

Development of an E-Module Based on Jepara Local Cultural Ethnomathematics to Improve Geometry Problem-Solving Skills

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Abstract

This study was conducted with two primary objectives: (1) to develop an e-module on plane geometry grounded in Jepara's local cultural ethnomathematics that meets validity and practicality standards, (2) to examine improvements in students' problem-solving abilities after the implementation of the e-module in the learning process. The development procedure followed a R&D approach utilizing the ADDIE model, which includes the phases of analysis, design, development, implementation, and evaluation. The findings demonstrated that the developed e-module satisfied the required criteria of validity and practicality based on evaluations by material and media experts, and it also received positive responses from students. In addition, the effectiveness analysis showed a significant enhancement in students' problem-solving skills after using the e-module. By incorporating mathematical concepts related to plane geometry within the local cultural context of Jepara, the e-module supports more meaningful learning and facilitates students' conceptual understanding. From a practical perspective, this study contributes an alternative form of innovative, digitally based instructional material that promotes more engaging and contextually relevant mathematics learning. In addition, the e-module may be used as a reference for curriculum designers in developing similar instructional resources for other mathematics topics while continuing to integrate ethnomathematical elements derived from local culture.

Keywords: E-Module; Ethnomathematics; Jepara Local Culture; Problem Solving Skills; Geometry

1. Introduction

Education has entered the era of Society 5.0, where learning now adapts to knowledge, attitudes, and mastery of technology. The different educational objectives in this learning also aim to reflect relevant and better education. Furthermore, it aims to improve student needs, so that success in this digital age depends heavily on student abilities, such as communication, collaboration, problem-solving, and critical thinking [1]. In light of developments in the Society 5.0 era, teachers are no longer limited to traditional lecture methods. This is because lectures are no longer effective in teaching. Therefore, instructional practices must adapt to contemporary developments, including the integration of learning media as an essential component of the teaching and learning process that significantly contributes to instructional success. Learning media support teachers in presenting subject matter more effectively, particularly in enhancing students' problem-solving abilities [2].

Problem-solving represents a fundamental skill in mathematics education. As mathematics is a compulsory subject for students in Indonesia, the learning process is inherently connected to the development of problem-solving abilities. In this context, problem-solving can be understood as the process through which students identify and determine solutions to

mathematical challenges they encounter. Moreover, problem-solving skills developed in mathematics learning influence and are reflected in students' understanding across various disciplines as well as in their daily lives [3], [4], [5]. The problem-solving process consists of three main stages: (1) reading and comprehending the problem, (2) selecting an appropriate strategy and carrying out the solution, and (3) reviewing both the solution and the overall problem-solving procedure [6], [7], [8].

According to the results of the Programme for International Student Assessment (PISA) 2022 released by the OECD in December 2023, Indonesian students' mathematical problem-solving performance remains relatively low when compared to international benchmarks and is still below the OECD average. The report indicates that only about 18% of students in Indonesia attained a minimum proficiency level of Level 2 in mathematics, while very few reached the higher proficiency levels of Level 5 or 6. In addition, Indonesia recorded an average mathematics score of approximately 366 in PISA 2022, which is considerably lower than that of many other participating countries [9]. In addition to these data, many students in Indonesia still feel unable to solve mathematical problems well [10]. What happens in the field in general, learning mathematics is focused on achieving programmed goals and necessary documentation, rather than understanding the material being studied. As a result, students usually only learn mathematical concepts without understanding their meaning [11].

Geometry is one of the core topics in mathematics that requires excellent problem-solving skills. Geometry examines the characteristics, measurements, and relationships between points, lines, planes, and space [12]. In this study, the authors focused on the geometry of plane figures for seventh grade, specifically Triangles and Quadrilaterals. Several prior studies have reported that the mathematical problem-solving skills of seventh-grade junior high school students, particularly on topics related to plane figures and quadrilaterals, remain relatively low [13]. Furthermore, teachers have a pivotal role in fostering students' problem-solving abilities by creating supportive learning environments, including the selection and use of appropriate instructional materials [14]. Unfortunately, the current development of teaching materials is still general and has not been directed to support the achievement of more specific abilities. In addition to the content, the format and media of teaching materials also play a crucial role in learning activities, as both can influence the success of material delivery, provide learning motivation, and improve students' basic skills [15].

Teachers must have additional teaching resources besides textbooks to help students learn more effectively and develop competencies in line with the latest technological advances. This will help students develop mathematical thinking skills and broaden their knowledge of science and technology [16]. One form of instructional material that is suitable for development in contemporary learning contexts is the electronic module, commonly referred to as an e-module. Given that students in the current digital era tend to engage more frequently with mobile devices than with printed textbooks, the development of instructional resources in the form of e-modules has become increasingly relevant. E-modules are a form of module whose creation process is very easy to implement, containing audio, video, images, and animations as well as links in the form of quiz tests [17], [18], [19]. However, to ensure that these e-modules are not merely technological media, we need to enrich their content with contexts close to students' lives.

One way to create a context that is familiar to students is by linking mathematics to the culture around them. This approach is called ethnomathematics. With ethnomathematics, e-modules not only function as digital learning media but also serve as a bridge connecting mathematical concepts with local cultural practices already familiar to students [20]. The ethnomathematics approach is expected to aid mastery of the targeted mathematics material while maintaining existing cultural values [21]. Jepara Regency is one of several regencies in Central Java that boasts a diverse culture. Jepara is renowned as a center for crafts, including batik, wood carving, monel, and Troso weaving. Because the public is likely only familiar with Jepara carvings, it can be difficult for locals to introduce other crafts. Troso weaving is one such area; its unique, attractive, and European-inspired motifs have made it popular in the global market. Furthermore, its motifs are also inspired by several regions in Eastern Indonesia, such as Bali, Flores, and Sumbawa. Interestingly, the motifs in Troso weaving are linked to a mathematical concept known as ethnomathematics [22].

This research focuses on the development of interactive e modules based on ethnomathematics as has been done by [20], [23] and to determine whether there is an increase in students' problem-solving abilities after using e-modules. The e-modules are integrated with the concept of Geometry of flat shapes with local Jepara culture. In addition, this study is regarded as highly relevant for several key reasons. (1) it aims to enhance the quality of mathematics instruction. Mathematics is commonly perceived as an abstract and challenging discipline; however, the implementation of e-modules grounded in an ethnomathematical approach allows students to develop a clearer understanding of mathematical concepts by linking them to concrete examples derived from their own cultural environment. (2) this research contributes to the preservation and meaningful integration of local wisdom within educational practices. Troso carving and weaving are cultural heritages of the Jepara people which are rich in mathematical values. The use of local wisdom in learning not only improves students' understanding [24] but also helps preserve this culture. (3) Innovation in digital instructional materials is reflected in the use of Flip PDF Corporate for e-module development, which enables learning content to be presented in a more engaging, visually rich, and interactive manner than conventional instructional approaches [23]. (4) This study also aligns with the objectives of the Independent Curriculum, which places strong emphasis on contextual and project-based learning. The ethnomathematics-based e-module developed in this research supports culture-oriented

learning and the implementation of innovative learning projects. Based on the preceding discussion, this research is considered necessary to undertake. Accordingly, the purpose of this study is to develop a plane geometry e-module grounded in Jepara's local cultural ethnomathematics that meets validity and practicality criteria, as well as to investigate the enhancement of students' mathematical problem-solving skills following the use of the developed e-module in learning activities.

2. Method

This study employed a Research and Development (R&D) approach, which is designed to produce a specific product and to evaluate its effectiveness [25]. The research and development process in this study followed the ADDIE instructional design model, which consists of five stages: analysis, design, development, implementation, and evaluation [19], [26]. The following explains the steps in each ADDIE stage.

Table 1. ADDIE Branch Development Model and ADDIE E-Module Development Model Based on Ethnomathematics

ADDIE Stage	Steps
Analysis	(1) Conduct a literature review analysis. (2) Analyze the conditions of students, teachers, and schools. (3) Conduct a needs analysis to determine learning and media needs.
Design	(1) Media Design: collecting references, designing materials, and creating concept maps. (2) Material Design: developing teaching materials with ethnomathematics elements. (3) Instrument Design: compiling supporting instruments (tests, questionnaires, observation sheets). (4) Creating a storyboard for the e-module flow. (5) Conducting a design stage evaluation to revise the design.
Development	(1) Creation of initial product (e-module draft). (2) Validation of media and materials by experts. (3) Testing the feasibility of test instruments (content, construct, reliability, level of difficulty, differentiating power). (4) Limited class trial. (5) Evaluation of the development stage.
Implementation	(1) Implementation of e-module products in real learning. (2) Providing pre-tests and post-tests, as well as teacher and student response questionnaires. (3) Evaluation at the implementation stage.
Evaluation	(1) Comprehensive evaluation based on test results. (2) Analysis of teacher and student responses. (3) Determining the level of success and product improvement.

The study involved seventh-grade students of SMP Al-Amin 1 Batealit Jepara along with a mathematics teacher teaching at the same grade level. Data collection was carried out using questionnaires and testing instruments. The questionnaires were used to obtain information regarding the validity and practicality of the ethnomathematics-based e-module [27]. Testing instruments were employed to assess the effectiveness of the e-module through the administration of pretest and posttest evaluations. The data analyzed in this study comprised the results of validity testing, practicality assessments of the e-module, and students' achievement data related to plane geometry topics, which together were used to evaluate the effectiveness of the developed e-module.

The data analysis techniques applied in this research and development study were tailored to the nature of the data obtained, encompassing both qualitative and quantitative data [28]. Qualitative data were examined through a descriptive analytical approach. In this stage, the researcher collected both written and oral information obtained from interviews, along with comments and suggestions provided by seventh-grade mathematics teachers, material experts, media experts, and validators of the test instruments. These qualitative inputs were analyzed and synthesized to formulate conclusions that informed subsequent development revisions. Quantitative data were analyzed using scores obtained from validation sheets completed by material and media experts, as well as from feasibility and response questionnaires administered to seventh-grade teachers and students of SMP Al-Amin 1 Batealit Jepara. The scores from each expert were calculated using a specified formula to determine the validity and feasibility levels of the developed learning media. The learning media were categorized as valid or feasible when the validation results met the criteria of the four-point assessment scale applied in the validation and response questionnaires, as shown in Table 2.

Table 2. Valid Criteria

No	Achievement Level (%)	Information
1.	81-100%	very valid
2.	61-80%	Valid
3.	41-60%	less valid
4.	21-40%	Invalid

Source: [29]

The practicality analysis of the e-module was conducted by:

$$percentage = \frac{\sum score \text{ per item}}{maximum \text{ score}} \times 100\%$$

The assessment outcomes were classified according to their respective levels of practicality, as presented in Table 3.

Table 3. Practicality Criteria

%	Criteria
0 – 20	Impractical
21 – 40	Less practical
41 – 60	Quite Practical
61 – 80	Practical
81 – 100	Very Practical

Source: [29]

The effectiveness of the e-module was assessed through the administration of a problem-solving test related to plane geometry material. The results derived from the residual value analysis are presented in Table 4 and were used as the basis for evaluating the effectiveness of the developed product.

Table 4. Effective criteria

Final Grade	Criteria
76 - 100	Very Effective
56 - 75	Effectife
40 - 55	Moderately Effectife
0 - 39	Less Effectife

Source: [30]

3. Result

The media developed is an e-module for flat geometry based on Jepara's local cultural ethnomathematics, with a discussion of quadrilaterals and triangles. The ADDIE development model in this study can be explained as follows.

(1) Analysis stage. Based on the results of interviews conducted with mathematics teachers at SMP Al-Amin 1 Batealit Jepara, several issues related to the learning implementation were identified. The findings indicated that instructional activities were predominantly carried out using a lecture-based approach, with teaching materials mainly relying on student worksheets (LKS). The school has quite complete supporting facilities for activities, such as a computer laboratory, LCD projector, and internet network. However, all the facilities in the school have not been utilized optimally as learning media in learning activities. Based on the problems experienced in the implementation of learning, an innovation is needed and a variation of learning media is carried out that can maximize supporting facilities to become a solution to existing problems so that it can facilitate learning. Next, a curriculum analysis was carried out according to learning needs. Then an analysis of student character was carried out. Based on observations made by the researcher, it was found that the enthusiasm and interest in learning in class VII of SMP Al-Amin 1 Batealit Jepara during mathematics learning was still low. During the implementation of mathematics learning, students lacked focus and paid less attention to the teacher when giving explanations, this was seen when the teacher asked students to do practice questions, most students were still confused in solving them.

(2) Design stage. At the design stage, learning objectives are determined based on the material determined at the analysis stage. Then determine the initial components to create an e-module with the discussion material of quadrilaterals and triangles, then continue with the preparation of the e-module design using Microsoft Word. After the e-module is completed, the e-module is converted into a flip model with the help of the Flip pdf corporate application. a) E-module concept. The front cover contains the title of the e-module, class and level, as well as images of local Jepara cultural nuances, namely carvings and Troso weaving). Created using the Canva application. b) Introduction. The e-module media is designed to help students understand the material on plane figures and practice problems independently. The introductory section of the e-module, as shown in Figure 2, contains core competencies, basic competencies, and learning instructions.



Figure 1. Front Cover of E-Module

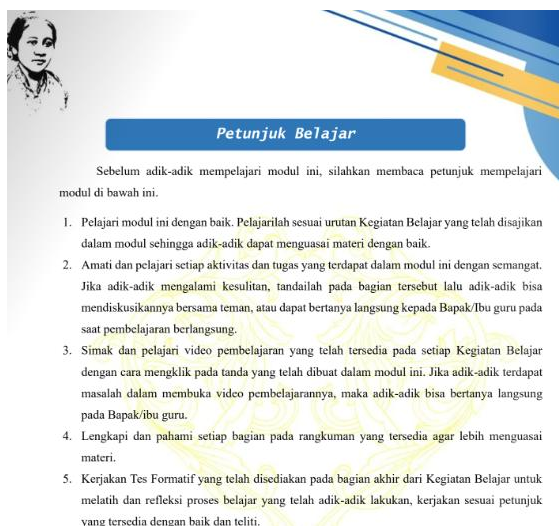


Figure 2. Introduction to E-Module

c) The e-module content is organized in a clear and comprehensible manner, thereby enhancing student engagement. The material interface is equipped with navigation buttons that allow learners to move forward or return to previous sections, enabling them to review concepts that have not yet been fully understood. Each subtopic is accompanied by illustrative examples and practice exercises. Upon completing the example questions, students are provided with automatic explanations, while responses to the practice exercises determine the subsequent navigation—correct answers redirect students to the main material, whereas incorrect responses guide them back to the relevant subtopic. In addition, the e-module incorporates instructional videos sourced from YouTube. Figure 3 illustrates the ethnomathematics-based e-module learning media that integrates Jepara's local cultural context.



Figure 3. Display of Material in the E-Module

d) Evaluation section of the e-module. This section includes assessment items related to triangles and quadrilaterals, which are integrated into ethnomathematics content derived from Jepara wood carvings and Trosro woven fabrics. The questions were designed to measure students' problem-solving abilities after engaging with the ethnomathematics-based

e-module learning media. Upon completing the evaluation, which consists of 15 items, students are able to view their obtained scores. The finalized design was subsequently implemented and assembled using the Canva application. The evaluation interface is illustrated in Figure 4.



Figure 4. Evaluation Display on E-Module

(3) Development stage. The designed e-module was subsequently reviewed by expert validators, including material experts and media experts, to evaluate its validity. Any revisions identified during the validation process were addressed by refining the e-module in accordance with the feedback and recommendations provided by the experts before it was classified as valid. The validation results of the e-module based on Jepara's local cultural ethnomathematics indicated a *very valid* category from both material and media experts, as presented in Tables 5 and 6.

Table 5. Summary of Material Expert Validation

Assessment Aspects	Subject matter expert I		Subject matter expert II		Average Percentage (%)	Criteria
	Score	Percentage	Score	Percentage		
Material (Contents)	34	85	35	87,5	86,25	Very Valid
Presentation	32	80	33	82,5	81,25	Very Valid
Language	16	80	16	80	80	Valid
Total Average					82,5	Very Valid

The evaluation conducted by material experts aimed to assess the validity of the e-module in terms of content accuracy, presentation quality, and language use. As shown in Table 5, the overall assessment yielded an average score of 82.5%, indicating that the developed e-module satisfies the criteria for the *very valid* category.

Table 6. Summary of Media Expert Validation

Assessment Aspects	Media Expert I		Media Expert II		Average Percentage (%)	Criteria
	Score	Percentage	Score	Percentage		
Media View	42	8	44	88	86	Very Valid
Content Alignment	8	80	9	90	85	Very Valid
Construction	12	80	12	80	80	Valid
Total Average					83,67	Very Valid

The validation performed by media experts focused on evaluating the e-module in terms of visual design, content alignment, and construction quality. As presented in Table 6, the overall average score across all assessed aspects was 83.67%, indicating that the developed e-module falls within the *very valid* category.

(4) Implementation stage. The implementation phase was conducted after the e-module had successfully passed the validation process by material and media experts and was deemed suitable for trial use. Students' responses and the

practicality of the e-module were evaluated using a student response questionnaire that was administered during the trial. The limited trial involved six seventh-grade students of SMP Al-Amin 1 Batealit Jepara. The results of the trial analysis are presented as follows.

Table 7. Results of the Practicality Questionnaire Trial

Question items	Student					
	1	2	3	4	5	6
1	4	5	5	4	3	4
2	5	5	4	5	3	4
3	5	4	4	4	3	3
4	4	3	4	5	4	4
5	5	4	4	4	4	5
6	4	4	5	5	4	4
7	5	5	4	5	5	5
8	4	3	4	5	5	4
9	5	5	4	4	5	5
10	4	5	5	5	4	4
11	3	3	4	5	4	5
12	5	4	3	4	5	3
13	4	4	5	4	4	5
14	5	5	5	3	5	5
15	5	4	4	3	5	5
Amount	67	63	64	65	63	65
Average Score	64,5					
Overall Percentage	86%					
Criteria	Very Practical					

Based on Table 7 above, the overall percentage was 86%. It can be seen that the developed e-module meets the criteria of "very practical."

(5) Evaluation stage. The evaluation phase represents the final step of the ADDIE model. During this stage, the developed learning media were implemented with students who had not previously learned the concepts of triangles and quadrilaterals. The effectiveness of the e-module was measured based on students' learning outcomes resulting from its use, starting with a pretest administered to determine students' initial knowledge prior to using the e-module. After completing the pretest, students accessed the e-module via smartphones to facilitate learning both in and outside the classroom and to complete evaluation tasks. Upon completion of the learning activities, a posttest was conducted to assess students' understanding of triangle and quadrilateral materials. The evaluation comprised four essay questions related to the subject matter. Figure 5 presents the average pretest and posttest scores obtained by students.

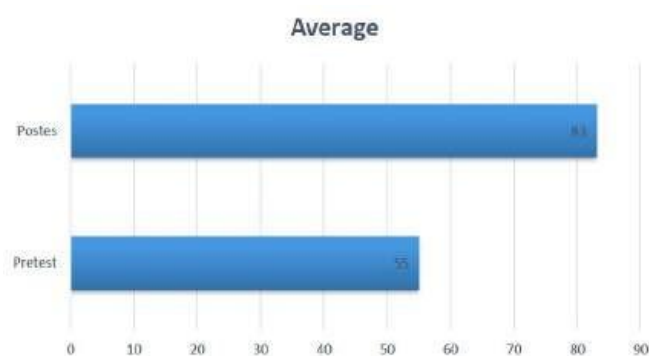


Figure 5. Graph of Students' Average Pretest and Posttest Scores

Figure 5 shows an increase in students' problem-solving abilities using the normal gain test. This N-Gain test was conducted to determine whether there was an increase in students' problem-solving abilities before and after using the e-module learning media based on Jepara's local cultural ethnomathematics. Based on the results of the normal gain test calculations, it showed very good results (seen from the post-test results). Therefore, it can be concluded that students' problem-solving abilities increased after using the e-module based on Jepara's local cultural ethnomathematics.

4. Discussion

Based on the development process and the research findings described above, an e-module on triangles and quadrilaterals for seventh-grade students was successfully produced. The e-module was designed by integrating ethnomathematical elements derived from Jepara's local culture, particularly from traditional wood carving art and Troso woven fabrics [22], [31], [32]. By using an ethnomathematics approach, it is hoped that it can provide an alternative for teachers in teaching students about mathematical concepts and can increase students' motivation to learn mathematics, thereby providing a meaningful learning impact [33]. In addition, the development of ethnomathematics-based e-modules can also improve problem-solving skills [34]. Previous studies have also reported that the development of STEM-based digital modules contributes to the enhancement of students' problem-solving skills. The validity of such modules was demonstrated by an average score of 88.67%, which falls within the valid category. In addition, the modules showed a high level of practicality, with an average practicality score of 87%, while teachers' responses yielded an average score of 83.90%, indicating a very practical classification. Analysis of learning outcomes using problem-solving test items revealed an improvement between pretest and posttest results, with an N-gain value of 0.69, categorized as moderate [11].

By engaging directly with learning activities that incorporate cultural elements, students are expected to explore their surrounding cultural environment and establish meaningful connections with mathematical concepts [35]. In every learning activity, the e-module provides clear usage instructions along with engaging images or illustrations that are relevant to the presented content. The inclusion of well-structured guidance for delivering the material supports students in comprehending the underlying learning concepts. In addition, the visual design of the e-module is intended to enhance students' interest by integrating images and illustrations with textual explanations, thereby facilitating a better understanding of the subject matter [36], [37].

This learning e-module uses the ADDIE development model [38] and produces valid categories that can be used in learning. The development of e-modules based on Jepara's local cultural ethnomathematics and other cultures is often encountered in students' daily lives, facilitating students' understanding and problem-solving skills [39]. The e-module serves as an interactive instructional resource, with various problem-solving activities developed using the live worksheet feature, making it suitable for implementation in both online and offline learning environments [40]. The e-module, which integrates Jepara's local cultural context into the topics of triangles and quadrilaterals, has the potential to broaden the development of mathematical problem content.

Creative learning approaches that promote meaningful, engaging, and enjoyable learning experiences encourage students to connect with cultural contexts and the learning environments around them [41]. Students' everyday experiences related to mathematics learning can enhance conceptual understanding and inform strategies for designing learning experiences that integrate cultural contexts, commonly referred to as culture-based learning [42], [43]. The learning e-module on triangles and quadrilaterals based on Jepara's local cultural ethnomathematics has the advantage of being able to be used as a learning reference and facilitate students in gaining new experiences and understanding the concept of triangles and quadrilaterals based on Jepara's local cultural ethnomathematics. It can also improve students' problem-solving skills.

The following are the implications based on the results obtained from this research and development: 1) for schools, it can improve its positive image by integrating local culture into learning, so that students are more proud of their regional culture; 2) For teachers, it helps teachers in presenting geometry learning with digital media that is more concrete, interesting, and close to students' lives; 3) For students, it helps improve problem-solving abilities because students are invited to think critically through real problems originating from their environment; 4) For other researchers, it becomes a basis for further research on the development of digital learning media based on ethnomathematics in other areas or on different mathematical topics.

The following are the limitations of this research and development: 1) The developed e-module is limited to triangle and quadrilateral material, so it does not cover all geometry topics or other mathematical fields; 2) The e-module only raises the local culture of Jepara only on carvings and troso cloth, so the results may be less relevant if applied in other areas that have different cultures; 3) The research subjects are limited to small class trials, so the generalization of the results to a wider population is still limited; 4) The use of e-modules is highly dependent on the availability of devices (laptops/cellphones) and adequate internet access. Limited facilities can affect the effectiveness of the use of e-modules.

5. Conclusion

The results of research and development show that: 1) The mathematics learning e-module based on Jepara local cultural ethnomathematics on the material of triangles and quadrilaterals of class VII of SMP Al-Amin 1 Batealit Jepara which was developed with the ADDIE development model produces an e-module that meets the valid and practical requirements based on the assessment of material experts and media experts as well as student respondents; 2) Based on the results of the normal gain test calculations, it shows very good results (seen from the post-test results). So it can be concluded that students' problem-solving abilities have increased after using the e-module based on Jepara local cultural ethnomathematics.

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