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Development of Web-Based Modules to Improve Digital Literacy and Learning Outcomes in Science Learning

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Abstract: This study aims to produce e-modules for science lessons that are valid, practical, and effective to improve junior high school students' digital literacy and learning outcomes. This study used research and development methods with the ADDIE model. The data collection techniques were observation, interviews, validation sheets, student activity sheets using e-modules, learning outcomes tests, digital literacy assessment rubrics, student response questionnaires, and documentation. The data analysis techniques used in this study were validity test techniques, practicality tests and effectiveness tests. The results of the validation data analysis obtained a validation value of 91% with a very valid category, including aspects of content and construct validation. The practicality analysis results obtained a value of 91.20% with an efficient category. The results of the effectiveness analysis were based on the increase in learning outcomes, which resulted in an n-gain of 0.61 with a moderate category. Meanwhile, the results of the effectiveness analysis based on the ability of digital literacy indicators got an n-gain of 0.71 with a high category. The results of the effectiveness analysis were seen from student questionnaires, which scored 83.23% in the excellent category. Thus, the e-module product that has been developed is said to be feasible to be implemented in junior high school science learning to improve digital literacy and learning outcomes of junior high school students.

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Introduction

Digital literacy is the skills and abilities of individuals to obtain, interpret, and use information in various types, channels, and formats from multiple sources when displayed through a digital and computing network (Falloon, 2020; Setiadi et al., 2022). Digital literacy skills can be said to be individual skills to find, evaluate, and compile information in the form of writing and other media on various digital programs or platforms and the internet (Tsankov & Damyanov, 2017) in a healthy, polite, intelligent, efficient, accurate, and rule-abiding manner to facilitate communication and learning in daily activities (Yunita & Watini, 2022). Alt & Raichel (2020) stated that digital literacy can increase knowledge, which requires students to have critical thinking skills in acting, behaving, and engaging on digital platforms that are developing at this time. Therefore, digital literacy is an essential competency component in life.

The rapid development of information and communication technology is a challenge and opportunity in various dimensions. Education development, especially at the junior high school level, can allow educators and students to give a new nuance during learning. Digital literacy is part of the current educational development. Digital literacy can improve thinking

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critically and comprehensively (Syaifuddin et al., 2022; Techataweewan & Prasertsin, 2018). For educators, digital literacy offers simplicity and success in designing, Realizing, and evaluating classroom learning activities. In addition, learning planning, designing teaching materials, and developing simple learning media can increase interest in the material being taught. Educators who master technology can easily prepare and create exciting teaching materials and learning media by utilizing images, videos, or music as teaching materials and resources as needed (Harjono, 2018).

The primary paradigm of education in Indonesia has not been maximized because learning activities carried out in the classroom do/ not provide an opportunity for students in the field of science to be taught. In science subjects, students are less than optimal in gaining new experiences in the classroom. The results of the Kominfo survey 2022 show that digital literacy in Indonesia has increased from the previous year, namely from an index of 3.49 to 3.54 on a scale of 5. However, the index is still in the medium-level category or relatively low. Therefore, there is a need to improve digital literacy in Indonesia (Katadata Insight Center, 2023). The lack of integration of digital literacy in education causes the lack of ability to use digital literacy in science learning. One way to combine digital literacy with classroom learning is by designing and compiling digital technology-based teaching materials (Wahyuni et al., 2022; Webb et al., 2017).

In addition to low digital literacy, student learning outcomes in science subjects are still unsatisfactory. Based on the 2018 PISA study findings, Indonesia is ranked 70 out of 78 countries in science, which shows the low science learning outcomes of Indonesian students. Several factors influence expected student learning outcomes. According to El Widad et al. (2023), learning is dominated by teacher explanations, memorization of material from books, and the main focus on material and questions in books and student worksheets, which are some factors for low learning outcomes. The lack of experimental activities results in the understanding of the material taught by the teacher, thus causing a decrease in student learning outcomes. Teachers are also still focused on completing the subject matter quickly. As a result, students have little experience in the learning process and have less understanding and mastery of learning materials. These various phenomena are the main problems that cause the value of science learning outcomes in Indonesia to be low. Teaching materials with monotonous learning media are also included in the expected improvement in digital literacy and student learning outcomes due to the lack of varied and interactive teaching materials, so students have more difficulty understanding the material, and learning becomes boring (Pratiwi et al., 2020).

Several previous studies offer alternative solutions to solving the problem of low digital literacy and student learning outcomes in the learning process (Gemikonakli et al., 2020; Podgorny & Volokhova, 2020). According to research by Wahyuni et al. (2022), mobile learning modules effectively improve digital literacy. However, when viewed from the analysis, it is still not optimal for mastering concept understanding. Therefore, the module utilizes electronic media that can provide a more precise interpretation so that students can understand and interpret events correctly. According to Kale et al. (2021), the design of making e-modules based on digital literacy and learning outcomes that can be enhanced through Google Sites to encourage students to be able to use and utilize technology simultaneously so that students can analyze by looking at simulations, images or videos according to actual phenomena. Google Sites is a web-based online learning platform. Learning with Google Sites innovation can integrate learning with digital literacy. This is expected to improve digital literacy and learning outcomes (Adzkiya & Suryaman, 2021).

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Based on the description of the problems above, the use of e-module media based on Google Sites has the potential to improve digital literacy and science learning outcomes in science learning. For this reason, the development of web-based e-modules made by utilizing Google Sites was carried out in the research.

Research Method

This method of research was Research and Development (RnD) with the ADDIE development model (Branch, 2009), which consists of five stages (Figure 1), namely: (1) analyze, (2) design, (3) develop, (4) implement, (5) evaluate. The subjects of this study were 30 students of class VII F at MTsN 2 Jember located at Merak Street No. 11, Puring, Slawu, Patrang, Jember Regency, East Java. This research was conducted during the odd semester of the 2023/2024 academic year.

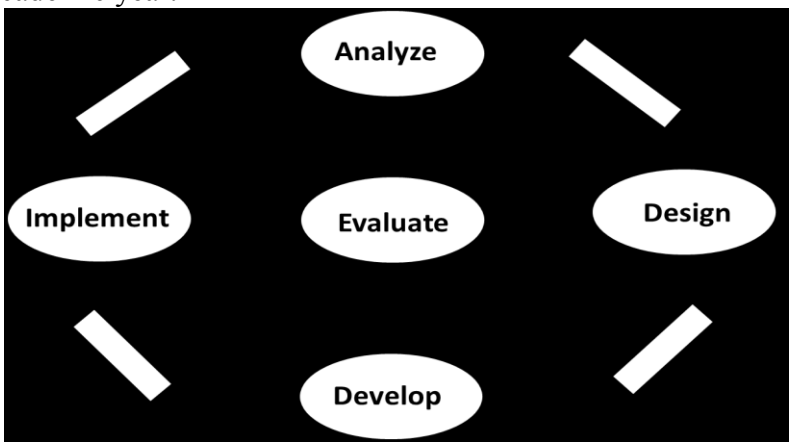

Figure 1. Model ADDIE (Branch, 2009)

In this research, the data analysis techniques used are as follows:

a). Validity Analysis

The average validity value in each aspect is used to calculate the validity of the product. The formula for determining the validity of the product is as follows:

$$V = \frac{Tse\ Tse}{\text{TsmTsm}} \text{ x } 100\%$$

Notes:

V : percentage of validity
Tse : total score obtained
Tsh : total maximum score

The calculated *V* value is used to determine the validity level of the e-module. The criteria for the validity level of e-modules can be seen in Table 1.

Table 1. Validity criteria

Percentage	Category
86%-100%	Valid
66%-85%	Enough
46%-65%	Less
25%-45%	Invalid

(Haking & Soepriyanto, 2019)

b). Practicality Analysis

Practicality analysis was conducted based on observations of student activities during the learning process using the e-module. The formula for determining the practicality of e-modules is:

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$$P = \frac{TseTse}{TshTsh} \text{ x } 100\%$$

Notes:
P : practicality percentage
Tse : Total score obtained
Tsh : total maximum score
The percentage value of practicality that has been calculated is then classified based on the following Table:

Tabel 2. Practicality criteria

Percentage	Category
86%-100%	Highly Practical
66%-85%	Practice
46%-65%	Less Practical
25%-45%	Impractical

(Puspita et al., 2017)

c). Effectiveness Analysis
The effectiveness of e-modules can be determined by analyzing digital literacy achievements, student learning outcomes, and student response questionnaires. The improvement in student learning outcomes and digital literacy was defined using the N-gain calculation. The effectiveness of e-modules in improving learning outcomes is determined using the formula proposed by (Hake, 1998) as follows.

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

Notes:
N-gain : n-gain score
S_{post} : average post-test score
S_{pre} : average pre-test score
S_{max} : maximum score
The effectiveness of e-modules in improving digital literacy is determined by a formula adopted from (Hake, 1998) as follows:

$$N - gainN - gain = \frac{(average\ score\ of\ the\ second\ lesson) - (average\ score\ of\ the\ first\ lesson)}{maximal\ score - (average\ score\ of\ the\ first\ lesson)}$$
$$\frac{(average\ score\ of\ the\ second\ lesson) - (average\ score\ of\ the\ first\ lesson)}{maximal\ score - (average\ score\ of\ the\ first\ lesson)}$$

The results of the N-gain calculation are then classified according to the provisions in Table 3.

Table 3. Scale and category of N-gain mean score

Criteria	Category
$(gg) \geq 0.7$	High
$0.3 \leq (gg) < 0.7$	Enough
$(gg) < 0.3$	Low

(Hake, 1998)
Student responses to using e-modules in learning were analyzed using the following formula.

$$V = \frac{AA}{BB} \text{ x } 100\%$$

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Notes:
V : percentage of students' response
A : total score
B : total maximum score
The results of calculating student responses to e-modules in science learning are categorized according to the criteria in Table 4.

Table 4. Student response criteria

Percentage	Category
86%-100%	Very Good
66%-85%	Good
46%-65%	Less Good
25%-45%	Not Good

(Sari et al., 2016)

Results and Discussion

Analysis Stage

The analysis stage was carried out by researchers with interviews and observations to collect information about MTs Negeri 2 Jember. According to Ainy et al. (2024), based on information obtained through interviews with seventh-grade science teachers at MTs Negeri 2 Jember, it was found that the teaching materials used were technology-assisted as a companion to the subject textbook. However, teachers often utilize printed textbooks to provide assignments and practice questions. The results of the analysis of information from interviews and observations obtained that MTs Negeri 2 Jember showed that learning activities had not yet implemented e-modules based on Google Sites. The media used during the learning process is still a printed book, giving assignments and practice questions from the book. Based on the results of interviews, digital literacy and science learning outcomes are still low and need to be improved through learning. In addition, students already have smartphones, which makes it easier for researchers to develop e-modules. An analysis of the curriculum used for reference in learning uses the independent curriculum.

Design

At this stage, researchers designed learning tools consisting of teaching modules (SMI) and e-modules based on Google Sites. The e-module design is made directly on the Google Sites website. The Google Sites-based e-module on the subject of class VII material on the classification of living things consists of the initial appearance of the web cover, table of contents, preface, concept map, introduction, learning activities, evaluation, feedback, answer key, glossary, profile, and bibliography. There are three learning activities to improve digital literacy and student learning outcomes in learning science, especially the classification of living things. The cover view of the web that first appears when opening the e-module can be seen in Figure 2.

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Figure 2. WEB Cover, Main Menu of Google Sites-Based E-Module

Develop

The development stage was carried out by conducting a validation process by experts and product revision. Validation was carried out by three validators: one biology lecturer in science education at the University of Jember and two MTs Negeri 2 Jember science teachers. Product validation aims to improve the feasibility of the product before it is implemented in schools. After the validation was carried out, the researcher made revisions according to the advice given by the validator. In addition to e-module validation, the validation of teaching modules containing learning activities was also carried out. Validation was carried out to determine the accuracy of the instrument. The results of the e-module validation can be seen in Table 5.

Table 5. E-module validation results

No	Validation Aspect	Score (%)			Average	Category
		Validator 1	Validator 2	Validator 3		
1.	Contents Validity	75	95	95	88	Valid
2.	Construct Validity:					
	Content Feasibility	75	93	96	88	Valid
	Display	93	96	89	93	Valid
	Language	82	89	93	88	Valid
	Graphics	89	96	100	95	Valid
Total Score of Validity					**91**	**Valid**

The results of the validation of e-modules based on Google Sites obtained an average score percentage of 91%, which is included in the valid category. These results indicate that e-modules based on Google Sites can be categorized as good to implement in school science learning. E-modules are feasible to use, both from content and construct. E-modules have content feasibility, which means meeting the elements of need and state of the art. The e-modules developed are needed in science learning to improve digital literacy and student learning outcomes. The utilization of Google Sites and the features contained in the module make new things in research products. In addition, the e-module meets the construct feasibility criteria because it is arranged systematically and has good consistency between parts of the module. Rojikin et al. (2022) argue that the material presented in the e-module must be organized systematically and coherently so that students can easily understand it independently and during classroom learning. According to Mardhiyyah et al. (2022), student independence is prioritized in carrying out learning activities so that students can solve a problem independently. The feasibility of e-modules is also seen from several aspects assessed by validators. The language used in the e-module is easy for students to understand.

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The e-module also has a display and components that can facilitate digital literacy. The validity of e-modules can also be reviewed based on the product's supporting components. The supporting elements of the e-module, such as images, links, and videos, are presented clearly and neatly. The layout, font, and instructions for using the e-module are also easy to understand. This gives the e-module a good score from the validator. At the validation stage, the e-module also received suggestions and comments from the validators. Revisions were made according to these suggestions and comments to improve the e-module for school use.

Implementation

Data on student activity while using Google Sites-based e-modules were obtained through observations by three observers during the development trial. The development trial is a form of science learning using research products as student learning resources. The subjects of this study were students of class VII F MTs Negeri 2 Jember, as many as 30 students. The analysis results regarding learning activities can be seen in Table 6.

Table 6. Learning activities using e-modules

Stage	Lesson			Percentage of Activity	Category
	1	2	3		
Introduction Stage	95.83	88.89	95.83	93.51%	Practice
Core Stage	86.36	87.50	87.25	87.00%	Practice
End Stage	93.75	93.75	91.66	93.00%	Practice
Total of Activity	91.98	90.04	91.58	91.20%	Practice

The analysis of student activity in learning using e-modules based on Google sites obtained an average percentage of 91.20% of all meetings with an efficient category. Teaching media in the form of e-modules is practical, namely that the e-module media can be used easily and interestingly in learning activities and has no obstacles in its use (Bagus et al., 2023). This category illustrates that learning using e-modules is easy to implement in learning. The results of the analysis of the implementation of learning using the e-module follow the results of research stated by Sembiring et al. (2021) that the e-module that has been developed is feasible to be reapplied in teaching and learning activities because it makes it easier for students to learn the material and the learning atmosphere created is fun.

Evaluation

The evaluation stage is carried out to determine whether the e-modules that have been developed are effective in learning activities. The effectiveness of research products is reviewed based on improving student learning outcomes and digital literacy. The product's effectiveness is also seen based on the results of the student response questionnaire. The results of the pre-test and post-test data analysis of student learning outcomes are shown in Table 7. The results of the n-gain analysis on each aspect of digital literacy are shown in Table 8. The results of data analysis of student responses to the use of e-modules are shown in Table 9.

Table 7. E-Module effectiveness test results for improving learning outcomes

Test	Average	*N-gain*	Criteria
Pre-test	38.63	0.61	Enough
Post-test	77.53		

Based on Table 7, the average pre-test and post-test scores increase, from the pre-test with an average score of 38.63 to the post-test with an average score of 77.53. These results indicate improved learning outcomes after using Google sites-based e-modules in learning activities.

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Table 8. Digital literacy analysis results

Aspect	Indicator	*N-gain*	Category
Information skills	Problem definition	0.87	High
	Problem finding	0.49	Enough
	Interpretation	0.73	High
	Applications and information	0.80	High
Skill in using digital tools	Use of digital apps and devices and digital ethics	0.64	Enough
Evaluation skills	Produce and design media	0.58	Enough

Based on Table 8, the improvement of digital literacy analyzed by N-gain on each indicator shows that the problem definition indicator with an N-gain score of 0.87 is categorized as high. The problem search indicator with an N-gain score of 0.49 is classified as moderate. The interpretation indicator has an N-gain score of 0.73, and the application and information indicator has an N-gain score of 0.80 with a high category. Digital literacy is about using digital applications, devices, and ethics, with an N-gain score of 0.64 in the medium category. The last indicator is producing and designing media, with an N-gain score of 0.58 in the medium category. The results of the N-gain analysis of each indicator show that the problem definition indicator has the highest value, while the problem search indicator has the lowest value. Based on this value, the Google sites-based e-module product is a development product in the excellent category. Research by Hasanah et al. (2023) shows that well-designed e-modules can improve digital literacy and student learning outcomes. These results align with the research of Wahyuni et al. (2022), who found that e-modules developed using electronic media can train digital literacy.

Table 9. Results of student response questionnaire analysis

Aspek	Percentage (%)	Category
Engagement and attention	82.92	Good
Ease of use	81.67	Good
Learning support	85.12	Good
Average	**83.23**	**Good**

The data shows that the overall average of student responses is 83.23% with a suitable category, so it can be concluded that student responses after learning using e-modules are good. The interest and attention aspect reached a value of 82.92% with a suitable category, the convenience aspect obtained a value of 81.67% with an appropriate category, and the learning assistance aspect obtained a value of 85.12% with suitable criteria. A good category was obtained because the e-module is easy to use, so students respond well. E-modules based on Google sites are designed practically so users can easily access them. The e-module can be accessed through a link or an already-available barcode. The ease of use of e-modules makes students respond well so that e-modules can be used effectively in learning. It follows previous research by Wahyuni et al. (2022) shows that products that are developed attractively have variations, making it easy for students to study science concepts and support the learning process. A pleasant learning process will trigger students to respond well, impacting interest in learning and class activity and improving learning outcomes.

The acquisition of excellent criteria is due to the e-module design that attracts students' attention and is interactive, simple language selection and clear fonts. It helps students understand science learning materials, especially in classifying living things. In addition, the e-module has clear instructions and directions, can be accessed easily online through links or barcodes, and is equipped with various student activities that contain digital

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literacy indicators. In line with the opinion of Ainy et al. (2024), who said that teaching materials applied in electronic form are effective in learning to increase student understanding, arouse student interest in the learning process, increase learning achievement, and support students in achieving 21st-century learning needs.

Conclusion

The results of product development in the form of e-modules based on Google sites on science subject matter about the classification of living things are declared valid, practical, and effective. The validity of e-modules based on Google Sites obtained an average percentage of 91% in the valid category. The practicality of e-modules based on Google Sites got an average percentage of 91.20% with an efficient category. Effectiveness is seen from the analysis of learning outcomes with an n-gain of 0.61 in the medium category. The results of the digital literacy study obtained an increase in a reasonably good category, and the analysis of student responses got an average percentage of 83.23% in the excellent category. The results showed that the e-modules developed in this study were effective in science learning. Based on the validation results, this Google Sites-based e-module is suitable for science teaching and learning activities in junior high schools. E-modules can facilitate students in active learning to develop digital literacy and learning outcomes.

Recommendation

Suggestions for educators related to the low digital literacy and learning outcomes of junior high school students are to use the help of learning media based on Google sites. Google site can be used to design learning media innovations in the form of website-based e-modules integrated with digital literacy indicators. Teachers can use website-based e-modules to promote digital literacy and learning outcomes in science learning.

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