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Development of Science E-Modules Based on Local Potential to Improve Student's Science Literacy

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ABSTRACT

A person who is science literate is able to comprehend, apply science concepts and solve problems related to science. Learning that integrates science literacy can help students provide scientific explanations AND draw conclusions based on scientific evidence. Local potential integrated into science learning can help students connect scientific knowledge with the cultural context in everyday life. This study attempts to evaluate the validity, practicability, and effectiveness of local potential-based science E-Modules to enhance junior high school students' science literacy. This research uses the ADDIE development approach which comprises five stages analysis, design, development, implementation, and evaluation. The validators of this study consisted of 3 validation experts. The instruments used in this research include validation sheets, observation sheets, student response questionnaire sheets, test results sheets. The validity stage carried out by the validator includes 2 aspects, namely content validity and construct validity. The results obtained were (1) the percentage of validation test was 86.25% with a very valid category; (2) the percentage of practicability test was 90.1% with a very practical category; (3) the percentage of effectiveness test on pretest and posttest was 0.68 with a moderate category and the response of students reached 88.22% with a very positive category. Based on the results of data analysis obtained, the science E-Modules based on local potential developed is said to be very valid, very practical, and effective enough to improve students' science literacy so that it can be used in science learning.

INTRODUCTION

The requirements for 21st-century scientific advancement are oriented towards technology and science. Every society is required to be able complete to become a superior, qualified and trustworthy individual. In the 21st century, particularly with regard to education, one of the abilities needed is science literacy, Science literacy is defined as a person's ability to use their knowledge to formulate new ideas, formulate scientific explanation for question, analyse existing ones, draw conclusions based on scientific data, and cultivate different mindset so that they can contribute to solving various issues related to science (Yusmar & Fadilah, 2023). Paul de Hart Hurt of Stanford University introduce the term "scientific literacy" and defined it as an interpretation of science and how to apply it to meet the needs of society. Science literacy as a basic skill that every individual must have includes the ability to analyze and interpret science phenomena that are well obtained. Students who have high science literacy skills will find it easy to link science, technology, and society (Herdiana et al., 2021).

Internationally, the level of science literacy of Indonesian students has begun to improve from before. Based on the test results conducted by the Program for International Student Assessment (PISA). The PISA results in 2022 revealed that Indonesia's literacy ranking had increased by 5 to 6 levels compared to the results in 2018 which showed the resilience of the Indonesian education system (Putra et al., 2024) . However, Indonesia's literacy score was the

lowest when compared the previous year, which decreased by 13 points or equivalent to the international average which fell by 12 points due to the pandemic (Amelia et al., 2023).

Any factors that causes science literacy in Indonesian students to remain low are the selection of teaching materials that are less relevant, learning methods that are less contextualized, and students' low reading ability. Most science learning in Indonesia refers to textbooks in the form of texts compared to direct learning (Fuadina et al., 2022). This is related to the results of interviews with science teachers at Junior High School 2 Puger, who explained that seventh grade students have a low level of science literacy, because the learning process uses textbooks and other conventional teaching materials. The learning process is still mostly focused on the teacher so that students are not trained to learn independently.

The application of contextualized learning in the classroom can help in improving students' science literacy, for example, local potential-based science learning. The application of local potential to enhance learning can be integrated through the development of Science E-Modules as well as a bridge between scientific knowledge and students' daily environmental conditions. (Permataningsih et al., 2021) mentioned that integrating local potential in learning can increase their interest in local wealth and internalize the values of local potential. Lestari et al., (2023) in their research stated that E-Modules based on local potential can improve students' science literacy. This is because the teaching material presents learning materials accompanied by images, videos, and case examples combined with the local potential of the local area so that it can increase student learning motivation.

Teaching materials are learning resources that are utilized by students and teachers achieving learning objectives. One form of teaching material is a module which is independent learning unit. Currently, modules have developed in various formats, such as E-Modules. E-Modules are learning media in digital format designed with use electronic device to support in the educational learning process (Wahyuni et al., 2022). The use of E-Modules offers better flexibility, interactivity and accessibility compared to conventional modules. The development of local potential-based science E-Modules is designed by utilizing local wealth that can increase the relevance of learning to students' daily activities, making it easier for them to understand scientific concepts. The presentation of teaching materials in the form of electronic modules designed with reference to local potential can be used as an alternative to enhance students' science literacy. The effective use of E-Modules can provide solutions to limited resources and infrastructure in remote area schools, and help improve students' abilities to contend in global rivalvy throughout the Industrial Revolution 4.0 (Permataningsih et al., 2021).

Some previous studies proved that the STEM approach integrated in the module can develop students' science literacy. Abdi et al., (2023) explained in their research that using E-Modules based on the STEM approach has been proven to develop students' science literacy regarding the digestive system. However, this research has not been associated with learning based on local potential. Therefore, this study was conducted to address this shortcoming and produce a product combining E-Modules based on local potential of Puger's with the STEM approach that focuses on the utilization of soybean crops. Putri et al., (2022) mentioned that STEM-integrated learning contains steps that can improve science literacy. Additionally, improving science literacy can enhance students' ability to apply scientific knowledge to make decisions related to their surroundings. Integrates the STEM approach can also improve students' science literacy because learning using the STEM approach includes steps that can support students' science literacy In addition, increasing science literacy in students can hone their ability to utilize science knowledge to make decisions related to the surrounding nature.

This research's goal is to generate teaching materials in the form of E-Modules of Science based on local potential that are valid, practical, and effective to enhance the science literacy of junior high school students. The development of local potential-based science E-Modules is

designed by utilizing local wealth that can increase the relevance of learning to students' daily activities, so that it can facilitate students in understanding scientific concepts.

METHODS

Research Design

The type of research used is development research (Research and development). The research design uses five stages of ADDIE models, which consist of (1) Analyze, (2) Design, (3) Develop; (4) Implement, and (5) Evaluate. The results of the research conducted include validation result data (product validity, evaluation question validity, and learning device validity), practicality result data, and effectiveness result data. The development model uses the ADDIE design according to Branch (2009) which is presented as follows.

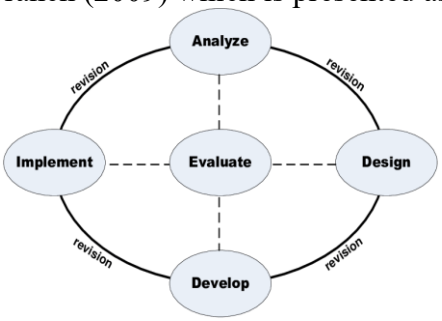

Figure 1. ADDIE Development Research Model (Branch, 2009)

Research Target

The population of this study were all seventh grade students at Junior High School 2 Puger. The research sample was selected using purposive sampling technique, namely students of class VII C as many as 36 people. The determination of the research sample was based on several criteria, including the number of students suitable for obtaining valid data without requiring a large population and class VII C was considered representative to measure effectiveness because it reflected the diverse ability levels of students. The validators of this study consisted of 3 validation experts with the object of research, namely the Science E-Module based on Puger's local potential with the STEM approach.

Research Data

Data collection techniques were carried out by researchers to determine the level of validity, practicality, and effectiveness of the science E-Modules based on local potential. The data collection methods used were test and non-test methods. The non-test method was used to determine student needs, validity, and practicality. The test method is used to determine the ability of students in classroom learning.

Research Instruments

The instruments used in this research include validation sheets, observation sheets, student response questionnaire sheets, test results sheets. Validation sheets are used to assess the suitability of material / content, language, and constructs on learning devices and E-Modules filled in by expert validators. The observation sheet is assessed by the observer during the implementation of learning in the classroom to determine that the developed product can be used optimally. Student response questionnaire sheet is used to measure the level of student satisfaction with learning by using the developed E-Modul. Test results sheet (*pretest* and *posttest*) is used to measure the increase in student science literacy after using the developed E-Modul.

Data Analysis

The validity stage carried out by the validator includes 2 aspects, namely content validity and construct validity. The results of the data values given by the validator through the validation sheet will then be analyzed using calculations from relevant theories. The calculation formula for analyzing validity is as follows:

$$\text{Vah} = \frac{\text{Tse}}{\text{Tsh}} \times 100\%$$

Description:

Vah = Validity percentage

Tse = Final score attained

Tsh = The highest score

Then the percentage results of E-Modules validity obtained from validators are then categorized based on the table below.

Table 1. Criteria for E-Modules validity

Validity Percentage (%)	Category
85,01 ≤ V ≤ 100,00	Very Valid
70,01 ≤ V ≤ 85,00	Valid
50,01 ≤ V ≤ 70,00	Less Valid
20,00 ≤ V ≤ 50,00	Invalid

(Pratama et al., 2022)

The results of the practicality of the E-Modules are based on the activity implementation sheet assessed by three observers through observation during learning activities and calculated using the equation as follows:

$$\text{P} = \frac{\text{TSe}}{\text{TSh}} \times 100\%$$

Description:

P = Percentage of practicality

TSe = Final score attained

TSh = The highest score

Then the percentage results of the practicability of using the E-Modules obtained will then be categorized based on the criteria as shown in the table below.

Table 2. E-Modul practicality criteria

Practicality percentage (%)	Criteria
80 < P ≤ 100	Very practical
60 < P ≤ 80	Practical
40 < P ≤ 60	Practical enough
25 < P ≤ 40	Not practical

(Choiroh et al., 2024)

The improvements in students' science literacy, as measured by the outcomes of the pretest and posttest, indicate the effective of E-Modules were analyzed applying the N-Gain calculation as follows:

$$\text{N} - \text{Gain score} = \frac{\text{posttest score} - \text{pretest score}}{\text{maximum score} - \text{pretest score}} \times 100\%$$

The results of the N-Gain score obtained are then normalized and categorized according to the criteria in the following table.

Table 3. N-Gain score criteria

N-Gain	Criteria
0,7 ≥ (g)	High
0,3 ≤ (g) < 0,7	Medium
(g) < 0,3	Low

(Hake, 1998)

The results of the effectiveness of the E-Modules obtained from student responses on a questionnaire sheet with assessment indicators including appearance, content/material, and language. The student response questionnaire will then be analyzed using a Likert scale with a total scale choice of 4 points through the following formula :

$$\text{Percentage of student response (R)} = \frac{\text{Total score obtained}}{\text{Total maximum score}} \times 100\%$$

The results of the student response questionnaire scores obtained are then categorized based on the table below.

Table 4. Student respons criteria

Response percentage (%)	Student's response criteria
80 < R ≤ 100	Very positive
60 < R ≤ 80	Positive
40 < R ≤ 60	Positive enough
25 < R ≤ 40	Not positive

(Choiroh et al., 2024)

RESULTS AND DISCUSSION

This research results in the form of an electronic module (E-Modules) of science based on local potential with an approach that aims to support learning activities, especially in improving the science literacy of junior high school students. The development research was carried out for students of class VII C at SMP Negeri 2 Puger during the odd semester of the 2024/2025 academic year. This research focuses on the extent to which the products developed can meet the criteria of being valid, easy to apply in learning, and can increase students' understanding of science concepts in the context of local potential.

a. Analysis Stage

The first stage begins with analyzing the curriculum, problems and needs, and student characteristics which are carried out through observation and interviews with the science teacher of SMP Negeri 2 Puger. The results of curriculum analysis prove that grades 7 and 8 have implemented the Merdeka Curriculum, while grade 9 still uses the 2013 Curriculum. Student analysis obtained through interviews with science teachers explains that students in class VII C SMP Negeri 2 Puger experience many difficulties in learning, one of which is that they easily feel bored due to the teaching materials used being too monotonous and there is no renewal. In addition, the results of the needs and problem analysis obtained prove that the level of science literacy of seventh grade students at SMP Negeri 2 Puger is still low. This is because the use of teaching materials is still conventional such as textbooks and has never applied E-Modules based on local potential with a STEM approach. The use of teaching materials is not associated with technology and only contains general learning material. Exercise questions that are applied also refer to printed books so that students tend to get bored and tend to be passive in learning.

Observation of Grenden Village was also conducted at the analysis stage to obtain information needed in the product development process. The observation results showed that Grenden Village has local potential, most of which are engaged in the agricultural sector. One of the crops of interest in this village is corn, soybeans, peanuts, mustard greens, and tobacco. Corn and soybeans are local food sources with high nutritional value and have the potential to be processed into innovative products, such as multigrain tempeh. Multigrain tempeh products have considerable benefits because their nutritional content can help meet the nutritional needs of children, especially during the growth period so that they can be an alternative in preventing stunting in Grenden Village. Multigrain tempeh made from a mixture of grains, one of which is corn and soybeans, which is the local potential of Grenden village, has a strong scientific relevance in improving science literacy. This is because the process of making multigrain tempeh involves various science concepts, such as the fermentation process, nutritional changes in the loading material, as well as processing and packaging. Through this learning, students are trained to think critically, conduct experiments, and analyze data so as to strengthen applicable science literacy.

b. Design Stage

The second stage is done by designing the E-Modules based on the results of the analysis. At this stage, text and images are integrated systematically while still paying attention to the layout so that it is not too dense, but still informative and comfortable to read. The documentation included taken directly in Grenden Village. The preparation of the Science E-Modules involves several parts, including instructions for use, learning outcomes, learning objectives, concept maps, table of contents, material descriptions, and student activities that have been adjusted to science literacy indicators by integrating STEM aspects. The E-Modules is prepared on the material of Substances and their Changes for class VII which is integrated in the local potential of Grenden Village in the form of making multigrain tempeh. The following is the display design of the developed Science E-Modules.

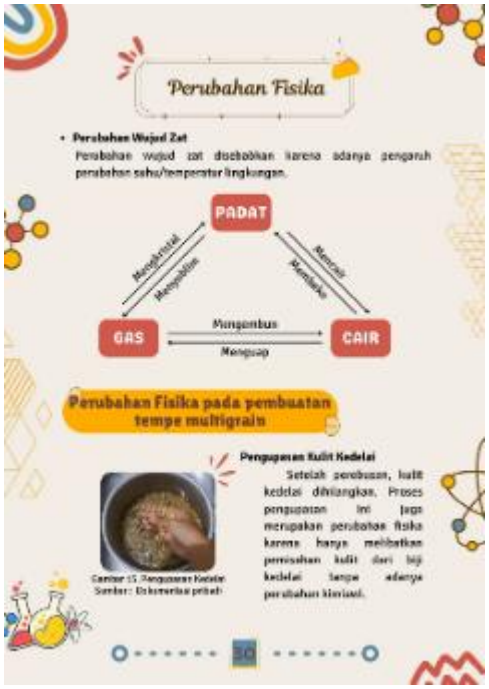

Figure 2. Display of the E-Modules

Science E-Modules based on local potential with a STEM approach that have been compiled through the Canva editing platform, will be converted into PDF format and uploaded on the Flip PDF Professional platform to make edits, including inserting learning videos, links access tasks and questions integrated with the *Live worksheet* platform, and adding navigation buttons. Then, the E-Modules that has been completed will be uploaded online and published so that it will get a link to access the E-Modules. Research conducted by Paramitha et al., (2023) states that the Canva application as a medium in making E-Modules was chosen because it is able to display text, images, videos, illustrations, music, and animations that can help improve student understanding of learning materials. In addition, electronic learning media makes the content presented more visually appealing and provides convenience for users to be able to access anywhere and anytime (Yuliana et al., 2023).

c. Develop Stage

The outcomes from Local Potential Based Validation Test of Science E-Modules

The development product in the form of Science E-Modules based on local potential with STEM approach will then go through the validation stage by expert validators. There were three validators who conducted the process of validation using a validation sheet with a Likert scale to determine the feasibility of the developed module. Validation is carried out on a Likert scale with a range of assessment scores from 1 to 5, where a score of 1 means that it is included in the "invalid" criteria and a score of 5 includes "very valid" criteria. Some components that will be validated include the flow of learning objectives (ATP), teaching modules, pretest and posttest questions that have been prepared in accordance with science literacy indicators, as well as teaching materials in the form of local potential-based science E-Modules. Some suggestions and input given by validation experts as revision material include, among others, the sources listed on the images contained in the E-Module are more concerned, the mention of important terms in the E-Module is corrected, and the mathematical aspects in the E-Module are more reproduced.

Table 5. Local potential based E-Modules validation results

Assessment aspect	Validity Score (%)			Average (%)	Category
	V1	V2	V3		
Content	72,5	92,5	95	86,67	Very Valid
Material	84	92	88	88	Very Valid
Presentation	70	93,33	93,33	85,56	Very Valid
Language	80	88,57	89	85,71	Very Valid
Graphics	80	88	88	85,33	Very Valid
Average score (%)	77,3	90,08	90,67	86,25	Very Valid

The validity outcomes of local potential-based science E-Modules earned an average score of 86,25% with very valid criteria but still required minor improvements according to the suggestions of the validator. In content validity, it gets very valid criteria with an average score of 86,67%. Research by Wulandari et al., (2023) says that teaching materials can be said to be good when they match the skills, learning goals, and thinking level of students. While construct validity includes aspects of material, presentation, language, and graphics respectively obtaining an average score of 88%, 85,56%, 85,71%, and 85,33%, Science E-Modules based on local potential are said to be very valid because of their systematic presentation, clear language use, and organized graphic structure. According to Sherliyanti & Jauhariyah (2023) the validity of a product in the construct aspect can be seen in the components that make up the product are interconnected and arranged systematically.

d. Implement Stage

Practicality Test Results of Science E-Modules based on local potentials

The practicality test of local potential-based science E-Modules was conducted through filling out the implementation observation sheet by three observers from undergraduate science education students. According to Kurniawati et al., (2021) the involvement of observers in observing learning activities aims to ascertain whether the use of E-Modules is applied practically and effectively in the learning process. The implementation of product trials was conducted on class VII C students totaling 36 people at SMP Negeri 2 Puger on the material of substances and their changes. The results from the practicality of learning using local potential-based science E-Modules are presented in table 6 below:

Table 6. Practicality results of local potential based E-Modules

Assessment Activities	Meeting- (%)						Average (%)	Criteria
	1	2	3	4	5	6		
Introduction	91,7	91,7	91,7	91,7	89,6	97,9	92,4	Very Practical
Core Activities								
a. Observe and describe phenomena scientifically in the material contained in the E-Modules	75	91,7	100	91,7	75	91,7	87,5	Very Practical
b. Doing homework as an exercise to practice science literacy	-	-	75	100	-	91,7	88,9	Very Practical
c. Designing and evaluating problems in the task section of the E-Modules	91,7	91,7	91,7	100	100	83,3	93,1	Very Practical
d. Delivering the results of the assignment in evaluate problems in E-Modules	83,3	91,7	91,7	91,7	83,3	75	86,1	Very Practical

Assessment Activities	Meeting- (%)						Average (%)	Criteria
	1	2	3	4	5	6		
e. Respond to results evaluation problems from other learners	91,7	75	75	83,3	91,7	91,7	84,7	Very Practical
f. Ask questions related to the overall material	91,7	83,3	100	91,7	83,3	100	91,7	Very Practical
Closing	96,7	96,7	96,7	98,3	91,7	90	95	Very Practical
Average score (%)	88,8	89,6	91,9	90,9	89,1	90,0	89,9	Very Practical

The data analysis results from the implementation of learning by using E-Modules of Science based on local potential showed an average percentage value of the entire meeting of 89,9% which was classified as very practical. Thus, the outcomes data shown in table 6 prove that E-Modules based on Puger's local potential can be implemented in learning according to plan. The statement by Kurniawan & Syafriani (2021)also strengthens the results of the study that the practicality of a teaching material is assessed from the ease of use and the form of the teaching material.

e. Evaluate Stage

Effectiveness Test Results of Science E-Modules based on local potentials

The effectiveness test was conducted to measure the effectiveness of the use of local potential-based science E-Modules with a STEM approach in learning. At this stage, 2 activities were carried out, namely formative tests and student response questionnaire sheets. Formative tests were conducted in the form of pretest and posttest to obtain data on the results of improving science literacy skills in students. The formative test results obtained were then analyzed using the N-Gain calculation and presented in table 7.

Table 7. E-Modul effectiveness test results

Component	Average score a science literacy		N-Gain	Criteria
	Pretest	Posttest		
Number of students	36	36	0,68	Medium
Lowest score	25	67		
Highest score	91	100		
Average N-Gain score	61,80	87,13		

Based on table 7 above, the N-Gain score of students in class VII C SMP Negeri 2 Puger, totaling 36 students, was recorded at 0,68 with moderate criteria. The results of the N-Gain score indicate that students' science literacy has increased after using the local potential-based science E-Modules. Details of the pretest score showed that the lowest score 25 and the highest score was 91 with an average pretest score of 61,80. Meanwhile, the posttest score was recorded at 67 on the lowest score and 100 on the highest score with an average posttest score of 87,13. The data obtained was also used to analyze the N-Gain score on each science literacy indicator. The results of the achievement of science literacy indicators on pretest and posttest questions are presented in table 8 below.

Table 8. N-Gain analysis on science literacy indicators

Science Literacy Indicators	Average score		N-Gain	Criteria
	Pretest	Posttest		
Describe phenomena with a scientific approach	59,72	88,54	0,72	High
Evaluate and design scientific investigations	68,06	79,17	0,35	Medium
Interpret data and evidence scientifically	58,33	92,71	0,83	High

Based on table 8 above, the N-Gain value on the indicator of describing phenomena with a scientific approach gets a score of 0,72 which is classified as high. In the indicator of evaluating and designing scientific investigations, the score is 0,35 which is classified as medium. The indicator of interpreting data and evidence scientifically received a total score of 0,83 in the high category. This is because the learning process focuses on problem-solving and data analysis to encourage critical thinking. These results are in line with the opinion according to Niate & Djulia (2022) which states that the indicator of interpreting data and evidence scientifically requires students to have the ability to process data, draw conclusions, and evaluate evidence so that it can help students prove the truth in a data.

The indicator of describing phenomena with a scientific approach obtained an N-Gain score in the high category of 0,72. This is because the method used in learning is not only about memorizing theories, so that it can help students to relate scientific concepts to real life. In accordance with the statement Niate & Djulia (2022) which explains that the indicator of describing phenomena with a scientific approach requires students to be able to explain knowledge accompanied by reasons, so that students not only memorize concepts, but also provide an understanding of the benefits of knowledge for society. While the indicator of evaluating and designing scientific investigations received the lowest N-Gain score of 0,35 in the moderate category because this skill requires a deep understanding of the scientific method.

The results of the effectiveness of the use of E-Modules of Science based on local potential with the STEM approach can also be measured through the responses given by students. The response was obtained from the results of a questionnaire sheet filled out by students to find out their perceptions of the use of E-Modules based on local potential with the STEM approach during the learning process. The results of the effectiveness analysis obtained from the student response questionnaire are presented in table 9 below.

Table 9. the results of the student response questionnaire

Assessment aspect	Average score (%)	Criteria
Display	88,19	Very positive
Content/Material	87,93	Very positive
Language	88,54	Very positive
Average student response	88,22	Very positive

The results of the effectiveness analysis were also obtained from a response questionnaire by 36 students of class VII C SMP Negeri 2 Puger after using teaching materials in the form of E-Modules based on local potential. The average percentage of overall score obtained is 88,22% with very positive criteria. In the display aspect, the score is 88,19% which is classified as very positive, the content/material aspect scores 87,93%, and the language aspect scores 88,54% which is classified as very positive. Based on the data from the analysis of student responses obtained through filling out questionnaires, it is known that the E-Modules based on local potential with the STEM approach developed is effective for use in learning. This is because in terms of appearance, the E-Modules developed already contains visuals and designs that are relevant to the students' environment so that it can help increase their interest in learning.

Based on the data from the analysis of student responses obtained through filling out questionnaires, it can be said that the E-Module based on Puger's local potential with a STEM approach developed is effective for use in classroom learning, because in terms of appearance, the E-Module developed has contained visuals and designs that are relevant to the student's environment so that it can help increase their interest in learning. In terms of content/material, this E-Modules presents applicable material and is directly related to the surrounding environment so that students are easier to connect theory with simple practice through STEM-based projects. In addition, in terms of language, this E-Modules uses simple and communicative sentences that are adapted to the level of understanding of students so that it makes it easier for them to follow the learning flow independently. In line with research conducted by Choiroh et al., (2024) which states that the assessment of learner responses which includes aspects of interest, motivation, satisfaction, and responses obtained an average score of 78,5% student response assessment which is classified in the positive category. The high score indicates that the developed product can be used in classroom learning activities.

CONCLUSION AND RECOMMENDATIONS

According to the outcomes of this research and development of local potential-based science E-Modules using a STEM approach to enhance junior high school students' science literacy, the conclusion obtained is that the E-Modules has been very valid with a validity score of 86,25% because it includes aspects of STEM and local potential, and has been presented in electronic form that can be accessed via smartphone. The practicality test obtained an average score of 90,1% which is included in the very practical criteria. The effectiveness test obtained an N-Gain score of 0,68 with medium category and student responses obtained an average score of 88,22% in the very positive category. Therefore, the local potential-based science E-Modules product with the STEM approach can be used in the learning process as an innovation to improve students' science literacy for future research, e-modules can be developed using a STEM approach based on regional potential.

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