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Integration of Local Potential from Grenden Village into Science E-Modules to Enhance the Science Process Skills of Junior High School Students

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ABSTRACT Understanding the scientific process plays an important role in junior high school science education. These skills include observing, categorizing, hypothesizing, analyzing data, and communicating findings. However, various studies show that junior high school students in Indonesia still struggle to develop these skills effectively. One of the leading causes of this problem is the lack of contextual relevance in teaching materials that do not focus on improving science process skills. Therefore, this research aims to improve students' understanding of the basic concepts of thermodynamics, especially temperature and heat, by developing e-modules integrated with the local context in Grenden Village, Jember. The ADDIE model was used to develop the e-module, which includes five systematic phases: analysis, design, development, implementation, and evaluation. Data were collected through validation sheets, practicality questionnaires, pretest and posttest instruments, and student response questionnaires. The N-gain value of 0.68 indicated a moderate level of improvement, demonstrating that the e-module effectively enhanced students' science process skills. The student response questionnaire yielded an average score of 78.95% (good). Overall, the e-module based on the local potential of Grenden Village is valid, practical, and effective, making it suitable for junior high school science instruction and as a foundation for further research.

Keywords: E-modules, Local potential, Science process skills, Thermodynamics

1. INTRODUCTION

Scientific process skills play an important role in science learning because they include several interrelated concepts and theories that can be honed through empirical investigation, such as observation, experimentation, and data analysis. In addition, these skills provide a strong foundation for developing scientific knowledge and supporting further research. (Barokah, Yulistia, Putri, & Hidayat, 2022). Experimental activities in science learning require a range of skills. Some competencies needed in science process skills include procedural, experimental, and systematic competencies. Furthermore, these skills can reflect students' ability to apply the scientific method and investigative procedures in experimental activities. Science process skills facilitate knowledge construction and are the foundation of an inquiry-based approach. Scientific process skills play a role in science learning because they involve a variety of interrelated concepts and theories that can be enhanced through hands-on, inquiry-based activities such as observation, experimentation, and data analysis. (Senisum, 2021). In addition, these skills provide an important foundation for developing scientific insights and conducting research later. (Handina & Khotimah, 2023).

Science process skills are crucial for students to keep up with the rapid development of science and technology. Strengthening these skills encourages students to become accustomed to accessing and understanding information and concepts independently, while training their thinking and cognitive abilities more effectively (Nuayi, 2020). Some basic scientific process skills include observation, measurement, and communication. When students learn these abilities, they can be motivated to formulate problems and hypotheses and to draw conclusions from experiments (Sinurat et al., 2023). Later, students who have science process skills will be able to solve problems, formulate concepts, develop concrete thinking, and

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become more creative in developing solutions (Dignam & Makerspace, 2025).

According to research conducted by Rophi et al. (2024) Shows that students' science process skills are still limited, especially in making observations, interpreting data, and conducting experiments. In addition, teaching materials that are less relevant to students' environment and cultural background also exacerbate the problem. This results in many science learning experiences becoming less transparent and less connected to students' real lives, thereby reducing their relevance and impact. (Rosario & Chua, 2023). Therefore, it is important to incorporate local potential into teaching materials to bridge the gap between scientific concepts and students' daily experiences. According to Dini & Rini (2024)When this learning is completed, the class will be more meaningful, effective, and engaging. Despite the recognized importance of science process skills for understanding science and developing intellectual abilities, many students still struggle to perform these skills effectively. Science process skills, including observation, measurement, classification, prediction, hypothesis testing, experimental design, and data interpretation, are essential for meaningful engagement in science learning. However, the literature shows that students often do not receive sufficient opportunities or structured guidance to develop these skills. (Gizaw & Sota, 2023). This gap is compounded when teaching methods and instructional materials are not designed to integrate science process skills explicitly or to actively engage students in hands-on and minds-on activities, which are crucial for developing these competencies.

This research focuses on addressing the low level of students' science process skills in junior high school. The urgency of developing effective teaching materials is supported by the study of Yunita & Nurita (2021), which showed that students' predicting skills reached only 25%, formulating problems 45.83%, determining variables 8.33%, conducting investigations 18.83%, analyzing data 16.67%, and drawing conclusions 18.05%. The development of this finding aligns with Santiawati et al. (2022) Research results revealed that junior high school students' science process skills were also still at a low level, with 37.5% for observing, 34.5% for predicting, and 42.9% for concluding. These data indicate that students still struggle to apply the scientific thinking process, including identifying problems, making predictions, and drawing evidence-based conclusions. Therefore, it is necessary to develop teaching strategies and materials that can foster the improvement of these essential scientific skills. Remain relatively low and require learning interventions that are more contextual and relevant to their

In a study conducted by Saleh et al. (2020) Learning resources that are less interactive and not contextualized tend to result in relatively low science process skills among students. Often, available learning resources lack both an inquiry and a critical thinking component. These components are important and help improve students' science process skills. In addition, according to Wijaya & Fajar (2020) Students often find monotonous learning resources less attractive and ineffective. One of the solutions used in the research of Nuri et al. (2023) The goal is to develop teaching materials that are more engaging, interactive, and tailored to students' needs. E-modules can be a solution because they are teaching materials that offer visuals, animations, and sound. So that, by using E-modules, student learning motivation can increase through the presentation of more interesting material.

E-modules were selected as the primary learning medium in this study due to their distinctive pedagogical and technological advantages over conventional media. As explained by Sofyan et al. (2019)E-modules are digital learning resources designed to enable students to learn independently, either with minimal guidance or without direct teacher supervision. In contrast to traditional printed modules or worksheets, e-modules offer a more interactive and engaging learning environment through features such as hyperlinks, multimedia content, and embedded assessments that provide immediate feedback. According to research conducted by Ningsi & Nasih (2020)Indicators of science process skills, such as designing experiments, determining variables, predicting results, and successfully concluding, increased after using E-modules during learning. Research by Wasthi et al. (2023) also showed that E-modules can support sustainable learning practices by significantly reducing paper usage, besides improving learning efficiency through technology integration. Furthermore, according to Suryani et al. (2022)The preparation of E-modules designed in line with the epistemological character of science, which emphasizes the inquiry approach, hands-on practice, and reflective activities, can help develop students' science process skills more effectively. When students actively participate in authentic scientific activities such as observation, experimentation, and data interpretation, they will have a deeper conceptual understanding while developing critical and analytical scientific competencies.

According to Kurniawati, Wahyuni, and Putra (2017), the local potential of an area can be utilized as a contextual learning resource for students. Utilizing local potential aligns with the principle of curriculum development that emphasizes planning and determining learning objectives and teaching materials, which are adjusted within educational units based on regional diversity, potential, characteristics, needs, and local environmental conditions. Furthermore, research by Karimah, Setyawan, and Handika (2025) showed that a region's local potential is highly relevant for integration into learning media, especially e-modules. E-modules based on local potential are considered effective and efficient as learning media because they can link academic activities with the reality of student life, which is reinforced by the findings of Jumaniar, Rusdianto, & Ahmad (2024) who stated that local culture is closely linked to a region's potential, so integrating the two into the learning process can increase the material's relevance and closeness to students' real experiences. Thus, local potential-based learning not only increases the relevance of the material but also encourages students' active involvement in understanding science concepts that are close to their daily lives.

Puger was selected as the local context for this study because it is one of the most prominent agricultural areas in Jember, particularly for corn production, with a total of 41.211 tons from a harvested area of 6.840 hectares. (Badan Pusat Statistik Kabupaten Jember, 2021). Among its subareas, Grenden village is the primary contributor to this productivity, with most residents relying on corn cultivation as their primary livelihood. In this village, corn not only cultivated as a staple commodity but also processed into various derivative products, one of which is corn milk, a popular and locally branded beverage often produced and sold by the communitythe local agricultural potential, especially corn, has strategic value for integrationTherefore integrating the process of making corn milk into science learning particularly in the topic of temperature and heat. It can provide meaningful contextual learning that connects students every day with scientific principles such as heating, phase changes, and energy transfer. The use of corn products in science learning materials, especially on the topic of temperature and heat, involves creativity. In addition, creativity also mediates the relationship between adaptability and learning outcomes. (Ong, Lu, Chou, & Chen, 2022).

In this context, the development of e-modules based on local potential that links scientific processes with local cultural practices is expected to create a rich learning environment, encourage student adaptation to contextual materials, and optimally stimulate creativity and science process skills. However, the results of field observations and interviews show that the application of e-modules based on local potential, specifically designed to improve science process skills, remains limited and has not been widely implemented in schools' science learning practices. Development research reported student responses of 86% and module validity of 85%, yet the impact on science process skill was still categorized as moderate. This suggests that while media show potential, their breadth and depth of implementation in everyday school practice remain low. (Nuryah, 2022). This study aims to develop an e-module based on the local potential of Grenden Village, namely, high corn production, and to integrate it with temperature and heat materials. In addition, it also evaluates its validity, practicality, and effectiveness in improving the science process skills of junior high school students.

2. METHOD

Development research is a systematic and iterative process that aims to design, test, and refine educational products to increase their effectiveness in authentic learning environments. (Martatiyana, Usman, & Lestari, 2023). This research uses a Research and Development (R&D) approach to develop e-modules based on local potential. The stages of the ADDIE instructional model consist of analysis (analysis of student needs and characteristics), design (e-module design), development (product development and validation), implementation (limited implementation in the classroom), and evaluation (evaluation of effectiveness and product revision) (Figure 1) (Branch, 2009; Mdodana-zide, 2024).

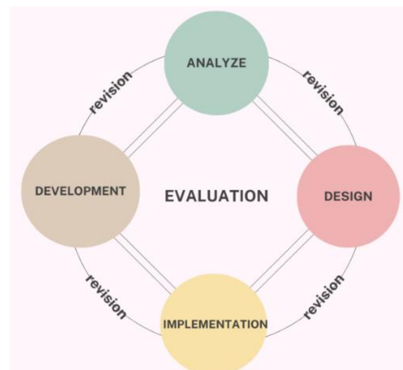

Figure 1 Research Flow of ADDIE Development Model (Branch, 2009)

A thorough review of the curriculum, student characteristics, and learning needs is conducted in the analysis phase. Furthermore, at the design stage, the structure and content of the e-module were developed in Canva, tailored to the targeted learning materials, and then converted to an electronic format using Flip PDF software. At the development stage, the e-modules were validated by three experts. Revisions and improvements to the module were made to ensure its validity and readiness for implementation in the educational environment. The revisions and improvements were adjusted to the validators' suggestions. Moreover, the implementation stage involves applying the validated e-module in class VII at Sultan Agung Grenden Junior High School, Jember, during the odd semester of the 2024/2025 academic year. This module was used in six learning sessions for one month. The research flow is illustrated in Figure 2.

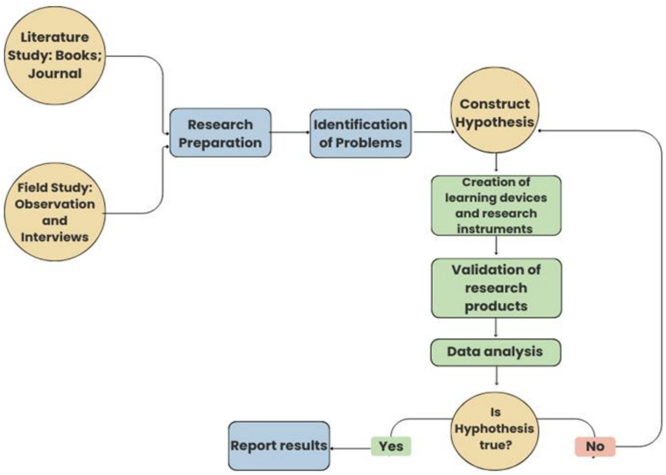

Figure 2 Research flow

2.2 Participant and Research Design

The participants in this study were nineteen seventh-grade students from a junior high school selected through purposive sampling. The selection was based on preliminary interviews with the science teacher, which indicated that students in this class demonstrated relatively low levels of science process skills, particularly in observing, predicting, and drawing conclusions. Since the school has only one seventh-grade class, all students in that class were included in the research sample. This group was therefore considered appropriate for implementing the local-wisdom-based e-module aimed at enhancing students' science process skills. In this study, the seventh-grade students at SMP Sultan Agung were selected through skills, according to

Given that the generated e-module was created using a mobile learning technique, one inclusion criterion for selecting participants was students' proficiency with cell phones. This decision was carefully made to ensure product testing occurred in an environment that aligned with students' technology readiness and learning requirements. Three science teachers from SMP Sultan Agung served as expert validators of the local wisdom-based e-module developed in this project. As part of the product implementation and assessment phase, the e-module was piloted among the target student group to determine how well it improved students' science process skills.

This research is a developmental study that includes effectiveness testing to measure students' science process skills after the implementation of the developed e-module. The effectiveness testing employed a weak experimental design, specifically a one-group pretest-posttest design, because the study did not involve a comparison or control group. In this design, the same group of students was given a pretest before and a posttest after using the local-wisdom-based e-module to determine improvements in their science process skills.

2.3 Instrument and Data Collection Techniques

The effectiveness of the local potential-based e-module developed in Grenden Village was further tested using a pretest-posttest design to measure students' science process skills. The results revealed an improvement in posttest scores, indicating that the e-module effectively enhanced students' abilities to observe, predict, and conclude. In addition, students' responses toward that e-module were analyzed through a questionnaire covering three indicators: interest, content, and language, each consisting of five items.

The questionnaire, completed by teachers and students during the product trial, was designed to evaluate the e-module from a media and materials perspective. The four main criteria that the material validator questionnaire focused on were the effectiveness of the learning elements, the depth and accuracy of the content (substantial quality), the appropriateness and clarity of language use, and the suitability of the material to the applicable syllabus. On the other hand, the media validator questionnaire emphasized visual and design elements, such as the attractiveness and readability of the cover design, the quality of the module illustrations, the uniformity and readability of the font use, and the effectiveness of the color scheme. Overall, the questionnaire served as a comprehensive evaluation tool to measure how well the e-module aligned with the intended learning objectives and met the expectations of both educators and learners.

2.4 Data Analysis Techniques

Several data analysis techniques applied in this study included validity, practicality, and effectiveness testing. In the validity analysis, the following aspects were examined: content validity, construct validity, and readability. Data validity was obtained through a content validity assessment sheet completed by three expert validators. The results were then analyzed using a special calculation formula to determine the instrument's validity level:

$$Vi = \frac{\sum S}{Smaks} \times 100\%$$

Description:
Vi = percentage of validity
$\sum S$ = the number of scores of the assessment results
Smaks = maximum score

The validity percentage obtained is then adjusted to the content validity category in Table 1.

Table 1 Classification of e-module validity

Validity Percentage (%)	Category
76-100	Very valid
51-75	Valid
26-50	Fairly valid
0-25	Less valid

Practicality data analysis was obtained through observation sheets of learning implementation completed by observers during the learning process using the local potential-based e-module. The obtained validity percentages were converted into practicality level categories, as listed in Table 2.

To find out the practicality in the learning process, the following formula is used:

$$\text{Percentage} = \frac{score\ obtained\ for\ an\ item}{maximum\ score} \times 100\%$$

Table 2 Practical criteria for e-modules based on the local potential of grujugan village

Percentage (%)	Category
75.01 – 100	Very Practical
50.01 – 75.00	Practical
25.01 – 50.00	Fairly Practical
00.00 – 25.00	Less Practical

The data analysis conducted in this study began with a Kolmogorov-Smirnov normality test. The results of the normality test showed that all data tested were not normally distributed ($p<0.05$). Because the data did not meet the assumption of normality, a non-parametric test, specifically the Wilcoxon signed-rank test, was used to analyse the difference between pre-test and post-test scores. The Wilcoxon test is appropriate for dependent samples and is commonly used to determine whether there is a significant difference between two related groups when the distributions are not normal. The effectiveness of the intervention was further analyzed using the N-gain score, calculated based on the difference between pre-test and post-test results to determine the magnitude of improvement in students' science process skills. The N-gain test using the formula:

$$(g) = \frac{Spost - Spre}{Sm{-}ideal - Spre}$$

Description:

(g) = Normalized average gain score

Spost = Post-test mean

Spre = Average of pre-test

Sm-ideal = Maximum score

The average N-gain scores are then categorized according to Table 3.

Table 3 N-gain criteria

N (gain)	Category
$g \geq 0.70$	High
$0.30 \leq g < 0.70$	Medium
$g < 0.30$	Low

(Arikunto, 2008; Asyhari & Silvia, 2016)

An analysis of student response questionnaires will be conducted for the questionnaires administered after using e-modules based on local potential. The formula calculates the percentage:

$$\text{Percentage} = \frac{score\ obtained\ for\ an\ item}{maximum\ score} \times 100\%$$

The average student response scores are then categorized according to Table 4.

Table 4 Student response criteria

Student Response Score (%)	Category
75.01 – 100	Very Good
50.01 – 75.00	Good
25.01 – 50.00	Not good
00.00 – 25.00	Not very good

(Fuldiaratman, Pamela, & Lubis, 2023)

3. RESULT AND DISCUSSION

This research developed interactive e-modules that integrate the natural resources of Grenden Village into science lessons for students at Sultan Agung Middle School. The e-modules were implemented with seventh-grade students.

3.1 E-Module Development Based on Local Potential of Grenden Village

The development of e-modules that promote local wisdom values has been proven to encourage improved science process skills, especially in areas with limited access to quality educational resources (Fauziah, Ningrum, & Nandi, 2023) In developing this e-module, several important aspects were analyzed, namely local potential, learning resources available to students, levels of learning motivation, and students' science process skills. Interview results indicated that science learning at the school still uses student worksheets and textbooks. The findings indicate that students' science process skills remain relatively low, which is suspected to be due to student worksheets that are not explicitly designed to develop these skills. The curriculum implemented in grade VII of Sultan Agung Middle School is the Independent Curriculum.

Based on interviews with science teachers, students' motivation for learning remains relatively low. One of the leading causes identified is the limited availability of open-ended materials that support engaging, relevant contextual learning. Teachers reported that students often feel bored because the materials are not interactive enough and do not integrate science concepts with everyday situations (Tul'adawiyah, Nurihsan, & Budiman, 2024). To identify local potential for learning, researchers conducted direct observations in Grenden Village. The observations showed that this village has rich agricultural potential, with corn as a leading commodity with high production value (Figure 3) (Putri, Mumtazah, Jannah, & Abdullah, 2023). Corn production was specifically chosen as the local context because its processing activities, particularly the production of corn milk, are directly related to the science topic of temperature and heat studied by students. The process involves several physical changes, such as heating,


Figure 3 Local potential of Grenden Village


Figure 4 Demonstrating corn milk processing to the public

evaporation, and energy transfer, which can help students understand abstract scientific concepts through authentic and meaningful experiences. Corn can be processed into various products, including corn milk. This locally sourced corn milk product can engage students in the learning process, especially on topics related to temperature and heat, thereby improving their science skills.

In Grenden Village, abundant corn production and the development of corn milk offer a practical context for teaching science process skills. Heating corn causes starch to gelatinize (around 64-72 °C), affecting texture and viscosity and demonstrating how temperature impacts product quality. Controlling temperature during pasteurization is also crucial to inactivate microbes without damaging nutrients. By connecting this process to learning, students can practice skills such as measuring temperature, observing texture changes, forming hypotheses, analyzing data, and communicating results, making science process skills relevant and contextual.

Corn processing into corn milk has been introduced in Butu Village, Bonebolango, Gorontalo, as a way to empower the community through processing the region's abundant sweet corn. This activity enables locals to produce hygienic, affordable corn milk. Research also indicates that corn milk is highly nutritious, especially rich in vitamins and fiber. In science education, this method offers opportunities to contextualize lessons in schools, making them more relevant and adaptable to the community's needs and conditions. Using local resources as a learning tool helps develop teaching methods suited to the social environment and available materials. (Devitasari, 2022).

Based on the six indicators of basic science process skills, experimental activities play a crucial role in learning. In this study, the researchers integrated the processing of corn milk, a typical product from Grenden Village, into the study. They conducted observations and direct trials in the community. These trials evaluated how the developed learning content could be implemented daily (Figure 4).

The next stage is designing the e-module, which includes developing a basic framework, planning evaluation instruments, and developing module systematics. This framework serves as a general guide to the module's content. According to Najuah et al. (2020), the ideal module structure includes sections such as a conclusion, foreword, table of contents, competency description, user instructions, learning materials, summary, activities, evaluation, answer key, and bibliography. The e-module design uses harmonious color selection and a visually appealing layout, complemented by strategically arranged images to enhance student understanding. This approach is based on Dual Coding Theory, which explains that information is more easily understood when presented simultaneously through verbal and visual channels. Student responses indicate that using color helps them comprehend

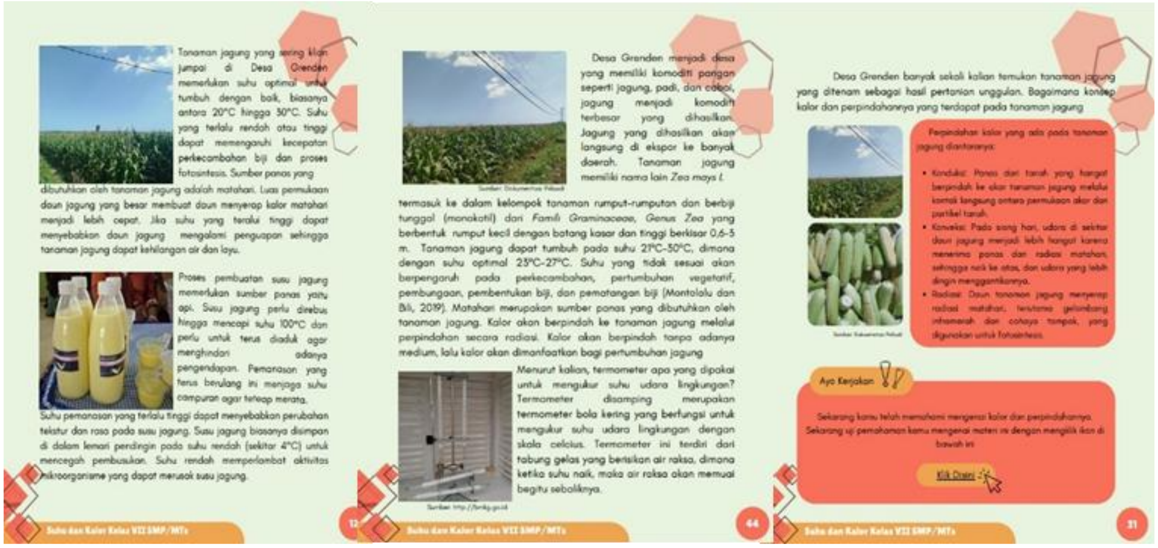

Figure 5 Presentation of the local potential of Grenden Village in the e-Module

Figure 6 Student activities to improve science process skills

information and distinguish key concepts (Mir, Fatima, & Fatima, 2023)

The e-module developed based on the local potential of Grenden Village contains three types of learning activities. The integration of these local potentials into the content is shown in Figure 5. Meanwhile, students' implementation of experimental activities to improve their basic science process skills is shown in Figure 6.

3.2 Validation of E-modules Based on Local Potential of Grenden Village

Three validators, consisting of competent science teachers, evaluated the product's validity. The validity testing process included content and construct validation, conducted by the teachers to assess the feasibility and suitability of the developed e-module. The results of the validators' assessment of the e-module are presented in Table 5 below:

Referring to Table 5, the content validity results indicate that the average percentage of assessments across the three validators was 93.00%, placing it in the very valid category. A very valid category indicates that the e-module's material, design, and structure meet expert criteria and are suitable for implementation without significant revisions. The highest percentage was obtained for the content and presentation aspects, 94.00%. This high validity value indicates that the instrument used meets the validity criteria; conversely, a low validity value indicates that the instrument is less feasible. (Jumaniar et al., 2024). The preparation of the e-module based on the local potential of Grenden Village was carried out in line with indicators of basic science process skills, thereby supporting the achievement of learning objectives and minimizing the risk of misconceptions. Furthermore, the material in the e-module is carefully structured to avoid misunderstandings and multiple interpretations by students. (Suryani et al., 2022).

Table 5 Result of e-modul validity

No.	Assessment Aspect	Percentage Validity			Percentage (%)	Category
		Validator 1	Validator 2	Validator 3		
I	Content	1.00	0.92	0.92	94.00	Very Valid
II	Material	0.875	0.92	0.92	90.30	Very Valid
III	Presentation	0.92	1.00	0.92	94.00	Very Valid
IV	Language	0.92	1.00	0.83	92.00	Very Valid
V	Graphics	0.85	0.95	0.95	92.00	Very Valid
	Average	0.91	0.96	0.91	93.00	Very Valid

Table 6 The results of the e-module practicality test

Activity Assessment	Practicality score at the meeting						Percentage	Category
	1	2	3	4	5	6		
Students open the e-module	75.00	83.33	83.33	83.33	83.33	91.67	83.33	Very Practically
Students work on assignments	73.68	69.47	77.67	78.07	73.33	80.00	75.37	Very Practically
Students conduct the experiment	-	-	83.33	-	75.00	83.33	80.56	Very Practically
Students discuss	58.33	66.67	75.00	83.33	66.67	75.00	70.83	Very Practically
Average	69.01	73.16	79.83	81.58	74.58	82.50	77.52	Very Practically

According to research by Sari et al. (2022)Integrating text and images has been shown to increase student interest in learning and facilitate comprehension of learning materials. Based on this, the e-module based on the local potential of Grenden Village is declared valid and suitable for use in learning activities. Each subtopic in the e-module includes illustrations that serve as supporting visual media to explain key concepts, helping students understand the material more effectively. (Janah, Syarif, & Nuhdi, 2023). A high score on the graphic aspect indicates that the e-module design can attract students' attention and increase learning motivation. The attractive visual design of the e-module also provides a more interactive and enjoyable learning experience than using printed textbooks. (Hati & Setiaji, 2024). Furthermore, the use of language in the e-module must refer to refined spelling rules, avoid the use of ambiguous terms, and choose vocabulary that is simple and easy for students to understand (Ahmad, 2022).

During the validation process, the validators provided several suggestions and comments to improve the e-module's quality. Based on these inputs, several revisions were made. In the material component, additional explanations were included to provide more detailed descriptions of the tools and materials used in the learning activities. In the graphic section, some illustrations were replaced with more representative images that better reflect Puger's local potential. Meanwhile, in the language aspect, corrections were made to the use of capital letters in scientific units, such as capitalizing the unit Joule (J). These improvements were carried out to enhance the e-module's clarity, accuracy, and contextual relevance in representing local potential within science learning.

3.3 Evaluation of the Practicality of E-modules Integrating the Local Potential of Grenden Village

The e-module practicality test assesses how easy the module is to use for teachers and students during the learning process. During classroom implementation, teachers and students were asked to use the e-module directly in learning activities on temperature and heat, which included a practicum on making corn milk as a contextual experiment. The results of the e-module practicality test are shown in Table 6.

The indicators of the ease and effectiveness of the e-module for students during learning can be determined through a practical test. In the next stage of this study, an e-module effectiveness test was conducted to assess achievement of learning objectives, specifically the improvement of students' science process skills related to temperature and heat.

The science process skills instrument was used as a data collection tool to measure effectiveness, which was analyzed through evaluation and calculation using the N-gain formula. In addition, the student response questionnaire was explained using a specific formula to obtain scores and describe students' responses to the e-module. The science process skills test instrument, not the students themselves, was used as the primary tool to collect data on the effectiveness of the developed e-module. The research results showed that students could complete the assignments and draw conclusions from the experiments presented in the e-module. This ease of understanding the material and solving problems was achieved because the e-module included explanations and practice questions for each learning topic. Research by Yuliawati et al. (2020) also found that students felt enthusiastic and enjoyed working through the practice questions in the e-module. The improvement in students' science process skills was analyzed quantitatively using the N-gain formula, which compared pretest and posttest scores to determine the level of learning progress.

3.4 Results of the Effectiveness Test of the E-Module Based on the Local Potential of Grenden Village

The learning objectives can be assessed by testing the effectiveness of electronic modules. This assessment also focuses on improving students' process skills in temperature and heat. The tool used in this assessment is a science process skills test to collect effectiveness data. The data on the effectiveness of the e-module were collected using a science process skills test administered through pretest and posttest procedures. Because the data were non-normally distributed, the Wilcoxon signed-rank test was used. Students' skill improvements were also analyzed and calculated using the N-gain formula. Student response questionnaires were also explained using a specific formula to obtain scores reflecting their responses.

Normality and Significance Test

The pretest and post-test data were first analyzed using the Kolmogorov-Smirnov test to assess normality. The results of the normality test are shown in Table 7. Table 7 shows that the pretest and post-test data are not normally distributed. Therefore, the pre-test and post-test data were further analyzed using the Wilcoxon test.

The researchers used the Wilcoxon test in SPSS 25. A description of the pre-test and post-test values using the Wilcoxon test is shown in Table 8.

From Table 8, it can be seen that the negative ranks between the baseline values for the pre-test and post-test are zero. This value indicates that no students experienced a decline in their pre-test to post-test scores. Meanwhile, the positive ranks indicate that 19 students improved their abilities from pre-test to post-test. Ties indicate no similarity between pre-test and post-test scores, indicating that students' scores were not similar. The Wilcoxon test hypothesis is shown in Table 9. Based on the output, Asymp Sig (2-tailed) is 0.000. Because $0.000 < 0.05$, it can be inferred that there is a difference in students' ability test scores between the pre-test and post-test.

The effectiveness test is based on a science process skills test.

The use of e-modules based on local potential in Grenden Village has had a positive impact, as evidenced by improvements in students' post-test scores. This indicates that the e-modules effectively support the improvement of science process skills. The average results of the students' science process skills test are shown in Figure 7

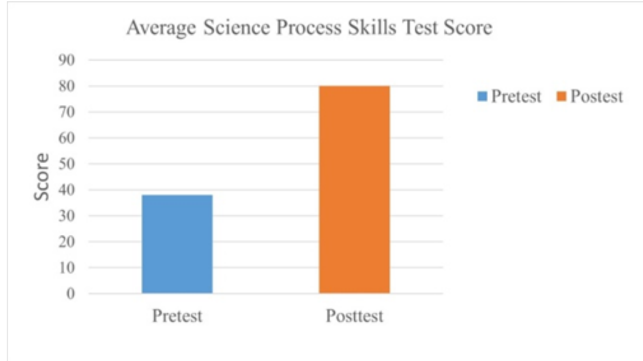

Figure 7 Pre-test and post-test result

Figure 7 shows that the average pretest score was 38. After implementing the e-module tailored to Grenden Village's local potential, the average score increased to 81. The learning effectiveness was then calculated using the N-gain method, with the results presented in Table 10.

Table 10 Result of the N-gain analysis

Average		N-gain <g>	Category
Pre-test	Pos-test		
38	80	0,68	Medium

In addition, the effectiveness data were analyzed for each indicator. The analysis results for each indicator of science process skills are shown in Table 11.

Table 11 Percentage gain by student performance category

Category	Sampel	Percentage
Low (<0,3)	0	0%
Moderate (0,3-<0,7)	11	57,89%
High ((≥ 0,7)	8	42,11%
Total	19	100%

Table 11 shows that the observation indicator achieved the lowest N-gain value, at 0.46, which is categorized as moderate. Conversely, the drawing conclusions indicator representing students' inferential skills achieved the highest N-gain value (0.88) and is classified as high. Based on this classification, the developed product can be categorized as good. The improvement in the inferential skills indicator in this learning was due to students' active involvement in experimental activities at each learning phase. Science process skills can be improved through practical activities that encourage students to observe, identify variables, test hypotheses, and draw independent conclusions. When students actively observe and analyze data, they can more easily relate their findings to scientific principles. (Yunita & Nurita, 2021). Consistent with Senisum (2021)Experimental-based learning can strengthen students' ability to draw accurate conclusions because it provides concrete experience that connects theory with practice. suggests

Table 12 Results of analysis of science process skills indicators

Indicator	Question number	Activity	N	Mean	N-gain	N-gain category
Observe	1	Pretest	19	3	0,46	Medium
		Postest		4		
Calculate	2	Pretest		1	0,63	Medium
		Postest		4		
Classify	3	Pretest		2	0,70	High
		Postest		4		
Predict	4	Pretest		2	0,70	High
		Postest		4		
Communicate	5	Pretest		1	0,62	Medium
		Postest		4		
Conclude	6	Pretest		2	0,88	High

The purpose of the experimental activities in this study was to teach students how to categorize objects by temperature and to understand heat transfer, including the process of making corn milk. To master these skills, students must be able to sort objects based on similarities, differences, and relationships between them. (Fitriana, Zulhelmi, Fakhruddin, & Islami, 2021). Throughout the experiment, students must hone their prediction skills and strive to improve them. According to Matsna et al. (2023)Students can improve their prediction skills by participating in laboratory practical activities and receiving stimulation from specially designed assignments or experiments. Furthermore, when students work on basic experimental assignments, the e-module they receive also allows them to determine the amount of heat and calculate temperature.

The purpose of this study's experimental activities was to teach students how to categorize objects by temperature and to understand how heat is transferred, including how corn milk is made. Students must be able to arrange items according to their similarities, distinctions, and connections to master this skill. (Fitriana et al., 2021). Throughout the experiment, students hone their prediction skills, which will improve over time. Students can enhance their prediction skills by participating in laboratory practicum activities and receiving stimulation from specially created assignments or experiments. Additionally, when students engage in basic experimental tasks, the e-module allows them to determine the amount of heat and calculate temperature.

The results of this study align with the opinion of Firdaus & Subekti (2021), who stated that learning is crucial in guiding students to conduct in-depth research using direct experience to improve their mathematics skills. As shown in Table 12, the observation indicator showed the lowest N-gain value of 0.46, which falls within the moderate category. This low increase in N-gain is due to students having previously participated in visual-based activities and having fairly good observation skills. Students' ease of observation during experiments, which only requires using the senses, also helps improve their science process skills. (Adikalan, Supeno, & Wicaksono, 2022). Overall, the N-gain calculation shows a significant increase in students' science process skills after using the e-module developed based on the local potential of Grenden Village. Qualitative data from classroom observation further revealed that most students were enthusiastic during the experiment but tended to focus on procedural steps rather than on detailed qualitative data recording. Some students reported relying more on visual impressions than on systematic note-taking, which affected the depth of their observational records.

Effectiveness test based on the student response questionnaire.

Effectiveness was also examined in student responses to the developed e-module based on the local potential of Grenden Village. The student response questionnaire included three indicators: an interest indicator with 5 questions, a material indicator with 5 questions, and a language indicator with 5 questions. The results of the student response questionnaire analysis are presented in Table 13. The results of this questionnaire are directly related to the effectiveness of the e-module in improving science process skills because students' perceptions reflect the level of engagement, clarity, and understanding they experienced during learning.

Table 13 Student response questionnaire results

No	Assessment Result	Percentage (%)	Category
I	Interest	90.53	Very Good
II	Material	78.95	Very Good
III	Language	67.37	Good
	Average	78.95	Very Good

High scores on the interest indicator indicate that students were motivated to engage actively with the e-module content, which supports the development of science process skills through inquiry and experimentation. Positive responses to the material indicator show that the content was explicit, relevant, and easy to follow, allowing students to better understand the concepts of temperature and heat transfer. Likewise, favorable ratings on the language indicator suggest the instructions and explanations in the e-module were easy to comprehend, enabling students to carry out scientific procedures independently and accurately.

The results showed the highest scores on the interest indicator, with students rating the e-module as engaging due to its attractive design and well-designed illustrations. This ultimately led to students' high curiosity and enthusiasm during the learning process. According to Widiana & Rosy (2021). An attractive module design fosters students' interest in learning, increases their intrinsic motivation, and significantly improves learning outcomes. This suggests that visual and structural elements of educational materials are crucial in facilitating effective student engagement and academic success.

The highest score was obtained for the interest indicator, where students rated the e-module as engaging due to its attractive design, visual consistency, and well-integrated illustrations. This visual appeal successfully stimulated students' curiosity and enthusiasm throughout the learning process. The material indicator also received high ratings, suggesting that students found the content clear, relevant, and easy to understand. The integration of local potential, such as the corn milk-making activity, helped students connect scientific concepts to real-life contexts, thereby enhancing their understanding of heat transfer and temperature changes. The language indicator showed positive results, reflecting that the e-modules' use of simple, clear, and grammatically correct language made it easier for students to follow experimental instructions and record their observations accurately.

4. CONCLUSION

The e-module based on the local potential of Grenden Village, developed to improve science process skills in junior high school students, achieved an average content validity of 93.00%, placing it in the very valid category, and demonstrates that integrating local context into digital learning materials can make science learning more meaningful and relevant to students' daily experiences. The practicality test of the e-module showed an average of 77.52%, indicating that the module is practical to implement. In addition, the N-gain calculation yielded 0.68, which falls within the moderate category. The N-gain calculation results show that students' science process skills improved significantly after learning with the developed e-module. Based on the student response questionnaire, this module achieved an average of 78.95%, which falls within the good category. The module promotes engagement and motivation, supporting active participation in scientific investigations. Thus, this e-module is suitable for school science instruction and can serve as a basis for further research.

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REFERENCES

Abdussamad, S., Lukum, N. B., Dunggio, S., Zohrahayaty, Solikahan, E. Z., & Zainuddin, A. (2024). Pemanfaatan jagung manis menjadi produk susu jagung di Desa Butu Kecamatan Tilong Kabila Kabupaten Bonebolango [Utilization of sweet corn into corn milk products in Butu Village, Tilong Kabila District, Bone Bolango Regency]. *Jurnal Pengabdian Pada Masyarakat Eldimas, 2*(2), 42–51. https://doi.org/10.37915/EJPPM.v2i2

Adikalan, T. H., Supeno, & Wicaksono, I. (2022). Kemampuan inkuiri siswa SMP dalam pembelajaran IPA memanfaatkan media e-LKPD [Junior high school students' inquiry abilities in science learning utilizing e-LKPD media]. *Pedagogi: Jurnal Ilmu Pendidikan, 22*(1), 39–45. https://doi.org/10.24036/pedagogi.v22i1.1271

Ahmad, Z. (2022). Pengembangan modul pembelajaran sejarah terintegrasi Islam pada sekolah menengah atas di Kota Batam [Development of Islamic integrated history learning modules at senior high schools in Batam City]. *Jurnal An-Nur, 10*(2), 31–38. http://dx.doi.org/10.24014/an-nur.v10i2.15459

Arikunto, S. (2008). *Dasar-dasar evaluasi pendidikan* [Fundamentals of educational evaluation]. Jakarta, Indonesia: Bumi Aksara.

Asyhari, A., & Silvia, H. (2016). Pengembangan media pembelajaran berupa buletin dalam bentuk buku saku untuk pembelajaran IPA terpadu [Development of learning media in the form of bulletin in pocket book form for integrated science learning]. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni, 5*(1), 1–13. https://doi.org/10.24042/jpifalbiruni.v5i1.100

Badan Pusat Statistik Kabupaten Jember. (2021). *Data produksi jagung menurut kecamatan di Kabupaten Jember tahun 2020* [Data on corn production by district in Jember Regency in 2020]. Jember, Indonesia: Author.

Barokah, A., Yulistia, A., Putri, S., & Hidayat, M. (2022). Penerapan pendekatan keterampilan proses sains untuk meningkatkan pemahaman konsep siswa pada pembelajaran IPA SD [Application of science process skills approach to improve students' concept understanding in elementary science learning]. *Jurnal Dikoda, 3*(1), 18–31. https://doi.org/10.37366/jpgsd.v3i01.1061

Branch, R. M. (2009). *Instructional design: The ADDIE approach*. New York, NY: Springer Science.

Devitasari, P. I. (2022). Analisis kebutuhan pengembangan web modul IPA terintegrasi tanaman lokal untuk SMP kelas VIII [Needs analysis for the development of web science modules integrated with local plants for 8th grade junior high school]. *Jurnal Al-Mujaddid Humainora, 8*(2), 75–85. https://doi.org/10.58553/jalhu.v8i2.125

Dignam, C., & Makerspace, C. (2025). Makerspace and the 5 C's of learning: Constructing, collaborating, and creatively-thinking. *International Journal of Studies in Education and Science, 6*(1), 104–127. https://doi.org/10.46328/ijses.135

Dini, N. A. I., & Rini, E. F. S. (2024). Integration of local potential in science learning to improve 21st-century skills. *International Journal of Chemistry Education Research, 8*(2), 156–165. https://doi.org/10.20885/ijcer.vol8.iss2.art9

Fauziah, Y. N., Ningrum, E., & Nandi. (2023). Development of e-modules using the STAD learning model to improve ecological competence (aspects of knowledge and attitudes). *Proceedings of International Conference on Education Teacher Training & Education Faculty, 1*(1), 4–7. https://doi.org/10.32672/pice.v1i1.429

Firdaus, N. N., & Subekti, H. (2021). Analisis keterampilan proses sains dan minat belajar siswa pada pembelajaran daring menggunakan media Microsoft Teams [Analysis of science process skills and students' learning interest in online learning using Microsoft Teams media]. *Pensa: Jurnal Pendidikan Sains, 9*(3), 297–303.

Fitriana, D., Zulhelmi, Fakhruddin, Z., & Islami, N. (2021). Hasil belajar keterampilan proses sains siswa berbasis pendekatan inkuiri pada materi teori kinetik gas [Learning outcomes of student science process skills based on inquiry approach on kinetic theory of gases material]. *INKUIRI: Jurnal Pendidikan IPA, 10*(1), 1–12. https://doi.org/10.20961/inkuiri.v10i1.25238

Fuldiaratman, Pamela, I. S., & Lubis, D. M. E. (2023). Blended learning: Interests, responsibilities, and students' metacognitive abilities using the discovery model. *Indonesian Journal of Science Education, 11*(2), 401–420. https://doi.org/10.24815/jpsi.v10i4.27810

Handina, H., & Khotimah, S. N. (2023). Implementation of research-based learning for prospective physics teachers: A case study. *Journal of Science Learning, 6*(4), 457–464. https://doi.org/10.17509/jsl.v6i4.57589

Hati, F. K., & Setiaji, B. (2024). Pengembangan e-modul fisika untuk meningkatkan kemandirian belajar dan kemampuan berpikir kritis peserta didik [Development of physics e-module to improve learning independence and critical thinking skills of students]. *Jurnal Pendidikan Fisika, 11*(1), 56–65. https://doi.org/10.21831/jpf.v11i1.20519

Janah, M., Syarif, A., & Nuhdi, A. (2023). Analisis kesulitan siswa dalam memahami materi IPA dan upaya mengatasinya pada kelas V di MI Islamiyah [Analysis of students' difficulties in understanding science material and efforts to overcome them in class V at MI Islamiyah]. *Tarbituana: Journal of Islamic Education Studies, 3*(1), 75–86. https://doi.org/10.47467/tarbiatuna.v3i1.2182

Jumaniar, J., Rusdianto, & Ahmad, N. (2024). Pengembangan e-modul berbantuan Flip PDF Professional untuk meningkatkan keterampilan proses sains siswa SMP [Development of e-modules assisted by Flip PDF Professional to improve junior high school students' science process skills]. *Jurnal Basicedu, 8*(2), 1094–1104. https://doi.org/10.31004/basicedu.v8i2.7232

Karimah, Setyawan, A., & Handika, I. (2025). Development of a learning module based on local wisdom of Bangkalan. *Eductum: Jurnal Literasi Pendidikan, 3*(4), 239–251. https://doi.org/10.56480/eductum.v3i3.1344

Kurniawati, A. A., Wahyuni, S., & Putra, P. D. A. (2017). Utilizing of comic and Jember's local wisdom as integrated science learning materials. *International Journal of Social Science and Humanity, 7*(1), 47–50. https://doi.org/10.18178/ijssh.2017.7.1.793

Martatiyana, D. R., Usman, H., & Lestari, H. D. (2023). Application of the ADDIE model in designing digital teaching materials. *Journal of Education & Teaching Primary School Teachers, 6*(1), 105–109.

Matsna, F. U., Rokhimawan, M. A., & Rahmawan, S. (2023). Analisis keterampilan proses sains siswa melalui pembelajaran berbasis praktikum pada materi titrasi asam-basa kelas XI SMA/MA [Analysis of student science process skills through practicum-based learning on acid-base titration material for class XI SMA/MA]. *Dalton: Jurnal Pendidikan Kimia dan Ilmu Kimia, 6*(1), 21–30. https://doi.org/10.31602/dl.v6i1.9187

Mdodana-Zide, L. (2024). Using ADDIE model for scaffolded learning and teaching intervention. *Interdisciplinary Journal of Education Research, 6*, 1–15. https://doi.org/10.38140/ijer-2024.vol6.28

Mir, K. J., Fatima, S. A., & Fatima, S. T. (2023). Impact of dual coding strategy to enhance students' retention of scientific concepts in middle schools. *Annals of Human and Social Sciences, 4*(4), 655–666. http://doi.org/10.35484/ahss.2023(4-IV^3

Najuah, Lukitiyo, P. S., & Wirianti, W. (2020). *Prosedur penyusunan dan aplikasinya* [Preparation procedures and their application]. Medan, Indonesia: Yayasan Kita Menulis.

Ningsi, A. P., & Nasih, R. (2020). Mendeskripsikan keterampilan proses sains mahasiswa pendidikan fisika Universitas Jambi pada materi pembiasan pada lensa cembung dengan menggunakan e-modul [Describing science process skills of physics education students at Jambi University on refraction on convex lenses using e-modules]. *Jurnal Penelitian dan Pembelajaran MIPA, 5*(1), 1–9.

Nuayi, A. W. V. (2020). Implementasi model pembelajaran guided inquiri untuk meningkatkan keterampilan proses sains dan hasil pengetahuan kognitif siswa [Implementation of guided inquiry learning model to improve science process skills and cognitive knowledge results of students]. *Jurnal Luminous: Riset Ilmiah Pendidikan Fisika, 1*(2), 1–7. https://doi.org/10.31851/luminous.v1i2.4556

Nuri, L. N. N., Wahyuni, S., & Ridlo, Z. R. (2023). Development of an Android-based mobile learning module to improve the students critical thinking skills. *Jurnal Penelitian Pendidikan IPA, 9*(7), 4991–4998. https://doi.org/10.29303/jppipa.v9i7.2944

Ong, K.-J., Lu, C.-H., Chou, Y.-C., & Chen, K.-J. (2022). Learning environment and course experience vs adaptability, motivation, and creativity: Their contribution to learning effectiveness. *Journal of Integrated Design and Process Science, 26*(1), 1–24. https://doi.org/10.3233/JID-220004

Putri, D. K. Y., Mumtazah, Z., Jannah, D. P. N. M., & Abdullah, L. K. (2023). Pemberdayaan petani melalui inovasi biochar sebagai solusi pengganti pupuk kimia di Desa Grenden Kecamatan Puger Kabupaten Jember [Empowerment of farmers through biochar innovation as a substitute solution for chemical fertilizers in Grenden Village, Puger District, Jember Regency]. *Sewagati, 7*(5), 716–723. https://doi.org/10.12962/j26139960.v7i5.565

Rophi, A. H., Megawati, R., Aiboy, Y. T., Citraningrum, M., & Krisson, E. (2024). Analysis of science process skills of junior high school students. *Journal of Research in Science Education, 10*(5), 2294–2299. https://doi.org/10.29303/jppipa.v10i5.7194

Rosario, K. D. Del, & Chua, E. N. (2023). Case and project-based learning lessons in enhancing science process skills. *International Journal of Science, Technology, Engineering and Mathematics, 3*(3), 79–102. https://doi.org/10.53378/353006

Saleh, A., Yuxin, C., Hmelo-Silver, C. E., Glazewski, K. D., Mott, B. W., & Lester, J. C. (2020). Coordinating scaffolds for collaborative inquiry in a game-based learning environment. *Journal of Research in Science Teaching, 57*, 1490–1518. https://doi.org/10.1002/tea.21656

Santiawati, Yasir, M., Hidayati, Y., & Hadi, W. P. (2022). Analisis keterampilan proses sains siswa SMP Negeri 2 Burneh [Analysis of science process skills of students of SMP Negeri 2 Burneh]. *Jurnal Natural Science Educational Research, 4*(3), 222–230. https://doi.org/10.21107/nser.v4i3.8435

Sari, A. P., Wahyuni, S., & Budiarso, A. S. (2022). Pengembangan e-modul berbasis blended learning pada materi pesawat sederhana untuk meningkatkan keterampilan berpikir kritis siswa SMP [Development of e-modules based on blended learning on simple machines material to improve critical thinking skills of junior high school students]. *SPEKTRA: Jurnal Kajian Pendidikan Sains, 8*(1), 10–18. https://doi.org/10.32699/spektra.v8v2.228

Senisum, M. (2021). Keterampilan proses sains siswa SMA dalam pembelajaran biologi [Science process skills of high school students in biology learning]. *Jurnal Pendidikan dan Kebudayaan Missio, 13*(1), 76–89. https://doi.org/10.36928/jpkm.v13i1.661

Sinurat, L., Sriyati, S., & Solihat, R. (2023). Pengembangan modul berbasis keterampilan proses sains untuk meningkatkan kemampuan pemecahan masalah berdasarkan realitas lokal Danau Toba [Development of modules based on science process skills to improve problem solving abilities based on local reality of Lake Toba]. *Lectura: Jurnal Pendidikan, 14*(1), 1–14. https://doi.org/10.31849/lectura.v14i1.10889

Sofyan, H., Anggereini, E., & Saadiah, J. (2019). Development of e-modules based on local wisdom in central learning. *European Journal of Educational Research, 8*(4), 1137–1143. https://doi.org/10.12973/eu-jer.8.4.1137

Suryani, L., Noer Hodijah, S. R., & Taufik, A. N. (2022). Pengembangan e-modul IPA berbasis science process skills dengan tema transportasi hijau untuk melatih keterampilan komunikasi sains siswa SMP kelas VIII [Development of science e-modules based on science process skills with green transportation theme to train science communication skills of grade VIII junior high school students]. *Pendipa Journal of Science Education, 6*(2), 322–330. https://doi.org/10.33369/pendipa.6.2.322-330

Tul'adawiyah, R., Nurihsan, J., & Budiman, N. (2024). Student boredom in elementary school: Implications for school counseling practices. *Konselor, 13*(3), 284–298. https://doi.org/10.24036/0202413392-0-86

Wasthi, S. N., Burhanuddin, Loka, I. N., & Sofia, B. F. D. (2023). Pengembangan e-modul kimia berbasis keterampilan proses sains pada materi senyawa hidrokarbon [Development of chemistry e-module based on science process skills on hydrocarbon compounds material]. *Chemistry Education Practice, 6*(2), 248–253. https://doi.org/10.29303/cep.v6i2.5535

Widiana, F. H., & Rosy, B. (2021). Pengembangan e-modul berbasis flipbook maker pada mata pelajaran teknologi perkantoran [Development of e-modules based on flipbook maker on office technology subjects]. *Edukatif: Jurnal Ilmu Pendidikan, 3*(6), 3728–3739. https://doi.org/10.31004/edukatif.v3i6.1265

Wijaya, I. K. W. B., & Fajar, A. M. (2020). Pengembangan modul pembelajaran berorientasikan problem based learning (PBL) untuk meningkatkan keterampilan proses sains siswa pada materi cahaya dan alat optik [Development of learning modules oriented towards problem based learning (PBL) to improve students' science process skills on light and optical instruments material]. *Quantum: Jurnal Inovasi Pendidikan Sains, 11*(1), 8–17. https://doi.org/10.20527/quantum.v11i1.7568

Yuliawati, L., Aribowo, D., & Hamid, M. A. (2020). Analisis kebutuhan pengembangan media pembelajaran e-modul berbasis Adobe Flash pada mata pelajaran pekerjaan dasar elektromekanik [Needs analysis for the development of e-module learning media based on Adobe Flash on basic electromechanical work subjects]. *Jurnal Pendidikan Teknik Elektro, 5*(1), 35–42. https://doi.org/10.25273/jupiter.v5i1.6197

Yunita, N., & Nurita, T. (2021). Analisis keterampilan proses sains siswa pada pembelajaran daring [Analysis of students' science process skills in online learning]. *Pensa E-Jurnal: Pendidikan Sains, 9*(3), 378–385.