2022). Jambi batik, as a cultural heritage with values contained in each motif, is a relevant choice for integration in mathematics learning (Supana, 2019; Prastio et al., 2023; Raya et al., 2021).

In Indonesian cultural studies, Melnikov et al. (2020) stated that mathematics is not only a scientific discipline but also a part of culture. Prastika et al. (2021), added that mathematics is a symbolic technology that grows in cultural activities. Therefore, learning mathematics that links culture, or what is called ethnomathematics, is important to provide students with a better understanding of mathematical concepts. Jambi batik is a rich cultural representation with mathematical values contained in every motif (Risdiyanti & Prahmana, 2018). By Andriyani et al. (2023), integrating transformation geometry in mathematics learning with the context of Jambi Batik, it is hoped that students can more easily understand mathematical concepts and see their relevance to local culture.

This research aims to describe the elements of ethnomathematics in Jambi batik motifs and produce an integrated mathematics learning tool for Jambi batik ethnomathematics that is valid, practical, and effective. It is hoped that this research can make a positive contribution to improving the quality of mathematics learning in Class IX Middle Schools, especially in the Jambi area which is rich in Jambi Batik cultural heritage.

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Method

This research combines ethnographic and design research approaches to explore Jambi Batik. Data about Jambi Batik was collected through observation, interviews, and documentation studies, including monitoring motifs and the manufacturing process with photos videos, and interviews. Data analysis was carried out using data reduction steps, data presentation, and conclusions. The results will identify the Ethnomathematics aspects of Jambi Batik, which are grouped into five mathematical ideas such as counting, measuring, locating, designing, playing, and explaining (Rosa & Orey, 2016). These aspects are the basis for designing learning tools using a design research approach. The design research phase involves analyzing needs, curriculum, concepts, and students. Development involves designing RPPs and LKPD based on Jambi Batik ethnomathematics with formative evaluation by experts and small trials. Individual and group evaluations were conducted to assess quality and practicability. Field tests are carried out to measure the practicality and effectiveness of learning tools, involving tests of student learning outcomes (Viyanti et al., 2023).

The learning tools were tested in class IX of SMP Negeri 21 Batanghari with instruments in the form of questionnaires, interview guides, and implementation observation sheets. Qualitative data involves input, comments, criticism, and suggestions from students, while quantitative data is obtained from questionnaires, observation sheets, and learning outcomes tests. The data collection instruments involved checklist sheets, interview guides, student questionnaires, observation sheets for the implementation of lesson plans, as well as student and teacher response questionnaires. Validity is measured using a Likert scale, and practicality and effectiveness are analyzed using percentages. The type of data taken is qualitative and quantitative. All instruments, from preliminary analysis to field tests, involve a validation process by experts and validators (Elangovan & Sundaravel, 2021; Elo et al., 2014). Data were analyzed using the technique of providing an overall picture of the need, practicality, and effectiveness of Jambi Batik ethnomathematics learning tools.

Result and Discussion

The results of ethnographic research are presented in narrative form based on field notes, observations, interviews, and documentation at the Maryana Mastum Batik Studio, led by Mrs. Maryana and Solihin.

Mathematical Ideas in the Jambi Batik Making Process

Jambi batik is made in three ways, namely written batik, stamped batik, and printed batik, producing distinctive motifs with different precision in shape and coloring. Equipment includes wickets, stoves, cauldrons, sieves, canting, tablecloths, chairs, batik patterns, stamps, tables, gloves, and other materials with the process of cutting cloth, giving basic colors, cutting, coloring, color-locking, and boiling the night. Jambi batik motifs, such as Angso Duo, Durian Pecah, Kapal Senggat, Riang-Riang, Batanghari, Bungo Melati, Bungo Tanjung, Daun Keladi, Kuwao Ornamental, and Tampuk Manggis, contain philosophy and deep meaning from everyday life and beauty. surrounding nature.

Mathematical Ideas in Jambi Batik Motifs

In observing Jambi Batik, we found mathematical ideas related to the concept of counting (numbers). Using the concept of equal comparison in estimating batik production time, measuring. Measuring the area of cloth and stamps to estimate the number of stampings done. Playing. Division tasks for employees in the production process, with examples of combinations for determining the division of work, locating (determining location), determining the location for placing motifs on fabric dividing marketing areas, and designing (designing). Use of geometric concepts, geometric transformations, and flat shapes in designing batik motifs.

Development of Learning Tools

The products developed are Learning Implementation Plans (RPP) and Student Worksheets (LKPD) based on Jambi Batik Ethnomathematics on Transformation material which are expected to be able to improve student learning outcomes. Product development is based on ethnographic research conducted by the research subjects of this research, class IX students at SMPN 21 Batanghari. The tool developed uses an ethnomathematics approach that connects mathematics and Jambi batik culture.

Validity of Jambi Batik Ethnomathematics-Based Learning Tools on Transformation Material

The validity of Jambi Batik ethnomathematics-based learning tools on transformation material was evaluated through content, presentation, linguistic, and graphic aspects. Five validators, including three mathematics education experts, one educational technology expert, and one Indonesian language expert, gave an average validity value for the lesson plan of 93.91%, indicating very good validity. The review includes subject identity, basic competencies, indicators and learning objectives, material and media selection,

activity steps, assessment, as well as language and writing.

The Transformation Geometry LKPD based on Jambi Batik Ethnomathematics obtained an average validity value of 89.51%, categorized as very valid. The evaluation involves aspects of language, presentation, graphics, and content, showing conformity with the 2013 curriculum. The language used meets the standards of goodness and understanding of students. The presentation is by the indicators and learning objectives, while the graphics are in clear and interesting writing. Thus, the LKPD is considered very valid in facilitating the learning of transformation material in an ethno-mathematics way.

Table 1. Average Recapitulation of Jambi Batik Ethnomathematics-Based LKPD Validation Results by Experts

Rated aspect	Average Rating(%)					Average (%)	Criteria
	V1	V2	V3	V4	V5		
Language	-	-	-	-	81.20	81.25	Very Valid
Presentation	-	-	-	-	-	95.83	Very Valid
Contents	96.40	92.80	96.40	-	-	95.24	Very Valid
Graphics	-	-	-	85.70	-	85.72	Very Valid
Overall Average	-	-	-	-		89.51	Very Valid

The Practicality of Jambi Batik Ethnomathematics-Based Learning Tools on Transformation Material

The purpose of this practicality test is to evaluate the benefits, ease of use, and time efficiency of using RPP and LKPD by teachers and students. Evaluation is carried out through one-to-one evaluation and small group evaluation. At the one-to-one Evaluation stage, an evaluation was carried out on Prototype 2 which had received a review from experts. Three students with high, medium, and low abilities were given a Student Worksheet (LKPD) based on Jambi Batik Ethnomathematics with the topic Transformation. Evaluation is carried out through structured interviews to obtain student responses regarding grammar, spelling, punctuation, question instructions, sentences, suitability to the material, and ease of use. The evaluation results show that students of various abilities can understand the LKPD instructions well (Ranti & Usmeldi, 2019). They provide feedback on the writing, presentation of the LKPD, and the questions given. Observations show that students with medium and high abilities can understand the problem well, while students with low abilities need more time.

Figure 1. Implementation of one-to-one evaluation

At the Small Group Evaluation stage, the results of the analysis showed that the Jambi Batik Ethnomathematics-based RPP Implementation Observation Sheet had a very practical average value for each meeting. The results of the teacher response practicality questionnaire also reached the very practical category (91.07%). The practicality test of LKPD on teachers and students showed a very practical category, with an overall average of 88.19%. The Jambi Batik Ethnomathematics-based mathematics learning tool at the Small Group Evaluation stage was considered very practical (Jablonski & Ludwig, 2023; Ristanti & Murdiyani, 2021; Richardo et al., 2019). After revision, the product is called Prototype 4 and is ready to be tested at the next stage, namely Field Test (Zaki et al., 2020).

Table 2. Results of Analysis of Observation Sheet on Implementation of RPP in Small Group Evaluation

Meeting	1	2	3	4	5	Average
Mark (%)	90.38	84.62	90.38	82.69	96.15	88.85
Criteria	SP	SP	SP	SP	SP	SP

Table 3. Recapitulation of the Average Results of the Jambi Batik Ethnomathematics-Based LKPD Practicality Questionnaire (Small Group Stage Student Responses)

Rated aspect	Average	Criteria
Legibility	89.58	Very Practical
Presentation	87.50	Very Practical
Ease of Use	88.19	Very Practical
Time	87.50	Very Practical
Overall average	88.19	Very Practical

Assessment Phase: After revising the results of the Small Group Evaluation, it continues with the field test phase in class IX-3 of SMPN 21 Batanghari. The teacher is the teacher, and the researcher is the observer. The product is called Prototype 4 after Small Group Evaluation and is ready to be tested at the Field Test stage.

Table 4. Results of Practicality Questionnaire Analysis of LKPD based on Jambi Batik Ethnomathematics by Students in Field Test Activities

Rated aspect	Average	Criteria
Presentation	0.89	Very
Ease of Use	0.90	Very
Time	0.90	Very
Legibility	0.93	Very
Overall average	0.90	Very Practical

From the results of the table above, it can be seen that the Jambi Batik Ethnomathematics LKPD has an overall practicality value of 90.6% in the very practical category. Details of the results of the Jambi Batik Ethnomathematics LKPD practicality questionnaire by students in the field test activity can be. From the results of the observation sheet and the results of all questionnaires given to teachers and students, it can be concluded that the RPP and LKPD based on Jambi Batik Ethnomathematics have practical value and can be used.

Effectiveness of Jambi Batik Ethnomathematics-Based Learning Tools on Transformation Material

The effectiveness test was carried out on the Jambi Batik Ethnomathematics-based Student Worksheet (LKPD). Learning activities use the Learning Implementation Plan (RPP) and LKPD, followed by an examination of student learning outcomes. Participants' answer sheets are assessed using a rubric, and test results are analyzed to determine the effectiveness of learning tools by comparing them with the school's Minimum Completeness Criteria (KKM). The test results show that on average students can understand the definition and characteristics of transformation, helped by the motifs on Jambi batik. The average student test result is 82.5 with a completion percentage of 80%, exceeding the school's KKM of 75. This implies that the objectives of learning mathematics, especially transformation geometry material, have been successfully achieved. It can be concluded that the RPP and LKPD based on Jambi Batik Ethnomathematics are effective because the test scores of students after using these learning tools are higher than the school's KKM.

Discussion

The results of ethnographic research regarding mathematical ideas in the process of making Jambi Batik. Ramani et al. (2020) identified six mathematical activities, such as counting, locating, measuring, designing, playing, and explaining, which are involved in the development of mathematical ideas. In the process of making Jambi Batik, counting activities can be seen in estimating the length of batik production using the concept of value comparison, while locating is related to locating motifs on the fabric and determining the location of patterns based on geometric lines. Measuring appears in measuring the size of cloth, stamps, and stamping areas with the concept of the surface area of objects. Designing is related to geometric motifs of transformation such as reflection, rotation, dilation, and translation, while playing is seen in employee assignments with combination concepts.

The expression of mathematical ideas in Jambi Batik motifs, illustrated with geometric patterns and symmetry groups, is in line with Ethnomathematics research by (Katsap & Silverman, 2016). These motifs include reflection, rotation, translation, and dilation, illustrating mathematical concepts as they occur in transformation geometry.

In developing learning tools based on Jambi Batik Ethnomathematics, RPP, and LKPD are designed to improve student learning outcomes by integrating Jambi Batik culture (Hartindya et al., 2022). The validity of the tool was rigorously assessed by experts in mathematics education, educational technology, and Indonesian, demonstrating conformity with theory and the interrelationship of components (Arnawa et al., 2023). Testing of the device and practicality questionnaire showed ease of use, understanding, and attractiveness, which was very practical according to teachers and students. The effectiveness test shows that the average student score is 82.5, exceeding the KKM of 75. Thus, the Jambi Batik Ethnomathematics-based Transformation Geometry learning tool proves its effectiveness in significantly improving student learning outcomes, in line with the expectations of this research (Jablonski & Ludwig, 2023; Teplá et al., 2022; Drijvers et al., 2016).

Conclusion

This research is a combination of ethnographic research and development research, producing learning tools based on Jambi Batik Ethnomathematics in the form of lesson plans and LKPD. The research results concluded that in the process of making Jambi Batik, there are fundamental mathematical activities such as counting, locating, measuring, designing, playing, and explaining. Jambi Batik motifs include transformation materials, such as reflection, dilation, translation, and rotation. This learning tool has been proven to be valid and appropriate in terms of content, presentation, language, and graphics, as well as meeting practical characteristics in terms of implementation, convenience, and time. Apart from that, Jambi Batik Ethnomathematics-based learning tools are also effective in improving student learning outcomes, as evidenced by the increase in average scores after their use in class IX SMP/MTs.

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Conceptualization; T. M., A. F., E. M.; methodology.; T. M., validation; A. F., formal analysis; E. M., investigation.; T. M., resources; A. F., data curation: E. M., writing—original draft preparation.; A. F., writing—review and editing: E. M., visualization: E. M. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest.

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