MATHE*dunesa*
Homepage: https://ejournal.unesa.ac.id/index.php/mathedunesa/index
Email: mathedunesa@unesa.ac.id
p-ISSN: 2301-9085; e-ISSN: 2685-7855
Vol. 15 No. 2 Tahun 2026
Halaman 462-476

Development of E-modules Based on Ethnomathematics of Anjuk Ladang Batik Motifs Assisted by GeoGebra

Brilian Rahma Fitria[1*], Rini Setianingsih[2]

[1]Mathematics Education, State University of Surabaya, Surabaya, Indonesia
[2]Mathematics Education, State University of Surabaya, Surabaya, Indonesia

DOI: https://doi.org/10.26740/mathedunesa.v15n2.p462-476

Article History:
Received: 31 July 2025
Revised: 18 May 2026
Accepted: 19 May 2026
Published: 30 June 2026

Keywords:
E-module
Ethnomathematics
GeoGebra
Geometric Transformation
Batik Anjuk Ladang

***Corresponding author:**
brilianrahma12@gmail.com

Abstract: The use of textbooks as the main learning resource often makes mathematics learning less engaging and limits students' motivation to learn independently. In addition, the integration of digital technology in mathematics classrooms is still relatively limited. Therefore, this study developed an interactive e-module based on the ethnomathematics of Batik Anjuk Ladang motifs assisted by GeoGebra to support independent learning in geometry transformation material for Grade IX junior high school students. The integration of ethnomathematics was intended to provide contextual learning experiences through local cultural elements, while GeoGebra was used to enhance visualization and interactivity. This study employed the Plomp development model consisting of three phases: preliminary research, development or prototyping phase, and assessment phase. The e-module was developed using Flip PDF Professional and integrated with GeoGebra features. The product was tested on Grade IX students at SMP Negeri 2 Nganjuk. The quality of the developed e-module was evaluated based on validity, practicality, and effectiveness criteria. The results showed that the developed e-module met all quality criteria. The material validity score reached 86.31% and the media validity score reached 86.08%, both categorized as very valid. The practicality test obtained a score of 85.09%, indicating that the e-module was very practical and easy for students to use independently. In addition, the effectiveness test showed an average N-gain score of 0.701, which falls into the high category. These findings indicate that the integration of ethnomathematics and GeoGebra can support students' conceptual understanding and independent learning in geometry transformation material. The study implies that contextual and technology-assisted digital teaching materials can be used as an alternative learning resource to create more meaningful and interactive mathematics learning. Furthermore, the developed e-module can support the preservation of local culture by integrating Batik Anjuk Ladang motifs into mathematics learning activities.

INTRODUCTION

Learning is a process of interaction between students and the learning environment to gain knowledge, skills, and experiences that support the development of mindsets and behavior (Siregar et al., 2021). However, in reality, there are still many students who are less motivated in participating in the learning process, especially in mathematics subjects. Low learning motivation is one of the causes of the lack of active involvement of students in understanding the subject matter. One of the factors that influence low learning motivation is the use of teaching materials that are less varied and tend to be monotonous, such as

textbooks that only focus on delivering material without paying attention to the activities and direct involvement of students (Pulungan et al., 2022; Hendrizal, 2020).

The use of monotonous and non-contextual textbooks causes learning to be less interesting and does not encourage students to learn independently. In addition, the utilization of technology in learning is also still relatively low (Rahma et al., 2023), even though the use of technology can help increase learning motivation, concept understanding, and learner participation (Prasetyo & Meiliasari, 2025). Therefore, it is necessary to develop innovative and interactive teaching materials, one of which is an ethnomathematics-based E-module equipped with GeoGebra features as interactive media. E-modules can be an alternative digital teaching material that allows students to learn independently, get immediate feedback, and interact with learning materials actively (Iskandar et al., 2022; Sidiq & Najuah, 2020).

The integration of ethnomathematics content in E-modules aims to bring local cultural contexts into mathematics learning. Ethnomathematics is a learning approach that links mathematical concepts to the social, economic, and cultural context of a particular community (D'Ambrosio, 1985; Orton & Shirley in Budiarto et al., 2020). One form of ethnomathematics used in this study is Batik Anjuk Ladang. Batik Anjuk Ladang is a typical batik of Nganjuk Regency that has various motifs with geometric elements such as translation, reflection, rotation, and dilation (Rudianingsih & Ratyaningrum, 2014). These geometric elements have a strong connection with the geometric transformation material of class IX junior high school, so it is very relevant to be used as a learning context. In addition to providing a meaningful learning experience, the integration of Batik Anjuk Ladang also contributes to the preservation of local culture.

In addition, GeoGebra is software that can be used to present mathematical visualizations dynamically and interactively. The use of GeoGebra in E-modules allows learners to explore the concept of geometric transformations directly through interesting digital simulations and activities (Hohenwarter et al., 2008; Fernandez, 2020). Thus, the integration of GeoGebra in the E-module is expected to improve concept understanding while encouraging students' motivation to learn independently.

However, previous studies on ethnomathematics-based learning media generally focus only on cultural integration without optimizing interactive digital technology features that can support students' independent learning. Several studies have developed ethnomathematics-based teaching materials, while other studies have examined the use of GeoGebra in mathematics learning separately. Nevertheless, studies that combine ethnomathematics, interactive digital modules, and GeoGebra simultaneously in geometry transformation learning are still limited, especially those integrating local cultural elements from Batik Anjuk Ladang.

In addition, most existing digital teaching materials mainly emphasize content delivery and concept explanation, but have not fully facilitated interactive exploration and contextual learning experiences. As a result, students still tend to rely on teacher explanations and experience difficulties in understanding abstract concepts independently.

Therefore, there is a need for teaching materials that not only integrate local cultural contexts but also provide interactive visualizations to support students' conceptual understanding and self-directed learning.

The novelty of this study lies in the development of an ethnomathematics-based e-module integrating Batik Anjuk Ladang motifs with GeoGebra-assisted interactive exploration on geometry transformation material for Grade IX junior high school students. Unlike previous studies, this e-module combines cultural context, interactive visualization, audio-visual learning resources, and self-learning activities within a single digital platform. In addition, this study evaluates the quality of the developed product comprehensively in terms of validity, practicality, and effectiveness to support independent mathematics learning.

Based on this description, this study aims to: (1) describe the development process of the ethnomathematics-based E-module of Batik Anjuk Ladang motif assisted by GeoGebra; and (2) describe the quality of the developed E-module in terms of validity, practicality, and effectiveness. The E-module development in this study used Plomp's (2013) development model which consists of three phases, namely preliminary research, development or prototyping phase, and assessment phase. The quality evaluation of the E-module was conducted based on the quality criteria proposed by Nieveen (1999), namely valid, practical, and effective. The validity of the E-module is obtained through validation tests by material experts and media experts, practicality is obtained from the results of teacher and learner response questionnaires to the E-module, and effectiveness is measured using the N-gain test based on the pretest and posttest results of students.

This research is expected to provide alternative teaching materials that are interactive and contextual for students in understanding geometric transformation material. In addition, the results of this study can be a reference for teachers in designing meaningful learning and inspire other researchers in developing ethnomathematics and technology-based teaching materials.

METHODS

This study is a development research that aims to produce a product in the form of ethnomathematics-based E-module Batik Anjuk Ladang motif assisted by GeoGebra on geometry transformation material for grade IX junior high school. The development model used in this research is the Plomp development model. Plomp's development model consists of three main phases, namely preliminary research, development or prototyping phase, and assessment phase (Plomp, 2013). This model was chosen because it has systematic stages and is oriented towards developing quality educational products through an iterative process of evaluation and revision. The stages in the preliminary research phase include analyzing learners' needs and problems, reviewing the literature, and developing a conceptual framework.

The development or prototyping phase aims to develop solutions to the problems identified in the preliminary research phase, namely in the form of an E-Module based on

ethnomathematics of Batik Anjuk Ladang motifs assisted by GeoGebra. The stages in this phase include the design and development of the E-Module, including display design, content, systematic material, as well as the preparation of research instruments in the form of validity and practicality sheets prepared based on the adaptation of Martin's (2021) indicators and consulted with the supervisor, and pretest-posttest sheets. The effectiveness of the module was measured through pretest and posttest in the form of descriptions analyzed by N-gain. Furthermore, the validity test of prototype-1 was carried out by material and media experts to obtain input, which determined whether the module could be tested directly, needed minor revisions, or needed major revisions until it was declared valid.

In the assessment phase, two types of trials were conducted to evaluate the quality of the E-module, namely the practicality test and the effectiveness test. The practicality test was conducted through a learner response questionnaire after using the E-module in independent learning to assess its ease of use and suitability for learning needs. The effectiveness test was carried out by comparing the pretest and posttest results of students after using the ethnomathematics-based E-module of Batik Anjuk Ladang motif assisted by GeoGebra, which was then analyzed using the N-gain formula to determine the effectiveness of the E-module.

The subjects used in this E-module trial were students of grade IX junior high school as much as 1 (one) class. Previously, a validity test was carried out by experts consisting of lecturers and teachers who mastered geometric transformation material and teaching material development.

Before conducting the research, permission was obtained from the school and mathematics teachers involved in the study. Students participated voluntarily and were informed that the collected data would only be used for research purposes. The identities of participants were kept confidential by using initials in the presentation of the data. In addition, the research activities were conducted without disrupting the regular learning process at school.

The data collection instruments used in this study consisted of: (1) interview guidelines to explore the needs of students and teachers for contextual and interactive teaching materials; (2) media validation sheets by media experts and junior high school mathematics teachers to assess the appearance and interactivity aspects; (3) material validation sheets by material experts and teachers to test the clarity, accuracy, and conciseness of the content; (4) pretest sheets to determine the level of mastery of the initial material of students; (6) posttest sheets to measure the increase in mastery of the material after using the E-module; and (7) student response questionnaires to determine the level of practicality of the E-module.

The assessment of the validity of the E-module was carried out based on the results of validation provided by material experts and media experts, namely mathematics education lecturers and junior high school mathematics teachers. Meanwhile, the practicality of the E-module as a learning media was assessed through students' responses

after using the product in learning. The validity and practicality assessment instruments were prepared using a Likert Scale (score 1-4). The validity sheet assessment score is presented in Table 1 below.

Table 1. Validity Sheet Assessment Score

Category	Score
Very Good	5
Good	4
Neither Good nor Poor	3
Poor	2
Very Poor	1

(Adopted from Riduwan, 2019).

Data processing was conducted using the following formula.

$$Validity\ Level = \frac{Gained\ Score}{Maximal\ Score} \times 100\%$$

The data obtained was then interpreted according to the following criteria.

Table 2. Interpretation of validity test data

Intervals	Criteria	Description
$80\% < x \leq 100\%$	Very Valid	No revision required
$60\% < x \leq 80\%$	Valid	Needs minor revision
$40\% < x \leq 60\%$	Quite Valid	Needs moderate revision
$20\% < x \leq 40\%$	Less Valid	Needs mayor revision
$0\% < x \leq 20\%$	Invalid	Product cannot be used

(Adapted from Riduwan, 2019)

Based on Table 2, the E-module is said to be valid if it has a percentage value of more than 60%. If the E-module has met the valid value criteria, the E-module can be tested.

Data on the results of positive responses of students were analyzed using a quantitative descriptive approach. Assessment of each statement is done using a Guttman scale, as shown in the following table.

Table 3. Practicality Sheet Assessment Score

Category	Score
Strongly Disagree (SD)	1
Disagree (D)	2
Agree (A)	3
Strongly Agree (SA)	4

(Adopted from Riduwan, 2019)

Practicality data processing was conducted using the following formula.

$$Practicality\ Level = \frac{Gained\ Score}{Maximal\ Score} \times 100\%$$

The data obtained was then interpreted according to the following criteria.

Table 4. Interpretation of Practicality Test Data

Intervals	Criteria
$80\% < x \leq 100\%$	Very Practical
$60\% < x \leq 80\%$	Practical
$40\% < x \leq 60\%$	Quite Practical
$20\% < x \leq 40\%$	Less Practical
$0\% < x \leq 20\%$	Not Practical

(Adopted from Riduwan, 2019)

Based on **Table 4**, the E-module is said to be practical if it has a percentage value of more than 60%.

The analysis of the effectiveness of the ethnomathematics-based E-module of Batik Anjuk Ladang motif assisted by GeoGebra is based on the results of the normalized gain (N-gain) test on students' pretest and posttest scores. N-gain can be calculated using the formula:

$$g_{ave} = \langle \frac{\text{Posttest Score} - \text{Pretest Score}}{Ideal\ Score - \text{Pretest Score}} \rangle$$

Description:

g_{ave} = Average *N-gain*

(Adopted from Wahab et al., 2021)

The estimated level of effectiveness of the treatment can be interpreted as follows.

Table 5. Interpretation of N-gain Test Data

N-gain Score	Effectiveness Level
$(g) \geq 0{,}7$	High
$0{,}3 \leq (g) < 0{,}7$	Medium
$0 < (g) < 0{,}3$	Low
$(g) \leq 0$	Fail

(Adopted from Hake, 1999)

Based on the table above, the E-module is claimed to be effective to facilitate the learning of geometry transformation of class IX junior high school if the class average N-gain reaches medium or high criteria.

RESULT AND DISCUSSION

The results of this development research include the process and results of the development of ethnomathematics-based E-modules of Batik Anjuk Ladang motifs assisted by GeoGebra on geometry transformation material for class IX junior high school. The resulting E-module is a flipbook in HTML form that allows users to use it online via a browser. The following is a description of the research results of the development of E-modules based on ethnomathematics of Batik Anjuk Ladang motifs assisted by GeoGebra on geometry transformation material for grade 9th.

Preliminary Research

The steps in preliminary research include analyzing the needs of students and problems that occur in learning through interviews with grade 9th mathematics teachers.

Researcher : How is the use of teaching materials in learning mathematics in class 9th currently, ma'am?

Teacher : For now, I still use textbooks. That's what is most often used because it has been provided by the school.

Researcher : How do you respond to students' independent learning motivation when using textbooks as the main teaching material in class?

Teacher : If we only use textbooks, the children usually seem less enthusiastic. But when there are videos or animations, or things that they often find or do in the power point, then they seem a bit interested.

Researcher : How are students' learning outcomes on geometry transformation material?

Teacher : I wouldn't say it's really good, but it's not really bad either. Alhamdulillah, you could say it's moderate.

The conclusions from the interview transcripts are: 1) students are less motivated when learning using only textbooks; 2) insertion of videos, animations, and content relevant to students' experiences can increase students' attention and interest; 3) students prefer visual learning such as videos compared to print or static media; 4) students' learning outcomes on geometry transformation materials are still relatively low. Then, researchers conducted a literature review to support the results of the interviews, as described in the introduction. The conceptual framework developed is

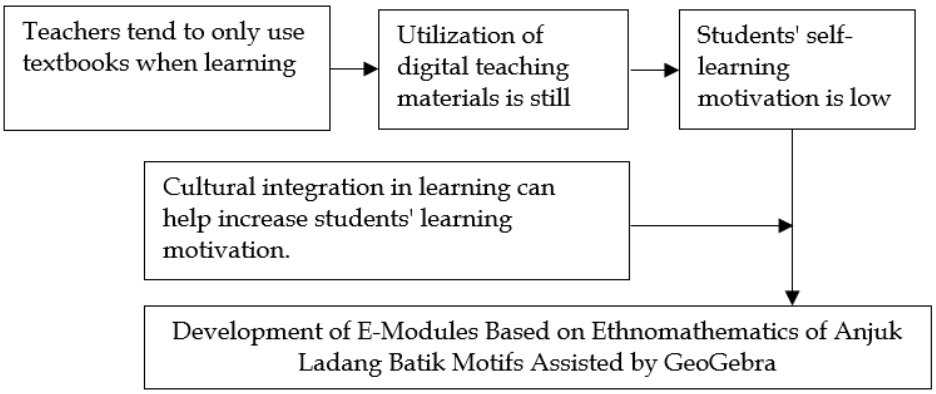


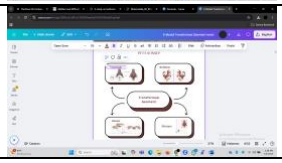
Figure 1 Conseptual Framework

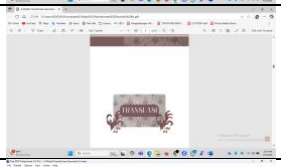
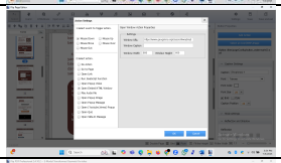
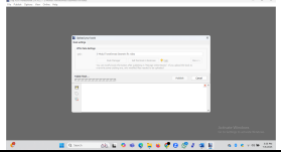
The framework describes the relationship between the problems identified in mathematics learning, the integration of ethnomathematics and GeoGebra, and the development of the e-module as a solution to support students' independent learning in geometry transformation material. The framework also shows how contextual cultural content and interactive digital visualization are expected to improve students' understanding and learning engagement.

Development or Prototyping Phase

The development or prototyping phase aims to design and develop solutions to the problems identified at the preliminary research stage by developing an Ethnomathematics-Based E-Module of Anjuk Ladang Batik Motifs Assisted by GeoGebra. E-module development using Flip PDF Professional software. The complete E-module development stages are as follows.

Table 6. Stages of E-Module Development

No.	Development Stages	Figure
1.	Designed the E-module interface using Canva.	
2.	Determine the content and sequence of material on the E-module	

3.	Writing geometry transformation material on Canva..	
4.	Make a video about geometry transformation	
5.	Create exploration content in GeoGebra.	
6.	Converting material files in Canva into pdf form.	
7.	Convert pdf files into E-modules with Flip PDF professional software.	
8.	Inputting videos, GeoGebra content, audio explanations, as well as practice questions and discussion questions on the E-module.	
9.	Convert the E-module into an HTML file.	
10.	The E-module produced at this stage is called prototype-1.	https://online.flipbuilder.com/hsutr/kmwo/

The next stage is the validity test of prototype-1. There are two validity tests, namely the material validity test and the media validity test. This validity test was carried out by validators consisting of material experts and media experts. The material validity test was conducted by two validators of material experts, lecturers of geometry transformation courses and 9th grade mathematics teachers. The results of material validation for each aspect are presented in Table 7 below.

Table 7. The Result of Material Validation

Aspect	Score Average (%)	Interpretation
Appropriateness	88	Very Valid
Ease	85	Very Valid
Completeness & Clarity	85	Very Valid
Language	87,5	Very Valid
Level of Material Validity	86,3	Very Valid

Based on the material validation results, the developed e-module achieved a very valid category in all assessed aspects. The highest score was obtained in the appropriateness aspect, indicating that the content, learning objectives, and ethnomathematics integration

were considered relevant to geometry transformation material. In addition, the high score in the language aspect shows that the explanations, instructions, and presentation of material were sufficiently clear and understandable for junior high school students. These findings indicate that the developed e-module has appropriate content quality and can support students in learning independently.

The media validity test was conducted by one media expert validator, a lecturer in the learning media course. The results of media validation for each aspect are presented in Table 8 below.

Table 8 The Result of Media Validation

Aspect	Score (%)	Interpretation
Interface	80	Very Valid
Ease of Use	84	Very Valid
Appropriateness	90	Very Valid
Interactivity	80	Very Valid
Level of Media Validity	83,5	Very Valid

The media validation results indicate that the developed e-module has good visual quality and interactivity. The highest score was obtained in the appropriateness aspect, showing that the integration of multimedia features, GeoGebra activities, and digital navigation was suitable for the learning objectives. Furthermore, the interactivity aspect achieved a very valid category, indicating that the e-module was able to facilitate active student engagement through videos, exploration activities, and interactive simulations. Overall, the validation results suggest that the e-module is feasible to be implemented as an interactive digital learning resource.

Assessment Phase

In the assessment phase, the practicality test and effectiveness test of the validated E-module were conducted. The practicality test was conducted using a practicality sheet in the form of a student response questionnaire to the use of the E-module. The results of the E-module practicality test are presented in Table 9 below.

Table 9 The Results of Practicality Test

No	Aspect	Score
1	E-module interface is attractive	112
2	GeoGebra's interactive features are interesting.	109
3	The use of language and terms in the E-module is clear and easy to understand	106
4	The information on the ethnomathematics context of Batik Anjuk Ladang is clear and easy to understand.	102
5	The e-module is easy to operate.	106
6	GeoGebra interactive features are easy to operate.	104
7	The instructions for using the E-module are clear and easy to understand.	110
8	Images on the E-module can be seen clearly.	113
9	The video on the E-module can be played smoothly.	113
10	The audio on the E-module can be heard clearly.	114
11	GeoGebra features in the E-module can be used smoothly.	110
12	Image illustrations in E-modules help in understanding the material.	108
13	Videos in E-modules help in understanding the material.	108

No	Aspect	Score
14	The GeoGebra feature in the E-module helps in understanding the material.	106
15	The illustration of Batik Anjuk Ladang is in accordance with the material discussed.	109
16	The exercise questions in the E-module are easy to understand and relevant to the material	111
	Gained Score	1741
	Maximum Score	2048
	Practicality Level (%)	**85,09**

The practicality test results demonstrate that students responded positively to the developed e-module. Students considered the e-module attractive, easy to operate, and helpful in understanding geometry transformation material. The highest scores were obtained in multimedia-related aspects, such as image clarity, video quality, and audio clarity, indicating that interactive multimedia features increased students' interest during learning activities. In addition, the GeoGebra features were perceived as useful for visualizing abstract mathematical concepts more concretely. These findings suggest that the e-module can support flexible and independent learning experiences for students.

The effectiveness test was carried out by comparing the pretest results and posttest results of students. The results of the two tests were then analyzed using the N-Gain formula to determine the effectiveness of the treatment. The results of the effectiveness test on 32 students are presented in Table 10 below.

Table 10 The Result of The Effectiveness Test

Subject	Test Score			*N-gain*	Criteria
	Pre	*Post*	Ideal		
AEDS	32	83	100	0,75	High
ALR	25	55	100	0,4	Medium
ANI	41	88	100	0,79	High
ASA	40	84	100	0,73	High
ASB	52	74	100	0,45	Medium
AWR	30	84	100	0,77	High
BKS	62	91	100	0,76	High
BLAA	63	84	100	0,56	Medium
CAS	54	88	100	0,73	High
CM	57	88	100	0,72	High
DHY	43	72	100	0,5	Medium
EDNAP	57	84	100	0,62	Medium
ENA	60	88	100	0,7	High
EYPA	11	81	100	0,78	High
IRP	25	57	100	0,42	Medium
JIDP	19	88	100	0,85	High
KA	73	100	100	1	High
KAM	57	96	100	0,9	High
MAM	0	76	100	0,76	High
MAWP	23	69	100	0,59	Medium
MHM	13	76	100	0,72	High
MI	34	88	100	0,81	High
NAZ	21	82	100	0,77	High

Subject	Test Score			*N-gain*	Criteria
	Pre	*Post*	Ideal		
NBB	52	84	100	0,67	Medium
NHP	6	65	100	0,62	Medium
NSS	55	91	100	0,8	High
PTNP	51	84	100	0,67	Medium
RPSA	52	91	100	0,81	High
RSW	18	76	100	0,7	High
SLM	2	76	100	0,75	High
WMA	27	80	100	0,72	High
ZSBU	10	67	100	0,63	Medium
Average Score *N-gain*				**0,701**	**High**

The effectiveness test showed that the developed e-module contributed to students' improvement in understanding geometry transformation concepts. Most students achieved medium to high N-gain scores, with an average score of 0.701 categorized as high. This result indicates that the integration of ethnomathematics and GeoGebra-assisted activities supported students in constructing mathematical understanding more effectively.

The findings of this study are in line with constructivist learning theory, which emphasizes that students actively construct knowledge through meaningful learning experiences and interaction with learning environments (Piaget, 1972; Vygotsky, 1978). Through the integration of Batik Anjuk Ladang motifs, students were able to connect mathematical concepts with cultural contexts that were familiar to their daily lives. This contextual learning process helped students understand abstract geometry transformation concepts more meaningfully.

The results also support the concept of ethnomathematics proposed by Ubiratan D'Ambrosio (1985), which states that cultural elements can be integrated into mathematics learning to create more relevant and meaningful learning experiences. In this study, Batik Anjuk Ladang motifs served not only as visual ornaments but also as contextual representations of translation, reflection, rotation, and dilation concepts.

Furthermore, the integration of GeoGebra supported interactive and visual learning processes. The dynamic visualization features enabled students to directly observe changes in geometric objects during transformation activities. This finding is consistent with previous studies showing that GeoGebra can improve conceptual understanding, visualization ability, and student engagement in mathematics learning (Hohenwarter et al., 2008; Fernandez, 2020). Compared with conventional textbooks, the developed e-module provided more interactive learning experiences through the combination of videos, audio explanations, visual illustrations, and interactive exploration activities.

However, several limitations were identified during the implementation process. Some students still required teacher guidance when using the e-module because they were not fully accustomed to independent digital learning. In addition, differences in students' digital literacy influenced their perceptions of the practicality of GeoGebra features. Therefore, teacher assistance remains important to maximize the use of e-modules in classroom learning. Despite these limitations, the developed e-module has shown strong

potential as an innovative learning resource that combines local culture, digital technology, and interactive mathematics learning.

There are several notes from the researchers while developing the ethnomathematics-based E-module with GeoGebra-assisted Batik Anjuk Ladang motif on geometry transformation material for grade IX. First, there are limited features in Flip PDF Professional such as no restrictions on page navigation, no randomization of questions and answers, and no direct monitoring of quiz scores.

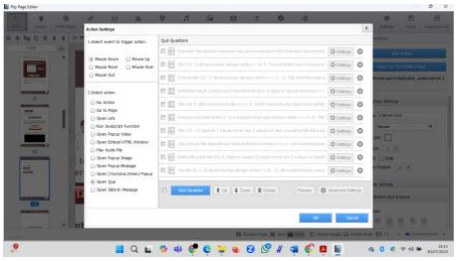
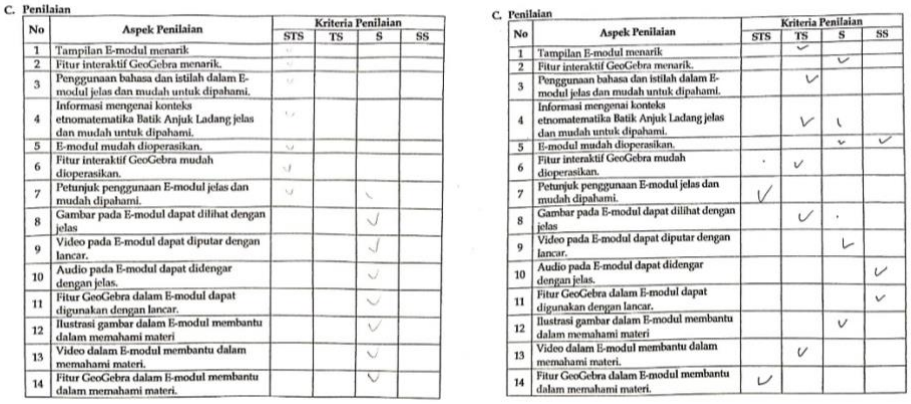


Figure 2. Limitations of Flip PDF Professional Features

Second, specific data on the effect of ethnomathematics integration on learning motivation has not been obtained due to the lack of assessment aspects that address the purpose of ethnomathematics integration. Third, in the practicality test, two students gave a score of "strongly disagree" regarding the ease of use of GeoGebra because they were not used to using technology, indicating that digital literacy affects perceptions of the practicality of e-modules.



C. Penilaian

No	Aspek Penilaian	Kriteria Penilaian			
		STS	TS	S	SS
1	Tampilan E-modul menarik				
2	Fitur interaktif GeoGebra menarik.				
3	Penggunaan bahasa dan istilah dalam E-modul jelas dan mudah untuk dipahami.				
4	Informasi mengenai konteks etnomatematika Batik Anjuk Ladang jelas dan mudah untuk dipahami.				
5	E-modul mudah dioperasikan.				
6	Fitur interaktif GeoGebra mudah dioperasikan.				
7	Petunjuk penggunaan E-modul jelas dan mudah dipahami.				
8	Gambar pada E-modul dapat dilihat dengan jelas				
9	Video pada E-modul dapat diputar dengan lancar.				
10	Audio pada E-modul dapat didengar dengan jelas.				
11	Fitur GeoGebra dalam E-modul dapat digunakan dengan lancar.				
12	Ilustrasi gambar dalam E-modul membantu dalam memahami materi				
13	Video dalam E-modul membantu dalam memahami materi.				
14	Fitur GeoGebra dalam E-modul membantu dalam memahami materi.				

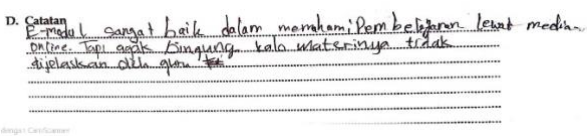
C. Penilaian

No	Aspek Penilaian	Kriteria Penilaian			
		STS	TS	S	SS
1	Tampilan E-modul menarik				
2	Fitur interaktif GeoGebra menarik.				
3	Penggunaan bahasa dan istilah dalam E-modul jelas dan mudah untuk dipahami.				
4	Informasi mengenai konteks etnomatematika Batik Anjuk Ladang jelas dan mudah untuk dipahami.				
5	E-modul mudah dioperasikan.				
6	Fitur interaktif GeoGebra mudah dioperasikan.				
7	Petunjuk penggunaan E-modul jelas dan mudah dipahami.				
8	Gambar pada E-modul dapat dilihat dengan jelas				
9	Video pada E-modul dapat diputar dengan lancar.				
10	Audio pada E-modul dapat didengar dengan jelas.				
11	Fitur GeoGebra dalam E-modul dapat digunakan dengan lancar.				
12	Ilustrasi gambar dalam E-modul membantu dalam memahami materi				
13	Video dalam E-modul membantu dalam memahami materi.				
14	Fitur GeoGebra dalam E-modul membantu dalam memahami materi.				

Figure 3. The Result of Practicality Test

Figure 3 presents students' responses regarding the practicality of the developed e-module. Although most students gave positive responses, a few students experienced difficulties in operating GeoGebra features because they were not familiar with digital learning technology. This finding indicates that students' digital literacy influences the effectiveness and practicality of technology-assisted learning media.

Fourth, the use of E-modules to facilitate independent learning of geometry transformation still requires explanation from the teacher. This is based on a note from one of the following students.



D. Catatan
E-modul sangat baik dalam memahami pembelajaran lewat media online. Tapi agak bingung kalo materinya tidak dijelaskan oleh guru

Figure 4. Notes from Student 1

"E-modules are very good in understanding learning through online media. But it is a bit confused if the material is not explained by the teacher." Therefore, the use of E-modules will be maximized if the teacher still provides explanations on the material in the E-module and students can use E-modules as an additional learning resource for flexible self-learning.

Lastly, the E-module trial was conducted on students who had studied geometric transformation material at the beginning of the even semester of class IX SMP due to time constraints and the pretest results of students who were still below the Minimum Completion Criteria (KKM = 75). The students' pretest results showed that students did not remember the geometry transformation material that had been studied previously. The statement is supported by the following notes from students.

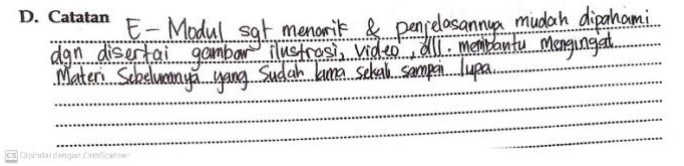


Figure 5. Notes from Student 2

"The e-module is very interesting and the explanation is easy to understand with illustrations, videos, etc. It helps to remember the previous material that has been forgotten for a long time." The use of E-modules can help students to recall material that has been previously obtained

Based on the results of the study, the E-module developed has met the criteria of validity, practicality, and effectiveness, so it is feasible to use to support learning geometry transformation, either independently or as a learning supplement or flexible additional learning resources. E-module utilization will be maximized if the teacher continues to provide assistance or explanation of the material presented.

CONCLUSION AND SUGGESTIONS

The study concluded that the ethnomathematics-based e-module of Batik Anjuk Ladang motifs assisted by GeoGebra was successfully developed using the Plomp development model through three phases: preliminary research, development or prototyping, and assessment. The developed e-module integrates local cultural contexts, interactive multimedia, and GeoGebra-assisted exploration activities to support independent learning in geometry transformation material for Grade IX junior high school students.

The developed product fulfilled the quality criteria of validity, practicality, and effectiveness. The material and media validation results indicated that the e-module was highly suitable for learning use. In addition, students gave positive responses toward the usability and interactivity of the e-module, while the effectiveness test demonstrated significant improvement in students' understanding of geometry transformation concepts, as indicated by the high average N-gain score.

These findings indicate that the integration of ethnomathematics and digital interactive technology can create more meaningful, contextual, and engaging mathematics

learning experiences. Therefore, the developed e-module can serve as an alternative digital teaching material to support both classroom learning and independent learning activities.

Based on the results of this study, several suggestions can be proposed for future research and implementation. First, future studies are recommended to develop e-modules using platforms that support more advanced interactive features, such as automatic score recording, question randomization, and answer input systems to facilitate assessment activities.

Second, further research is encouraged to examine students' learning motivation and digital literacy more specifically in relation to the integration of ethnomathematics and technology-based learning media. In addition, broader trials involving different schools and student characteristics are needed to obtain more comprehensive findings regarding the effectiveness of the developed e-module.

Lastly, teachers are advised to provide initial guidance and assistance when implementing the e-module, especially for students who are not yet familiar with digital learning environments. Teacher support remains important to maximize the effectiveness of e-modules as flexible and interactive learning resources.

REFERENCES

Budiarto, M. T., Setianingsih, R., & Artiono, R. (2020). Ethnomathematics in Majapahit's culture: Geometry concepts and pedagogy reviews in the life of Mlaten Trowulan villagers. *Journal of Physics: Conference Series, 1569*(4), 042063. https://doi.org/10.1088/1742-6596/1569/4/042063

D'Ambrosio, U. (1985). *Ethnomathematics and its place in the history and pedagogy of mathematics. For the Learning of Mathematics*, *5*(1), 44–48.

Fernandez, A. J. (2020). *Mahir GeoGebra*. Deepublish.

Hake, R. R. (1999). *Analyzing change/gain scores*. Indiana University.

Hendrizal. (2020). Rendahnya Motivasi Belajar Siswa Dalam Proses Pembelajaran. *Jurnal Riset Pendidikan Dasar Dan Karakter, 2*(1), 44–53. https://ojs.adzkia.ac.id/index.php/pdk/article/view/57/48

Hohenwarter, J., Kreis, Y., & Lavicza, Z. (2008). *Teaching and Learning with free dynamic mathematics software GeoGebra.* 11th International Congress on Mathematical Education, 1–9.

Iskandar, D., Zuwerni, Z., & Sofyan, S. (2022). Pengembangan E-Modul Pelatihan Aplikasi Google Workspace For Education Untuk Penguatan Kompetensi Literasi Digital Guru Mts. *Jurnal Manajemen Pendidikan Dan Ilmu Sosial, 3*(2), 1005–1018. https://doi.org/10.38035/jmpis.v3i2.1268

Martin, M., Syamsuri, S., Pujiastuti, H., & Hendrayana, A. (2021). Pengembangan E-Modul Berbasis Pendekatan Contextual Teaching And Learning Pada Materi Barisan Dan Deret Untuk Meningkatkan Minat Belajar Siswa SMP. *Jurnal Derivat: Jurnal Matematika Dan Pendidikan Matematika, 8*(2), 72–87. https://doi.org/10.31316/j.derivat.v8i2.1927

Piaget, J. (1972). *The psychology of the child*. Basic Books.

Plomp, T., & Nieveen, N. (2013). *Educational design research: An introduction. Netherlands Institute for Curriculum Development (SLO).*

Prasetyo, R. B., & Meiliasari. (2025). Analisis Literatur Tentang Media Pembelajaran Berbasis Digital dalam Meningkatkan Efektivitas Belajar Matematika. *Jurnal Ilmiah Pendidikan Matematika, Matematika Dan Statistika, 6*(1), 74–86.

Pulungan, E. R., Purnamasari, R., & Handayani, R. (2022). Pengembangan Media Pembelajaran Flipbook Materi Ekosistem. *Jurnal Ilmiah PGSD FKIP Universitas Mandiri, 8*(2), 3059–3069.

Rahma, F. A., Harjono, H. S., & Sulistyo, U. (2023). Problematika Pemanfaatan Media Pembelajaran Berbasis Digital. *Jurnal Basicedu, 7*(1), 603–611. https://doi.org/10.31004/basicedu.v7i1.4653

Riduwan, D. (2019). *Belajar Mudah Penelitian untuk Guru dan Karyawan dan Peneliti Pemula*. Alfabeta

Rudianingsih, N. M. E. P., & Ratyaningrum, F. (2014). Pengembangan Desain Batik Motif Anjuk Ladang Di Kota Nganjuk. *Jurnal Pendidikan Seni Rupa, 2*(3), 137–145.

Sidiq, R., & Najuah. (2020). Pengembangan E-Modul Interaktif Berbasis Android pada Mata Kuliah Strategi Belajar Mengajar. *Jurnal Pendidikan Sejarah, 9*(1), 1–14. https://doi.org/10.21009/JPS.091.01

Siregar, S., Nazliah, R., Hasibuan, R., Julyanti, E., Siregar, M., & Junita. (2021). Manajemen Peningkatan Kualitas Pembelajaran Matematika Pada Sma Labuhanbatu. *Jurnal Education and Development, 9*(2), 285–290.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Wahab, A., Junaedi, & Azhar, M. (2021). Efektivitas Pembelajaran Statistika Pendidikan Menggunakan Uji Peningkatan N-Gain di PGMI. *Jurnal Basicedu, 5*(2), 1039–1045.