

Development of a Jigsaw-based E-Module on the topic of matter and its changes using google sites for students

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Article History

Received: 1 August 2024

Revised: 9 September 2024

Accepted: 30 December 2024

Keywords

ADDIE

E-module

Google Sites

Abstract

This development research was conducted because students felt bored during lessons and struggled to understand the material, as they were only learning through printed materials rather than technology-based resources. The objective of this research is to describe the development of an electronic module, evaluate its suitability for daily use, assess its feasibility in terms of media, content, and language, and measure its effectiveness in improving student understanding. The use of the e-module aims to facilitate students' understanding of the learning material. This electronic module was created using Google Sites. The research employed a development research type with the ADDIE model. The subjects of the study were 24 students and teachers from Grade IV at SDN Ketapanrame 1. The data analysis methods included both qualitative and quantitative approaches. In this study, Google Sites was used for Grade IV to create a jigsaw-based electronic module on the topic of matter and its changes. The results of the feasibility test by media experts showed a score of 90%, categorized as "very feasible," while the content expert evaluation yielded a score of 90.9%, also categorized as "very feasible." The language expert gave a score of 85%, which falls under the "feasible" category. Meanwhile, the practicality score from teachers was 95%, categorized as "very practical," and the students' score was 95.3%, also categorized as "very practical." Based on the effectiveness test, the e-module scored 84.5%, falling under the "very effective" category.

1. Introduction

Learning is the interaction between learners and learning materials, which must be integrated with technological advancements. According to Chris (2020), the digital era has a significant impact on the learning process. The success of this learning process is influenced by various factors, including the use of learning materials. Learning materials are instructional resources used to discuss learning themes in line with the predetermined learning objectives. In this technological era, many modules have been developed in the form of electronic modules, known as e-modules (Luh, 2021). Similarly, Pertiwi (2021) notes that learning must adapt to existing technological advancements to provide students with experience and familiarity with technology.

Observations of classroom teachers revealed that learning resources provided by teachers are still based on printed materials. This is because teachers have not yet developed digital teaching materials, such as e-modules. Teachers in schools have a tight teaching schedule, leaving them with little time to develop teaching materials, resulting in students feeling bored during lessons. Consequently, students' understanding capabilities have declined.

According to Inanna (2021) and Chairunisa (2022), electronic modules allow for diverse learning experiences. An e-module is content delivered in an electronic format that includes audio and animations. Essentially, e-modules are organized in a way that makes the language easy for students to understand and aligns with their comprehension levels. According to Laili (2019), Fitriyani (2022), and Kustini (2022), the advantages of using electronic modules include the incorporation of images and videos, which help boost student motivation and make learning more engaging. Assessments are more interactive as they are presented in an electronic format, allowing students to complete them without the need for paper.

Google Sites was chosen to create this electronic module because it is well-suited for use and helps students understand the learning material. According to Setiawan (2022) and Devya (2022), with the advancement of technology, the internet has increasingly been utilized for learning purposes. Sitepu (2022) found that the use of internet technology simplifies learning, as this development involved creating an electronic module on Google Sites. Mellandika (2023) noted that teachers can input content in Word, PDF, or PowerPoint formats and use Google Sites to display images, text, and engaging animated information, which can help students grasp the material. In line with Rosiyana (2021) and Adzkiya (2021), the advantages of Google Sites include increasing student interest in learning, making learning enjoyable, and providing access to learning materials anytime and anywhere. Using electronic modules ensures that materials are stored securely, allowing students to read them without worrying about losing them. Additionally, Google Sites facilitates teachers in conducting student evaluations and quickly accessing student grades, enabling follow-up actions like remediation or enrichment. According to Heryadi, (2021), Google Sites was chosen for creating this e-module because it is easy for teachers, especially beginners, to use, and while learning typically occurs in the classroom, using this e-module allows learning to take place in the school's computer lab, preventing students from becoming bored during lessons.

This study utilized the development of a jigsaw-based e-module. According to Rosyidah (2016), jigsaw is a cooperative learning model where groups consist of 4 to 6 members. This method allows students to collaborate with their peers while fostering independence and responsibility. Alfaz (2016) outlined the steps of the jigsaw method: in the first activity, the teacher informs students of the learning objectives and provides motivation. In the second stage, the teacher presents the day's topic; in the third stage, the teacher divides the class into home groups; in the fourth stage, expert groups are formed; and in the fifth stage, after discussing with the experts, students return to their home groups. In the sixth stage, the teacher awards the groups that performed well. According to Sholihah (2016), the benefits of jigsaw include promoting critical thinking among students, as they meet in expert groups and then explain the content to their peers. Discussions are not limited to specific students; all students must participate, and they will understand the material better when their peers explain it. According to Abdullah (2017) and Handayani (2022), the advantages of jigsaw include students enjoying collaboration with their peers, having the opportunity to explain the material in each study group, and frequently engaging in discussions. This method teaches students to appreciate others' opinions and communicate effectively with one another.

Based on previous studies conducted by Susilowati (2022), Yose (2023), Setiawan (2022), Amar (2023), and Saputra (2023), earlier research using jigsaw and e-module development was deemed suitable for interactive teaching materials to enhance students' understanding in online learning and ADDIE development. The similarity with this study lies in investigating how teaching materials using electronic modules can be used effectively in elementary schools. The difference from previous studies is that while e-modules were used for online learning, this research employs e-modules for direct classroom learning. The researcher was interested in developing an electronic module using Google Sites, as interviews with teachers revealed that they had never used the platform. The researcher chose the topic of "The States of Matter and Their Changes." The research objective is to describe the feasibility, practicality, and effectiveness of the jigsaw-based electronic module.

2. Method

The research method used for developing the jigsaw-based e-module was Research and Development (R&D), applying the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). According to Hidayat (2021), the ADDIE model is commonly used in development processes (Figure 1).

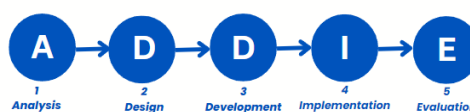


Figure 1. ADDIE Stages Procedure

Based on the diagram above, the first stage is analysis, where interviews with teachers are conducted to strengthen problem analysis. The purpose of these interviews is to facilitate the design of the product to be developed. The second stage is design, involving the creation of an e-module

design to meet students' needs. The third stage is development, where teaching materials are created according to the design, and the e-module is revised by media, language, and content experts. Validation includes media validation, language validation, and content validation. The fourth stage is implementation, where the researcher conducts a practicality test of the e-module with teachers and students. The fifth stage is evaluation, where the researcher conducts an effectiveness test with 24 fourth-grade students by having them complete an evaluation task within the e-module.

The research subjects or respondents were fourth-grade students and the fourth-grade homeroom teacher at SDN Ketapanrame 1. The testing was conducted twice: on a limited scale and a broader scale. The limited field test was conducted with two groups of fourth-grade students, while the broader field test involved four groups. The target experts included media experts, content experts, language experts, and fourth-grade teachers and students. The research involved two types of data: qualitative and quantitative. Quantitative data was obtained from the questionnaire results given to the students. Qualitative data referred to input or suggestions for improving the material in the electronic module.

In this study, data was collected using questionnaires. The questionnaire contained responses that were scored. The research instruments were used to determine the feasibility, practicality, and effectiveness of the developed product. The data analysis methods included qualitative and quantitative analysis. Qualitative analysis was used to manage input from media experts, language experts, content experts, teachers, and students. Quantitative analysis included results from the questionnaires evaluating the experts in content, language, and media, as well as the teachers and students. The data from expert validation was calculated using a Likert scale, as shown in the guidelines below, to assist respondents in evaluating, as presented in Table 1.

Table 1. Likert Scale Rating

Interpretation	Scale Value
Very Feasible	4
Feasible	3
Unfeasible	2
Very Unfeasible	1

Source : Ernawati (2017)

The feasibility analysis of the jigsaw-based e-module teaching materials can be determined through the validation data analysis conducted by expert lecturers in media, content, and language. The calculation of the feasibility percentage uses the following formula:

$$P = \frac{\sum x}{\sum xi} \times 100\% \tag{1}$$

Description:

P = Percentage

$\sum x$ = Total Score of Respondents

$\sum xi$ = Highest Score

The results obtained are recorded in Table 2 according to the following criteria.

Table 2. Criteria for E-Module Feasibility

Percentage Range	Criteria
86% - 100%	Very Feasible
76% - 85%	Feasible
60% - 75%	Not Feasible
≤55% - 59%	Highly Not Feasible

Source : Diana (2016)

Practicality analysis can be calculated by determining the percentage of respondents to assess the practicality of teaching materials from the perspectives of teachers and students using the following formula:

$$\text{Percentage of Respondents} = \frac{\text{Obtained Score}}{\text{Expected Score}} \times 100 \tag{2}$$

For the student questionnaire, the researcher provides scoring rules to calculate student practicality. The following are the scoring rules for student practicality data (Table 3).

Table 3. Scoring Rules for Practicality Data Instruments

Description	Scale Value
Very Practical	4
Practical	3
Not Practical	2
Highly Not Practical	1

Source : Andriani, (2019)

Once the responses are known, they can be matched with the percentage of student responses obtained according to the practicality criteria (Table 4).

Table 4. Criteria for E-Module Practicality

Percentage Range	Criteria
86% - 100%	Very Practical
76% - 85%	Practical
60% - 75%	Not Practical
≤55% - 59%	Highly Not Practical

Source: Sahida (2018)

Effectiveness analysis can be calculated by finding the total score obtained by students to determine the effectiveness of the e-module developed by the researcher using the following formula:

$$N = \frac{n}{SM} \quad (3)$$

Description:

- N = Score Obtained by Students
- n = Total Score Obtained by Students
- SM = Total Number of Students

Once the students' scores are known, the average is calculated to determine the effectiveness of the product developed by the researcher. The determination of the average is presented in Table 5 and Table 6.

Table 5. Criteria for E-Module Effectiveness

Score	Criteria
80-100	Very Effective
60-80	Effective
40-60	Ineffective
20 - 40	Highly Ineffective

Source: Yuliana (2019)

Table 6. Assessment Aspects from Experts, Teachers, and Students

Experts	Aspect
Media	Design
	Writing
Content	Content
	Presentation
	Language
Language	Language Used
Teachers	Appearance
	Content
	Presentation
Students	Appearance
	Content
	Presentation

3. Results and Discussion

The development of the e-module uses the ADDIE development model. The first stage of e-module development, the analysis phase, involves gathering field information through interviews to identify issues in Grade IV. This analysis includes curriculum analysis, student characteristics, and the use of teaching materials in the learning process. During the curriculum analysis, it was found that the current curriculum in use is the Merdeka Curriculum, but the focus was on one subject. In analyzing student characteristics, it was noted that students are less active in participation, have difficulty understanding the material, often feel bored, and prefer group learning. When analyzing teaching materials, it was observed that the materials were still in paper or print form, which led to student boredom due to the lack of technology usage. Therefore, the researcher used a jigsaw-based e-module on Google Sites.

In the design phase, the content and overall design of the e-module were determined. This e-module design uses Google Sites and includes a cover, interactive slides, videos to enhance student understanding, and practice and evaluation questions to assess student comprehension. The presentation was developed to engage students' interest in learning and is based on the Jigsaw method. The designed teaching material is accessible via the website. The material description includes how to illustrate changes in objects, as shown in Figure 2 below.

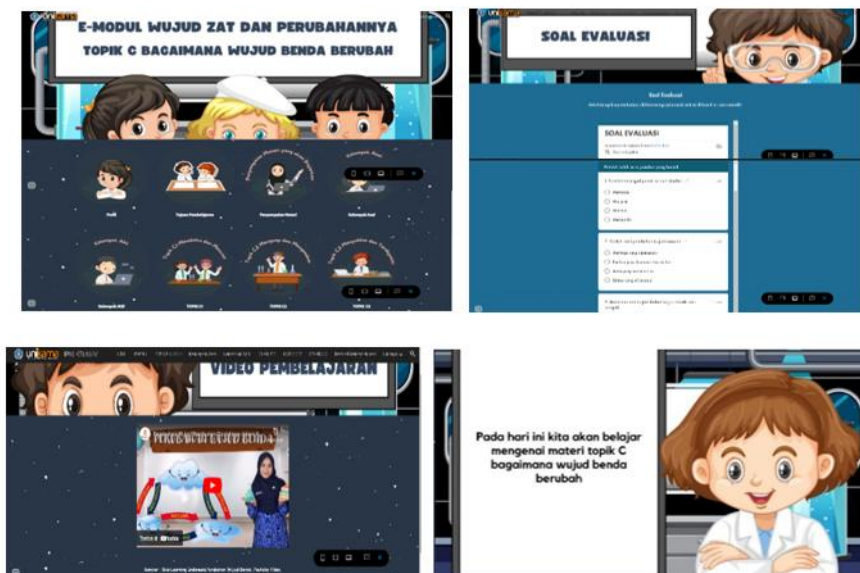


Figure 2. Display in E-Module

In the development stage, the researcher made improvements or revisions to the e-module. The research instruments included questionnaires for media validation, content validation, and language validation. During the validation process, the researcher provided questionnaires for assessment to the three experts. If the e-module is deemed feasible, it can proceed to the implementation stage. Suggestions from the media expert included adding the campus logo to the top right corner of the e-module and slightly increasing the font size for better readability. The language expert suggested correcting punctuation in each paragraph and clarifying punctuation in questions. The content expert recommended adding more detailed material to avoid misconceptions. Following this, the researcher revised, edited, and incorporated the experts' recommendations. Once these revisions were made, the e-module was ready for implementation and use in schools. Below are the results of the validation from the three experts (Table 7).

Table 7. Percentage of Feasibility

Experts	Percentages (%)	Criteria
Media	90%	Very Feasible
Content	90,9 %	Very Feasible
Language	85%	Feasible

Based on Table 7, which details the results of the assessments conducted by media experts, content experts, and language experts, the findings are as follows: Media experts received a score of 90% with the criterion "very feasible," content experts received a score of 90.9% with the criterion "very feasible," and language experts received a score of 85% with the criterion "feasible." This indicates that the e-module is suitable for use.

In the implementation phase, a trial was conducted with the fourth-grade teacher. The researcher provided a questionnaire for the teacher to evaluate the e-module. The teacher's evaluation resulted in a percentage of 95% categorized as "very practical," indicating that the e-module can be implemented with students. The researcher conducted a limited trial with 2 groups and a broader trial with one class of 24 students divided into 4 groups. Since it is based on Jigsaw, the learning was conducted in groups. During the trial phase, the researcher sought to understand student responses to the e-module by providing a questionnaire for students to evaluate and complete evaluations within the e-module. The results of the teacher's assessment of the e-module, conducted by Ms. LK, are categorized as follows (Table 8).

Table 8. Teacher's Practicality Assessment

Experts	Percentages (%)	Criteria
Teachers	95%	Very Practical
Students	96%	Very Practical

Based on Table 8 the large-scale trial with 24 students achieved a percentage of 96% with the criterion of "very practical," indicating that the e-module is highly practical for use. This high rating is attributed to students enjoying group learning, leading to enthusiastic engagement with the e-module. In the evaluation phase, students took a test by completing evaluation questions within the e-module. The scores for students, based on roll numbers 1 to 24, can be seen in Figure 3.

The average score obtained from 24 students was 2030, resulting in an average score of 84.5. This score falls into the "Very Effective" category, indicating that students were able to grasp the material provided by the e-module effectively and achieve good results.

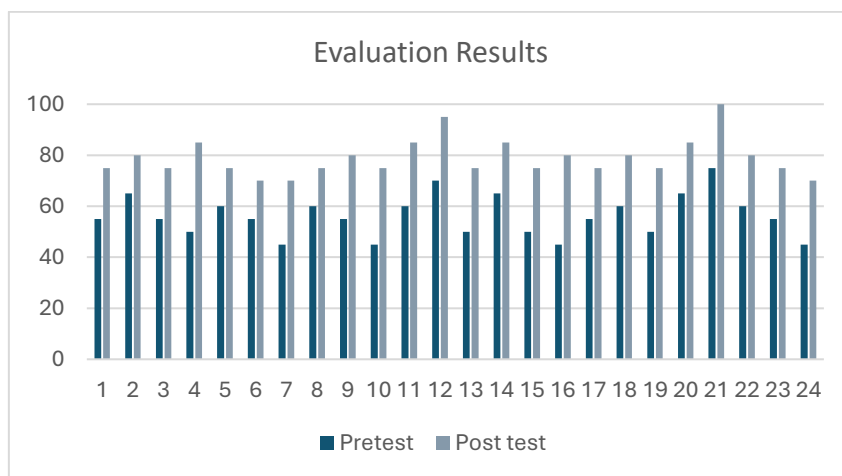


Figure 3. Evaluation Scores

In this study, a product was developed in the form of a Jigsaw-based e-module using Google Sites for 4th-grade students at SDN Ketapanrame 1. According to Hasanah (2023), development research is research that produces a product. The development of this electronic module functions as a learning resource for students to understand the material about the state of matter and its changes, specifically Topic C: how the shape of objects changes. According to Kustini (2022), this electronic module is easily accessible and can be opened anytime and anywhere using mobile phones or laptops. This electronic module is easy for students to access and provides features that allow students to better understand the material. The instruments created in this research include validation questionnaires for media experts, content experts, and language experts, as well as practicality questionnaires for teachers and students. The design of the media trial was conducted

over two days with the assistance of the class teacher. Similarly, the research conducted by Teknik (2023) with the title "Development of Jigsaw-Based E-Module to Improve Problem-Solving Skills" shows that the use of the ADDIE technique is easy and practical. It can motivate students and improve student learning outcomes. The feasibility of the Jigsaw-based e-module using Google Sites can be determined at the development stage using the ADDIE model. The development phase was carried out through validation by media experts, content experts, and language experts. Therefore, the percentages were calculated by the researcher. The media feasibility assessment of the e-module reached 90% with the category "very feasible." The content expert assessment achieved 90.9% with the category "very feasible." Conversely, the language expert assessment reached 85% with the category "feasible." All three validations were deemed suitable for implementation in teaching. Similarly, research conducted by Susanti (2021) states that valid instruments indicate high validity. Additionally, a feasible e-module means the content is relevant and easy to understand. The e-module received a feasible rating from the media expert because the operation of the e-module makes it easy for students to access. The content expert rated it feasible because the e-module contains material explaining how the state of matter changes with examples, making it easier for students to understand, while the language expert rated it feasible because the language used in the e-module is easy for students to understand. This is consistent with research by Laraphaty (2021) and Mustika (2022), which found that a feasible e-module meets criteria such as content coverage and presentation, making it easier for students to understand the material and encouraging them to study. It can be seen from the evaluated aspects that the criteria of being very feasible were met by the media, content, and language experts.

The practicality of the Jigsaw-based e-module using Google Sites can be assessed during the implementation stage, which follows the ADDIE model. The results of the practicality assessment of this e-module, as evaluated by the 4th-grade teacher and students, show the following: According to the teacher's evaluation, the e-module received a 95% rating with the category "Very Practical." The evaluation conducted by students during the limited field trial received a 95.6% rating, and the broad trial within one class received a 95% score. It can be concluded that the developed e-module is highly practical for teaching the topic of matter and its changes. The e-module is rated practical because it is easy for students to access, so they do not feel confused when using it. Additionally, students enjoy using the e-module due to its attractive design, as they are typically accustomed to only using printed books. This has led to high enthusiasm among students, and they enjoy group learning with the Jigsaw method. This is consistent with research conducted by Agung Maharcika (2021) and Kurniawan (2021), which states that a practical e-module simplifies the learning process, can be used independently, and makes students happy to use it. Practicality here refers to how engaging students find the e-module during use. This is in line with research conducted by Anak Agung (2021), which explains that the practicality of e-modules can be demonstrated through the results of analyses that show it helps students better understand the material.

The effectiveness of the Jigsaw-based electronic module using Google Sites can be determined through evaluation according to the ADDIE model. The effectiveness evaluation of this e-module's content was conducted with 4th-grade students who answered the evaluation questions within the e-module. According to Prastiwi (2023), student learning outcomes can be measured through two types of assessments: written tests and non-tests. However, the researcher used test assessments to measure student learning outcomes. This approach allows for determining the extent of students' understanding of the material taught through the e-module developed by the researcher. After students completed their work, the average evaluation score was 84.5%, which can be categorized as "very effective." According to Putri (2022), developed products should be evaluated for their effectiveness in the learning process. This e-module explains the content in a way that is understandable to students, preventing confusion and enabling them to achieve good scores on the assessment questions, thus resulting in a very effective evaluation. This finding is consistent with research by Mutmainnah (2021) dan Kusna (2023) on effective electronic modules that can influence student learning outcomes. It can be concluded that students have an understanding of material related to the state of matter and its changes.

From the discussion presented, there are recommendations that can be used as input. This e-module development research can serve as an example for further development of electronic teaching materials.

4. Conclusion

This jigsaw-based e-module utilizes Google Sites to create an electronic module on the topic of the states of matter and their changes. The model used is the ADDIE model. The e-module's feasibility is assessed through evaluations by media experts, content experts, language experts, teachers, and students, all of which have achieved the categories of "Very Feasible" and "Very Practical." Additionally, its effectiveness evaluation has received a "Very Effective" rating. Based on these percentages, the e-module is suitable and practical for use in the learning process and effective for application in teaching. It is recommended that teachers use this developed e-module as a reference and as a useful tool for instructional activities. This product is accessible from mobile phones or laptops and can be used by students for independent learning at home. Other researchers who develop e-modules can use this as a reference and strive to create more creative products to enhance the quality of student learning. One limitation is that accessing this module requires an account and the use of Google Sites.

Author Contributions

All authors have equal contributions to the paper. All the authors have read and approved the final manuscript.

Funding

No funding support was received.

Declaration of Conflicting Interests

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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