Development of Ethno-Stem E-Modules Integrated with Batik Situbondo to Improve Students' Creative Thinking Skills in Junior High School Science Learning

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Article History:
Received: Dec 29, 2024
Revised: Mar 01, 2025
Accepted: Apr 25, 2025
Online First: Jul 01, 2025

Keywords:
Creative Thinking Skills,
E-Module,
Ethno-STEM.

Kata Kunci:
E-Modul,
Etno-STEM,
Keterampilan Berpikir Kreatif.

How to cite:
Muliana, S., Ahmad, N., & Rusdianto, R. (2025). Development of Ethno-Stem E-Modules Integrated with Batik Situbondo to Improve Students' Creative Thinking Skills in Junior High School Science Learning. *Edunesia : Jurnal Ilmiah Pendidikan, 6*(3), 1281-1302.

Abstract: Developing interactive and contextual learning media is crucial in enhancing 21st-century skills, particularly creative thinking. However, the facts show that many students still have difficulty developing these skills, especially in science learning, which is often considered abstract and complex. This study aims to develop and analyze the effectiveness of the Etno-STEM E-Module, which integrates science concepts with local culture through Situbondo batik to enhance students' creative thinking skills. This research employs the ADDIE (Analysis, Design, Development, Implementation, Evaluation) development model. Effectiveness was measured using pre-test and post-test results analyzed with the N-Gain Score. The trial was conducted on seventh-grade students at SMP Negeri 2 Panji, Situbondo. The results indicate that the e-module has a very high level of validity, with an average score of 92%, is considered practical with a score of 95,2%, and is effective in improving students' creative thinking skills, achieving an N-Gain score of 0.63 in the medium category. The implications of this research suggest that integrating local culture into STEM-based learning can be an innovative solution to enhance students' creative thinking skills. Therefore, this e-module has the potential to be applied in science education across various educational contexts.

Abstrak: Pengembangan media pembelajaran yang interaktif dan kontekstual berperan penting dalam meningkatkan keterampilan abad ke-21, khususnya berpikir kreatif. Namun, fakta menunjukkan bahwa masih banyak siswa yang mengalami kesulitan dalam mengembangkan keterampilan ini, terutama dalam pembelajaran sains yang sering dianggap abstrak dan kompleks. Dilakukannya penelitian ini bertujuan untuk mengembangkan dan menganalisis efektivitas E-Modul Etno-STEM yang mengintegrasikan konsep sains dengan budaya lokal melalui batik Situbondo guna meningkatkan keterampilan berpikir kreatif siswa. Penelitian ini menggunakan model pengembangan ADDIE (Analysis, Design, Development, Implementation, Evaluation). Efektivitas e-modul diukur menggunakan hasil pretest dan posttest yang dianalisis dengan N-Gain Score. Uji coba dilakukan pada siswa kelas 7 SMP Negeri 2 Panji, Situbondo. Hasil penelitian menunjukkan bahwa e-modul ini memiliki tingkat validitas yang sangat tinggi dengan skor rata-rata 92%, dinilai praktis dengan skor 95,2%, serta efektif dalam meningkatkan keterampilan berpikir kreatif siswa dengan skor N-Gain sebesar 0,63 dalam kategori sedang. Implikasi penelitian ini menunjukkan bahwa integrasi budaya lokal dalam pembelajaran sains berbasis STEM dapat menjadi solusi inovatif dalam meningkatkan keterampilan berpikir kreatif siswa. Oleh karena itu, e-modul ini berpotensi untuk diterapkan dalam pembelajaran sains di berbagai konteks pendidikan lainnya.

https://doi.org/10.51276/edu.v6i3.1136

A. Introduction

Creative thinking skills are important skills that every individual needs to possess, especially students facing various challenges in the current era of globalization. The Industrial Revolution 4.0 encourages technology, automation, and disruption to define the future of the world of work, which is uncertain. While creating new career opportunities in various emerging industries, these changes have also resulted in millions of people losing their jobs due to a lack of relevant skills (Adha et al., 2020). Quality education is expected to produce a young generation that is superior and ready to face global challenges. The quality of human resources is determined by their education (Doyan et al., 2023).

Creative thinking skills are the ability to explore possibilities through varied methods, both in terms of concepts and art. It involves looking at an idea, notion, or problem from different perspectives, thinking of new and unusual things, and creating interesting points. Creative thinking involves combining existing ideas into unique combinations that ultimately result in original innovations (Busyairi & Sinaga, 2021). Creative thinking skills enable learners to think rationally when solving problems and making decisions. This includes understanding relationships and similarities, analyzing cause and effect, considering various points of view, proper judgment, identifying problems, gathering relevant information, and asking questions with clear reasons. Creative thinking skills have four indicators: originality, fluency, flexibility, and elaboration.

Creative thinking skills have declined for several years in various countries, especially from early childhood to third grade (Almuharomah et al., 2019). The results of research by Samudera et al (2023) and Supiadi et al (2023) concluded that Indonesia is still relatively low in the creative thinking skills of its students. The study conducted by Supiadi on the effectiveness of integrated learning models in improving creative thinking skills with research results in the initial phase of 60.71% in the moderate category. Meanwhile, Samudera's research on the profile of children's creative thinking skills shows that the average value is 39% in the insufficient category. This data shows that there is still a gap between expectations and reality in developing creative thinking skills in Indonesian schools.

Many students still have difficulty developing these creative thinking skills, especially in science learning, which is often considered abstract and complex. Science learning should be contextualized, linking science concepts with real-life events. Science learning strategies in the classroom are expected to support the formation of student creativity in order to become a reliable generation in the future. It is expected that students can become superior, innovative, productive, and creative individuals (Wicaksono, 2020). Overall, science learning in junior high school is a dynamic process that integrates theoretical knowledge with practical applications.

The government has made various efforts to improve the quality of education in Indonesia, including curriculum changes. Implementing the Merdeka Curriculum, for example, emphasizes the importance of character development and 21st-century competencies, including creative thinking. However, its implementation still faces various

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obstacles, including the lack of teaching materials and learning media that can hone students' creative thinking skills (Sari & Manurung, 2021).

In 21st-century learning, E-Modules are one of the effective teaching material innovations because they present material in a digital format that is interactive and easily accessible to students (Megawati et al., 2022). E-Modules can contain text, images, videos, and interactive simulations that help increase student interest and motivation to learn. However, most of the currently available E-Modules are still general, and few have adopted the STEM approach and local culture integration. Integrating STEM concepts with local culture through the Etno-STEM E-Module integrated with Situbondo batik is an innovative solution to overcome this problem by presenting learning that is more relevant, interactive, and able to effectively improve students' creative thinking skills.

E-Modules are suitable teaching materials for this context because they present learning materials in a digital form containing text, images, or videos that can foster student interest and motivation to learn. One of the advantages of E-Modules is that they make it easier for students to learn independently and are flexible. Electronic modules make learning more interactive, while printed modules only contain materials and images. Each learning activity in the e-module has navigation links so students can be more active and interact with materials that enrich the learning experience (Maulida et al., 2022). E-Modules present information in a structured and engaging way and offer high interactivity (Turnip et al., 2021). E-modules have several important characteristics for increasing learning effectiveness and independence, including self-instructional, self-contained, stand-alone, adaptive, and user-friendly.

Most previous studies have discussed various learning methods and models to improve students' creative thinking skills. For example, research by Megawati et al (2022) showed that STEM-based learning can improve students' creative thinking skills. However, this study has not integrated local cultural aspects to provide a learning context closer to students' lives. Meanwhile, other studies have explored the benefits of ethnopedagogical approaches in science education. Nurhayati et al (2021) revealed that integrating local culture into learning can improve students' understanding of science concepts. However, this study has not specifically examined the effectiveness of cultural integration in the STEM approach.

The gaps in previous research indicate that few studies explicitly develop STEM-based teaching materials integrated with local culture. Therefore, this study offers a novel contribution by developing an Etno-STEM E-Module that integrates science concepts with Situbondo's local batik culture. This E-Module is designed to provide a more contextualized learning experience for students and encourage the development of their creative thinking skills.

STEM (Science, Technology, Engineering, and Mathematics) has been recognized as an effective learning approach for improving understanding of science concepts and developing creative thinking and problem-solving skills (Widiastuti & Indriana, 2019). This approach allows students to learn holistically by linking theory with real-world

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applications. STEM is a science field involving mathematics as a data processing instrument and technology and engineering as science applications (Sumarni & Kadarwati, 2020). Many developing countries have used STEM in learning, which makes STEM included in the curriculum as an approach, learning model, or teaching material (Awaludin et al., 2024).

In addition, local culture and wisdom have great potential to support science learning through an ethnopedagogical approach (Nurhayati et al., 2021). Cultural integration in learning can help students understand the material better regarding familiar things in their lives. Situbondo Regency, for example, has a typical Rengganis batik that reflects local cultural values and traditions (Saed & Lodra, 2022). The meaning of Situbondo batik is visualized through symbols of flora, fauna, and marine life, which reflect the natural wealth and source of life of the community, so batik is not only a cultural product but also a reflection of the daily life of the local community (kifrizyah et al., 2015). By integrating Situbondo batik in STEM-based science learning, students can understand science concepts more contextually and relevant to their surrounding environment.

The process of batik making is closely related to science learning, especially in the material of Temperature, Heat, and Expansion. The process of batik making is intricately linked to the principles of temperature, heat, and expansion, making it an important context for learning in physics. Research shows that various stages of batik production, such as heating wax for pattern application and dyeing cloth, directly involve heat transfer and temperature regulation (Nikmah et al., 2023). In addition, the batik learning process in educational settings emphasizes the importance of preparation and technique, which also involves temperature management during the dyeing and setting process. Overall, integrating batik into science learning preserves cultural heritage and enriches students' understanding of fundamental scientific principles.

The urgency of this research arises from the low level of student's creative thinking skills in science learning, which is still a big challenge in education. In the Industrial Revolution 4.0 era, creative thinking skills are needed so that students can adapt to rapid and complex technological changes. However, various studies show that these skills are still not optimally developed in school learning, especially in science subjects, which are often considered abstract and difficult to understand (Samudera et al., 2023; Supiadi et al., 2023). One of the causes is the lack of teaching materials that can connect science concepts with students' real experiences, so learning tends to be theoretical and less meaningful. In addition, innovations in teaching materials such as E-Modules are still limited, especially those that integrate aspects of local culture as a learning context. A culture-based approach can improve students' understanding because it is closer to their lives. Thus, this research is very important to develop an Etno-STEM E-Module based on Situbondo batik that can connect STEM concepts with local culture to make learning more relevant and interactive and increase student creativity. Therefore, the development of Etno-STEM E-Modules integrated with Situbondo batik in this study aims to assess the effectiveness of e-modules in improving students' creative thinking skills in science learning.

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B. Method

This research applies the Research and Development (R&D) method to develop an Ethno-STEM E-Module integrated with Situbondo local batik. The research implementation time was September-October 2024, the odd 2024/2025 school year semester. The research subjects were VII D grade students selected through purposive sampling technique. The development model used is ADDIE, which consists of five stages: Analyze, Design, Develop, Implement, and Evaluate. Research flow based on the ADDIE development model can be seen in Figure 1.

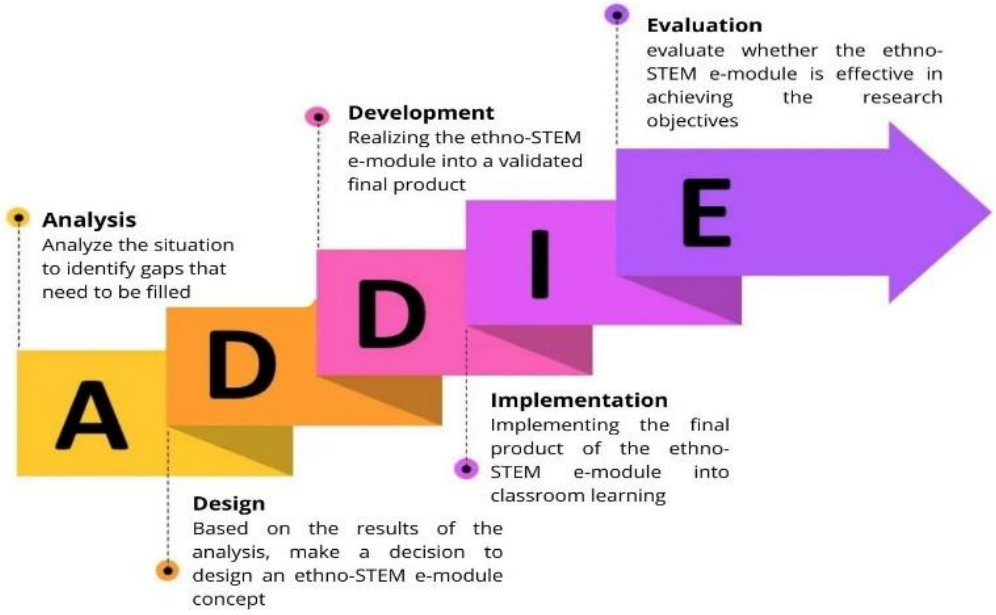

Figure 1. Research Flow

At the Analysis stage, researchers analyze the needs and characteristics of students, curriculum analysis, and learning materials. Researchers formulated objectives, selected teaching materials, and designed product concepts using Ethno-STEM E-Modules at the Design stage. At the development stage, researchers realized the product design was based on the structural framework, content systematics, and material determined at the design stage, which was then validated to determine the feasibility of the product. Furthermore, researchers conducted product trials that had been developed and declared feasible for classroom learning at the implementation stage. Then, researchers evaluated to assess the effectiveness of the e-module. Evaluation is carried out at each stage (formative evaluation) to identify problems and improvements during the development and implementation process, and evaluation at the end (summative evaluation) to assess the overall success of the e-module.

Data collection techniques and instruments in this study consist of several components. For validity data, scores obtained from validators were obtained through questionnaire techniques and validation sheet instruments. Practicality data was obtained from observers by applying observation techniques and using activity implementation

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sheets as instruments. Effectiveness is measured through student test results, including pre-test and post-test, using creative thinking skills test sheets as instruments, and student responses collected through questionnaire techniques with student response questionnaire instruments.

Data analysis techniques in this study include (1) validity test analysis, (2) practicality test analysis, and (3) effectiveness test analysis. The validity test was used to measure the validity of the E-Module developed using a validity sheet. The validity of the Situbondo batik integrated Ethno-STEM E-Module was measured based on the following formula.

$$V_{ah} = \frac{T_{se}}{T_{sh}} x100\%$$

The score of the e-module validity results was obtained from the assessment by the validator using a questionnaire technique and an instrument in the form of a validation sheet. The validators consisted of two lecturers and one science teacher. The score of each validator for each aspect of the assessment is accumulated in the form of a validity percentage defined in Table 1 below.

Table 1. Criteria for Product Validity Level

No.	Percentage	Criteria
1.	85,01%− 100%	Very Valid
2.	70,01%−85%	Valid
3.	50,01%−70%	Less Valid
4.	20%−50%	Not Valid

(Pratama et al., 2024)

The practicality of the Situbondo batik integrated Ethno-STEM E-Module was measured based on the following formula.

$$P = \frac{T_{se}}{T_{sh}} x100\%$$

The score of e-module practicality results was obtained from the assessment by observers using observation techniques and instruments in the form of activity implementation sheets. Observers consisted of three science education students. The scores of each observer for each aspect of the assessment were accumulated as a percentage of practicality, as defined in Table 2 below.

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Table 2. Criteria for Product Practicality Level

No.	Percentage	Criteria
1.	85%<P≤100%	Very Practical
2.	70%<P≤ 85%	Practical
3.	50%<P≤ 70%	Less Practical
4.	25%<P≤ 50%	Not Practical

(Nesri & Kristanto, 2020)

According to Hake (1998), effectiveness was obtained from students' pre-test and post-test scores, which were analyzed using the N-gain formula.

$$N - gain = \frac{Spost - Spre}{Smax - Spre}$$

The N-gain values are the result of analyzing student tests obtained from pre-test and post-test scores using the N-gain test with an instrument in the form of a creative thinking skills test sheet. The N-gain value is categorized into three levels. For each creative thinking indicator, the N-gain values are accumulated as in Table 3 below.

Table 3. Criteria for Students' Creative Thinking Ability Level

No.	Values <g>	Criteria
1.	g ≥ 0,7	High
2.	0,30 ≤ g < 0,7	Moderate
3.	g < 0,3	Low

(Wahyuni et al., 2022).

The percentage of student responses also determines the effectiveness of the developed e-module.

$$Rs = \frac{score\ obtained}{max\ score}\ x100\%$$

Students' responses to e-modules were obtained by filling out a questionnaire with an instrument in the form of a student response questionnaire. This student response questionnaire was given after students finished learning using the e-module. Student responses are accumulated as response percentages and defined in Table 4 below.

Table 4. Student Response Percentage Criteria

No.	Percentage	Criteria
1.	85%<Rs≤100%	Very good
2.	70%< Rs ≤ 85%	Good
3.	50%< Rs ≤ 70%	Quite Good
4.	25%< Rs ≤ 50%	Not Good

(Amira et al., 2024).

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C. Result

The results of the research using the ADDIE model are as follows:

1. Analyze Stage

The analysis stage is the initial research results on needs analysis, learner characteristics, curriculum analysis, and learning materials. The needs analysis data obtained from interviews with seventh-grade science teachers at SMP Negeri 2 Panji shows that in related schools, many difficulties are still found during the learning process, especially those experienced by students. The need for new teaching materials is a problem that cannot be ignored. Using old teaching materials that only focus on describing material without actively involving students causes students to lack creativity in solving problems during learning activities. In addition to students, teachers also claimed to be interested in using new teaching materials. This means that new teaching materials that are more interactive, flexible, and can be used independently are needed. The research school has used the Merdeka Curriculum. The Temperature, Heat, and Expansion materials were selected based on material analysis and the suitability of integrating Situbondo batik into the material. The process of making batik is closely related to this material, and batik is intricately related to the principles of temperature, heat, and technical mastery.

2. Design Stage

Researchers designed e-module products based on the analysis results to match the expected objectives. This e-module is designed in such a way that it has an attractive appearance and a touch of the local culture of Situbondo batik, which is close to the daily lives of students in order to improve their creative thinking skills. Researchers design e-module products using the Canva application, which is then uploaded to the *pdffiller.com* website so that it is electronic. The cover of the ethno-STEM e-module can be seen in Figure 2 below.

Figure 2. E-Module Cover

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The components contained in the Ethno-STEM E-Module include Learning Outcomes, learning objectives, material topics/topics, STEM aspects related to batik that are relevant to the material, and coverage of creative thinking indicators consisting of: (1) fluency; (2) flexibility; (3) originality; (4) elaboration. Figure 3 presents some of the STEM aspects contained in the e-module, while the display of creative thinking indicators can be seen in Figure 4.

Figure 3. STEM Aspects in E-Modules

Figure 4. Display of Creative Thinking Indicators in the E-Module

3. Develop Stage

The Ethno-STEM E-Module integrated with Situbondo batik, which has been previously designed, will continue for development. Researchers realized the product design by the structural framework, content systematics, and material determined at the design stage and then validated to determine the feasibility of the product. Etno-STEM E-Module validation was carried out by three validators: one science education lecturer at the University of Jember, one physics education lecturer at the University of Jember, and one

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science teacher at SMP Negeri 2 Panji. The results and data analysis of validation by three expert validators are listed in Table 5 below.

Table 5. Ethno-STEM E-Module Validation Results

No.	Assessment Aspect	Interval Score			Percentage (%)	Categories
		Validator 1	Validator 2	Validator 3		
1	Format aspect	100	88	92	93,3	Very Valid
2	Content and material aspects	96	92	96	94,7	Very Valid
3	Language aspects	90	90	90	90	Very Valid
4	Graphics aspect	95	85	90	90	Very Valid
	Average	95	89	92	92	Very Valid

The results of the data analysis of the Ethno-STEM E-Module validation from the three expert validators based on the table above show an average percentage of 92% with a very valid category for each aspect of the assessment, making the Situbondo batik integrated Ethno-STEM E-Module suitable for use in classroom learning without revision.

4. Implement Stage

This stage is for testing e-module products that have been said to be valid for classroom learning. The product's practicality is obtained by observing and assessing the implementation of learning in the classroom while using the Etno-STEM E-Module. Three observers carried out this observation during the learning process. The results of the data analysis of the practicality of the Etno-STEM E-Module integrated with Situbondo local batik can be seen in Table 6.

Table 6. The Results of the Analysis of the Learning Implementation Sheet

No.	Assessment Activities	Learning Session						Percentage (%)	Categories
		1	2	3	4	5	6		
1	Students and teachers can access e-modules well during the learning process	100	96	100	100	96	100	98,7	Very Practical
2	Students and teachers can utilize e-modules well during the learning process	91	91	100	100	100	96	96	Very Practical
3	Students can understand concepts or perform science processes through e-modules	96	96	87	96	100	96	95	Very Practical
4	E-modules have learning steps that can be understood by students and implemented by teachers	96	100	91	96	91	91	94	Very Practical

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No.	Assessment Activities	Learning Session						Percentage (%)	Categories
		1	2	3	4	5	6		
5	Activities in e-modules can stimulate students' creative thinking skills in each indicator (fluency, flexibility, originality, elaboration)	96	94	96	96	100	91	95,5	Very Practical
6	Information in the e-module provides knowledge to students related to STEM aspects in the batik-making process related to the material	91	91	91	91	91	91	91	Very Practical
7	The teacher provides learning reflections according to the e-module instructions	91	91	100	100	91	100	95,5	Very Practical
	Average	**94**	**94**	**95**	**97**	**96**	**95**	**95,2**	**Very Practical**

The results of the practicality analysis through the learning implementation sheet, as presented in Table 4.4 above, show the average percentage of practicality of the Ethno-STEM E-Module is at 95.2% with a very practical category. Thus, the results of observations of learning implementation when using the Ethno-STEM E-Module state that this product is very practical for classroom learning. However, it is undeniable that researchers encountered several classroom obstacles during learning. These obstacles can be seen in Table 7.

Table 7. Constraints in Learning Implementation

No.	Constraints	Solutions
1	Some students had no internet quota, so they could not access the e-module.	Providing E-Modules in PDF form so students can access them without needing an internet network.
2.	When conducting experiments, some students are not conducive and less cooperative.	Provide interactive and more interesting experiments for students. Experiments are carried out in small groups so that all students can be involved in each group.

Several obstacles were encountered during the application of the Situbondo batik integrated Ethno-STEM E-Module product trial to students, but these obstacles did not affect the assessment of the practicality of learning implementation results.

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5. Evaluate stage

The evaluation stage is the assessment stage of the previous three stages: the analysis, design, and development. Evaluation is carried out to measure the effectiveness of the Etno-STEM E-Module used in learning science in grade VII on the material Temperature, Heat, and Expansion. Two tests, namely pre-test and post-test, must be conducted to determine the effectiveness of Etno-STEM E-Modules. Data on the results of students' pre-test and post-test assessments can be seen in Table 8.

Table 8. Results of Pre-test and Post-test Data Analysis

No	Indicators of creative thinking	Total Score		N-*gain*	Criteria
		Pre-test	Post-test		
1	*Fluency*	15,45	23,26	0,81	High
2	*Flexibility*	6,07	15,45	0,49	Moderate
3	*Originality*	2,60	13,71	0,49	Moderate
4	*Elaboration*	5,90	21,0	0,76	High
Average		**7,51**	**18,36**	**0,63**	**Moderate**

Based on the data in Table 8, the average result of the N-gain value analysis using Ethno-STEM E-Modules is 0.63 with moderate criteria. These results were obtained based on the pre-test and post-test scores of student's creative thinking skills while using the Ethno-STEM E-Module on Temperature, Heat, and Expansion material. Analysis of the N-gain value shows an increase in students' creative thinking skills before and after using the Etno-STEM E-Module in learning science on Temperature, Heat, and Expansion.

The results of data analysis on the fluency indicator showed the highest N-gain value of 0.81 with a high category. Students could generate many ideas/answers that varied and were closely related to the concept of temperature change, and these ideas showed a deep understanding of the material. For example, in the question that asked students to mention as many events of temperature change in everyday life, almost all students provided different answers related to the concept of temperature change. However, some students had difficulty generating diverse ideas, indicating they still needed to improve this ability. In line with the ideas of Nafizatunni'am et al (2024), fluency is the ability to come up with many ideas, answers, questions, and solutions to various problems quickly. It can provide many suggestions for various things.

The N-gain value on the flexibility indicator shows 0.49 with a moderate category. Students can change their thinking and provide several solutions with different perspectives referring to the concept of heat transfer at a moderate level. For example, in answering a question about how to keep the dye solution hot during the batik soaking process without using an electric heater, student A came up with a solution using an insulated container with the right scientific basis. In contrast, student B utilized more solar heat. However, some students still tended to stick to one way of thinking, so they could not offer alternative solutions. An example of a less creative answer was written by student C as follows:

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"*Besides using an electric stove, we can also use a gas stove to keep the dye hot. If the dye remains on the gas stove and the flame is turned on, the dye solution will not cool down*."

As written by Sari et al (2024), the indicator of flexibility of creative thinking is related to the various ideas that students can think of and different answers. In the classroom, only some students can think flexibly, while others tend to have difficulty changing their way of thinking to solve the same problem.

The results of data analysis of the originality indicator showed an N-gain value of 0.49 in the moderate category. Students can generate original ideas, but the proposed solutions are not common and show unique thinking at a moderate level. For example, when asked to design clothes that can be used on hot days and cold nights, student D created an innovative idea, namely clothes consisting of several removable layers by utilizing the material's thermal conductivity. Some other students gave answers similar to the examples taught in class, showing a lack of creativity in generating new ideas. Such as the thoughts of student E, who came up with the following general and less innovative idea:

"*For a garment that can be used during the day and night, I designed a double-sided jacket (back and forth). The first side is used during the day, with a thin material like rayon. The second side is used at night, with a thick material like wool*."

A study by Liwalidya et al (2024) showed similar results: Students tended to follow conventional patterns or techniques and gave less creative answers. Although students have the potential to improve, they lack the courage to think outside the box to find new solutions.

The results of data analysis of the elaboration indicator showed an N-gain value of 0.76 with a high category. Students can develop or enrich ideas and explain these ideas in detail regarding the working mechanism of the system/tool/experiment. All materials, procedures, and scientific concepts are explained clearly and in detail, including a complete analysis. For example, when asked to explain an experiment to demonstrate the effect of expansion, some students mentioned the steps and the function of the tools/materials used. However, some only gave basic answers without further elaboration. This aligns with the ideas of Chimam & Aryani (2024), who state that elaboration students can master creative thinking if they can develop ideas in problem-solving in detail.

The effectiveness of the Etno-STEM E-Module is measured not only based on the analysis of N-gain values but also through the analysis of student responses. Student responses to using Etno-STEM E-Modules were collected through student response questionnaires for each individual. The results of the analysis of student responses to the Etno-STEM E-Modules can be seen in Table 9.

Table 9. Results of Student Response Questionnaire Analysis

Assessment Indicator	Percentage (%)	Response Category
Interest	89	Very Good
Motivation	87	Very Good

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Effectiveness	88	Very Good
Average	**88**	**Very Good**

The average student response, based on Table 9, is 88%, with a very good response category. Students' positive responses to the Etno-STEM E-Module integrated with Situbondo batik make the e-module suitable for use in science learning, especially in the material of Temperature, Heat, and Expansion.

The effectiveness of the Etno-STEM E-Module product is also measured based on the positive response of its users (Setyaningrum et al., 2024). The average student response to using Etno-STEM E-Modules is 88%, with a very good response category. E-Modules are considered very good as teaching materials designed to improve students' creative thinking skills. Students gave excellent ratings for each assessment indicator, ranging from interest, motivation, and effectiveness. The response to the aspect of interest reached a percentage of 89% with a very good category, which means that students consider the Ethno-STEM E-Module to have an attractive appearance and content, and the context of the problem is not boring so that students become more interested and excited to learn using the E-Module. The motivation aspect reached 87% with a very good response category, which means that the E-Module can motivate students to learn independently because it is flexible, making students more comfortable while learning. The effectiveness aspect obtained a response with a percentage of 88% with a very good response category, which means that the use of Ethno-STEM E-Modules can help students better understand learning materials, including developing students' creative thinking skills on each thinking indicator through activities in the e-module.

D. Discussion

The final product in this research is the Etno-STEM E-Module integrated with Situbondo batik for science learning on Temperature, Heat, and Expansion. The content of the Ethno-STEM E-Module includes material concepts, experiments, videos, creative thinking activities and STEM activities, practice questions, and additional information related to STEM aspects in batik making related to the material.

The product is developed with the initial step of testing its validity to determine its feasibility as teaching material so that it can be implemented in learning. The results of the analysis of the validity of the Ethno-STEM E-Module product show an average percentage of validity at 92% with very valid criteria. A product is said to be valid if the product is declared suitable for use with or without revision from expert validators (Sundari et al., 2023). The results of the validity of the e-module in the format aspect get a percentage assessment of 93.3% with a very valid category. The valid category in the format aspect includes the accuracy of the presentation systematics, font size, image display, and the suitability of the image size with the media (Shiddiqy et al., 2024). The format of the Ethno-STEM E-Module is by provisions such as the selection of font size and shape used, the layout

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of the elements in the e-module is consistent, the numbering system, the writing systematic, and the parts that must be in the e-module.

The results of the validity of e-modules in the aspects of content and material get a percentage of assessment of 94.7% with a very valid category. The valid category in the content and material aspects includes the material's correctness and the material's suitability with the learning outcomes and objectives (Monik et al., 2024). The Ethno-STEM E-Module developed can clearly describe the material Temperature, Heat, and Expansion. The e-module presents the material clearly and coherently, the material presented is by the learning outcomes and objectives, the integration of ethnic-STEM values in the e-module is appropriate, and the e-module includes good creative thinking indicators.

The results of the validity of the e-module in the language aspect obtained an assessment percentage of 90% with a very valid category. This means that the language used in the e-module is by EYD, the sentences used are by the student's level of thinking, the language used is communicative, and the sentence structure is simple and does not contain double meanings. The language aspect is very important to determine the product's validity because it impacts how easily the reader understands the content delivered in a product (Tawil, 2024).

The results of the validity of the e-module in the graphic aspect obtained an assessment percentage of 90% with a very valid category. The valid category in the graphic aspect is if the display attracts students' attention, the design and cover are attractive, and the media display is clear (Sundari et al., 2024). Graphically, the Ethno-STEM E-Module has an attractive appearance, displaying good contrast. In addition, the text, images, videos, and tables in the e-module are also clear. There are no comments or suggestions from the validator in the graphic aspect, so there is no need to make revisions related to the graphic aspect in the e-module. If the product assessment produces consistent results, then the assessment results truly reflect the actual product quality (Munir et al., 2024). After the researchers made revisions based on the three validators' suggestions, this Ethno-STEM E-Module will be applied to science learning in the classroom.

The application of Etno-STEM E-Modules integrated with Situbondo local batik in science learning in class VII SMP Negeri 2 Panji was carried out for six learning sessions. Three observers observed each meeting to observe the implementation of learning while applying the Etno-STEM E-Module. The results of these observations were collected in the form of a learning implementation sheet. The results of the practicality data analysis based on the learning implementation sheet obtained an average percentage of 95.2% with a very practical category. Practicality means that the product is easy for students to use, so the teaching materials developed are easy to use and can be used anywhere. This refers to the idea that a product is considered practical if it is easy to use and can be practically applied in the field (Safitri et al., 2024).

Learning using the Ethno-STEM E-Module is considered very practical, but in its implementation, researchers still encounter some obstacles. These obstacles include learning session 2; some students do not have an internet quota, so they cannot access the e-module.

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So, researchers provide e-modules in PDF form to ensure that students can access them without needing an internet network. Another obstacle when conducting experiments was that some students were still not conducive and less cooperative. Therefore, an interactive and more interesting experiment is needed for students; the experiment is also carried out in small groups so that all students can be involved in each group.

A product is considered effective if it is successfully developed according to its research objectives. This Ethno-STEM E-Module development research aims to improve the creative thinking skills of junior high school students. The effectiveness of the Etno-STEM E-Module in ensuring continuity of learning can be seen by the difference in students' pretest-posttest scores (Kusmayadi et al., 2024). The effectiveness of Etno-STEM E-Modules is also obtained from the results of student response questionnaires (Setyaningrum et al., 2024).

The analysis of the pretest-posttest scores of creative thinking skills obtained an N-gain value of 0.63 with a moderate category. This means students' creative thinking skills have increased after using the Ethno-STEM E-Module based on analyzing each indicator of creative thinking skills: fluency, flexibility, originality, and elaboration. Fluency and elaboration creative thinking indicators have N-gain scores in the high category, while flexibility and originality indicators are in the moderate category. The increase in N-gain scores on each indicator varies due to differences in student ability. Each individual has a different brain capacity, which results in variations in the intellectual abilities of each learner (Jumaniar et al., 2024).

Using Ethno-STEM E-modules engages students in activities that encourage exploring various creative solutions, such as batik dyeing based on science principles (e.g., night temperature or chemical reactions in coloring). The E-Modules facilitate thinking skills such as fluency, flexibility, originality, and elaboration. Interactive features such as simulations or simple experimental activities give students space to try, make mistakes, and find new solutions. These activities then stimulate students' imagination and creativity. These advantages then succeeded in improving students' creative thinking skills based on the results of this study. Quality teaching materials are teaching materials that meet the criteria of validity, practicality, and effectiveness (Harahap et al., 2023). However, not all learning activities can achieve optimal results to the teacher's expectations in meeting predetermined standards (Ahmad et al., 2020).

E. Implication

The results of this study have implications in the world of education, especially in science learning at the junior high school level. The development of an Ethno-STEM E-Module that integrates science concepts with local culture, such as Situbondo batik, proved effective in improving students' creative thinking skills. This finding shows that the use of interactive, contextual, and local wisdom-based learning media can be an innovative solution to overcome students' difficulties in understanding abstract and complex material. In addition, the high level of validity and practicality of the e-module indicates that this

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media is feasible to be implemented more widely in other schools. Thus, this research encourages educators and learning media developers to continue to innovate by utilizing the potential of local culture as part of the learning process. The results of this study not only contribute to the improvement of 21st century skills, particularly creative thinking, but also support the preservation of regional culture through the integration of local values in education.

F. Limitation and Suggestion for Further Research

The development of this E-Module still has shortcomings which then become obstacles in research. These shortcomings such as e-modules must be accessed online. Therefore, future researchers are expected to develop Ethno-STEM E-Modules that can be accessed offline so that internet connection constraints do not hamper the use of this E-Module. Inhibit the use of this E-Module. E-Modules can be redeveloped by adding more interactive and more interactive and interesting experiments by actively involving all students, as well as the context of the problem that is adapted to the needs of students at school. Problems that are tailored to the needs of students at school.

Future research can develop e-modules that integrate with other cultural aspects in Indonesia to enrich students' learning experiences and broaden their understanding of cultural diversity. In addition, researchers can conduct a comparative study between classes using the Ethno-STEM e-module and classes using traditional learning methods to measure differences in learning outcomes and students' creative thinking skills.

G. Conclusion

This study successfully developed and analyzed the effectiveness of Etno-STEM E-Modules that integrate science concepts with local culture through Situbondo batik as a learning medium in improving students' creative thinking skills. The results showed that the developed e-module met the validity, practicality, and effectiveness criteria, making it feasible for science learning. This research confirms that the Etno-STEM approach in developing teaching materials can be an innovative strategy to improve the quality of science learning at the junior high school level.

This research shows that integrating local culture into STEM-based science learning can be an innovative solution to improving students' creative thinking skills. This approach makes learning more contextual, meaningful, and interesting for students while supporting the Merdeka Curriculum policy that emphasizes project-based learning. Therefore, the Etno-STEM E-Module integrated with Situbondo batik has the potential to be applied in various other educational contexts and further developed by adapting local wisdom from other regions.

https://doi.org/10.51276/edu.v6i3.1136

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