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The Framework of Ethnomathematics Learning Activities Based on Majapahit Culture with STEAM Approach: Utilizing Used Cardboard for Miniature Building Media Development in Enhancing the Students' Creative Thinking Abilities

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ABSTRACT: Creative thinking is one of the 21st-century skills that can be developed through learning mathematics. Mathematics learning involves the culture students already know to facilitate students' understanding. Mojokerto City carries the slogan Spirit of Majapahit, giving the city's layout a nuance. The concept of two-dimensional and three-dimensional shapes with a Majapahit nuance can be used as a source of ethnomathematics learning to enhance creative thinking skills. Teaching about two-dimensional shapes can be used as teaching material to improve creative thinking skills. Creative thinking skills are an individual's ability to find new ways, strategies, ideas, or concepts about how to obtain a solution to a problem. Students' thinking skills may need to be higher. One reason is that the teaching methods used so far have yet to highlight the concept of two-dimensional shapes related to ethnomathematics. Therefore, this study will apply an ethnomathematics-based learning activity framework based on the Majapahit culture with a STEAM approach by using cardboard to make miniature buildings to improve students' creative thinking skills. The most suitable approach is STEAM since it integrates five disciplines to enhance further creative thinking skills in solving problems related to two-dimensional and spatial constructions.

KEYWORDS: Cardboard, Creative Thinking, Ethnomathematics, Majapahit Culture, STEAM.

INTRODUCTION

Education and culture have a complementary relationship. Ki Hajar Dewantara stated, "Culture cannot be separated from education; in fact, culture is the basis of education" (Dewantara, 1994). Culture-based learning provides space for students to provide contextual coercion based on students' experiences as part of a cultural community (Wahyuni et al., 2013). Culture becomes a method for students to transform their observations into creative forms related to a particular field of knowledge.

Mathematics is closely related to everyday life. When teaching formal mathematics in schools, teachers should start by exploring the informal mathematics knowledge that students have acquired from their daily lives and communities. Therefore, a learning method is needed to bridge the gap between culture and mathematics, namely ethnomathematics. Culturally nuanced mathematics (ethnomathematics) will significantly contribute to mathematics learning since formal education is a social institution that differs from others, allowing for cross-cultural socialization (Zayyadi, 2017) (Manik, 2020).

Fig. 1. Various Cultural Bildings of Majapahit in Mojokerto City

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Mojokerto City is the second smallest city in Indonesia, covering an area of only 16.4 km^2 and consisting of three districts: Magersari, Prajuritkulon, and Kranggan. It has a unique cultural characteristic that sets it apart from other regions, namely the culture of the Majapahit Kingdom. While there are no historic temple sites in Kota Mojokerto, unlike in the surrounding Kabupaten Mojokerto region, the Mayor of Mojokerto strives to rekindle a sense of pride in the city's heritage as descendants of the Majapahit Kingdom by promoting the "Spirit of Majapahit" slogan. This means that the people of Mojokerto are descendants of the Majapahit Kingdom and that the kingdom would only have become great with competent human resources (Permata's Talk Podcast, March 8, 2022). To achieve this, the Mojokerto City Government is improving its infrastructure and superstructure by developing buildings, public places, and corners of the city with a Majapahit nuance. Examples include the Tribhuwana Tunggadewi Tower, the Majapahit Maritime Park, the Mojokerto City Square, and the use of the Majapahit sun symbol on fences, gates, and building architecture throughout the city. Every entrance gate to the office buildings uses a red brick gate, reminding the community of the glory of the Majapahit Kingdom centuries ago.

From the various buildings, concepts of flat and spatial geometry can be found. For example, in Surya Majapahit, concepts of the square, circle, reflection, and rotational symmetry can be found. In one corner of the Taman Kehati are circle, sphere, and cylinder concepts. Similarly, we can find concepts of rectangular prism and cube in the base of the flower pot.

To apply culturally-based ethnomathematics learning of Majapahit, researchers chose the STEAM learning approach, which is a development of STEM. The integrated STEM approach is highly effective in achieving learning goals and can improve the quality of education faster than before (Dafik, 2022). STEAM integrates art disciplines into the curriculum and learning areas of science, technology, engineering, and mathematics (Katz, 2018). STEAM is a learning approach that emphasizes the relationship between knowledge and skills in Science, Technology, Engineering, Art, and Mathematics to solve problems. When associated with 21st-century skills (critical thinking, creativity, communication, collaboration), research, and problem-solving, the STEAM approach is very suitable for 21st-century learning (Rina, et al., 2022). The STEAM approach is a learning approach that provides space for learners to expand their knowledge, science, and humanities and, at the same time, develop 21st-century skills such as critical thinking, communication, leadership, resilience, and creativity (Sibaweihi, et al., 2021). STEAM-based learning demands learners to identify problems and create something creative to solve them by collaborating and communicating effectively.

The identified problem is a real-life challenge close to the students and contains challenges. In this study, using used cardboard waste in the school environment is developed as a learning material for Mathematics for grade 6 in the even semester. The basic competencies developed are 3.4 (explaining the cube, rectangular prism, prism, pyramid, cylinder, cone, and sphere, as well as their combined shapes, as well as the surface area and volume of the cube and rectangular prism) and 4.4 (identifying the cube, rectangular prism, prism, pyramid, cylinder, cone, and sphere, as well as their combined shapes, as well as the surface area and volume of the cube and rectangular prism). This problem is related to the Majapahit culture in the environment around the students, namely the presence of various buildings as a manifestation of the Spirit of Majapahit slogan. By using geometric concepts familiar to students as a source of learning, it is hoped that they can easily absorb and understand the problem and improve their creative thinking skills.

Creative thinking ability is one of the important skills to face the challenges of the 21st century. According to Triwahyuningtyas et al., creative thinking skills will develop better if students can think broadly about new ideas and solutions through activities of asking unusual questions and designing equally unusual answers (Triwahyuningtyas, et al., 2021). With the ability to think creatively, students will be more capable of solving mathematical problems, making learning that focuses on developing creative thinking skills important to be implemented. Therefore, as formal educational institutions, schools and universities must carry out learning activities that can develop students' creative thinking skills (Nazula, et al., 2019). The ability to think creatively can be measured using "The Torrence Test of Creative Thinking (TTCT)." Indicators that demonstrate creative thinking ability include fluency, flexibility, and novelty. Fluency is related to generating various categories of ideas in response to a command. Flexibility relates to finding ideas from different perspectives and changing approaches in response to a command. Novelty is the ability to create new and unique ideas that are different from previous ones and not thought of by others.

Many studies on ethnomathematics have contributed positively to improving the quality of education, including efforts to enhance creative thinking skills. Similarly, research involving the STEAM approach has also shown promising results. In this study, ethnomathematics is focused on the Majapahit culture in Mojokerto City, combined with the STEAM approach. This aligns with the Mojokerto City government's slogan, the Spirit of Majapahit. Therefore, this research differs from previous studies and meets the novelty criteria.

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The material used in this study to enhance creative thinking skills is 2D and 3D shapes. Students can construct miniature buildings with Majapahit nuances using recycled cardboard waste available at school. The miniature buildings can be in the form of temples, gates, or houses with the characteristic of the Majapahit Kingdom, which is dominated by terracotta colors (in this study, still using the natural color of cardboard) and the symbol of Surya Majapahit. This is also an effort to tackle waste in the school environment by transforming it into useful and artistic objects. A learning tool is needed to enhance creative thinking skills through Majapahit culture-based ethnomathematics learning with a STEAM approach to achieve this. The tools developed in this Majapahit culture-based ethnomathematics learning with a STEAM approach include 1) a Syllabus; 2) a Lesson Plan; 3) Student Worksheets; and 4) Grids and test sheets for creative thinking skills in problem-solving.

RESEARCH METHODS

This study uses a research and development (R&D) approach involving iterative activities from model design to implementation (Borg & Gall, as cited in Hamzah, 2019), with qualitative descriptive data analysis. The study aims to develop a learning tool for ethnomathematics based on Majapahit culture with the STEAM approach to enhance creative thinking skills in solving problems related to 2D and 3D shapes. Specifically, the problem involves using recycled cardboard to construct miniature buildings that reflect the "Spirit of Majapahit" slogan. The learning tool will be tested for feasibility and further developed, including the syllabus, lesson plan, worksheets, criteria and test sheets for creative problem-solving skills, and research instruments consisting of validation sheets, readability questionnaires, questionnaires on students' responses to the learning tool and process, and criteria and test sheets for creative problem-solving skills.

This research began with a review of literature related to ethnomathematics, Majapahit culture, STEAM, and creative thinking skills. The next step was to explore and present the STEAM-ethnomathematics issues based on Majapahit culture as the basis for forming the research framework. Then, the role of the five STEAM elements in solving problems in ethnomathematics based on the Majapahit culture was described. This was followed by a complete and sequential description of each stage of the learning process in the form of learning activity presentations, which were then complemented by activity indicators and creative thinking skills using research instruments.

RESULTS

A. Syntax of Ethnomathematics Learning Based on Majapahit Culture with STEAM Approach

The application of Majapahit cultural-based ethnomathematics learning in this study was integrated with the STEAM (Science, Technology, Engineering, Art, and Mathematics) approach. To enhance creative thinking skills, this study's focus was using cardboard to create cultural-based Majapahit miniature buildings (such as miniature temples, gates, or houses). The first step in problem-solving to enhance creative thinking skills was understanding the problem thoroughly.

The accumulation of used cardboard waste in the school building has been utilized only for sale, without being considered for learning purposes. However, this cardboard waste can be used to learn about two-dimensional and three-dimensional structures, adapted to Mojokerto City's slogan, the "Spirit of Majapahit". The cardboard waste is used to make miniature cultural buildings related to the Majapahit Kingdom. Besides learning mathematics, this approach also instils pride in the students as citizens of Mojokerto, who are descendants of the Majapahit Kingdom.

Science	Technology	Engineering	Art	Mathematics
The benefit of using waste cardboard to create miniature buildings with cultural value from the Majapahit era is one of the efforts to preserve the environment.	Using the Internet to search for building information as a manifestation of the Spirit of Majapahit slogan, determining the equivalent shapes of the spatial structures, and designing and creating the miniature buildings from used cardboard.	Designing a simple building sketch as a manifestation of the Spirit of Majapahit slogan. Determining the tools, materials, and process of building construction as a manifestation of the Spirit of Majapahit slogan	Understanding the concept of the Spirit of Majapahit slogan as the culture of Mojokerto residents and applying it in the created work.	Determining measurements related to the surface area and volume of the miniature building as a manifestation of the Spirit of Majapahit slogan.

Fig. 2. Problems and Problem Analysis of STEAM.

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The following framework table presents the correlation between the elements in cultural-based ethnomathematics learning of Majapahit and the STEAM approach to enhance creative thinking skills in problem-solving in this research.

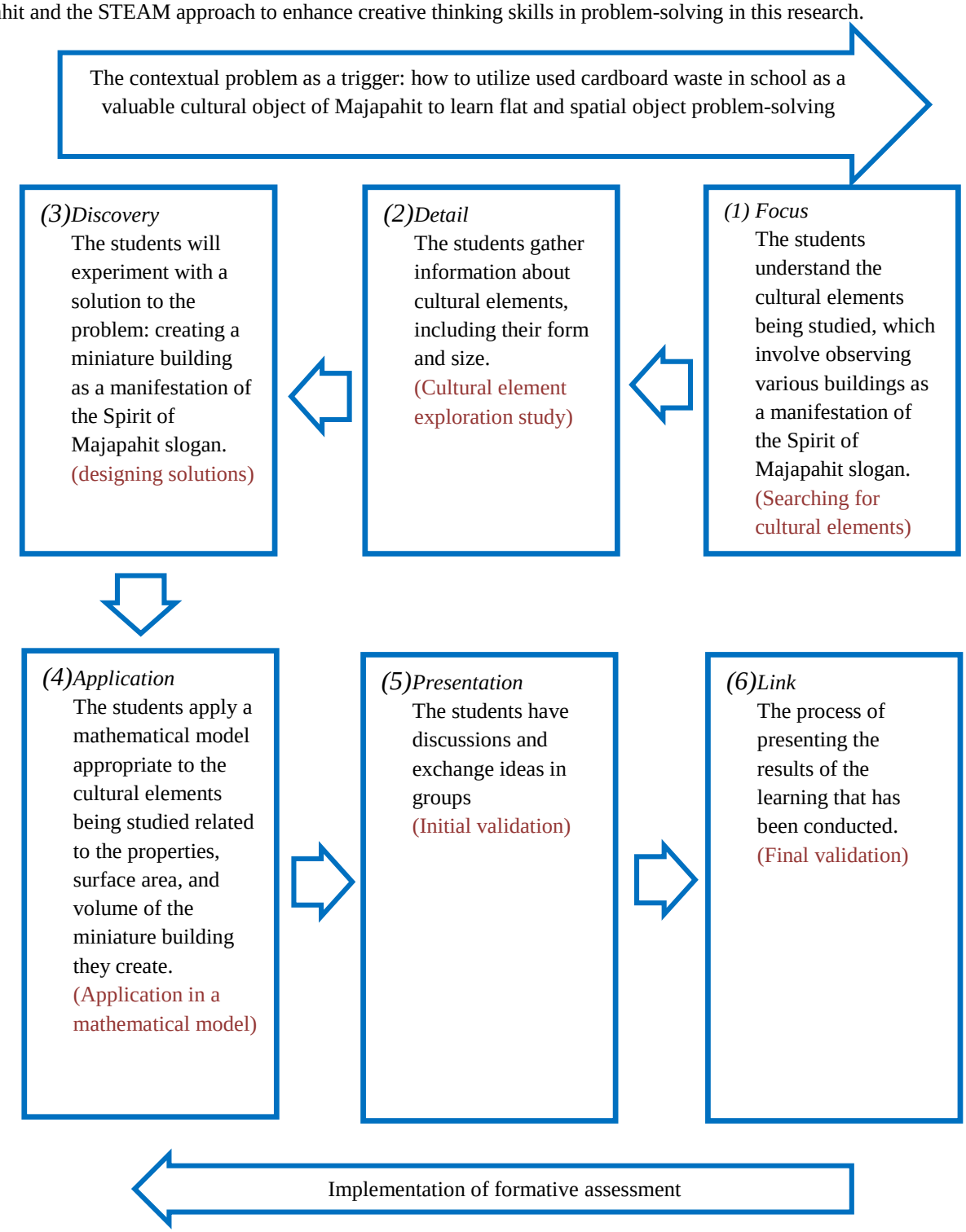

Fig. 3. Ethnomathematics Learning Framework Based on Majapahit Culture with STEAM Approach

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B. Student Learning Objectives and Goals

Learning objectives provide direction for learning. This stage is the initial step in creating a plan for implementing ethnomathematics learning based on Majapahit culture with a STEAM approach.

The learning objectives to be achieved are:

a. through the activity of observing pictures or direct observations, students can identify spatial structures in buildings according to the theme of Spirit of Majapahit;
b. through the activity of observing pictures or direct observations and exploring information, students can identify the characteristics of spatial structures in buildings according to the theme of Spirit of Majapahit;
c. through the activity of discussion, students can determine the surface area and volume of cubic and rectangular spatial structures;
d. Through exploring information, students can create a simple work of spatial structure that aligns with the Spirit of Majapahit slogan.

The learning outcomes expected from this learning are that students can design and create miniature buildings with Majapahit nuances by utilizing used cardboard waste available in the school or home warehouse. These learning outcomes indicate the development of students' creative thinking skills in solving problems related to two-dimensional and three-dimensional shapes.

The aim of learning ethnomathematics based on the culture of Majapahit with the STEAM approach is to develop knowledge and skills in several disciplines of science, technology, engineering, arts, and mathematics, including:

a. In the science aspect, students are expected to:
   Utilize used cardboard to become useful objects.
   Reuse used cardboard to support environmental preservation.
b. In the technology aspect, students are expected to:
   Use the Internet to search for information about buildings as a manifestation of the Spirit of Majapahit slogan.
   Literature source:
   Mojokerto City "Spirit of Majapahit":
   https://www.youtube.com/watch?v=aBbxG_4iHhY
   The Majapahit community created a model before building a house:
   https://radarmojokerto.jawapos.com/sejarah-dan-mojopedia/07/01/2023/masyarakat-majapahit-terbiasa-buat-maket-sebelum-bangun-rumah/
   Profile of Mojokerto City (Unofficial):
   https://www.youtube.com/watch?v=27bwuUU7Mxo
   City Tour of Mojokerto:
   https://www.youtube.com/watch?v=iIxm3ybYnK8
   Using the Internet to search for designs and techniques for making miniature buildings from cardboard.
   Literature source:
   https://youtu.be/bu8ttTyM2CI
   https://youtu.be/2H5QfvvJVMY
   https://www.youtube.com/watch?v=nPZHj3rCpxE
   https://www.youtube.com/watch?v=xiYx5l8VXN8
c. In terms of engineering, students are expected to:
   - Create a design for a miniature building from used cardboard that involves flat and spatial structures.
   - Determine the tools and materials needed to construct a miniature building from used cardboard.
d. In terms of art, students are expected to:
   - Create a miniature building from used cardboard to manifest the Spirit of Majapahit slogan.
e. In terms of mathematics, students are expected to:
   - Determine measurements related to the surface area and volume of the miniature building.

C. Elements of Ethnomathematics Learning Development based on Majapahit Cultural with STEAM Approach

1. Elements of Science Problem

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Waste is a residual material no longer used or utilized after a domestic or industrial process. Waste must be disposed of, but we must prioritize waste management to preserve the environment. Besides markets, households, industries, and offices, schools are among the biggest waste contributors. There are 3 (three) types of waste commonly found in schools, where the three types of waste have different colored trash cans provided. The three types of waste are organic waste, inorganic waste, and hazardous waste (B3 waste).

Cardboard is a commercially valued non-organic waste, often sold to waste collectors. However, cardboard waste can also be reused to create useful items. Through provided literacy sources, students can learn about several ways to use used cardboard waste to preserve the environment and create artistic value, such as the Majapahit culture.

Fig. 4. Used Cardboard Waste in School

2. The Elements of Technology Issues

To solve the problem of using used cardboard waste in making cultural value-based Majapahit miniature buildings, students can use internet technology to search for information. Students can search on internet sites through their mobile phones or laptops connected to the Internet at school.

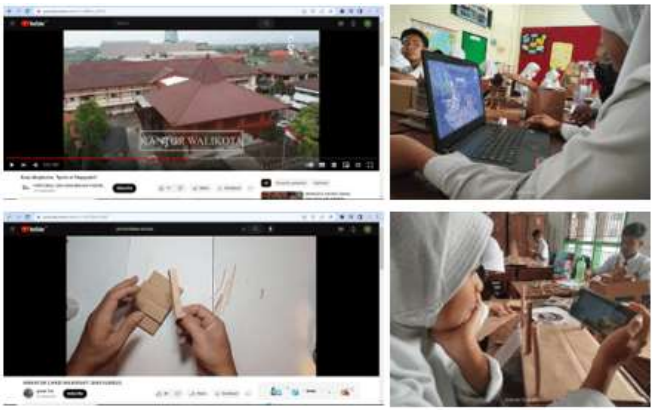

Fig. 5. Students researching on the Internet

3. Elements of Engineering Issues

The elements related to Engineering consist of creating a design for a miniature building from used cardboard waste that involves flat and solid shapes, determining the tools and materials needed to create the miniature building from used cardboard waste, and the process of making it.

The following steps are taken:

- Participants listen to the presented problem.
- Participants engage in literacy activities to determine the type of Majapahit-themed miniature building they will create and communicate it to the teacher.
- Participants create a simple design sketch on paper and ensure that it includes at least a solid block and cube shape along with their respective measurements.
- Participants prepare the necessary tools and materials.
- Participants measured the used cardboard according to their design to create the pattern.

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- Participants cut the cardboard according to their created pattern and attached the pieces according to the pattern.
- Participants add details to the miniature building they have created.
- Participants refine the miniature building they have created.

4. Elements of Artistic Issues

The elements related to art here are related to the culture of Majapahit, by the Spirit of Majapahit slogan carried by the leaders of Mojokerto City. The characteristics include temple buildings, gates, or houses with terracotta colors and decorated with the Spirit of Majapahit symbol.

Fig. 6. Miniature Buildings with Majapahit Cultural Nuances

5. Elements of Mathematics Problem

The elements related to mathematics in this learning are the properties of solid figures and the measurement of surface area and volume. Measurement activities can occur during the sketch/pattern-making process and when the miniature building is completed.

D. Majapahit Culture-Based Ethnomathematics Learning Framework with the STEAM Approach in Utilizing Used Cardboard Waste

There is no standard syntax for ethnomathematics learning. The steps in ethnomathematics learning can be made following local culture. For example, following traditional games, social customs in the community, and others. Meanwhile, STEAM is not a learning model. Therefore there are no specific steps. In this study, the steps to implement the STEAM approach in learning refer to: https://onlinedegrees.sandiego.edu/steam-education-in-schools/ (accessed on Saturday, April 8, 2022) [14], which can be outlined as follows:

a. Focus is choosing important questions or problems to be solved by focusing on the selected STEAM or art fields. The learning activities in the first stage are explained in detail in the following Table 1.

Table 1. The Focus Learning Activity Stage

Stage 1		Learning Activities
Focus	1	The students watched a video about Mojokerto City's "Spirit of Majapahit" and the presence of used cardboard waste in the school (Art and Science).
	2	The students paid attention to the issues presented by the teacher on the projector screen.
	3	The students read and examined each problem one by one.
	4	The students could design general steps to solve the problems presented through a brainstorming activity.

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b. Detail is finding the elements that contribute to the important problem or question. Students need to gather information to answer the question at this stage. In this stage, students need to gather information to answer the question.

Table 2. The Detail Learning Activity Stage

Stage 2		Learning Activities
Detail	1	The students were divided into six groups.
	2	The students conducted observations of buildings around them as well as of pictures provided by the teacher. The students were also allowed to search for information on the Internet.
	3	The teacher handed out Student Worksheet 1 (SW1) about the correspondence of spatial structures in buildings in Mojokerto City as a guide to collecting relevant information related to the cultural buildings of Majapahit. (Technology)
	4	The students wrote down their observations in SW1.
	5	The teacher went around observing each group's work and provided guidance and necessary feedback on the completeness and clarity of each group's information collection results.

c. The discovery means that students research the solutions that will be given and the existing solutions that have yet to be able to solve the problem.

Table 3. Discovery Learning Activity

Stage 3		Learning Activities
Discovery	1	The students were divided into six groups.
	2	The students conducted observations of buildings around them as well as of pictures provided by the teacher. The students were also allowed to search for information on the Internet.
	3	The teacher handed out Student Worksheet 1 (SW1) about the correspondence of spatial structures in buildings in Mojokerto City as a guide to collecting relevant information related to the cultural buildings of Majapahit. (Technology)
	4	The students wrote down their observations in SW1.
	5	The teacher went around observing each group's work and provided guidance and necessary feedback on the completeness and clarity of each group's information collection results.

Fig. 7. Preparation of Tools and Materials

d. Application means students begin to create a work that is a solution by utilizing the skills, processes, and knowledge they have learned previously and applying them in practice.

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Table 4. Application Stage Learning Activity

Stage 4	Learning Activities
Application	1 Students collaborate in groups to create a miniature building product that reflects the cultural nuances of the Majapahit era according to the predetermined design. (Engineering and Art)
	2 Students test the miniature building product that they have created.
	3 Students determine the surface area and volume of the miniature building they created. (Mathematics)

Fig. 8. Creating Miniature Buildings with the Nuances of Majapahit Culture

e. Presentation means students present the solution or work they have created to receive feedback. The presentation also serves as a means for students to express themselves based on their perspectives regarding the problems they have faced.

Table 5. Presentation Stage Learning Activities

Stage 5	Learning Activities
Presentation	1 Students collaborate in groups to create a miniature building product that reflects the cultural nuances of the Majapahit era according to the predetermined design. (Engineering and Art)
	2 Students determine the surface area and volume of the miniature building they created. (Mathematics)

Fig. 9. Presentation of group work results

f. Link, which means that students have the opportunity to reflect on the feedback provided, able to revise their work as needed, and produce even better solutions.

Table 6. Learning Activity Stage Linking

Stage 6	Learning Activities
Link	1 The product of the problem-solving results that have been presented is then displayed on the table provided for each group.
	2 Each group makes improvements based on the feedback received from other groups.
	3 Students pay attention to the teacher's reinforcement of the learning material.
	4 Students, with the help of the teacher, write down the conclusions of the learning material.

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E. Framework for Creative Thinking Ability Assessment Instrument

The instrument used to measure creative thinking ability is a student creativity observation sheet. The sheet contains indicators of creative aspects to be observed. The three aspects observed are fluency, flexibility, and novelty.

Table 7. Framework for Creative Thinking Ability Assessment Instrument

Indicator	Sub Indicator	Test Material
Fluency	a Solving problems with various interpretations, problem-solving methods, or solutions.	Problem: How can you overcome the problem of a lot of cardboard waste in school? Students can provide a precise solution to the problem of excessive cardboard waste, along with an explanation.
Flexibility	a Solving problems in one way and then using another method.	Students provide varied answers from different perspectives related to the problem of excessive cardboard waste in Majapahit cultural-themed buildings.
	b Discussing several methods of problem-solving.	
Novelty	a Examining multiple problem-solving methods or answers and then creating another that is different.	Students can provide their thinking-based solutions to the problem of excessive cardboard waste by designing their ideas.

F. Follow-up on the Development of Learning Materials

Follow-up on the development of learning tools in this research refers to the 4-D development model (Four-D model) consisting of four stages: define, design, develop, and disseminate. The 4-D model was chosen because the stages are sequential, clear, and suitable for the development needs of Majapahit cultural-based ethnomathematics learning tools with the STEAM approach. The stages are as follows:

1. Define Stage

There are five main steps in the definition stage: problem root analysis, student analysis, concept analysis, task analysis, and formulation of learning activity objectives. This stage is the initial step in creating a plan for Majapahit cultural-based ethnomathematics learning with a STEAM approach.

2. Design Stage

The design stage aims to prepare the initial form or design of the Majapahit cultural-based ethnomathematics learning tools with a STEAM approach to improving creative thinking skills, which include four steps, namely:

a. Development of observation assessment criteria so that the test assessment criteria remain relevant to the given tasks.
b. Selection of the model used in learning, namely the Majapahit cultural-based ethnomathematics learning model with a STEAM approach.
c. Selection of the format by adjusting the learning model with the appropriate format to make it easy to use.
d. The initial design is the initial design or draft syllabus, lesson plan, student worksheet, and creative thinking ability test sheet in problem-solving, which includes learning about Majapahit cultural-based ethnomathematics with a STEAM approach.

3. Development Stage (Develop)

This stage aims to produce the final form of learning tools that have been revised based on expert opinions. There are two steps taken in the development stage, namely:

a. Expert assessment (expert appraisal) followed by revision;
b. Development testing.

4. Dissemination Stage (Disseminate)

The dissemination stage aims to disseminate the Majapahit cultural-based ethnomathematics learning tools with a STEAM approach so that they can be used in several elementary educational institutions. The dissemination of learning tools is done through journal publications, seminars through KKG, and uploading learning videos on YouTube.

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DISCUSSION

Developing a framework for teaching ethnomathematics based on Majapahit culture with a STEAM approach to solving problems related to waste cardboard is very important and beneficial, especially for elementary school students who still need to be trained to develop creative thinking skills as one of the 21st-century skills. From this research activity, some things can be further developed, such as developing ethnomathematics learning tools by exploring more cultures around to enhance creative thinking skills while fostering the love of local culture with the 4-D development model and analyzing creative thinking skills in solving problems related to 2D and 3D shapes by using waste cardboard to create cultural miniatures of Majapahit buildings. This activity framework effectively enhances students' creative thinking skills, as demonstrated by previous research. The use of STEAM-based learning can improve creative thinking skills, and this is in line with the findings of research conducted by Suganda et al. (2020) with the title 'STEAM and Environment on Students' Creative-Thinking Skills: A meta-analysis study.

CONCLUSION

This research highlights the problematic situation and the syntax or framework of ethnomathematics learning activities based on Majapahit culture with a STEAM approach. The activity framework involves the utilization of used cardboard waste to create miniature buildings as a manifestation of the Spirit of Majapahit slogan. The research also includes a test instrument framework with indicators of creative thinking ability. Based on the research process and results, further research related to the development and implementation analysis of ethnomathematics learning tools based on Majapahit culture with a STEAM approach can be conducted more easily.

As a suggestion, teachers need to ensure safety in using tools and materials as sharp objects are used in making miniature buildings as a manifestation of the Spirit of Majapahit slogan. Teachers should implement the learning that supports the development of creative thinking abilities and guide students who are experiencing slow learning.

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