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# DEVELOPMENT OF AN ETHNOMATHEMATICS-BASED ICARE LEARNING MODEL ON MATHEMATICAL PROBLEM SOLVING SKILLS

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## ABSTRACT

This study aims to develop an ICARE learning model with ethnomathematics content which was developed by taking into account the mastery of mathematical problem solving in students. The learning model was developed by utilizing the Learning Management System on spatial building materials with a Lee and Owen (2004) model design. The development model consists of (1) analysis, (2) design, (3) development, (4) implementation, and (5) evaluation. Problem solving skills developed in the learning process include (1) understanding problems, (2) making plans, (3) implementing plans, and (4) looking back at solutions that have been resolved. This framework consists of two designs in coherence learning activities between pre-class and in-class. This research was only carried out in small groups and produced several conclusions. First, in order to achieve learning outcomes and learning objectives, content from the etomathematics aspect is needed in geometric materials so that students do not just master mathematics but understand how local cultural elements can foster a love for local culture. Second, to foster students' interest in learning geometric shapes, it is necessary to use more illustrations in the form of pictures, audio and video than text. Third, the ICARE learning model contains ethnomathematics can be used to support learning because it can improve problem solving skills. In the future, the products that have been created will be large group trials and tests on student learning independence.

**Keywords**: ICARE, ethnomathematics, problem solving

## 1. Introduction

21st century learning has shifted the learning paradigm, including that learning is not only carried out in the classroom where the teacher is the only source of knowledge for students (Handayani, 2022). In 21st century learning, students must be prepared to be able to learn about life and prepare themselves to face future challenges (Joynes et al., 2019; Laal et al., 2012; van Laar et al., 2020). Based on this, teachers are required to be ready and responsive in facing the challenges of 21st century learning. Teachers must understand that 21st century learning is learning oriented to Higher Order Thinking Skills (HOTS) (Sulistiawati et al., 2022) and requires the implementation of technology (Handayani, 2022; Renau, 2016; van Laar et al., 2020). With the implementation of technology, it is hoped that it can create an innovative learning environment so that students can do learning wherever and whenever (Ananiadou, n.d.). So that it can develop Critical Thinking, Communication, Collaboration, and Creativity skills (Ananiadou, n.d.; Handajani et al., 2018; Joynes et al., 2019).

The development of 21st century learning has an impact on the use of technology (Afriyanti et al., 2018; Anggraeni & Sole, 2018; Arifin, 2020; Praherdhiono, 2018; Rafi et al., 2020). Various innovations continue to be developed so that the quality of learning is maximized (Anggraeni & Sole, 2018; Oliveira et al., 2016; Praherdhiono, 2018; Rafi et al., 2020). One of the

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innovations carried out is the Learning Management System. The Learning Management System is a platform that accommodates online learning (Sulistyorini & Anistyasari, 2020). This Learning Management System is a web-based system that allows teachers and students to carry out learning, namely distributing material, making class announcements, collecting assignments, and communicating (Bradley, 2020; Kraleva et al., 2019; Rafi et al., 2020). The integration of the Learning Management System is not just a trend but a tool that provides various things that can help teachers and students in learning so that students are more interested in learning and can learn anywhere and anytime (Bradley, 2020; Kraleva et al., 2019; Oliveira et al., 2016; Rafi et al., 2020). Based on research conducted by (Al-Fraihat et al., 2020; Aldiab et al., 2019; Jung & Huh, 2019; Praherdhiono, 2018; Rafi et al., 2020) suggests that the Learning Management System can help learning activities and overcome problems in learning because by using the Learning Management System the teacher can monitor the development and performance of students (Rafi et al., 2020) and students can find out to what extent learning progress.

According to (Kulshrestha & Kant, 2013; Rafi et al., 2020) in general the Learning Management System consists of (1) learning content management in the Learning Management System facilitating teachers to upload various forms of learning materials which can then be accessed and downloaded by students, (2) tests and assessments provided by The Learning Management System provides features that students can use to upload assignments and take tests and students can immediately find out the results, (3) the Learning Management System provides features that can assist teachers in designing lesson plans, (4) there are features that helps teachers to report on student learning progress and students can also monitor their own learning progress, (5) activities carried out can take place collaboratively and communicatively, and (6) there is an announcement feature. So that by using the Learning Management System the teacher can facilitate, model learning, plan activities, set learning expectations, provide choices for students, and help solve student problems (Bradley, 2020).

Problem solving is encountered in everyday life so it is considered as one of the important skills that students must have in the 21st century (English, 2010; Khalid et al., 2020; Novotná, Jarmila et al., 2012). Problem solving can help students build an understanding of mathematical ideas and processes by involving physical participants in doing mathematics, including making, guessing, exploring, testing, and verifying (Inoue et al., 2019; Lester et al., 1993). Problem solving can also realize the success of learning mathematics. To solve mathematical problems, a systematic method or steps is needed so that the completion process becomes easy and directed. One way that can be done in solving the problem is to use the method introduced by Polya, including understanding the problem, making plans, implementing plans, and looking back at the solutions that have been resolved.

Some assumptions that think that mathematics is a science that is not related to life is a misunderstanding (Bender and Beller). In learning mathematics, contextual situations are needed, one of which is utilizing local wisdom. Local wisdom originating from the local area can be utilized to reach abstract mathematical contexts (Inoue et al., 2019). Ethnomathematics means cultural mathematics which refers not only to ethnic culture, but also to the experience of language, beliefs, customs, or history (Utami, 2022). Future learners will benefit from looking at ethnomathematics topics in their learning. This allows students to make connections with the culture and develop a deeper understanding of mathematics. Linking content and culture helps build knowledge and meaning for learners (Wikan, 2017). Students feel helped by learning ethnomathematics because it is an effort to maintain local cultural wisdom (Bazinet & Marshall, 2015).

Geometry is part of the mathematics lesson in phase D. Geometry is a science that discusses the relationship between points, lines, angles, planes and spatial shapes. In the geometric element, there is a learning achievement that students can use the relationship between angles formed by two lines that intersect each other and by two parallel lines that are intersected by a transversal line. Difficulties experienced by students in line and angle material include students' low ability to understand principles, lack of accuracy in understanding the problems given, and students not being careful in working on questions and not correcting answers that have been written (Rosdianah et al., 2019). Geometry has been used by humans since ancient times, one proof of this is as a tool for determining land

boundaries around the Nile River by the Ancient Egyptians (Purnama and Rahmah, 2018). So it can be said that geometry is also inseparable from culture. So a cultural approach is needed, one of which is batik.

To implement the learning needs of the 21st century and learning mathematics, an ICARE learning model is needed. To implement the learning needs of the 21st century and learning mathematics, a learning model is needed, one of which is the ICARE learning model. The ICARE Learning Model is a simplification of the Dick and Carey learning design model. The ICARE learning model proposed by Hoffman and Ritchie (1998) is a distillation model from the basic practice of instructional design and adapting various systems into a very useful component in the design and development of e-learning.

ICARE was originally used to facilitate distance learning so that ICARE became a method for planning a lesson, developing learning strategies, and creating teaching materials in accordance with developments in science and technology. ICARE can also be used as a strategy for developing learning media as well as a guarantee guide for distance education. ICARE provides a systematic and interactive approach to developing learning situations and improving mathematics learning.

From the description above, it is necessary to develop an ICARE learning model with ethnomathematics content by paying attention to students' mastery of mathematical problem solving.

## 2. Research Methods

The development model in this research is to develop an LMS with ethnomathematics material on lines and angles for junior high schools with a Lee and Owen (2004) model design. The development model consists of (1) analysis, (2) design, (3) development, (4) implementation, and (5) evaluation (Safitri et al., 2015). The LMS development process with ethnomathematics is presented in Figure 1 below:

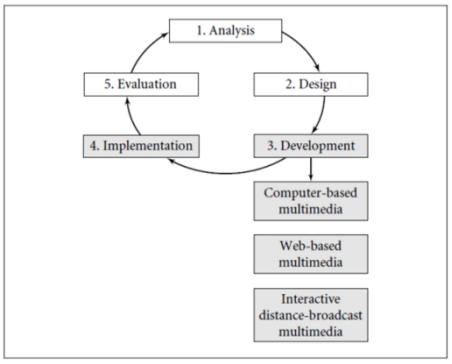


Figure 1. The process of developing online web learning with ethnomathematic content.

The model used has the following basics:

1. It is a procedural model that has a descriptive nature, provides clear and careful steps to produce a product,
2. The development stage is carried out by researchers specifically for LMS.

Development Procedures

The procedures for developing LMS follow the stages in the Lee and Owens (2004) model as follows:

Needs Analysis Stage

1. Determine the current situation and circumstances, carried out by identifying the causes of the desired needs,
2. Identifying the situation ideal according to the applicable regulations,
3. Determine the requirements for the ideal situation to be achieved,
4. Identify the current situation and circumstances,
5. Identify the potential needed before the research is carried out.

The steps in the initial and final analysis, namely

1. Participant analysis, this aims to find out the characteristics and initial knowledge of students. The data used includes knowledge, skills, attitudes, and user classes,
2. Technology analysis, the purpose of which is to identify how technological capabilities are owned, including devices and the internet,
3. Task analysis, the goal is to explain the tasks that related to work performed as a result of training or support from an appearance,
4. Critical incident analysis, conducted with the aim of determining the skills or knowledge that should be targeted as a result of LMS interventions,

5. Situation analysis, carried out with the aim of identifying the environment that affect the goals and design of online web learning,
6. Analysis of objectives, the goal is to determine the domain to be achieved in accordance with learning outcomes and learning objectives.
7. Media analysis, aims to choose the right strategy for using media,
8. Analysis of teaching materials, aims to identify existing teaching materials, manuals, references, and learning achievements of geometric elements (ATP),
9. Cost analysis, aims to identify the costs used and the profits earned in developing the product.

## 3. Results and Discussion

### A. Result

This research is still in the initial stage, namely developing a learning web with content ethnomathematics. The research sample was chosen as an elementary school that has a computer laboratory and students
who owns the device. The steps taken are as follows

1. Needs analysis

Based on the results of observations made on junior high school students in Tegal Regency, it was found:

a) The learning carried out comes from government books,
b) Learning with an ethnomathematics approach has not been fully implemented by students.
c) Learning is carried out teacher centered

2. Analysis of student characteristics

The learning carried out felt boring. The cause is a lack of variety in learning. The contextual cases used are still limited to those presented in books so that students do not explore their environment. The use and introduction of local culture to students is expected to increase students' knowledge and experience so that students can become more familiar with culture, create a love for local culture, and participate in preserving it.

3. Technology analysis

Some schools have computer laboratories so that it is possible to use computers with an internet connection. The use of devices by students is still not permitted due to concerns about device misuse.

4. Task analysis

When students are given assignments, they are free to use technology to search for learning resources and assignments can also be collected either in writing or by using technology.

5. Analyze the situation

Internet connections, laboratory availability, and device ownership can be used to support learning with an ethnomathematics-based LMS.

6. Analysis of teaching materials

The material that will be used is lines and angles which are presented through the introduction of batik patterns which utilize the relationship between angles formed by two intersecting lines and by two parallel lines cut by a transversal line. This is considered quite important because Tegal has a batik center.

Based on the results of this analysis, it is then obtained information that The LMS application used in this study is s.id. There are several steps to designing an application. The initial steps taken were the creation of a Software Requirement Specification (SRS), application development, system policy making, socialization of the e-learning system, monitoring, and evaluation. Software Requirement Specification is designed based on the results of system requirements analysis. The Software Requirement Specification is initial information about the steps in developing an LMS system, including web structure, infrastructure requirements, and hosting. The Software Requirement Specification is presented coherently in the LMS design process manual. Software Requirement Specification is also equipped with a flowchart which is an image or chart that shows the sequence and relationship between the process and the instructions. The image is represented by symbols, so that each symbol describes a certain process.

From the analysis then identified objects that play a role in the system and then developed from the results of the analysis. At this stage use case diagrams are used which function to describe the functionality of the system from the user's point of view so that the scope of the system, the actors who play a role in the system, and the interactions between the actor and the system can be known.

The researcher integrated the LMS with the ICARE learning design steps with Ethnomatematics content. Application development is carried out by programmers who in this case have full access to operating the LMS. ICARE as a learning design proceeds from the planning, implementation, to evaluation stages. ICARE stands for introduction, connection, application, reflection, and extend, which refers to

the stages of implementing the learning process (An et al., n.d.; Dwijayani, 2018; L H Sa'diyah, P Siahaan, A Samsudin, E Suhendi & Fatima, 2021; Nunung Anugrawati, 2016; Putu et al., 2019, 2020; Rodhi et al., 2022; Suartama et al., 2022; Ulya & Maris, 2022). ICARE has the following characteristics: (1) based on student needs based; (2) planned and implemented with the spirit of contextual learning; (3) engage students with active learning; (4) provide enrichment activities and fruitful reflection; (5) internal school conditions (teachers competency, school facilities, school committees, and parents).

ICARE as a learning design starting from planning, implementation, and evaluation. ICARE has the following characteristics: (1) made based on the needs of students, (2) planned and implemented with contextual learning, (3) involving students in active learning, (4) providing enrichment and reflection activities, and (5) paying attention to the internal conditions of the school include teacher competence, school facilities, school committees and school committees. In making the application, content testing will be carried out involving experts in the field of e-learning, subject matter experts, and students as users. If the content being tested gets a note, it must be repaired so that the application is ready for use according to its purpose.

The system policy serves to provide information to stakeholders in schools so that the system designed by researchers can be accommodated and harmonized with the existing system in schools. This policy was created with the aim of preventing problems with existing systems. The next step is socialization of the system, namely introducing the designed LMS to users. This aims to get a good response in the implementation from users.

**Introduction**. In the learning experience, the teacher instills an understanding of the content of mathematics lessons to students. This section must contain an explanation of the learning objectives and what will be achieved or the results during learning. The introduction should be short and simple. Convey learning objectives and motivate students to connect the mathematics material to be studied with real life so that students are interested in participating in learning. This stage is controlled by the teacher.

**Connection**. This part of the learning process requires competencies that are developed based on previous competencies. Therefore, all good learning experiences need to start from what students already know, can do, and develop it. The teacher tries to connect new teaching materials with something that is familiar to students from previous learning or experiences. Teachers can do this by conducting simple brainstorming exercises to understand what students already know, by asking them to tell what they remember from previous lessons, or by developing activities that students can do on their own. After that, the teacher can connect students with new information. This can be done through a simple presentation or explanation.

**Application.** This part is the most important of learning. After students acquire new information or skills through the connection stage, they need to be given the opportunity to practice and apply these knowledge and skills. The application part should last the longest from learning where students work alone, not with the teacher, in pairs or groups to complete real activities or solve real problems using the new information and skills they have acquired. At this stage it is done by giving a problem related to Singasari temple. In groups, students will discuss the findings with group members regarding the flat shapes forming the Singasari temple based on the concepts obtained at the connection stage. After that students were randomly selected to represent their groups to present the results of their discussions. Students play a major role in activities in their groups, while the teacher only acts as a facilitator and guide. At this stage the social system that occurs is very democratic and fully controlled by students.

**Reflection**. This section is a summary of the learning process, while students are given the opportunity to reflect on what they have learned. The teacher's task is to assess the extent to which the success of learning. Reflection or summary activities can involve group discussions where the teacher asks students to make presentations or explain what they have learned. They can also carry out independent writing activities where students write a summary of learning outcomes. This reflection can also be in the form of a short quiz in which students ask questions based on the content of the lesson. The important thing to remember in reflection is that teachers need to provide opportunities for students to express what they have learned related to the stages of problem solving, so that it is hoped that in the reflection step there will be an increase in problem solving abilities.

**Extend**. This section has been completed, it does not mean that all students have learned and can use what they have learned by themselves. This activity is an activity where the teacher provides activities that students can do after the lesson/session ends to strengthen and expand learning. Counseling activities are usually called homework. Extension activities can be in the form of providing additional reading materials, research assignments or exercises. the teacher enriches and expands students' knowledge about the flat shapes that make up the Singasari Temple. Furthermore, students answer quizzes (questions) given by the teacher and students must provide answers directly and the teacher immediately provides the discussion.

The ICARE learning plan developed in this study is a learning design that is integrated with the Learning Management System which aims to improve students' problem-solving skills in mathematics. The process is carried out in the following two stages. The activities that the researcher carried out before implementing the ICARE learning design were orientation and preparation of the design. ICARE learning design orientation is carried out by introducing it to the teacher through discussion. From this discussion it is hoped that an understanding will be formed between the writer and the teacher as research collaborators, especially regarding ICARE learning and the designs that will be implemented. The preparation of the ICARE learning design was carried out collaboratively by the researcher and the teacher. The design relates to teaching modules. The ICARE learning components developed in outline include learning outcomes, materials, activities, media, and learning evaluation. Learning outcomes are compiled based on the applicable curriculum and are directed at solving problems.

The material in the ICARE learning design is determined based on the subject matter to be studied. The purpose of this study is adjusted to the geometric elements in phase B. The learning activities developed in the ICARE learning design consist of five stages. Each stage is manifested in several teacher and student activities. The media/tools and learning resources used in the ICARE design study in this study include: (1) source books (student handbooks) as a reference for understanding the theory and practice being studied; and (2) LMS application.

The evaluation used includes process evaluation and outcome evaluation. Process evaluation is carried out using instruments in the form of observation guidelines during learning activities. Evaluation of learning outcomes is carried out through pre-test and post-test using a written objective test form. Evaluation is directed to assess the effectiveness of learning. Assessment indicators include material knowledge, understanding, application, analysis, and application of concepts.

The results of the first stage of validation carried out by class VII junior high school mathematics teachers were obtained

About the substance of matter

a. Learning on the LMS already shows angles and lines as material, but it needs to add content related to ethnomathematics to lines and angles.
b. The terms used are good so they can be developed for other sub-chapters
c. The material presented is representative enough.
d. The description of the material presented in learning on the LMS still does not enrich the theme of batik as a culture
e. The presentation of the material is in accordance with the learning outcomes of geometric elements,
f. The material presented in learning on the LMS needs to include examples of other batik motifs and how to determine the intersection of lines and angles formed and how these batik motifs apply the material.
g. The material is appropriate to field conditions.
h. The exercises/tasks given are less varied

About learning objectives

a. The learning objectives are visible
b. Learning outcomes are expected not only from the cognitive side but affective and psychomotor.
c. The verbs used require good formulation
d. The learning objectives are in accordance with the flow of learning objectives and learning outcomes for phase D geometry elements.

From the validation results in the first stage, the researcher makes improvements according to the input from the validator, which will then be submitted again for correction.

1. Serving design
   a. The domain used is correct
   b. The appearance of the web is still simple so it needs to be improved to make it more attractive,
   c. The accessories used are not crowded so they are used appropriately

d. Neat appearance
e. Videos, images and audio are needed that can attract students

2. LMS Operations
   a. The LMS used is quite easy to operate
   b. Easy to access
   c. LMS is easy to open with any device so that it can minimize difficulties in using it.
   d. The arrangement is neat enough so that students can more easily follow the learning flow
3. Interaction
   a. The provision of chat can provide interaction for students to communicate if they encounter difficulties
   b. Interaction instructions are required

The results of the first stage of validation by media expert validators are corrected and submitted again for correction.

After validation was carried out in the second stage, mathematics teachers and media experts were produced to try it out on several students to find out more about whether this LMS could be developed or not. Figure 2 below is an LMS with the help of s.id

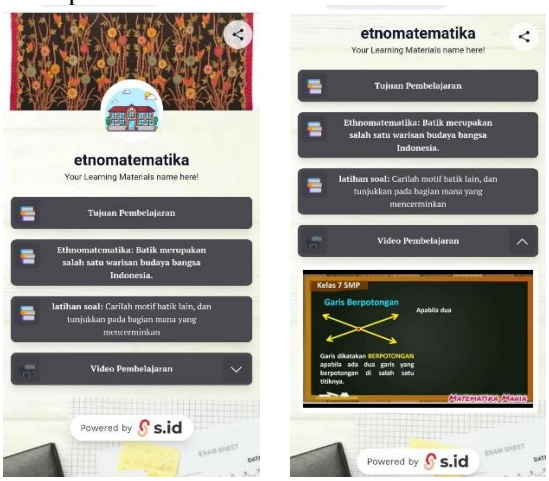


Figure 2. LMS with s.id

The first trial was carried out on 5 class VII students and results were obtained

Table 1. Descriptive Statistic

**Descriptive Statistics**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| pretest | 5 | 73 | 82 | 78.60 | 3.975 |
| posttest | 5 | 82 | 86 | 84.60 | 1.673 |
| Valid N (listwise) | 5 | | | | |

Table 1 explains that before using the LMS with ethnomathematics content, the average was 78.60. After using LMS with ethnomathematics content, students' abilities increased, this can be seen from the average gain of 84.60. So, an LMS with ethnomathematics content can be tested on medium-sized students to get further results.

**B. Discussion**

The research was carried out using the development method using the Lee and Owen (2004) design model which consists of 5 stages, namely (1) analysis, (2) design, (3) development, (4) implementation, and (5) evaluation. What was developed in this research was ICARE learning containing ethnomathematics with the help of LMS, namely s.id.

The ICARE learning model containing ethnomathematics with the help of LMS is used for mathematics learning in the seventh grade junior high school education unit. The aim of developing this learning model is to help students learn mathematics, especially lines and angles, as well as foster a sense of love for local culture by including batik content as Indonesian cultural heritage. By using ICARE learning containing ethnomathematics with the help of an LMS, students can organize, plan and evaluate their learning without space and time limitations because you can learn anywhere and anytime.

In the ICARE learning model containing ethnomathematics with the help of LMS, instructions, learning outcomes and learning objectives will be presented, ethnomathematics-laden material in the form of text, images, audio and video, tests, as well as material reinforcement in the form of projects related to ethnomathematics. determine the extent to which students understand the material presented.

The results obtained are an expert validity test. The experts involved are material and learning design experts. This aims to obtain opinions from other parties regarding the accuracy of the material from material experts and physical design from media experts. The first validation of junior high school mathematics material experts, namely junior high school mathematics teachers, showed that the learning outcomes and learning objectives and learning objectives

were quite good, but it was necessary to display ethnomathematics aspects in the presentation of line and angle material so that students not only get mathematics but also understand the elements of mathematics. local culture to foster love for local culture. From the results of the first validation, researchers made improvements by strengthening the concept of ethnomathematics with lines and angles regarding local culture in the form of introducing batik motifs in Indonesia. After revision, it was handed back to the junior high school mathematics material expert, and the results were obtained that the material could be tested on students.

The first validation by learning media experts showed that the design used was good but still less attractive for elementary school students, the use of images, audio and video increased compared to text, and the quizzes and assignments given were still monotonous and less challenging for students. student. Improvements made include redesigning the appearance to make it attractive, reducing the use of text as an explanation of material, and developing quizzes and tests to be more varied. After being corrected and handed back to stage II, the results can be tested on students.

This application has been tested on a small scale using 5 students. The results obtained show that the application can be used to support learning and from the scores obtained there is an increase in problem solving abilities

This research is still in the initial stage, namely at the expert validation stage. In the future, the product that has been created will be tested and continued with large group trials and there needs to be further analysis regarding solving students' mathematical problems more broadly.

## 4. Conclusions

After discussing these findings, this research produces several conclusions. First, in order to achieve learning outcomes and learning objectives, content from the ethomamatics aspect is needed in line and angle material so that students do not just master mathematics but understand how elements of local culture can foster a love of local culture. Second, to foster student interest, it is necessary to use images, audio and video more than text. Third, applications can be used to support learning. This research is still in the early stages, namely at the expert validation stage and small-scale trials and has not yet reached the implementation stage. This is due to the limited time that researchers have. In the future, the products that have been created will be tested and continued with large group trials and tests on students' mathematical problem solving abilities.

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