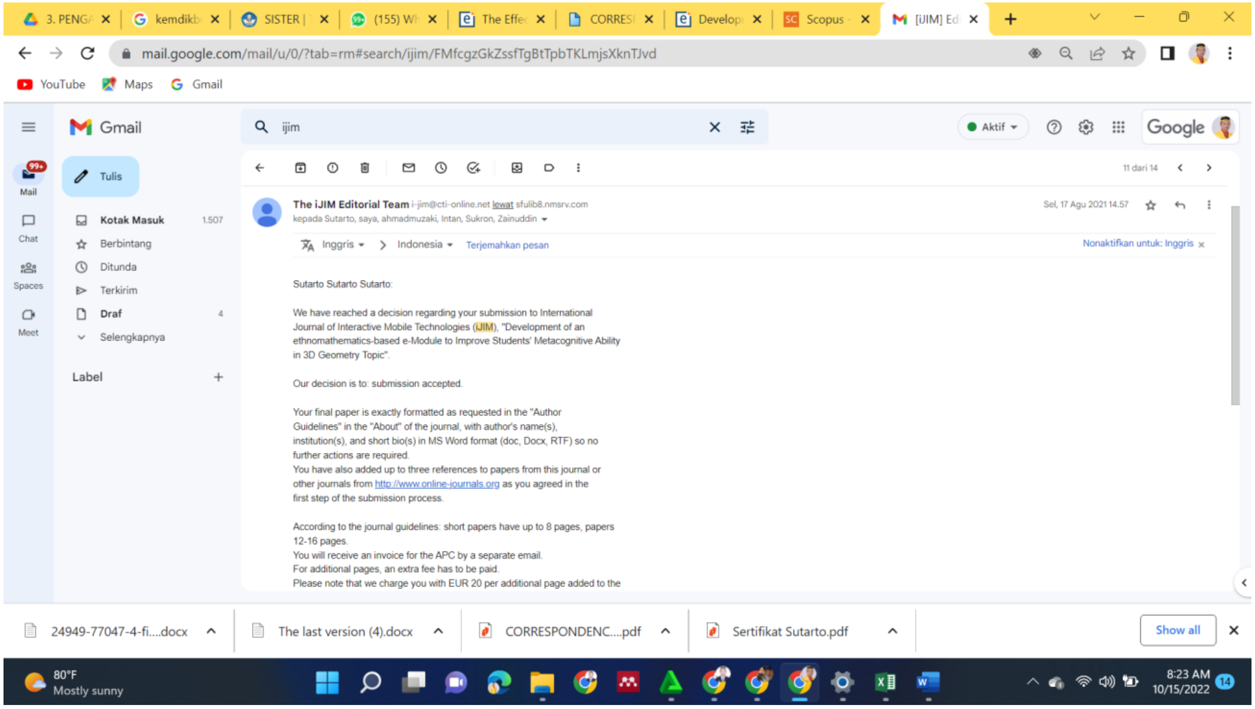
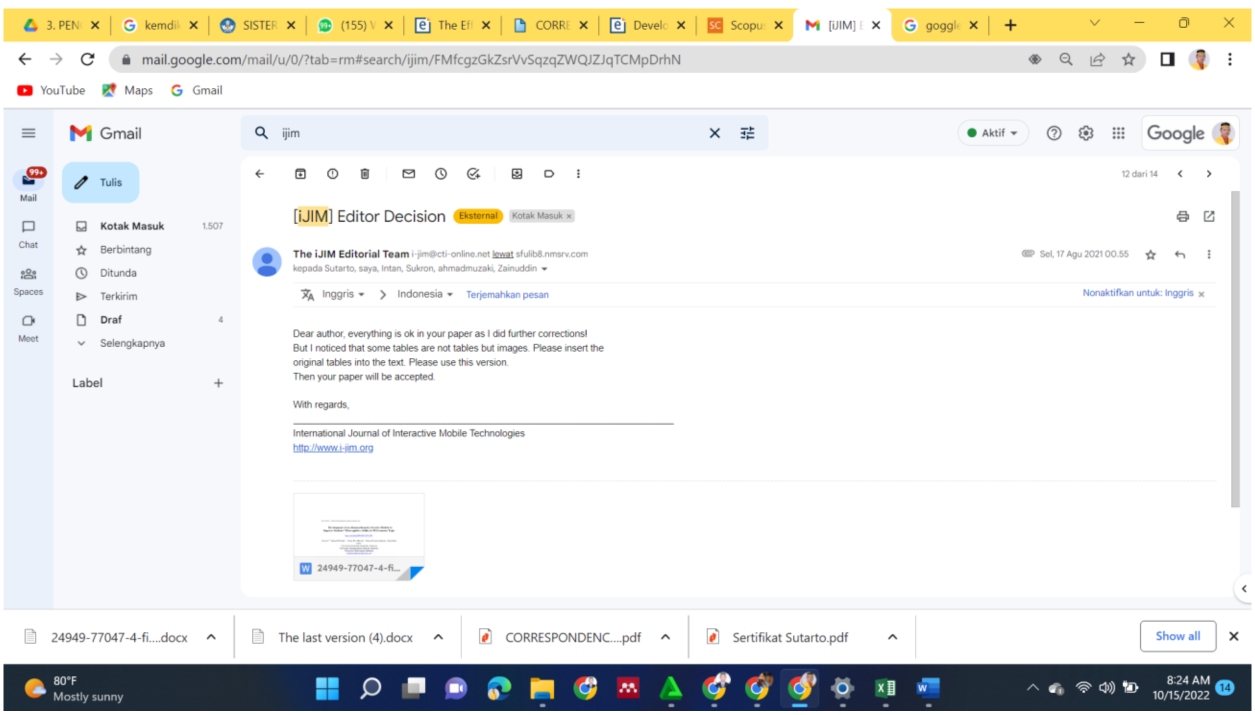
BUKTI CORESPONDING

Development of an ethnomathematics-based e-Module to Improve Students' Metacognitive Ability in 3D Geometry Topic





Development of an ethnomathematics-based e-Module to Improve Students' Metacognitive Ability in 3D Geometry Topic

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Abstract— Since the Covid 19 Pandemic by the end of 2020, the learning process has shifted from school to online home-based- learning. Several technologies are applied for enabling students' participation. Technology-based learning needs to be designed to be attractive and integrated with local culture. The present study developed a valid, practical, and effective Sasak ethnomathematics-based e-Module. The e-Module was mainly designed to improve students' metacognitive abilities. The study used development research using a 4D development model consisting of four categories: defining, designing, developing, and disseminating. The research was conducted in one of the elementary schools in West Lombok. Ten students of grade five and 30 students of grade six were selected for large-scale trials. The validity test showed that the ethnomathematics-based-e-Module was highly feasible to be used as a learning resource with an average score of 3.65. The questionnaire's analysis of students' responses showed that the e-Module fell into the practical category with a practicality percentage of 89%. The results of data analysis using independent sample T-Test showed that the T-test value was 0.00 < 0.05, thus the results of the study revealed a significant difference. Overall, the ethnomathematics-based- e-Module was valid, practical, and effective for improving students' metacognitive abilities on spatial material. The students can access the e-Module via smartphones or laptops, allowing them to remotely without time restrictions**.**

Keywords— e-Module, ethnomathematics, problem-solving, building space

1 Introduction

Since Covid 19 Pandemic hit the world by the end of 2020, the learning process has shifted from school to online home-based- learning. Several technologies are applied for enabling students' participation. Technology-based learning needs to be attractive to maintain students' enthusiasm and focus on independent learning. Technology-based learning facilitates the use of electronic modules (e-Module). The e-Module is one of the teaching materials that present separate learning materials arranged systematically in electronic format to achieve particular learning objectives. It is designed in animation and audio to make it more exciting and interactive [1]. The e-Module is an efficient, effective, and interactive alternative learning source that can be accessed anytime and anywhere via a smartphone or laptop with several supporting devices [2].

Observations and interviews conducted at three elementary schools in West Lombok, Indonesia, showed that mathematics classes were insufficient innovation and did not involve using technology. Learning was conducted teacher-centered, with most students' activities focused on textbooks and was not linked to local wisdom. In addition, students' success was fully emphasized on the cognitive aspect. The questionnaire spread in three elementary schools showed that 60% of students had difficulty understanding mathematics textbooks.

Mathematics learning needs to be linked with the local culture [3], [4]. This can be done through ethnomathematics. Elements of Sasak culture can be used for exciting and fun mathematics learning at the primary level [5]. Ethnomathematics of the Sasak tribe is extracted from traditional houses, special foods, and handicrafts. Ethnomathematics-based teaching materials in geometry topics need to be designed to provide opportunities for elementary school students to build knowledge and develop their potential according to the region's characteristics. Students can achieve learning goals by referring to the cultural values of their area to build good character among the society.

Mathematical concepts associated with culture and everyday experiences will improve students' ability to make meaningful connections and deepen their understanding of mathematics [6]. Applying ethnomathematics in mathematics will motivate students, create more meaningful learning, and enable students to realize that mathematics is helpful in real life [4], [6]. Another finding showed that using a local culture-based model combined with a scientific approach can foster higher-order thinking skills [7].

The scientific approach is nature-oriented learning [8]. Activities in the scientific method include: 1) observing, 2) trying, 3) reasoning, 4) asking questions, and 5) communicating [8], [9]. In implementing the 2013 curriculum in Indonesia, the scientific approach is one of the most recommended approaches as it can develop students' metacognitive competence, especially towards science and technology [10].

Metacognition ability is part of the 21st-century skills that need to be trained by students and is the key to the success of 21-century education [11], [12]. Metacognition is a higher-order thinking ability that involves understanding, analyzing, and developing cognitive processes [13], [14]. There are three metacognitive ability indicators, including planning, evaluation, and monitoring [15].

No previous research has developed an ethnomathematics-based e-Module that specifically addresses the culture of the Sasak tribe on geometry topic and analyzes the effectiveness of an ethnomathematical-based e-Module in terms of metacognitive abilities. Patri & Heswari developed an e-Module integrated with Jambi culture to improve logical thinking skills[7]. Serevina, Sunaryo, Raihanati, Astra, & Sari set an e-Module based on Problem Based learning on heat and temperature materials to improve science skills[16]. Kurniasari, rakh-mawati, & Fakhri have developed an e-Module characterized by the ethnomathematics of Lampung culture in two-dimensional figure material [17]. It is necessary to create an ethnomathematics-based e-Module, especially for the Sasak tribe- for primary students and to determine its effectiveness through indicators of metacognitive ability.

2 Literature Review

2.1 Electronic module (e-Module)

The e-Module is independent systematically arranged electronic learning materials that enable students to achieve specific learning objectives [2]. The use of e-Modules is following the principles of 21st-century learning of technology use for learning. An e-Module is more practical than the printed version since it is accessible by smartphone and functional [2]; thus, it can be accessed anytime and anywhere via smartphones or laptops with the supporting software. Mobile devices such as a smartphone are suitable for children's lifestyles because there is no need to sit or school to use the device. They only need students to activate smartphones [18]. Children nowadays use this technology earlier [19]. The e-Module is presented in an electronic format that includes animation, audio, and navigation, allowing interaction between users and the program.

Several studies have revealed that digital media can help children understand abstract concepts early [20]. The involvement of digital media in the school environment can develop logical thinking and strengthen students' problem-solving skills [21].

2.2 Digital Mathematics Activities and Children

Research on the use of digital technology in mathematics learning is not new [22]. Digital technology becomes part of mathematics learning to increase engagement and understanding in the learning process; mobile technology can make mathematics more meaningful [23] because it allows children to learn and practice skills interestingly and interactively [24]. Digital activities effectively promote mathematics, natural sciences, and languages, where specific goals can be selectively defined and developed in contexts related to specific learning activities and targets [25]. Studies have shown the benefits of using digital at the elementary school level as follow:

a. Digital activities can provide various educational services to children. Several studies have suggested that well-designed educational activities can motivate and encourage learning more than traditional teaching methods [26].
b. By using digital activities, students can learn cognitive abilities through repetition [27].
c. In primary education, students often engage in collaboration while playing digital activities [28].

The use of technologies could effectively support the learning process, particularly in mathematics [29]. Integrating mobile devices into the primary school curriculum increases elementary school students' interest [30]. The use of technology provides a positive role in improving students' early math skills. The use of mobile technology in mathematics education can encourage meaningful student engagement [29].

2.3 Ethnomathematics through Mobile Devices

Ethnomathematics represents local cultural objects in mathematical concepts. The concept of local culture in mathematics learning can improve students' knowledge and reasoning [31]. Ethnomathematics-based understanding affects problem-solving abilities by connecting real-world situations and cultural values that grow in society [3]. To facilitates a meaningful understanding of mathematics, it is necessary to integrate culture in learning mathematics. Integration of mathematics and local culture is an effective means to grow character and noble values in society. The elements of Sasak culture integrated with 3D Shape materials include traditional Sasak's houses, special foods, and traditional handicrafts.

The e-Module must have the following characteristics: a) Easy to use so that children can easily use it, b) Provide pictures related to the traditional culture of the Sasak Tribe, c) Combine animation and sound.

2.4 Metacognitive Ability.

Metacognitive abilities can encourage higher-order thinking skills [32]–[34]. Metacognitive skills help students in solving problems. Metacognitive abilities develop continuously with age development. Early engagement with metacognitive activities can lead to good metacognitive skills [10]. Metacognitive knowledge is one of the essential goals in the curriculum of Indonesia. Anderson & Krathwohl explained three indicators of metacognitive ability, i.e., planning, evaluation, and monitoring [15]. Planning consists of setting goals, linking with prior knowledge, and choosing the appropriate strategy. The assessment consists of realizing one's level of understanding and how to select the proper method. Monitoring checks one's progress and determines the right approach when the initial strategy does not work.

3 Method

3.1 Research Setting

This research was conducted from March 2021-May 2021 in one of the elementary schools in West Lombok, grade VI primary school in 2020/2021. The total number of subjects in this study was 30 students.

3.2 Research Design

This study used the 4D model. This model consists of 4 stages, they are 1) defining, 2) designing, 3) developing, and 4) disseminating. The defining stage in this research consists of five activities: preliminary analysis, student analysis, concept analysis, task analysis, and formulation of learning objectives. In the initial analysis activity, the researcher analyzed the curriculum related to the Competencies and Basic Competencies of the material to be developed. Student analysis activities aim to determine students' characteristics, level of student cognitive development, and student motivation. Student analysis was carried out by observation during the learning process in the classroom and interviews with teachers and students. Concept analysis activities were carried out to find the content of the material in the module to be developed through activities of detailing, identifying, and systematically compiling the material, the concepts of relevant building blocks volume taught based on the initial analysis. Task analysis aims to identify tasks or practice questions, and the primary skills students do during learning which the researcher then analyzes into a more specific sub-skills framework.

Furthermore, at the designing stage, the researcher prepared the e-Module design into steps; 1) test preparation, 2) media selection, and 3) format selection. Test preparation is an initial stage to measure the level of students' initial metacognitive skills. Media is selected to ensure that it fits the material to be taught and the characteristics of students. In the present research, the media is ethnomathematics based- e-Module. After the three stages were carried out, a draft or design of the ethnomathematics-based- e-Module was created following the content framework of the curriculum and material analysis.

At the development stage, the activities carried out were expert validation and test development. Expert validation aims to validate or assess the feasibility of the developed e-Module to a team of experts in their field. The instrument used to validate is a feasibility assessment questionnaire that includes content, presentation, grammar, and design components. After obtaining an assessment from the validator, suggestions for improvements to the e-Module were obtained and became the critical basis for revision. The evaluation aimed to make the e-Module developed to meet the concept, tested, and valuable. The four aspects in validation included content validation, presentation validation, language validation, and validation of the design components of e-Module. The validators stated that the e-Module was valid can be tested on research subjects.

In the test development stage, the researcher tested the draft on the actual subject. The e-Modules were tested in small classes before trying in large classes. The test results were used to improve the product to gain effective outcomes. The effectiveness of the module was evidenced by the independent sample T-Test used to analyze the research data. While the trial was conducted in a small class, the researchers observed, obtaining responses from questionnaires and interview comments. The instrument used in the small-scale practice was non-test instruments of observation sheets, validation sheets, and student questionnaires. After receiving input from a small-scale trial and revision, the e-Module was tested on a large-scale group to achieve the developed module's objectives and effectiveness. At this stage, the achievement of goals was measured to obtain thee-Modules' effect on students' metacognitive abilities. The instrument used was a problem-solving test instrument.

The dissemination stage was the socialization stage of learning media and e-Module links. They were distributed through Whatsapp Group. The dissemination stage aims to disseminate the e-Module. The developed e-Module was prepared using a scientific approach, including observing, asking, trying, and reasoning activities.

3.3 Data analysis technique

A quasi-experimental design with a pretest and post-test control group design was the research design used for data analysis. It was used to find the results of the pretest and post-test of the e-Module use for developing students' metacognitive abilities. The data collection techniques included expert validation tests, documentation studies, observations, and student learning outcomes. A questionnaire instrument was used for expert validation to gain a valid e-Module based on the expert overview. Comment as used to collect data related to the activities during learning activities with e-Modules. A problem-solving test was used to obtain data about the e-Module on students' metacognitive abilities. The effect of using the e-Module on metacognitive knowledge was measured by analyzing the students' scores. The instrument used to assess metacognitive ability was pretest and post-test questions consisting of one descriptive question. The effect of using the e-Module on metacognitive knowledge was gained through a paired sample T-Test with SPSS 17.00 for windows. For paired sample T-test, the data used must be normally distributed to analyze the data obtained. This value then determines the decisions taken in the study. Table 1 shows indicators used in determining the level of metacognitive [15].

4 Result And Discussion

4.1 Defining Stage

At the defining stage, the researchers analyzed the applied curriculum, i.e., the 2013 curriculum. The analysis found the Core Competencies and Basic Competencies to be developed to determine the volume of geometric shapes (prisms, cylinders, pyramids, cones, spheres, and a combination of several forms) and solve problems related to the importance of the figures. From observations at the initial analysis stage, the researchers found that students' problem-solving abilities were lacking. Students were only involved in routine questions with assessment emphasizing cognitive aspects.

4.2 Designing Stage

The researcher drafted e-Module through several stages at the design stage, i.e., 1) test preparation, 2) media selection, and 3) format selection. The preparation of the test was in the form of 5 problem-solving questions. The e-Module was selected as a media based on ethnomathematics by taking elements of Sasak culture, which includes traditional houses, special foods, and handicrafts. The draft or product design- the e-Module of ethnomathematics - was produced after the three stages were carried out. In the format selection activity, the researcher designed the material's content integrated with Sasak culture and combined a scientific approach. The purpose of incorporating elements of Sasak culture in the material is to motivate students to continue learning mathematics, create more meaningful learning, and enable students to know the direct benefits of learning mathematics in real life.

4.3 Developing Stage

The development phase consists of two activities, i.e., validation and testing of the e-Module. At this stage, a revised draft of the module was developed based on input from experts and data obtained through small-scale trials. Activities at this stage included expert validation and some limited tests. Expert validation was carried out by two mathematics education lecturers and two sixth-grade teachers (see Table 2). The practicality and effectiveness of the e-Module were also determined from the results of the testing activities. Responses from students (users) of the e-Module on the questionnaire and interviews show that the e-Module was user-friendly and the media meets the effective criteria based on the metacognitive ability test.

e-Module Validity

Tabel 2. E-Module Validity

No	Validator	Score	Validation Criteria	Information
1	X-1	3.53	Sangat Valid	Enlarge the image size in practice questions
2	X-2	3.57	Very Valid	No revision
3	X3	3.67	Very Valid	No revision
4	X-4	3.75	Very Valid	No revision
	Average	3.63	Very Valid	

Table 2 shows that the average value of e-Modul validation was 3.63 (high validity) criteria indicating that the e-Module was feasible to use without significant revisions.

e-Module practicality

Based on the results of interviews and questionnaires, the e-Module was practical (89,67%). Table 3 shows the indicators and responses to the e-Module usage questionnaire.

Tabel 3. Indicators of the e-Module Usage Questionnaire

No	Indicators	Percentage of Student Responses in Each Category (%)			
		Strongly disagree	Dis-agree	Agree	Strongly agree
Content Aspect					
1.	The material presented is following the learning objectives	76.67	16.67	3.33	3.33
2.	The learning steps in the E-Module are easy to follow	70.00	20.00	6.67	3.33
3.	The activities in the module are fun because they relate to the life around students.	73.33	16.67	3.33	6.67
Language Aspect					
4.	The e-Module can be read clearly	73.33	20.00	3.33	3.33

5.	The material presented is in easy-to-understand	60.00	26.67	10.00	3.33
6.	The language used is communicative	56.67	33.33	6.67	3.33
7.	Instructions for use, learning objectives, and learning activities in the E-Module are pretty clear	60.00	30.00	3.33	6.67
Benefit Aspect					
8.	Easy-to-use	66.67	23.33	6.67	3.33
9.	It triggers me to study harder	56.67	33.33	6.67	3.33
10.	The availability of pictures in the module makes it easier for me to do practical activities	60.00	23.33	10.00	6.67

Table 2 shows that the students positively responded to e-Module based on ethnomathematics for each indicator. They could easily follow each activity on the module and understand the material. The competency test at the end of the module was able to measure students' mathematical problem-solving abilities. The designed activities were always related to the culture closely associated with the students' daily lives and equipped with pictures of objects they often encounter. Below are excerpts from the interviews of researchers, students, and teachers.

Researcher interviews with students

R : *Do you understand the material easily after doing the learning activities associated with Sasak culture?*

S1 : *Yes, it is easier for me to understand. I often find examples and pictures shown on E-Modules.*

R : *What is your first impression when the teacher linked the learning activities with Sasak culture?*

S1 : *It's fun because, honestly, I've never studied mathematics associated with traditional Sasak houses, food, and handicrafts before. It is different from the textbooks that we've learned so far.*

R : *What is your first impression when working on/using the E-Module?*

S1 : *I felt more motivated to follow the activities; the pictures are good. The design is also good. It is also easier for me to understand this material after working on the E-Modul.*

Interviews with researchers and teachers

R : *In your opinion, can this E-Module help students understand spatial structure?*

T1 : *Yes, because the integration of the E-Modul with Sasak culture makes learning more meaningful for children, it turns out that mathematics is close to their daily lives.*

Interviews with both learners and teachers show that e-Module could motivate students to learn mathematics based on ethnomathematics.

E-Module Effectiveness

From the results of data analysis (interviews and student work), the percentage graphic of indicators metacognitive ability is as follows.

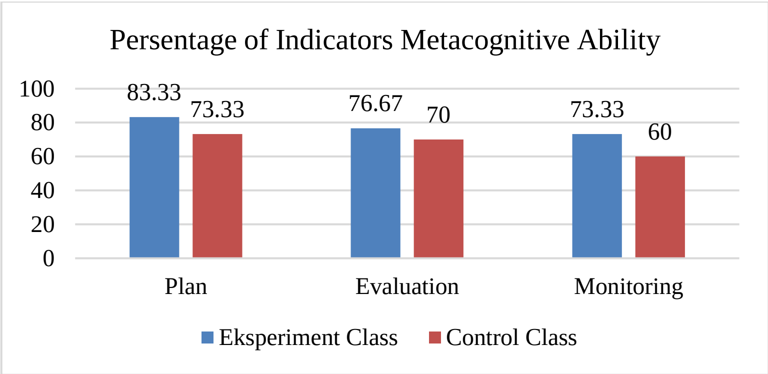

Figure 1. Percentage of indicators of metacognitive ability

The effectiveness of the e-Module was tested by using an independent sample T-Test. The experimental class was applied with an ethnomathematics-based- e-Module, while an ordinary printed module was used for the control class. The normality test of the data was checked before further analysis. The number of samples in this study was 60 students. As shown in Table 4 and Table 5, the pretest results from both the experimental class and control class indicated the similarity or not significant difference.

Tabel 4. The results of pretest data analysis

Group	N	Mean	Std. Deviation	Std. Error Mean
Experiment Class	30	1.5667	.77385	.14129
Control Class	30	1.5333	.68145	.12441

Based on Table 4, the average value of the experimental class students was 1.5667 with a standard deviation of 0.77835, while the average value of the control class students was 1.5333 with a standard deviation of 0.68145. Table 5 shows that the data obtained from the pretest value between the two groups was [t(30) = 0.367, p>0.05], meaning that it was not significantly different. The results of data analysis using independent sample T-Test showed that students in the experimental and control classes had similar abilities before treatment.

Table 5. The comparison of pretest score using independent sample T-Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Di ference	95% Confdence Interval of the Difference	
									Lower	Upper
Pre-test	Equal variances assumed	.828	.367	.177	58	.860	.03333	.18826	.34350	.41017
	Equal variances not assumed			.177	57.087	.860	.03333	.18826	.34363	.41030

Table 6. The results of post-test data analysis

Group	N	Mean	Std. Deviation	Std. Error Mean
Experiment Class	30	4.3667	1.37674	.25136
Control Class	30	2.7667	1.07265	.19584

Based on Table 6, the average value of the experimental class students is 4.367 with a standard deviation of 1.37674, while the average value of the control class students is 2.7667 with a standard deviation of 1.07265. Table 7 shows that the data obtained that the post-test value between the two groups was 0.00 (p = <0.05), meaning that it is significantly different. The results of data analysis using the independent sample T-Test showed that students in the experimental and control classes had different abilities after treatment. From the results of data analysis, there was a significant effect after treatment using E-Module.

Table 7. The comparison of the post-test score using independent sample T-Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Post-test	Equal variances assumed	3.437	.069	5.021	58	.000	1.60000	.31864	.96217	2.23783
	Equal variances not assumed			5.021	54.728	.000	1.60000	.31864	.96136	2.23864

Ethnomathematics-based- e-Module development was able to improve students' metacognitive ability. The teachers and students gave positive responses on the use of e-Module. The utilization of technology can enhance collaborative and exciting learning

[2]. The use of digital books makes learning more interesting; it is also easy to use and can be carried everywhere because it is accessible through smartphones. e-Module can also be accessed via a smartphone or laptop that makes it more flexible. With the e-Module, students can access subject matter from anywhere and anytime, and students who do not have math textbooks can learn through e-modules [3], [4], [35]
Learning activities in this e-Module allow students to generate reasoning, find their answers and collect and observe information as new learning experiences. Activities in the scientific approach include: 1) observing, 2) experimenting, 3) reasoning, 4) asking questions, and 5) communicating. The ethnomathematics-based e-Module uses a scientific approach that consists of 4 stages of 1) observing, 2) asking, 3) reasoning, 4) trying. In the early stages, students are given examples, illustrations, cases, or problems of building space associated with Sasak culture. Students can ask the teacher about the practical issues or things that are not understood about the sub-material to be studied at the questioning stage. At the reasoning, stage students try to understand the concept/material by working on the questions given. Students also process the information collected to make conclusions related to the concept/material being studied at this reasoning stage. Students begin to design strategies, develop strategies, and implement the chosen techniques to solve problems and use numeracy, algebraic, and geometric skills at the trying stage. At this stage, students also process the information that has been collected to make conclusions related to the concept/material being studied. The orientation of this scientific approach is to encourage students' curiosity about natural phenomena, and students are actively involved in constructing concepts and knowledge [8]

4.4 Disseminating Stage

The socialization stage of the learning media is carried out in schools through the school website and the E-Modul link distributed via Whatsapp Group.

5 Conclusion

Education and training are the best investments in society’s future [36]. They play a vital role in boosting growth, innovation, and job creation. The government's education and training systems need to give people the forward-looking knowledge, skills, and competencies they need to innovate and prosper. They also have an essential role in creating an identity, building on shared values and cultures. Children think mathematically long before they start school and mathematical thinking is a strong predictor for later academic success in school – indeed, it is a better predictor than early reading and early attention skills [37], [38]. Mathematics is fundamental to a child's development & communication in later life. Basic numeracy skills assist kids in terms of achievement & just being competent adults. A broader acknowledgment of this would lead to more parity with literacy. However, developing a solid foundation in early math skills is vital for later educational success and economic, health, and employment outcomes. Children who enter school with solid mathematics skills have a greater likelihood of success in mathematics in kindergarten and in later grades [39], [40].

The result of the present study is a valid, practical, and effective e-Module product. Based on the validity test, the ethnomathematics based on e-Module n is highly feasible to use in learning resources with an average score of 3.65 (valid). Students' questionnaire response shows that the e-Module was practical with a percentage of the practicality of 89%. The effectiveness of the e-Module was seen from the paired sample T-test used to compare the results of the pretest and post-test with the outcome of 0.00 (p = <0.05), indicating that there was a significant difference. In sum, there was a substantial effect of the ethnomathematics-based- e-Module use on students' metacognitive skills in solving spatial problems.

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Development of E-Module Based on Sasak Ethnomathematics to Improve Students' Metacognitive Ability in Building Materials

Abstract— Since Covid 19 Pandemic hit Indonesia at the end of 2020, the learning process has shifted from studying at school to learning online at home using several technologies. Technology-based learning needs to be designed as attractive as possible, one of which integrated with local cultural. This study developed an E-Module based on ethnomathematics, particularlly the Sasak Tribe in improving the students' metacognitive abilities. This study used development research using a 4D development model, consists of four categories, i.e., defining, designing, developing, and disseminating. The research was conducted in one of the elementary schools in West Lombok with a total 30 subject of students. Based on the validity test, it shows that the E-Module based on ethnomathematics is very feasible to be used in learning resources by students with an average score of 3.65. The analysis results of the student response from questionnaire showed that the E-Modul was in the practical category with a practicality percentage of 89%. Based on data analysis, it is known that the t-test sig (2-tailed) value of the independent post-test t-test is 0.00 (p = <0.05), indicating that there was a significant difference. Overall, E-Module based on ethnomathematics was effective for improving students' metacognitive abilities on spatial material. This e-module was accessesable by students via smartphones or laptops from anywhere without time restrictions**.**

Keywords— E-Modules, ethnomathematics, problem solving, building space

1 Introduction

Since Covid 19 pandemic hit the world, particular in Indonesia at the end of 2020, learning procces in schools has been changed from studying at school to learning online from home using some kinds of technologies. Technology-based learning must be designed as attractive as possible; thus, students remain enthusiastic about learning. Student activities are also more focused on independent learning, therefore technology-based on learning media are needed to learn independently that may facilitate students using Electronic Modules (E-Modules).

E-Module is a form for presenting self-learning material systematically arranged which is presented in an electronic format and It is designed in form of animation, audio, navigation that makes users more interactive with the program [1]. E-Modules can also be categorized as teaching materials that are systematically arranged, involving discovery activities, there are materials, and practice questions to make it easier for students to learn independently [2]. E-Module is an alternative learning that is efficient and effective, interactive, and can be accessed anytime and anywhere via a smartphone or laptop that has several supporting devices [3]–[6].

Based on the results of observations and interviews conducted by researchers at 3 elementary schools in West Lombok, it is concluded that the learning process of mathematics is still less innovative and does not involve the role of technology. Learning activities occured were still teacher-centered where the majority of student activities are still focused on textbooks and have not been linked to local wisdom. In addition, student success was fully emphasized on the cognitive aspect. From the results of observations through the provision of questionnaires distributed in 3 elementary schools in West Lombok, data also obtained that 60% of students had difficulty understanding mathematics textbooks.

Mathematics learning in elementary schools really needs to link school mathematics with the local culture [7], [8]. One of the innovative elementary school mathematics learning can be done by linking elementary school mathematics material with culture or ethnomathematics. Ethnomathematics represents cultural objects in mathematical concepts [9].

Elements of Sasak culture can be used as a source of interesting and fun elementary school mathematics learning [10]. Ethnomathematics in the Sasak tribe extracted from the structure of traditional houses, special foods, and handicrafts. Ethnomathematics-based teaching materials in spatial building materials need to be designed to provide opportunities for elementary school students to build knowledge and develop their potential in accordance with the characteristics of the region. Students be able to achieve learning goals by referring to the cultural values of their area, so that they will form a person of high character in society.

Mathematical concepts associated with culture and everyday experiences will be able to improve students' ability to make meaningful connections and deepen their understanding of mathematics [11]. The application of ethnomathematics in learning mathematics will motivate students, learning becomes more meaningful, and students realize that learning mathematics is useful in real life [8], [11]. Another finding shows that learning mathematics with a model based on local culture combined with a scientific approach can actually foster higher-order thinking skills [12].

The scientific approach is basically nature-oriented learning [13]. Activities in the scientific approach include: 1) observing, 2) trying, 3) reasoning, 4) asking questions, and 5) communicating [13], [14]. In implementing the 2013 curriculum in Indonesia, one of the recommended approaches is the scientific approach, because it can develop students' metacognitive competence, especially towards science and technology [15].

The metacognition skill is one of the 21st century skills that needs to be trained by students and is the key to the success of Edin 21 century education [16], [17]. Permendikbud No. 20 years 2016 emphasized that the method of metacognitives became one of the important components in the standard competency of the graduate education in the Indone-SIA. The metacognition is defined as part of the high-level thinking skills that include understanding, analysis, and cognitive process control [18], [19]. There are three metacognitive capabilities indicators, there are : 1) Plan, 2) Evaluation, and 3) Monitoring [20].

There has been no previous research that has developed an ethnomathematics-based E-Modul that specifically addresses the culture of the Sasak tribe on spatial materials and there are no previous studies that have analyzed the effectiveness of an ethnomathematical-based E-Modul in terms of metacognitive abilities. Patri & Heswari developed an E-Modul which was integrated with Jambi culture to improve logical thinking skills[12]. Serevina, Sunaryo, Raihanati, Astra, & Sari developed an E module based on Problem Based learning on heat and temperature materials to improve science skills[21]. Kurniasari, rakh-mawati, & Fakhri have developed an E module characterized by the ethnomathematics of Lampung culture in Waking Up Flat Material [22]. Therefore, it is necessary to develop an E-Module based on ethnomathematics, especially the Sasak tribe in building materials for elementary school students and determine its effectiveness through indicators of metacognitive ability. Based on the background of the problem described, the researcher conducted a research entitled "Development of E-Module Based on Sasak Ethnomathematics to Improve Students' Metacognitive Ability in Building Materials".

2 Literature Review

2.1 Electronic Module (E-Module)

E-Modules are teaching materials that present independent learning materials that are systematically arranged in an electronic format in order to achieve certain learning objectives [3]–[5]. The use of E-modules is in accordance with the principles of 21st century learning where student learning activities involve technology. E-Modules are more practical than printed modules, because E-Modules can be carried everywhere on a smart phone and cannot be used. burdensome for students if carried everywhere [6]. E-modules can be accessed anytime and anywhere via smartphones or laptops that have supporting software to access the E-modules. Through the E-Modul will make learning activities become more interesting, interactive, and can improve the quality of learning Materials in E-modules are presented using electronic devices that can be accessed anytime and anywhere such as computers, laptops, and androids [23]. The E-Module is presented in an electronic format which includes animation, audio, and navigation which makes the user more interactive with the program.

2.2 Etnomatematika

Ethnomathematics represents local cultural objects in mathematical concepts [9]. The concept of local culture in mathematics learning can improve students' knowledge and reasoning [24]. Ethnomathematics-based learning affects problem-solving abilities by connecting real-world situations and cultural values that grow in society [7]. To facilitate meaningful learning of mathematics, it is necessary to integrate culture in learning mathematics. Mathematics learning that is integrated with local culture is an effective means to grow character and noble values in society. The elements of Sasak culture that are integrated in the building materials include traditional Sasak houses, special foods, and traditional Sasak handicrafts.

2.3 Metacognitive Ability.

Metacognitive abilities can encourage higher order thinking skill [25]–[27]. Metacognitive abilities help students in solving problems. Metacognitive abilities develop continuously with age. Children will have metacognitive abilities if starting from low grades they are accustomed to being involved in metacognitive activities [15]. Curriculums in Indonesia have also established policies in which metacognitive aspects are an important component of competency standards for basic education graduates. Anderson & Krathwohl defined three indicators of metacognitive ability, namely 1) planning, 2) evaluation, and 3) monitoring [20]. The plan includes setting goals, enabling relevant resources, and choosing the right strategy. Evaluation includes Determine the level of understanding of a person and how to choose the right strategy. Monitoring includes Checking one's progress and choose the appropriate improvement strategies when the chosen strategy does not work.

3 Method

3.1 Research Setting

This research was conducted from March 2021-May 2021 in one of the elementary schools in West Lombok, grade VI elementary school in academic year the 2020/2021 The total subjects in this study were 30 students.

3.2 Research Desain

This study uses the Thiagarajan development model known as the 4D model. This model consists of 4 stages, namely 1) defining, 2) designing, 3) developing, and 4) disseminating. The defining stage in this research consists of five activities, namely: preliminary analysis, student analysis, concept analysis, task analysis, and formulation of learning objectives. In the initial analysis activity, the researcher analyzed the curriculum, which was related to the Competency Standards and Basic Competencies of the material to be developed. Student analysis activities aim to determine student characteristics, level of student cognitive development, and student motivation. Student analysis was carried out by observing during the learning process in the classroom, conducting interviews with teachers and students. Concept analysis activities were carried out to find the content of the material in the module to be developed, through activities detailing, identifying, and systematically compiling the material, the concepts of relevant building blocks volume taught based on the initial analysis. Task analysis aims to identify tasks or practice questions and the main skills that students do during learning which the researcher then analyzes into a more specific sub-skills framework.

Furthermore, at the designing stage, the researcher prepared the E-Module design intoseveral stages; 1) test preparation, 2) media selection, and 3) format selection. The preparation of the test as an initial measure to measure the level of students' initial metacognitive skills. The selection of media used to select learning media that are in accordance with the material and characteristics of students, in this case E-Module based on ethnomathematics. The choice of format was a step in presenting learning with modules that are in accordance with the conditions of students, in this case E-Modules which are linked to the Sasak culture which includes traditional houses, special foods, and handicrafts. After the three stages were carried out, a draft or design of the E-module ethnomathematics produced in accordance with the content framework of the curriculum results and material analysis.

At the development stage, the activities carried out are expert validation and development testing. Expert validation aims to validate or assess the feasibility of the developed E-Module to a team of experts in their field. The instrument used to validate is a feasibility assessment questionnaire that includes components of content, presentation, grammar, and design. After getting an assessment from the validator, suggestions for improvements to the E-Module will be obtained which will be developed to be used as the basis for revision. This assessment aims to make the E-Module developed more precise, in accordance with the concept, tested, and of high value. There were four expert validators involved in this research and cover 4 aspects, namely: content validation, presentation validation, language validation, and validation of the design components of the E-Module that can be tested on research subjects after being declared valid.

Furthermore, for the development test activity, the researcher tested the draft against the actual subject. The resulting E-Modules were then tested in small classes before being distributed or tested in large classes. The test results used to improve the product to get effective results. The effectiveness of the module was seen from the paired sample T test which was used to compare the results of the pre-test and post-test. In small class trials, researchers conducted observations to obtain response data, while user responsed from questionnaires, and comments from interview results. E-Module. Instruments in small-scale trials are non-test instruments, namely observation sheets, validation sheets, and student questionnaires. After receiving input during a small-scale trial and revision, the E-Modul was tested on a large scale in order to achieve the objectives and effectiveness of the developed module. At this stage, measurement of the achievement of goals was carried out, i.e., the effect of using E-Modules on students' metacognitive abilities. The instrument used in this study was a problem-solving test instrument. The dissemination stage was the socialization stage of learning media carried out in schools through the school website and E-Module links that were distributed through Whatsapp Group. The dissemination stage aims to disseminate the E-Module. The developed E-Module was prepared using a scientific approach which includes observing, asking, trying, and reasoning activities.

3.3 Data analysis technique.

The data analysis of research design used a quasi-experimental design with a pre-test post-test control group design; testing the results of the pretest and posttest in learning using an E-Modul for developing students' metacognitive abilities. The data collection techniques used in this study were expert validation tests, documentation studies, observations, and student learning outcomes tests (pre-test and post-test) using the developed E-Module. The questionnaire instrument was used for expert validation, in order to get a valid E-Module based on the expert. Observation is used to collect data about activities during learning activities with E-modules. Finally, a problem-solving test was used to obtain data about the E-Module on students' metacognitive abilities. The effect of using the E-Module on metacognitive ability was measured by analyzing the answer scores given by students in the pre-test and post-test. The instrument used to assess metacognitive ability was in the form of pre-test and post-test questions consist of one description question. The effect of using the E-module on metacognitive ability was carried out through a paired sample T test which was used to compare the results of the pre-test and post-test with the help of the computer program SPSS 17.00 for windows. Paired sample T test, the data used must be normally distributed, so that the data obtained can be analyzed. This value then determines the decisions taken in the study. Table 1 is some of the indicators used in determining the level of metacognitive [20]

Table 1. Indicators And Description of Metacognitive Ability

No	Indikator	Deskripsi
1	Plan	Setting goals (P1) Enabling relevant resources (P2) Choosing the right strategy (P3)
2	Evaluation	Determine the level of understanding of a person (E1) How to choose the right strategy (E2)
3	Monitoring	Checking one’s progress (M1) Choose the appropriate improvement strategies when the chosen strategy does not work. (M2)

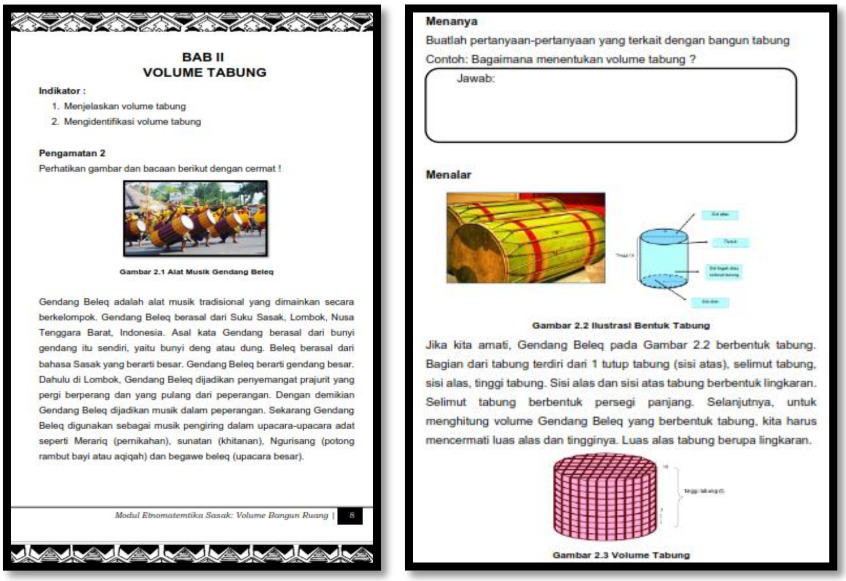
4 Result And Discussion

4.1 Defining Stage

At the defining stage, researchers analyzed the school curriculum that implemented the 2013 curriculum. The results of the analysis found that Core Competencies and Basic Competencies in the material to be developed, namely basic competencies related to determining the volume of geometric shapes (prisms, cylinders, pyramids, cones, spheres, and a combination of several shapes). how many shapes), and solve problems related to the volume of the shapes. Based on the results of observations at the initial analysis stage, the researchers found the fact that students' problem-solving abilities were still low and students were only involved in routine questions whose assessment emphasis was on cognitive aspects.

4.2 Designing Stage

The researcher drafted E-Module through several stages at the design stage, ie.e., 1) test preparation, 2) media selection, and 3) format selection. The preparation of the test was in the form of 5 problem solving questions, due to the type of problem-solving questions will bring up students' metacognitive skills. The selection of media in the form of E-Module based on ethnomathematics by taking elements of Sasak culture which includes traditional houses, special foods, and handicrafts. the draft or product design produced after the three stages were carried out; the E-module of ethnomathematics dealing with the framework of the content of the curriculum results and material analysis. In the format selection activity, the researcher designed the content of the material that was integrated with Sasak culture and combined a scientific approach. The purpose of integrating elements of Sasak culture in the material is to motivate students to continue learning mathematics, learning becomes more meaningful, and students know the direct benefits of learning mathematics in real life.



BAB II
VOLUME TABUNG

Indikator :
1. Menjelaskan volume tabung
2. Mengidentifikasi volume tabung

Pengamatan 2
Perhatikan gambar dan bacaan berikut dengan cermat !

Gambar 2.1 Alat Musik Gendang Beleq

Gendang Beleq adalah alat musik tradisional yang dimainkan secara berkelompok. Gendang Beleq berasal dari Suku Sasak, Lombok, Nusa Tenggara Barat, Indonesia. Asal kata Gendang berasal dari bunyi gendang itu sendiri, yaitu bunyi deng atau dung. Beleq berasal dari bahasa Sasak yang berarti besar. Gendang Beleq berarti gendang besar. Dahulu di Lombok, Gendang Beleq dijadikan penyemangat prajurit yang pergi berperang dan yang pulang dari peperangan. Dengan demikian Gendang Beleq dijadikan musik dalam peperangan. Sekarang Gendang Beleq digunakan sebagai musik pengiring dalam upacara-upacara adat seperti Merariq (pernikahan), sunatan (khitanan), Ngurisang (potong rambut bayi atau aqiqah) dan begawe beleq (upacara besar).

Modul Etnomatemtika Sasak: Volume Bangun Ruang | 8

Menanya
Buatlah pertanyaan-pertanyaan yang terkait dengan bangun tabung
Contoh: Bagaimana menentukan volume tabung ?
Jawab:

Menalar

Gambar 2.2 Ilustrasi Bentuk Tabung

Jika kita amati, Gendang Beleq pada Gambar 2.2 berbentuk tabung. Bagian dari tabung terdiri dari 1 tutup tabung (sisi atas), selimut tabung, sisi alas, tinggi tabung. Sisi alas dan sisi atas tabung berbentuk lingkaran. Selimut tabung berbentuk persegi panjang. Selanjutnya, untuk menghitung volume Gendang Beleq yang berbentuk tabung, kita harus mencermati luas alas dan tingginya. Luas alas tabung berupa lingkaran.

Gambar 2.3 Volume Tabung

4.3 Developing Stage

The development phase consists of two activities, i, e., validation and testing of the E-Module. At this stage, a revised draft of the module was developed based on input from experts and data obtained through small-scale trials. Activities at this stage consist of expert validation and some limited trials. Expert validation was carried out by two mathematics education lecturers and two sixth grade teachers. Table 2 shows the results of expert validation. The practicality and effectiveness of the E-Module were also determined from the results of the testing activities. Responses from students (users) of the E-Modul on the questionnaire and interviews shows that the E-Modul was user-friendly. It is also called that the media meets the effective criteria based on the metacognitive ability test.

E-Module Validity

Tabel 2. E-Module Validity

No	Validator	Score	Validation Criteria	Information
1	X-1	3.53	Sangat Valid	Enlarge the image size in practice questions
2	X-2	3.57	Sangat Valid	No revision
3	X3	3.67	Sangat Valid	No revision
4	X-4	3.75	Sangat Valid	No revision
	Average	3.63	Sangat Valid	

Table 2, shows tahat the average value of E-Modul validation is 3.63 with highly valid criteria. This shows that the E-module was feasible to use without major revisions

Practicality of E-Module

Based on the results of interviews and questionnaires, the E-Modul was declared practical, with a practicality percentage of 89,67%. Table 3 shows the indicators and responses to the E-Module usage questionnaire.

Tabel 3. Indicators of the E-Module Usage Questionnaire

No	**Indicator**	**Percentage of Student Responses in Each Category (%)**			
		Strongly disagree	**Disagree**	**Agree**	**Strongly agree**
Content Aspect					
1.	The material presented is in accordance with the learning objectives	76.67	16.67	3.33	3.33

2.	The learning steps in the E-Module are easy to follow	70.00	20.00	6.67	3.33
3.	The activities in the module are fun because they relate to the life around them.	73.33	16.67	3.33	6.67
Language Aspect					
4.	The writing in E-Module can be read clearly	73.33	20.00	3.33	3.33
5.	The material presented is in easy-to-understand sentences	60.00	26.67	10.00	3.33
6.	The language used is communicative	56.67	33.33	6.67	3.33
7.	Instructions for use, learning objectives, and learning activities in the E-Module are quite clear	60.00	30.00	3.33	6.67
Benefit Aspect					
8.	Easy-to-use learning e-module	66.67	23.33	6.67	3.33
9.	This E-Module triggers me to study harder	56.67	33.33	6.67	3.33
10.	The availability of pictures in the module makes it easier for me to do practical activities	60.00	23.33	10.00	6.67

Table 2, shows that the students gave a positive response to the use of E-modules based on ethnomathematics for each indicator. They can easily follow each activity on the module and understand the material. The competency test at the end of the module beable to measure students' mathematical problem-solving abilities. The designed activities were always related to the culture that was closely related to the students' daily lives and equipped with pictures of objects that they often encounter. The following are excerpts from the interviews of researchers (R), students (S1), and teachers (T1).

Researcher interviews with students

R : *Do you understand easily the material after learning activities which associated with Sasak culture?*

S1 : *Yes, it's easier for me to understand. I often come across examples and pictures shown on E-Modules.*

R : *What is your first impression when the teacher linked learning activities with Sasak culture?*

S1 : *It's fun, because honestly, I've never studied mathematics associated with traditional Sasak houses before, such Sasak food, and Sasak handicrafts. It's different from the textbooks that we've learned so far*

R : *What is your first impression when working/using on the E-module?*

S1 : *more motivated to do ma'am out of curiosity. The pictures are good, the design is also good. It's also easier for me to understand this material after working on the E-Modul*

Interviews with researchers and teachers

R : *In your opinion, can this E-Module help students understand spatial structure?*

T1 : *Yes, because use the integrated E-Modul with Sasak culture, it makes learning more meaningful for children, it turns out that mathematics is close to their daily lives.*

R : *After this lesson, will you use this E-Module for further learning?*

T1 : *Yes, I will use this E-Module*

Based on the results of interviews with both students and teachers, it is certain that the use of E-Module can motivate students to learn mathematics based on Ethnomathematics.

E-Module Effectiveness

Based on the results of the interview and students' work, the percentage of students who perform the three metacognitive skills indicators during the post-test can be concluded in the following graphic.

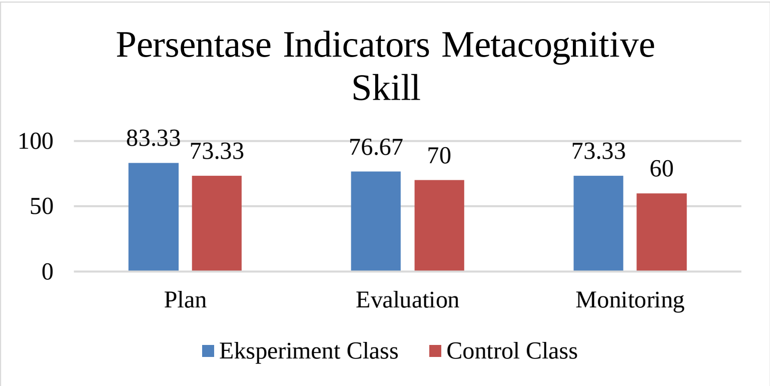


Figure 1. Percentages of Metacognitive Skill Indicators

To test the effectiveness of the E-Module based on ethnomathematics between the experimental class and the control class, an independent sample t-test was used. The experimental class was applied with an E-Module based on ethnomathematics and the control class was applied with an ordinary print module. The normality test of the data was checked before further analysis. The number of respondents is 30 students. As shown in Table 4 and Table 5, the results of the pre-test both the experimental class and the control class were the same or not significantly different. This assessment refers to the assessment rubric to measure metacognitive skills developed by Corebima (2009).

Tabel 4. Pre-Test Results And Mean Scores Between The Control Class And The Experimental Class

Group	N	Mean	Std. Deviation	Std. Error Mean
Experiment Class	30	1.5667	.77385	.14129
Control Class	30	1.5333	.68145	.12441

The average score in the experimental class is 1.5667 (SD = .77835), while the control class is characterized by an average score of 1.5333 (SD = .68145). The difference in pre-test scores between the two groups is [t (30) = 0.367, p> 0.05], meaning that it is not significant at alpha .05 levels. This shows that the two groups were equal before treatment.

Table 5. The Data Below Presents The Comparison of Pre-Test Score Of Experiment Class And Control Class Score Using Independent Sample T-Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Di ference	95% Confdence Interval of the Difference	
									Lower	Upper
Pre-test	Equal variances assumed	.828	.367	.177	58	.860	.03333	.18826	.34350	.41017
	Equal variances not assumed			.177	57.087	.860	.03333	.18826	.34363	.41030

Table 6. The Table Displays Post-Test Results And Mean Scores Between The Control Class And The Experimental Class

Group	N	Mean	Std. Deviation	Std. Error Mean
Experiment Class	30	4.3667	1.37674	.25136
Control Class	30	2.7667	1.07265	.19584

Table 6 shows the post-test results of the experimental class with the average score 4.367 (SD = 1.37674), while the control class is 2.7667 (SD = 1.07265). Furthermore, Table 7 shows that the sig (2-tailed) t-test of the independent post-test t-test is 0.00 (p = <0.05), meaning that it is significant. This shows that the two classes are different in the metacognitive skill in solving geometry problems after the application of E-Modul. Based on these results, it can be concluded that there is a significant influence on the application of E-Modul in improving students' metacognitive skill in solving geometry problems.

Table 7. The Data Presents the Comparison of Post-test Score of Experiment Class and Control Class Score using Independent Sample T-Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Post-test	Equal variances assumed	3.437	.069	5.021	58	.000	1.60000	.31864	.96217	2.23783
	Equal variances not assumed			5.021	54.728	.000	1.60000	.31864	.96136	2.23864

E-Module development based on ethnomathematics be able to improve students' metacognitive abilities. Teachers and students gave a positive response to the resulting E-Module. Learning by utilizing technology can create a more collaborative and interesting learning environment [6]. The use of digital books makes learning interesting, practical and can be carried everywhere because it can be read through smartphones [28]. This E-Module can also be accessed via a smartphone or laptop so that it becomes more flexible. With this e-module, students can access subject matter from anywhere and anytime, and students who don't have math textbooks can learn through e-modules [7], [8], [29].

Learning activities in this E-Modul provide opportunities for students to reason, try to find their own answers, collect and observe information so that they can provide new learning experiences for students. Activities in the scientific approach include: 1) observing, 2) experimenting, 3) reasoning, 4) asking questions, and 5) communicating. This ethnomathematics-based E-Module uses a scientific approach which consists of 4 stages, namely 1) observing, 2) asking, 3) reasoning, 4) trying. In the early stages, students are given examples, illustrations, cases or problems of building space associated with Sasak culture. At the questioning stage, students are given the opportunity to ask the teacher about the problems observed or things that are not understood about the sub-material to be studied. At the reasoning stage students try to understand the concept / material by working on the questions given. At this reasoning stage, students also process the information that has been collected to make conclusions related to the concept / material being studied. At the trying stage, students begin to design strategies, develop strategies, and implement the chosen strategies to solve problems, use numeracy skills, use algebraic and geometric skills. At this stage, students also process the information that has been collected to make conclusions related to the concept / material being studied. The orientation of this scientific approach is to encourage students' curiosity about natural phenomena and students are actively involved in constructing concepts and knowledge [13], [30]

4.4 Disseminating Stage

The socialization stage of learning media is carried out in schools through the school website and the E-Modul link which is distributed via Whatsapp Group.

5 Conclusion

The results of this study are valid, practical, and effective for E-module productios. Based on the validity test, it shows that the E-Module based on ethnomathematics is very feasible to be used by students in learning resources with an average score of 3.65 (in the valid category. The results of the student response questionnaire analysis show that the E-Module is in the practical category with the percentage of practicality is 89%. The effectiveness of the E-module seen from the paired sample T test which is used to compare the results of the pre-test and post-test. -test was 0.00 ($p = <0.05$), indicating that there was a significant difference. This shows that the metacognitive abilities of the students of the two classes are different in solving spatial problems after the application of the E-Module. Thus, it concluded that there is a significant effect on the application of E-Module based on ethnomathematics in improving students' metacognitive skills in solving spatial problems.

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Development of an Ethnomathematics-Based e-Module to Improve Students' Metacognitive Ability in 3D Geometry Topic

https://doi.org/10.3991/ijim.v16i03.24949

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Abstract—Since the Covid 19 Pandemic by the end of 2020, the learning process has shifted from school to online home-based- learning. Several technologies are applied for enabling students' participation. Technology-based learning needs to be designed to be attractive and integrated with local culture. The present study developed a valid, practical, and effective Sasak ethnomathematics-based e-Module. The e-Module was mainly designed to improve students' metacognitive abilities. The study used development research using a 4D development model consisting of four categories: defining, designing, developing, and disseminating. The research was conducted in one of the elementary schools in West Lombok. Ten students of grade five and 30 students of grade six were selected for large-scale trials. The validity test showed that the ethnomathematics-based-e-Module was highly feasible to be used as a learning resource with an average score of 3.65. The questionnaire's analysis of students' responses showed that the e-Module fell into the practical category with a practicality percentage of 89%. The results of data analysis using independent sample T-Test showed that the T-test value was $0.00 < 0.05$, thus the results of the study revealed a significant difference. Overall, the ethnomathematics-based- e-Module was valid, practical, and effective for improving students' metacognitive abilities on spatial material. The students can access the e-Module via smartphones or laptops, allowing them to remotely without time restrictions.

Keywords—e-Module, ethnomathematics, problem-solving, building space

1 Introduction

Since Covid 19 Pandemic hit the world by the end of 2020, the learning process has shifted from school to online home-based- learning. Several technologies are applied for enabling students' participation. Technology-based learning needs to be attractive to maintain students' enthusiasm and focus on independent learning. Technology-based learning facilitates the use of electronic modules (e-Module). The e-Module is one of the teaching materials that present separate learning materials arranged systematically in electronic format to achieve particular learning objectives. It is designed in animation and audio to make it more exciting and interactive [1]. The e-Module is an efficient, effective, and interactive alternative learning source that can be accessed anytime and anywhere via a smartphone or laptop with several supporting devices [2].

Observations and interviews conducted at three elementary schools in West Lombok, Indonesia, showed that mathematics classes were insufficient innovation and did not involve using technology. Learning was conducted teacher-centered, with most students' activities focused on textbooks and was not linked to local wisdom. In addition, students' success was fully emphasized on the cognitive aspect. The questionnaire spread in three elementary schools showed that 60% of students had difficulty understanding mathematics textbooks.

Mathematics learning needs to be linked with the local culture [3], [4]. This can be done through ethnomathematics. Elements of Sasak culture can be used for exciting and fun mathematics learning at the primary level [5]. Ethnomathematics of the Sasak tribe is extracted from traditional houses, special foods, and handicrafts. Ethnomathematics-based teaching materials in geometry topics need to be designed to provide opportunities for elementary school students to build knowledge and develop their potential according to the region's characteristics. Students can achieve learning goals by referring to the cultural values of their area to build good character among the society.

Mathematical concepts associated with culture and everyday experiences will improve students' ability to make meaningful connections and deepen their understanding of mathematics [6]. Applying ethnomathematics in mathematics will motivate students, create more meaningful learning, and enable students to realize that mathematics is helpful in real life [4], [6]. Another finding showed that using a local culture-based model combined with a scientific approach can foster higher-order thinking skills [7].

The scientific approach is nature-oriented learning [8]. Activities in the scientific method include: 1) observing, 2) trying, 3) reasoning, 4) asking questions, and 5) communicating [8], [9]. In implementing the 2013 curriculum in Indonesia, the scientific approach is one of the most recommended approaches as it can develop students' metacognitive competence, especially towards science and technology [10].

Metacognition ability is part of the 21st-century skills that need to be trained by students and is the key to the success of 21-century education [11], [12]. Metacognition is a higher-order thinking ability that involves understanding, analyzing, and developing cognitive processes [13], [14]. There are three metacognitive ability indicators, including planning, evaluation, and monitoring [15].

No previous research has developed an ethnomathematics-based e-Module that specifically addresses the culture of the Sasak tribe on geometry topic and analyzes the effectiveness of an ethnomathematical-based e-Module in terms of metacognitive abilities. Patri & Heswari developed an e-Module integrated with Jambi culture to improve logical thinking skills [7]. Serevina, Sunaryo, Raihanati, Astra, & Sari set an e-Module based on Problem Based learning on heat and temperature materials to improve science skills [16]. Kurniasari, rakh-mawati, & Fakhri have developed an e-Module characterized by the ethnomathematics of Lampung culture in two-dimensional figure material [17]. It is necessary to create an ethnomathematics-based e-Module, especially for the Sasak tribe- for primary students and to determine its effectiveness through indicators of metacognitive ability.

2 Literature review

2.1 Electronic module (e-Module)

The e-Module is independent systematically arranged electronic learning materials that enable students to achieve specific learning objectives [2]. The use of e-Modules is following the principles of 21st-century learning of technology use for learning. An e-Module is more practical than the printed version since it is accessible by smartphone and functional [2]; thus, it can be accessed anytime and anywhere via smartphones or laptops with the supporting software. Mobile devices such as a smartphone are suitable for children's lifestyles because there is no need to sit or school to use the device. They only need students to activate smartphones [18]. Children nowadays use this technology earlier [19]. The e-Module is presented in an electronic format that includes animation, audio, and navigation, allowing interaction between users and the program.

Several studies have revealed that digital media can help children understand abstract concepts early [20]. The involvement of digital media in the school environment can develop logical thinking and strengthen students' problem-solving skills [21].

2.2 Digital mathematics activities and children

Research on the use of digital technology in mathematics learning is not new [22]. Digital technology becomes part of mathematics learning to increase engagement and understanding in the learning process; mobile technology can make mathematics more meaningful [23] because it allows children to learn and practice skills interestingly and interactively [24]. Digital activities effectively promote mathematics, natural sciences, and languages, where specific goals can be selectively defined and developed in contexts related to specific learning activities and targets [25]. Studies have shown the benefits of using digital at the elementary school level as follow:

a. Digital activities can provide various educational services to children. Several studies have suggested that well-designed educational activities can motivate and encourage learning more than traditional teaching methods [26].
b. By using digital activities, students can learn cognitive abilities through repetition [27].
c. In primary education, students often engage in collaboration while playing digital activities [28].

The use of technologies could effectively support the learning process, particularly in mathematics [29]. Integrating mobile devices into the primary school curriculum increases elementary school students' interest [30]. The use of technology provides a positive role in improving students' early math skills. The use of mobile technology in mathematics education can encourage meaningful student engagement [29].

2.3 Ethnomathematics through mobile devices

Ethnomathematics represents local cultural objects in mathematical concepts. The concept of local culture in mathematics learning can improve students' knowledge and reasoning [31]. Ethnomathematics-based understanding affects problem-solving abilities by connecting real-world situations and cultural values that grow in society [3]. To facilitates a meaningful understanding of mathematics, it is necessary to integrate culture in learning mathematics. Integration of mathematics and local culture is an effective means to grow character and noble values in society. The elements of Sasak culture integrated with 3D Shape materials include traditional Sasak's houses, special foods, and traditional handicrafts.

The e-Module must have the following characteristics: a) Easy to use so that children can easily use it, b) Provide pictures related to the traditional culture of the Sasak Tribe, c) Combine animation and sound.

2.4 Metacognitive ability

Metacognitive abilities can encourage higher-order thinking skills [32]–[34]. Metacognitive skills help students in solving problems. Metacognitive abilities develop continuously with age development. Early engagement with metacognitive activities can lead to good metacognitive skills [10]. Metacognitive knowledge is one of the essential goals in the curriculum of Indonesia. Anderson & Krathwohl explained three indicators of metacognitive ability, i.e., planning, evaluation, and monitoring [15]. Planning consists of setting goals, linking with prior knowledge, and choosing the appropriate strategy. The assessment consists of realizing one's level of understanding and how to select the proper method. Monitoring checks one's progress and determines the right approach when the initial strategy does not work.

3 Method

3.1 Research setting

This research was conducted from March 2021–May 2021 in one of the elementary schools in West Lombok, grade VI primary school in 2020/2021. The total number of subjects in this study was 30 students.

3.2 Research design

This study used the 4D model. This model consists of 4 stages, they are 1) defining, 2) designing, 3) developing, and 4) disseminating. The defining stage in this research consists of five activities: preliminary analysis, student analysis, concept analysis, task analysis, and formulation of learning objectives. In the initial analysis activity, the researcher analyzed the curriculum related to the Competencies and Basic Competencies of the material to be developed. Student analysis activities aim to determine students' characteristics, level of student cognitive development, and student motivation. Student analysis was carried out by observation during the learning process in the classroom and interviews with teachers and students. Concept analysis activities were carried out to find the content of the material in the module to be developed through activities of detailing, identifying, and systematically compiling the material, the concepts of relevant building blocks volume taught based on the initial analysis. Task analysis aims to identify tasks or practice questions, and the primary skills students do during learning which the researcher then analyzes into a more specific sub-skills framework.

Furthermore, at the designing stage, the researcher prepared the e-Module design into steps; 1) test preparation, 2) media selection, and 3) format selection. Test preparation is an initial stage to measure the level of students' initial metacognitive skills. Media is selected to ensure that it fits the material to be taught and the characteristics of students. In the present research, the media is ethnomathematics based- e-Module. After the three stages were carried out, a draft or design of the ethnomathematics-based- e-Module was created following the content framework of the curriculum and material analysis.

At the development stage, the activities carried out were expert validation and test development. Expert validation aims to validate or assess the feasibility of the developed e-Module to a team of experts in their field. The instrument used to validate is a feasibility assessment questionnaire that includes content, presentation, grammar, and design components. After obtaining an assessment from the validator, suggestions for improvements to the e-Module were obtained and became the critical basis for revision. The evaluation aimed to make the e-Module developed to meet the concept, tested, and valuable. The four aspects in validation included content validation, presentation validation, language validation, and validation of the design components of e-Module. The validators stated that the e-Module was valid can be tested on research subjects.

In the test development stage, the researcher tested the draft on the actual subject. The e-Modules were tested in small classes before trying in large classes. The test results were used to improve the product to gain effective outcomes. The effectiveness of the module was evidenced by the independent sample T-Test used to analyze the research data. While the trial was conducted in a small class, the researchers observed, obtaining responses from questionnaires and interview comments. The instrument used in the small-scale practice was non-test instruments of observation sheets, validation sheets, and student questionnaires. After receiving input from a small-scale trial and revision, the e-Module was tested on a large-scale group to achieve the developed module's objectives and effectiveness. At this stage, the achievement of goals was measured to obtain thee-Modules' effect on students' metacognitive abilities. The instrument used was a problem-solving test instrument.

The dissemination stage was the socialization stage of learning media and e-Module links. They were distributed through Whatsapp Group. The dissemination stage aims to disseminate the e-Module. The developed e-Module was prepared using a scientific approach, including observing, asking, trying, and reasoning activities.

3.3 Data analysis technique

A quasi-experimental design with a pretest and post-test control group design was the research design used for data analysis. It was used to find the results of the pretest and post-test of the e-Module use for developing students' metacognitive abilities. The data collection techniques included expert validation tests, documentation studies, observations, and student learning outcomes. A questionnaire instrument was used for expert validation to gain a valid e-Module based on the expert overview. Comment as used to collect data related to the activities during learning activities with e-Modules. A problem-solving test was used to obtain data about the e-Module on students' metacognitive abilities. The effect of using the e-Module on metacognitive knowledge was measured by analyzing the students' scores. The instrument used to assess metacognitive ability was pretest and post-test questions consisting of one descriptive question. The effect of using the e-Module on metacognitive knowledge was gained through a paired sample T-Test with SPSS 17.00 for windows. For paired sample T-test, the data used must be normally distributed to analyze the data obtained. This value then determines the decisions taken in the study. Table 1 shows indicators used in determining the level of metacognitive [15].

Table 1. Indicators and description of metacognitive ability

No	Indicator	Description
1	Plan	Setting goals (P1) Enabling relevant resources (P2) Choosing the right strategy (P3)
2	Evaluation	Determine the level of understanding of a person (E1) How to choose the right strategy (E2)
3	Monitoring	Checking one's progress (M1) Choose the appropriate improvement strategies when the chosen strategy does not work. (M2)

4 Result and discussion

4.1 Defining stage

At the defining stage, the researchers analyzed the applied curriculum, i.e., the 2013 curriculum. The analysis found the Core Competencies and Basic Competencies to be developed to determine the volume of geometric shapes (prisms, cylinders, pyramids, cones, spheres, and a combination of several forms) and solve problems related to the importance of the figures. From observations at the initial analysis stage, the researchers found that students' problem-solving abilities were lacking. Students were only involved in routine questions with assessment emphasizing cognitive aspects.

4.2 Designing stage

The researcher drafted e-Module through several stages at the design stage, i.e., 1) test preparation, 2) media selection, and 3) format selection. The preparation of the test was in the form of 5 problem-solving questions. The e-Module was selected as a media based on ethnomathematics by taking elements of Sasak culture, which includes traditional houses, special foods, and handicrafts. The draft or product design- the e-Module of ethnomathematics—was produced after the three stages were carried out. In the format selection activity, the researcher designed the material's content integrated with Sasak culture and combined a scientific approach. The purpose of incorporating elements of Sasak culture in the material is to motivate students to continue learning mathematics, create more meaningful learning, and enable students to know the direct benefits of learning mathematics in real life.

4.3 Developing stage

The development phase consists of two activities, i.e., validation and testing of the e-Module. At this stage, a revised draft of the module was developed based on input from experts and data obtained through small-scale trials. Activities at this stage included expert validation and some limited tests. Expert validation was carried out by two mathematics education lecturers and two sixth-grade teachers (see Table 2). The practicality and effectiveness of the e-Module were also determined from the results of the testing activities. Responses from students (users) of the e-Module on the questionnaire and interviews show that the e-Module was user-friendly and the media meets the effective criteria based on the metacognitive ability test.

e-Module validity.

Table 2. e-Module validity

No	Validator	Score	Validation Criteria	Information
1	X-1	3.53	Very Valid	Enlarge the image size in practice questions
2	X-2	3.57	Very Valid	No revision
3	X3	3.67	Very Valid	No revision
4	X-4	3.75	Very Valid	No revision
	Average	3.63	Very Valid	

Table 2 shows that the average value of e-Modul validation was 3.63 (high validity) criteria indicating that the e-Module was feasible to use without significant revisions.

e-Module practicality. Based on the results of interviews and questionnaires, the e-Module was practical (89,67%). Table 3 shows the indicators and responses to the e-Module usage questionnaire.

Table 3. Indicators of the e-Module usage questionnaire

No	Indicators	Percentage of Student Responses in Each Category (%)			
		Strongly Disagree	Disagree	Agree	Strongly Agree
Content Aspect					
1.	The material presented is following the learning objectives	76.67	16.67	3.33	3.33
2.	The learning steps in the e-Module are easy to follow	70.00	20.00	6.67	3.33
3.	The activities in the module are fun because they relate to the life around students.	73.33	16.67	3.33	6.67
Language Aspect					
4.	The e-Module can be read clearly	73.33	20.00	3.33	3.33
5.	The material presented is in easy-to-understand	60.00	26.67	10.00	3.33
6.	The language used is communicative	56.67	33.33	6.67	3.33
7.	Instructions for use, learning objectives, and learning activities in the e-Module are pretty clear	60.00	30.00	3.33	6.67
Benefit Aspect					
8.	Easy-to-use	66.67	23.33	6.67	3.33
9.	It triggers me to study harder	56.67	33.33	6.67	3.33
10.	The availability of pictures in the module makes it easier for me to do practical activities	60.00	23.33	10.00	6.67

Table 2 shows that the students positively responded to e-Module based on ethnomathematics for each indicator. They could easily follow each activity on the module and understand the material. The competency test at the end of the module was able to measure students' mathematical problem-solving abilities. The designed activities were always related to the culture closely associated with the students' daily lives and equipped with pictures of objects they often encounter. Below are excerpts from the interviews of researchers, students, and teachers.

Researcher interviews with students

R: *Do you understand the material easily after doing the learning activities associated with Sasak culture?*

S1: *Yes, it is easier for me to understand. I often find examples and pictures shown on e-Modules.*

R: *What is your first impression when the teacher linked the learning activities with Sasak culture?*

S1: *It's fun because, honestly, I've never studied mathematics associated with traditional Sasak houses, food, and handicrafts before. It is different from the textbooks that we've learned so far.*

R: *What is your first impression when working on/using the e-Module?*

S1: *I felt more motivated to follow the activities; the pictures are good. The design is also good. It is also easier for me to understand this material after working on the E-Modul.*

Interviews with researchers and teachers

R: *In your opinion, can this e-Module help students understand spatial structure?*

T1: *Yes, because the integration of the E-Modul with Sasak culture makes learning more meaningful for children, it turns out that mathematics is close to their daily lives.*

Interviews with both learners and teachers show that e-Module could motivate students to learn mathematics based on ethnomathematics.

e-Module effectiveness. From the results of data analysis (interviews and student work), the percentage graphic of indicators metacognitive ability in Figure 1 as follows.

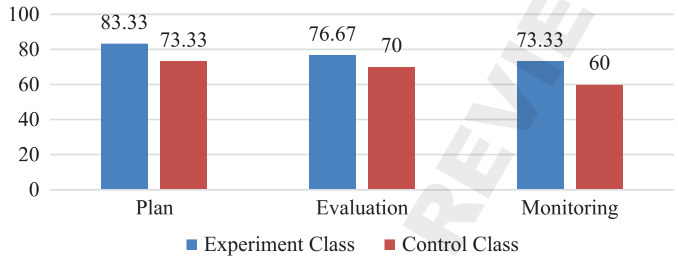

Fig. 1. Percentage of indicators of metacognitive ability

The effectiveness of the e-Module was tested by using an independent sample T-Test. The experimental class was applied with an ethnomathematics-based- e-Module, while an ordinary printed module was used for the control class. The normality test of the data was checked before further analysis. The number of samples in this study was 60 students. As shown in Table 4 and Table 5, the pretest results from both the experimental class and control class indicated the similarity or not significant difference.

Table 4. The results of pretest data analysis

Group	N	Mean	Std. Deviation	Std. Error Mean
Experiment Class	30	1.5667	.77385	.14129
Control Class	30	1.5333	.68145	.12441

Based on Table 4, the average value of the experimental class students was 1.5667 with a standard deviation of 0.77835, while the average value of the control class students was 1.5333 with a standard deviation of 0.68145. Table 5 shows that the data obtained from the pretest value between the two groups was [$t(30) = 0.367$, $p>0.05$], meaning that it was not significantly different. The results of data analysis using independent sample T-Test showed that students in the experimental and control classes had similar abilities before treatment.

Table 5. The comparison of pretest score using independent sample T-Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confdence Interval of the Difference	
									Lower	Upper
Pre-test	Equal variances assumed	.828	.367	.177	58	.860	.03333	.18826	.34350	.41017
	Equal variances not assumed			.177	57.087	.860	.03333	.18826	.34363	.41030

Table 6. The results of post-test data analysis

Group	N	Mean	Std. Deviation	Std. Error Mean
Experiment Class	30	4.3667	1.37674	.25136
Control Class	30	2.7667	1.07265	.19584

Based on Table 6, the average value of the experimental class students is 4.367 with a standard deviation of 1.37674, while the average value of the control class students is 2.7667 with a standard deviation of 1.07265. Table 7 shows that the data obtained that the post-test value between the two groups was 0.00 ($p = <0.05$), meaning that it is significantly different. The results of data analysis using the independent sample T-Test showed that students in the experimental and control classes had different abilities after treatment. From the results of data analysis, there was a significant effect after treatment using e-Module.

Table 7. The comparison of the post-test score using independent sample T-Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Post-test	Equal variances assumed	3.437	.069	5.021	58	.000	1.60000	.31864	.96217	2.23783
	Equal variances not assumed			5.021	54.728	.000	1.60000	.31864	.96136	2.23864

Ethnomathematics-based- e-Module development was able to improve students' metacognitive ability. The teachers and students gave positive responses on the use of e-Module. The utilization of technology can enhance collaborative and exciting learning [2]. The use of digital books makes learning more interesting; it is also easy to use and can be carried everywhere because it is accessible through smartphones. e-Module can also be accessed via a smartphone or laptop that makes it more flexible. With the e-Module, students can access subject matter from anywhere and anytime, and students who do not have math textbooks can learn through e-modules [3], [4], [35].

Learning activities in this e-Module allow students to generate reasoning, find their answers and collect and observe information as new learning experiences. Activities in the scientific approach include: 1) observing, 2) experimenting, 3) reasoning, 4) asking questions, and 5) communicating. The ethnomathematics-based e-Module uses a scientific approach that consists of 4 stages of 1) observing, 2) asking, 3) reasoning, 4) trying. In the early stages, students are given examples, illustrations, cases, or problems of building space associated with Sasak culture. Students can ask the teacher about the practical issues or things that are not understood about the sub-material to be studied at the questioning stage. At the reasoning, stage students try to understand the concept/material by working on the questions given. Students also process the information collected to make conclusions related to the concept/material being studied at this reasoning stage. Students begin to design strategies, develop strategies, and implement the chosen techniques to solve problems and use numeracy, algebraic, and geometric skills at the trying stage. At this stage, students also process the information that has been collected to make conclusions related to the concept/material being studied. The orientation of this scientific approach is to encourage students' curiosity about natural phenomena, and students are actively involved in constructing concepts and knowledge [8].

4.4 Disseminating stage

The socialization stage of the learning media is carried out in schools through the school website and the E-Modul link distributed via Whatsapp Group.

5 Conclusion

Education and training are the best investments in society's future [36]. They play a vital role in boosting growth, innovation, and job creation. The government's education and training systems need to give people the forward-looking knowledge, skills, and competencies they need to innovate and prosper. They also have an essential role in creating an identity, building on shared values and cultures. Children think mathematically long before they start school and mathematical thinking is a strong predictor for later academic success in school—indeed, it is a better predictor than early reading and early attention skills [37], [38]. Mathematics is fundamental to a child's development & communication in later life. Basic numeracy skills assist kids in terms of achievement & just being competent adults. A broader acknowledgment of this would lead to more parity with literacy. However, developing a solid foundation in early math skills is vital for later educational success and economic, health, and employment outcomes. Children who enter school with solid mathematics skills have a greater likelihood of success in mathematics in kindergarten and in later grades [39], [40].

The result of the present study is a valid, practical, and effective e-Module product. Based on the validity test, the ethnomathematics based on e-Module n is highly feasible to use in learning resources with an average score of 3.65 (valid). Students' questionnaire response shows that the e-Module was practical with a percentage of the practicality of 89%. The effectiveness of the e-Module was seen from the paired sample T-test used to compare the results of the pretest and post-test with the outcome of 0.00 ($p = <0.05$), indicating that there was a significant difference. In sum, there was a substantial effect of the ethnomathematics-based- e-Module use on students' metacognitive skills in solving spatial problems.

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Article submitted 2021-06-20. Resubmitted 2021-08-16. Final acceptance 2021-12-14. Final version published as submitted by the authors.