JINoP

JURNAL INOVASI PEMBELAJARAN

Volume 10, Nomor 1, Mei 2024

P-ISSN 2443-1591
E-ISSN 2460-0873

JINoP | Volume 10 | NOMOR 1 | HAL: 1-163 | Mei 2024 | P-ISSN 2443-1591 | E-ISSN 2460-0873

JINoP Jurnal Inovasi Pembelajaran Volume 10 NOMOR 1 HAL: 1-163 Mei, 2024 P-ISSN 2443-1591 E-ISSN 2460-0873

E-ISSN 2460-0873
9 772460 087006

P-ISSN 2443-1591
9 772443 159003

P-ISSN. 2443-1591
E-ISSN. 2460-0873

JINoP
Jurnal Inovasi Pembelajaran
Volume 10, Nomor 1, Mei 2024

JINoP (Jurnal Inovasi Pembelajaran) terakreditasi peringkat 2 berdasarkan Salinan Keputusan Direktur Jenderal Pendidikan Tinggi, Riset dan Teknologi, Nomor No. 158/E/KPT/2021, Tanggal 09 Desember 2021. Akreditasi berlaku selama 5 (lima) tahun yaitu Volume 6 Nomor 1 Tahun 2020 sampai dengan Volume 10 Nomor 2 Tahun 2024. JINoP (Jurnal Inovasi Pembelajaran) diterbitkan dua kali setahun pada bulan Mei dan November oleh Universitas Muhammadiyah Malang dalam satu volume ada 2 nomor. Berisi tulisan ilmiah hasil penelitian tentang inovasi pembelajaran mulai dari pendidikan dasar sampai perguruan tinggi. Untuk Jurnal Online dapat diakses dilaman : http://ejournal.umm.ac.id/index.php/jinop/

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JINoP (Jurnal Inovasi Pembelajaran)
P-ISSN : 2443-1591
E-ISSN : 2460-0873
Volume 10, Nomor 1, Mei 2024

DAFTAR ISI

Jurnal Inovasi Pembelajaran

JINoP. May, 2024, 10 (1): page 19-30
p-ISSN 2443-159, e-ISSN 2460-0873
https://doi.org/10.22219/jinop.v10i1.25819

Utilizing GeoGebra-assisted model-eliciting activities (MEAs) in mathematics instruction enhances students' comprehension of concepts and improves their problem-solving abilities

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uploaded: 04/12/2023
revised: 10/21/2023
accepted: 01/22/2024
published: 05/31/2024

Febriani, P. A., Mandailina, V., Abdillah, A., Syaharuddin, S., & Mehmood, S. (2024). Pembelajaran Utilizing GeoGebra-assisted model-eliciting activities (MEAs) in mathematics instruction enhances students' comprehension of concepts and improves their problem-solving abilities. *JINoP (Jurnal Inovasi Pembelajaran)*, 10(1), 19–30. https://doi.org/10.22219/jinop.v10i1.25819

Abstract

A key goal of teaching math is for students to develop a deep understanding of concepts. This understanding is the foundation for all future learning in math. The purpose of this study was to improve students' conceptual understanding and problem-solving skills in GeoGebra-assisted mathematics learning with Model Eliciting Activities (MEAs). The quantitative method with a nonequivalent (pre-test and post-test) group design was used to answer the hypothesis. The instruments used were pre-test and post-test in the form of descriptions consisting of 5 questions. The participants in this study were 26 junior high school students. Data analysis used Paired Sample T-tests (t-test) to determine the level of conceptual understanding and problem-solving ability of students. The results of data analysis obtained that the application of Model Eliciting Activities (MEAs) assisted by GeoGebra is effective in increasing student' understanding of mathematical concepts and student problem-solving skills. So, it is concluded that learning with the Eliciting Activities Model (MEAs) assisted by GeoGebra can improve students' conceptual understanding and problem-solving skills. In the future teachers are recommended to use Model Eliciting Activities (MEAs) assisted by GeoGebra in learning mathematics.

Keywords: Geogebra; Mathematics Concept Understanding; Model Eliciting Activities (MEAs); Problem Solving Ability.

INTRODUCTION

The interconnection of concepts in mathematics constitutes an integral aspect of the discipline, indivisible and interdependent (Sari, 2022). Mathematics, with its multifaceted roles, positions itself as a highly utilitarian field, one of which entails serving as a cognitive tool to facilitate students' understanding of mathematical concepts under study (Illahi & Pujiastuti, 2019). Understanding mathematical

concepts stands as a pivotal objective in education, as it forms the foundation for achieving subsequent learning goals in mathematics (Kastira & Irwan, 2019).

In mathematics, comprehension of concepts supersedes mere rote memorization of formulas to evade confusion and enable the derivation of pertinent formulas (Setyani & Suhendar, 2022). Proficiency in understanding mathematical concepts empowers students to easily recollect, utilize, and rearrange learned concepts, thus navigating through various mathematical problem scenarios (Hadi & Kasum, 2015). Conceptual understanding holds immense significance, as mastery of concepts facilitates students' ease in learning mathematics (Adliani et al., 2020).

Challenging problems necessitate specific procedural steps for resolution (Jumadi, 2017). Mathematical problem-solving prowess entails amalgamating previously acquired concepts and rules to overcome encountered difficulties, thereby achieving the goal of finding solutions (Osuna & Munson, 2024; Sumirattana et al., 2017; Nusantari, 2016). Proficiency in problem-solving is imperative for students, as it equips them with the skills to tackle both mathematical and everyday problems (Zulfitri, 2019).

Students tend to resort to rote memorization of presented material rather than comprehending the underlying concepts (Novitasari et al., 2021). At times, students may be able to respond to posed mathematical questions, yet exhibit carelessness in their calculations (Sulistyaningsih, 2017). A significant portion of students lacks the ability to understand problems, process data, and present issues mathematically in various forms, choose approaches and problem-solving methods, generate and interpret mathematical models, and complete problems (Thoyyibah et al., 2018).

Several factors influencing students' learning outcomes at SMPN 1 Lingsar include the less varied teaching methods employed by teachers, who often resort to conventional teaching by delivering content followed by giving exercises and tasks, students' high levels of self-doubt, and insufficient teacher-student interaction (Hirzi, 2015). Consequently, students merely accept what teachers convey, leading to diminished understanding of the material. It is often observed in schools that teachers' ability to employ varied teaching methods is low, teachers predominantly focus on solving problems, teachers tend to use ineffective teaching methods, and they rely more on exclusive teaching methods without comprehensively considering students' affective, cognitive, and psychomotor aspects (Yulianty, 2019).

Model Eliciting Activities (MEAs) serve as a mathematical learning model aimed at understanding, explaining, and communicating mathematical concepts embedded in a problem through mathematical modeling (Juniantari, 2019). MEAs are student-centered learning activities (Meisya et al., 2018). In Model Eliciting Activities (MEAs), the most crucial problem-solving iteration involves proposing, testing, and revisiting models to solve a problem (Junaidi, 2019). In MEAs instruction, students are presented with meaningful and relevant problems related to their daily lives (Budiman & Syayyidah, 2018).

GeoGebra is recognized as a computer program utilized in mathematics education, particularly in the realms of geometry and algebra (Baye et al., 2021; Jelatu &

Sariyasa, 2018; Arbain & Shukor, 2015). Moreover, Wijayanti (2013) defines GeoGebra as software designed for studying and teaching geometry, algebra, and calculus from elementary to university levels. GeoGebra serves as a mathematical learning tool emphasizing visual and solution-oriented approaches in solving mathematical problems (Mandailina et al., 2018). Students can employ GeoGebra to visualize their ideas through graphical illustrations (Nam, 2022). The application serves three primary purposes: as a mathematics learning medium, a tool for generating mathematics teaching materials, and a means to solve mathematical problems (Yanti et al., 2019). The combination of MEAs and GeoGebra fosters a more engaging, profound, and relevant mathematical learning experience, aiding students in understanding mathematical concepts interactively and within a more realistic context.

GeoGebra's widespread recognition has led to its frequent utilization by millions worldwide, including students, teachers, professors, and other stakeholders (Farida, 2021). The integration of GeoGebra into mathematics education offers benefits to students, facilitating enhanced conceptual understanding and mathematical problem-solving (Mukarramah et al., 2022). Students' mathematical conceptual understanding through the use of GeoGebra assists in observing the relationship between visual and symbolic representations (Nulhakim et al., 2022).

Previous research by Savitri et al (2021) concluded that GeoGebra as a learning media for solid geometry topics can be effectively employed in classroom instruction, enhancing students' conceptual understanding. Additionally, MEAs assisted by GeoGebra positively influence students' conceptual understanding and mathematical disposition. Statistical analysis yielded a significant F value of 5.656 with a significance level of 0.023, leading to the rejection of the null hypothesis. Thus, the research results indicate that MEAs assisted by GeoGebra positively affect students' conceptual understanding and mathematical disposition. However, further investigation is needed to determine whether MEAs assisted by GeoGebra positively impact students' mathematical problem-solving abilities. Moreover, research conducted by Dewi et al., (2019) demonstrated an increase in students' conceptual understanding scores across cycles, with improvement in mastery learning rates from 38.24% to 67.65%.

Based on the relevant research findings above, there has been no prior exploration into students' conceptual understanding and problem-solving abilities through the combination of Model Eliciting Activities (MEAs) and GeoGebra. Hence, the aim of this study is to enhance students' mathematical conceptual understanding and problem-solving abilities in GeoGebra-assisted mathematics instruction with Model Eliciting Activities (MEAs).

METHODS

The research employed a quantitative method utilizing a nonequivalent (pre-test and post-test) group design. The participants comprised 26 eighth-grade junior high school students. The research phases can be delineated through the flowchart presented in Figure 1.

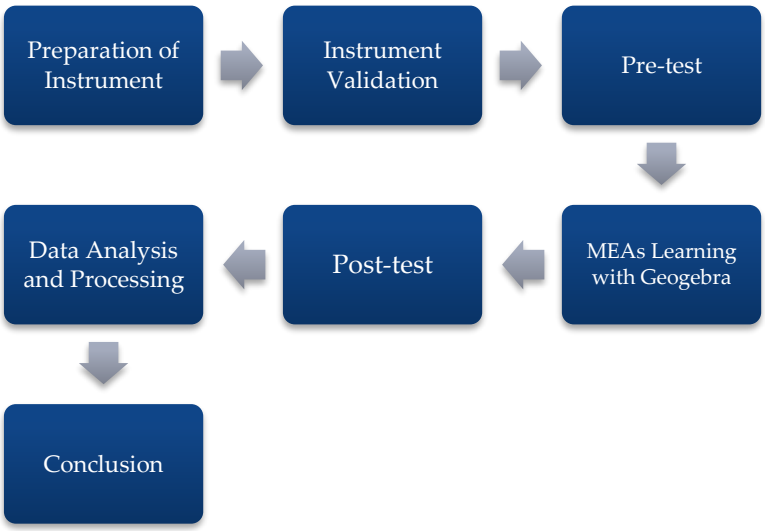

Figure 1. Research phases

In Figure 1, several stages of research are illustrated, such as instrument development. The instrument utilized in this research employs a test format consisting of 5 essay items for both pre-test and post-test to capture variables related to mathematical concept comprehension and problem-solving abilities. Subsequently, instrument validity is assessed by language and subject matter experts. Data collection involves a single sample drawn from a junior high school.
Prior to intervention, participants undergo a pre-test to gauge their initial abilities. This is followed by the implementation of the Model Eliciting Activities (MEAs) instructional approach aided by GeoGebra software, focusing on the topic of two-dimensional shapes and the surface area of cubes and rectangular prisms. To assess mathematical concept comprehension and problem-solving abilities, a final test, referred to as the post-test, is administered. The hypotheses under scrutiny are as follows:
H_a: There exists a significant difference in mathematical concept comprehension and problem-solving abilities among junior high school students following instruction employing the Model Eliciting Activities (MEAs) approach.
H_0:There is no significant difference in mathematical concept comprehension and problem-solving abilities among junior high school students following instruction employing the Model Eliciting Activities (MEAs) approach.
The data analysis process utilized SPSS version 24 software and hypothesis testing was conducted using the Paired Sample T-test. Prior to hypothesis testing, the normality of the data was assessed using the Shapiro-Wilk test. Finally, conclusions were drawn regarding the influence of implementing Model Eliciting Activities (MEAs) assisted by GeoGebra on mathematical concept comprehension and problem-solving abilities, with a significance level of 5%, employing the formula outlined (Nuryadi at al., 2017) as the formula (1).

$$t_{hit} = \frac{\bar{D}}{\frac{SD}{\sqrt{n}}} \quad (1)$$

where:

$SD = \sqrt{var}$

$var(s^2) = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2$

t = the calculated t-value

$\bar{D}$ = the mean difference between measurements 1 and 2

SD = the standard deviation

n = the sample size

Interpretation:

If:

Sig.2-tailed $>$ α $=$ 0,05, it indicates a significant difference (acceptance of H_0).

Sig.2-tailed $<$ α $=$ 0,05, it suggests no significant difference (rejection of H_0).

RESULT AND DISCUSSION

Data Collection Result

Based on the results obtained from the essay test consisting of several indicators of concept comprehension and problem-solving abilities, the graph presented in Figure 2 was generated.

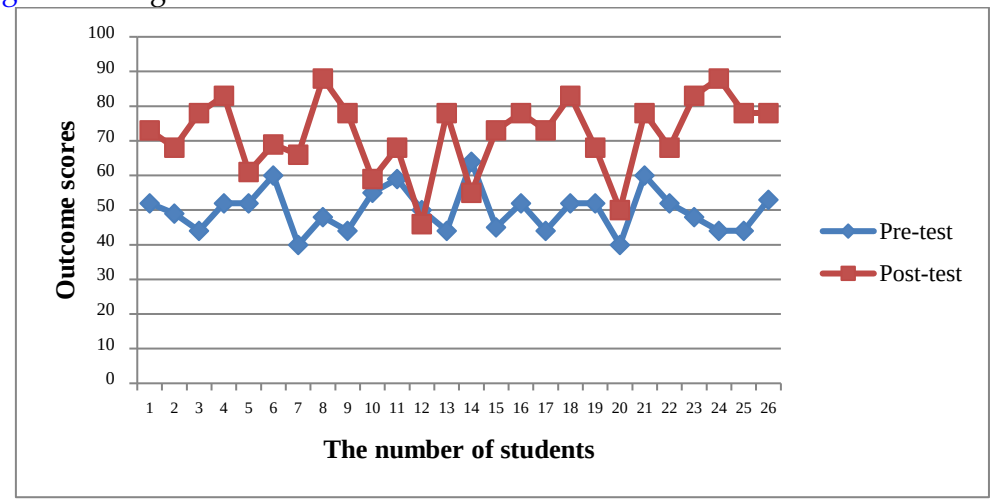

Figure 2. Student *pre-test* and *post-test* results

Figure 2 illustrates that the highest score in the post-test results of students is 88, while the lowest is 46. In contrast, the highest score in the pre-test results of students is 64, with the lowest being 40. Hence, the post-test results are higher compared to the pre-test results. A graphical comparison of the average scores of pre-test and post-test results of students can be observed in Figure 3.

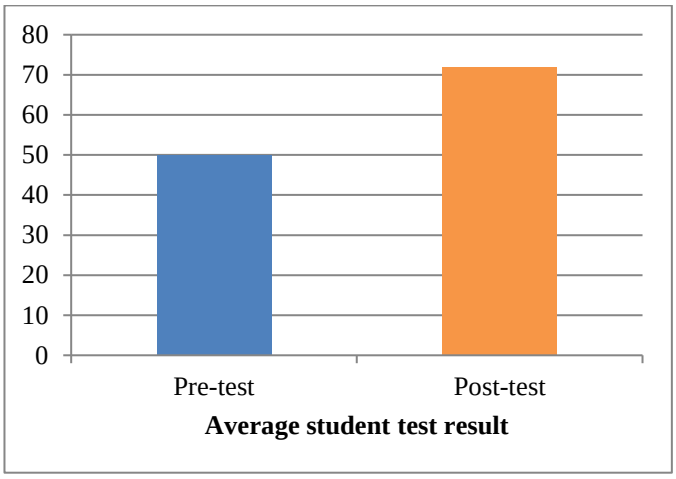

Figure 3. Comparison of average pre-test and post-test scores

In Figure 3, it is shown that the average score of the pre-test results is 50, while the average score of the post-test results is 72. This indicates an improvement following the implementation of Model Eliciting Activities (MEAs) assisted by GeoGebra.

Test of Normality

Further data analysis was conducted using inferential statistics through SPSS version 24. Before hypothesis testing a prerequisite analysis was performed, namely the normality test. To ascertain whether the data follows a normal distribution, the Shapiro-Wilk test was conducted on the pre-test and post-test results of concept comprehension and problem-solving abilities, as presented in Table 1.

Table 1. Normality test of student pre and post test results

	Shapiro-Wilk			Criteria	Conclusion
	Statistic	df	Sig.		
Pre-test	0.940	26	0.135	0,135 > 0,05	Normal
Post-tets	0.937	26	0.113	0,113 > 0,05	Normal

Table 1 presents the results of the Shapiro-Wilk test, indicating a significance value of 0.135 (Sig. > 0.05) for the pre-test data, suggesting a normal distribution. Similarly, for the post-test data, a significance value of 0.113 (Sig. > 0.05) was obtained, indicating a normal distribution as well.

Hypothesis test

Since both the pre-test and post-test data exhibit normal distributions, data analysis proceeds with the Paired Sample T-test.

Table 2. Uji hipotesis results

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Pre Test - Post Test	-21.885	13.492	2.646	-27.334	-16.435	-8.271	25	0.000

As presented in Table 2 presents the results of hypothesis testing regarding the extent of improvement in junior high school students' understanding of mathematical concepts and problem-solving abilities using the Paired Sample T-test, with a significance level of $\alpha = 0.05$. The obtained P-value (Sig.2-tailed) of 0.000 (Sig.2-tailed < 0.05) leads to the rejection of the null hypothesis H_0, indicating an enhancement in students' understanding of mathematical concepts and problem-solving abilities following instruction using Model Eliciting Activities (MEAs) assisted by GeoGebra. Based on these findings, it can be concluded that Model Eliciting Activities (MEAs) contribute to the improvement of mathematical concept comprehension and problem-solving abilities.

The results of the post-test regarding students' understanding of concepts and problem-solving abilities following instruction using Model Eliciting Activities (MEAs) assisted by GeoGebra in junior high school students indicate that the average scores obtained are higher than those of the pre-test. This suggests that instruction utilizing Model Eliciting Activities (MEAs) assisted by GeoGebra has an influence on students' understanding of concepts and problem-solving abilities.

Previous research provides insights into the significant influence of instruction utilizing Model Eliciting Activities (MEAs) on enhancing students' understanding of mathematical concepts and their problem-solving abilities, particularly when aided by GeoGebra applications, which facilitate the visualization of diagrams and graphs. The understanding of mathematical concepts taught by teachers in each topic is crucial for students, as it aids in the retention process and simplifies the solving of mathematical problems that require numerous formulas (Christou et al., 2024; Aini et al., 2020). Mathematical concept comprehension entails the ability to systematically understand and delve into mathematical ideas (Nurani et al., 2021).

Similar to previous research titled "The Influence of MEAs Approach on Problem-Solving Ability, Mathematical Communication, and Self-Confidence of Students" by (Wijayanti, 2013), it was concluded that instruction using the MEAs approach outperformed traditional approaches in terms of problem-solving abilities. Furthermore, a study by Muna et al. (2019) concluded that the implementation of Model Eliciting Activities assisted by APPEM (Assessment, Pedagogy, and Educational Management) enhanced students' conceptual understanding, as evidenced by the final research results showing a mean classical score of 78.24, indicating a good level of achievement. According to Meisya (2019), MEAs direct

students to think and reason, ultimately aiding them in understanding concepts or procedures.

In a study of Afhami, (2022), the research findings indicated that the use of the GeoGebra Classic application in instruction had a significant influence on students' understanding of mathematical concepts in the topic of geometric transformations. GeoGebra is an application that students can use in mathematics lessons to facilitate the drawing of graphs. Moreover, it can be utilized in calculus, geometry, and algebra topics (Vadya et al., 2022). GeoGebra aids students in learning mathematics because through its use, students encounter many mathematical formulas, algebraic presentations, and geometry (Mollakuqe et al., 2020). Additionally, understanding the required concepts becomes easier as GeoGebra can visualize geometric objects and depict geometric problems (Anggraeni et al., 2021).

CONCLUSION

This research found that students' understanding of mathematical concepts and problem-solving abilities significantly improved after using Model Eliciting Activities (MEAs) assisted by GeoGebra software. Higher post-test scores compared to pre-tests and a very low p-value from statistical analysis (indicating strong rejection of the idea that no improvement occurred) both support this conclusion. Incorporating MEAs with GeoGebra appears to be an effective strategy for enhancing mathematical learning.

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Jurnal Inovasi Pembelajaran

JINoP. May, 2024, 10 (1): page 31-50
p-ISSN 2443-159, e-ISSN 2460-0873
https://doi.org/10.22219/jinop.v10i1.32357

Digitalizing History: Development of E-Module for History Learning on the Subject of Japanese Colonialism Period in Indonesia

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uploaded: 02/16/2024
revised: 04/02/2024
accepted: 04/30/2024
published: 05/31/2024

Arviansyah, M. R., Safitri, S., Syarifuddin, S., & Alfiandra, A. (2024). Digitalizing History: Development of E-Module for History Learning on the Subject of Japanese Colonialism Period in Indonesia. *JINoP (Jurnal Inovasi Pembelajaran)*, 10(1), 31–50. https://doi.org/10.22219/jinop.v10i1.32357

Abstract

This study aims to investigate the effectiveness of using e-module teaching materials in history education. This study is development research conducted using direct observation techniques and the distribution of questionnaire surveys to the research location, in this case, SMA Srijaya Negara Palembang. The development of teaching materials was conducted using the Rowntree model, which comprises three stages: planning, development, and evaluation. The criteria utilized included the success rate and students' achievement in learning activities. The research findings indicate that the utilization of case-based learning e-modules is valid and suitable for history education in classrooms. This is supported by assessments from three validators of the materials, media and language aspects of the e-module, categorized as highly valid (4.4); individual assessments as valid (4.1); and small group assessments as highly valid (4.2). Moreover, there is a noticeable improvement in the students' learning outcomes, classified as valid (88.0), with an effectiveness score of N-gain reaching 0.80, falling into the high or very effective category.
Keywords: *Digitalizing History; Development; E-Module; SMA Srijaya Negara Palembang.*

INTRODUCTION

In this era of globalization, advances in science and technology (IPTEK) have become the cornerstone of the transformation in various sectors of life (Wuhe et al., 2021). One of the aspects most profoundly impacted is the education sector. The digitalization of education is a tangible manifestation of the integration of IPTEK in the learning process (Eka et al., 2023; Siti et al., 2021). This transformation not only modernizes teaching methods but also expands access to knowledge (Arviansyah &

Safitri, 2022; Ulfah et al., 2022). By leveraging technology, learning becomes more flexible and accessible (Arviansyah & Shagena, 2022).

One application of technological advancements in education is the implementation of e-modules or digital modules (Minamatov & Turobova, 2021; Usman et al., 2023). E-modules have become a key instrument in supporting the digitalization of education (Kalimullina et al., 2021). These modules facilitate the presentation of learning materials in an interactive format that can be accessed online (Arviansyah & Shagena, 2022; Liu et al., 2020) . Through the use of e-modules, it is expected to provide a new experience for students with various conveniences (Putri & Syarifuddin, 2023).

The convenience of e-modules allows students to study according to their learning styles (Duszenko et al., 2022; Ernawati & Susanti, 2021; Guiamalon et al., 2021) creating a more personalized and adaptive learning environmentz (Erdi & Padwa, 2021; Vesin et al., 2018; Zyu, 2022). However, based on the findings from observations and interviews conducted at SMA Srijaya Negara, there are various issues, including a low interest in literacy among students due to the perceived monotony of the learning process. This monotony arises because, in practice, teaching and learning activities still rely on thick, printed textbooks.

The limitations of using printed books in teaching are also attributed to the lack of training and guidance for teachers in creating engaging teaching materials based on technology (Amin, 2019). Therefore, the researchers here leverage available technology by creating teaching materials that can be utilized by both teachers and students in the learning process. Given this situation, there is a need for innovation in creating technology-based teaching materials that can facilitate students in understanding a subject (Sukmawati, 2021). Thus, this study aims to develop teaching materials in the form of e-modules (Nikou & Economides, 2018).

The use of e-modules as teaching materials can provide significant solutions and innovations in supporting the learning process (Cahyati et al., 2022). This is because of the integration of multimedia elements such as images, audio, and video (Noeryanti & Rejekiningsih, 2023), which would make the learning process more engaging and interactive (Keleşzade et al., 2018; Linzalone et al., 2020). By carefully designing said e-modules, we can create a learning experience that aligns with the individual needs of the students (Crisianita & Mandasari, 2022; van Boxtel & van Drie, 2018).

This presents a challenge in the history subject, particularly at SMA Srijaya Negara Palembang, where this research was conducted. The selection of this school was based on the implementation of the 2013 curriculum, which is still in effect and aligns with the materials developed by the researchers. Additionally, the availability of adequate internet access and permission for students to bring

smartphones provide support in the implementation of e-modules in the learning activities conducted.

The idea of applying electronic modules to learning activities in this study is supported by several previous, related studies on the matter, the first one being that from Susanti and Chairunisa (2020) titled "Development of E-Modules for Learning the History of Development Figures Post-Independence in South Sumatra," trying to gauge students' perceptions regarding the tested modules in their learning activities. Their study also indicates the success of electronic module teaching materials in learning.

Another study by Herwina et al., (2023) titled "Development of E-Modules Assisted by Sigil Software in High School History Subjects" showed practicality in this regard based on their data processing and practicality testing involving teachers and students with a practicality level of 80.73% deemed "very practical," indicating positive responses from students to the use of such e-modules in the learning.

Additionally, the study by Oktari, (2021) titled "Development of 3D PageFlip-Based Electronic History Modules" indicated that the use of e-modules had facilitated the teaching process they conducted. The module could be effectively and efficiently used by teachers to deliver learning materials to their students.

Based on the relevant research mentioned above, it can be concluded that the use of e-modules in the learning process is effective, as evidenced by the students' improved learning outcomes after using said e-modules. The novelty in the current study, meanwhile, lies in the development of history learning e-modules using the Calibre application, focusing on the Japanese colonization of Indonesia.

Calibre is one of several feasible applications to be used in creating digital learning modules. It can be easily used to create digital modules as it is open-source based on E-pub (electronic publication) introduced by the International Digital Publishing Forum (IDPF) in 2011. Additionally, the advantage of using Calibre is its accessibility on both smartphones and laptops (Mahsup et al., 2023).

Therefore, this study aims to develop teaching materials not only as a means in the learning process but also with a specific focus on increasing motivation and ease of use for both teachers and the 11th-grade Science 2 students at SMA Srijaya Negara Palembang as the research participants. The development of these e-modules is expected to facilitate the learning of history and make it easier for students to understand the material.

METHODS

The development of e-modules in this study on the topic of the Japanese colonization of Indonesia is conducted through a development research method, as illustrated in Figure 1 below:

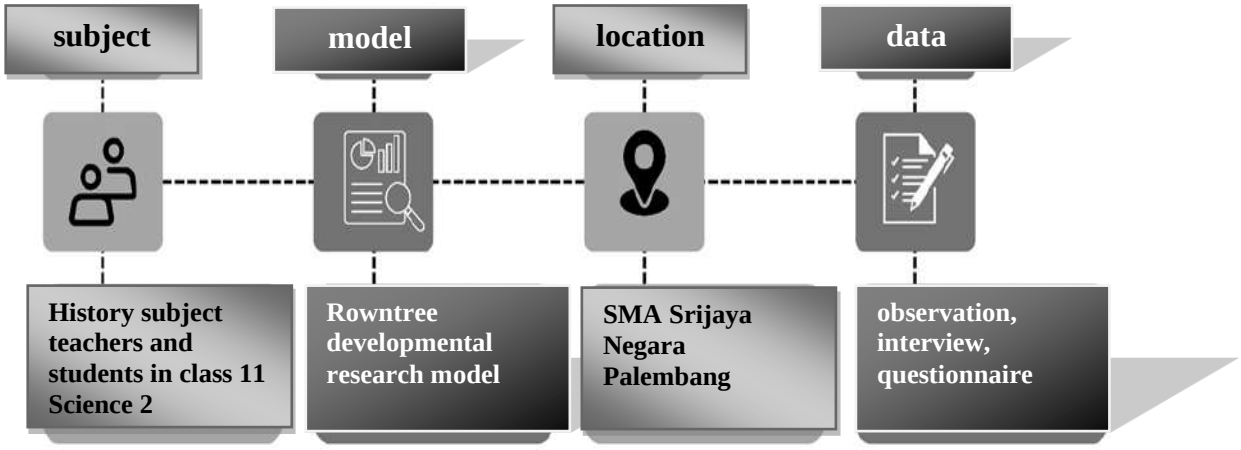

Figure 1. Research Method

As seen in Figure 1, the research method employed in this study is the Rowntree model development research, with the subjects being history teachers and 11th-grade Science 2 students at SMA Srijaya Negara. The research process was conducted at SMA Srijaya Negara, Palembang, and the data were collected through observation, interviews, and questionnaires. The data obtained were then analyzed from the results of the students' learning outcomes using the basic pre-test and post-test comparison formula and N-gain score formula. Development research is a method used to create and develop new products such as teaching modules, learning media, teaching materials, learning models, teaching methods, books, and more (Prucha et al., 2016). The research location is at SMA Srijaya Negara, Palembang, which is one of several private schools in the city.

The development model and its subsequent stages designed by the researchers in this study can be seen in Figure 2 below:

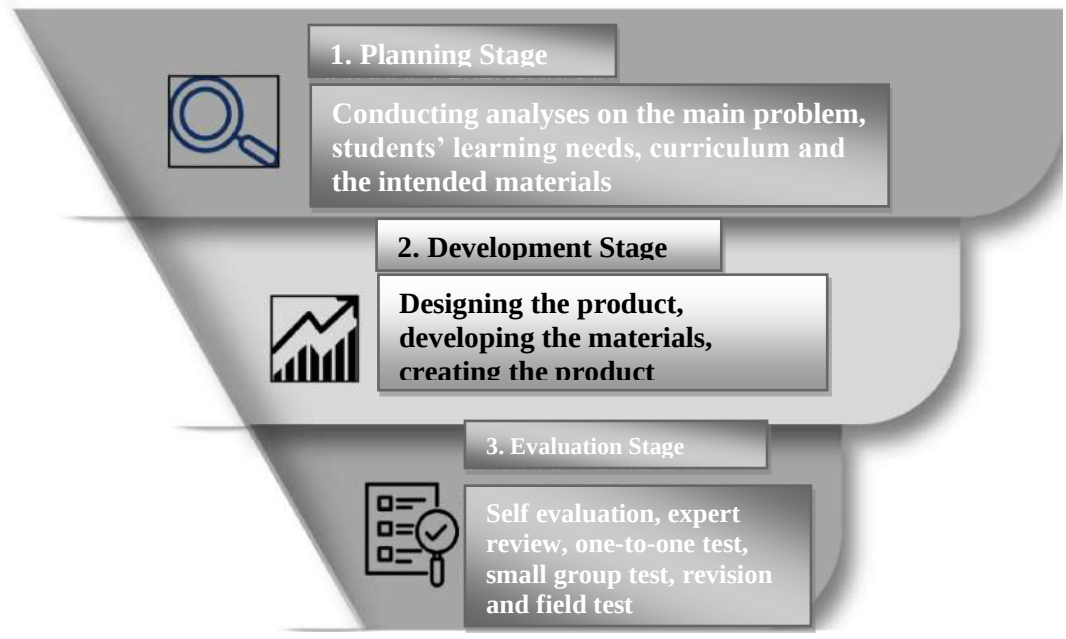

Figure 2. Rowntree Developmental Research Design

The diagram above represents the Rowntree development model, divided into several stages followed herein: planning, development, and evaluation (Dua Dhiu & Ngurah Laba Laksana, 2021). In the planning stage, direct observation was conducted by visiting the 36 students of class XII Science 2 at SMA Srijaya Negara Palembang for observation during their learning and for carrying out interviews with the history teachers at the school (Kurniawati et al., 2017; Onishchuk et al., 2020). Additionally, a questionnaire containing a survey was distributed to understand the various learning needs of the students and gather feedback from them (Fulcher, 2012).

Moving on to the development stage, it involves four follow-up steps. Firstly, the researchers designed the intended e-module learning product, followed by developing the material topic to be put in the e-module, then created the product itself, and finally drafted expert validation sheets. Furthermore, in the evaluation stage, formative assessment by Tessmer (Fahmir et al., 2021) was employed. Tessmer's assessment consists of five types of tests of its own: self-assessment, expert assessment, one-to-one (or individual) assessment, small group assessment, and field test (Osman et al., 2021).

The instruments used in this developmental research include 1) direct observation, conducted by the researchers in the planning stage to observe the school's conditions, students, and the learning environment; 2) interviews, used to identify various issues in the learning process, curriculum use, materials, and teaching aids; and 3) questionnaires, used to measure the ease of use of the developed product and assess students' understanding.

The validation score categories, converted from qualitative data to quantitative data, can be seen in Table 1 below:

Table 1. Conversion of qualitative data to quantitative data

Average score	Criteria
>4.2 s/d 5.0	Very valid
>3.4 s/d 4.2	Valid
>2.6 s/d 3.4	Less valid
>1.8 s/d 2.6	Invalid
>1.8 s/d 2.6	Invalid

(Source: Prahani et al., 2016)

The data obtained were then analyzed descriptively and statistically. Qualitative data, in the form of various comments and suggestions for improvement, were described qualitatively and descriptively for further product revision. A conversion table for the data and their analysis referring to and adapted from Syakura (2017) was used.

Regarding the field test activity, the researchers involved 36 11th-grade Science 2 students to assess the impact of using the product. Data in this testing process were obtained through pre-test and post-test sessions given to the students, and the analysis was conducted using the calculation of the N-gain score to determine expected improvements in the students' learning outcomes. The N-gain score can be obtained through the following formula:

$$N - gain = \frac{Posttest\ Score - Pretest\ Score}{Maximum\ Score - Pretest\ Score}$$

(Source: Prahani et al., 2016)

Following this, the results of the average N-gain calculation can be classified into criteria as shown in Table 2 below:

Table 2. Categorization of N-gain score

Percentage	Criteria
g ≥ 0.7	High (very effective)
0.3 ≤ g < 0.7	Medium (effective)
g < 0.3	Low (not effective)

(Source: Oksa & Soenarto, 2020)

RESULT AND DISCUSSION

E-modules have become an engaging instructional tool in educational contexts with the use of digital technology getting more implemented in schools (Rawashdeh et al., 2021). This aligns well with the innovative 21st-century learning approach, which focuses on technology-based engaging education (Arabloo et al., 2022). However, it is acknowledged that the implementation of technology-based instructional materials in education is not yet widespread (Malicka et al., 2019). With this in mind, this study was aimed at filling in this learning gap by developing an e-module entitled "Digitalizing History: Development of E-Module for History Learning on the Japanese Colonialism Period in Indonesia." Following the steps of the Rowntree research and development model, consisting of three stages, the outcomes of the research process are as follows:

Planning

In the planning stage, a set of analyses of problems, students' needs, curriculum, and materials was conducted. For the problem analysis, the researchers interviewed history teachers at SMA Srijaya Negara Palembang. Regarding the needs analysis, it can be seen in Figure 3 below:

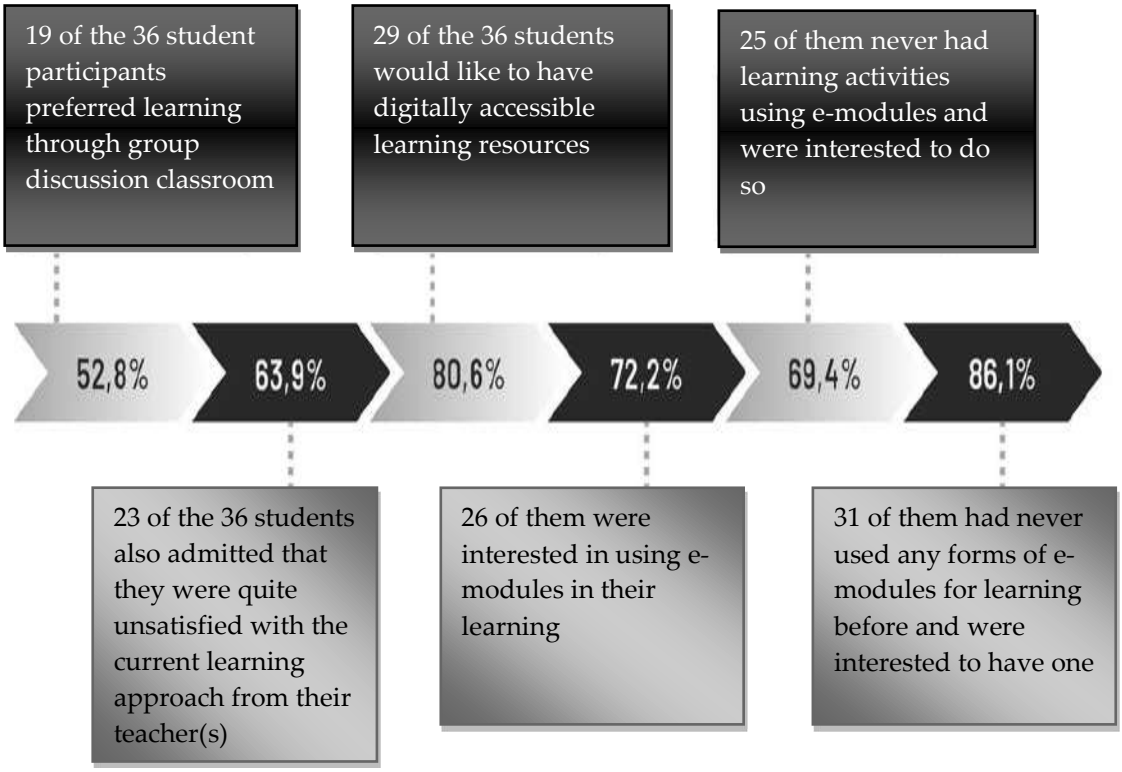

Figure 3. Analysis of Students' Learning Needs

Based on the needs analysis results, it can be concluded that only a relatively small number of students were satisfied with traditional history teaching methods. The majority of students have not used e-modules in their learning processes but express a strong interest in doing so. Interview data also indicates a desire for innovative and engaging learning methods using attractive learning media.

This study employed the Rowntree development model, focusing on developing a product in three steps: planning, development, and evaluation (Dua Dhiu & Ngurah Laba Laksana, 2021). In the planning stage, direct observation was conducted by visiting SMA Srijaya Negara for two observation activities (i.e. on the students and the teachers), the results of which are as follows:

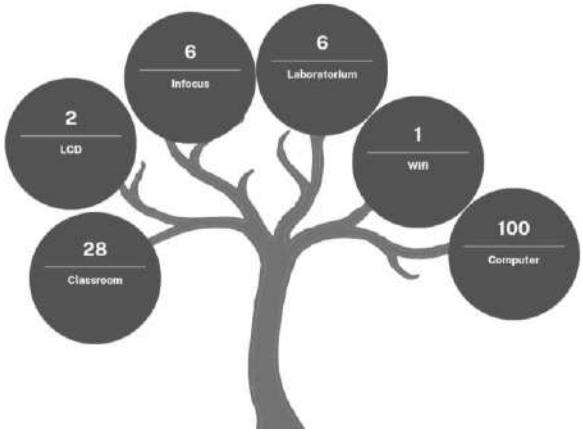

Figure 4. Observation results

Based on the observation results and interviews with history teachers regarding the material to be developed in the e-module, questionnaire surveys were also distributed to the students (Kurniawati et al., 2017; Onishchuk et al., 2020). Additionally, a questionnaire was distributed to understand various students' learning needs and gather their feedback (Fulcher, 2012).

In this context, it is evident that students require e-modules as a novel and technology-based instructional tool. For this reason, the researchers modified the details of the sub-materials to be covered, as seen in Figure 5 below:

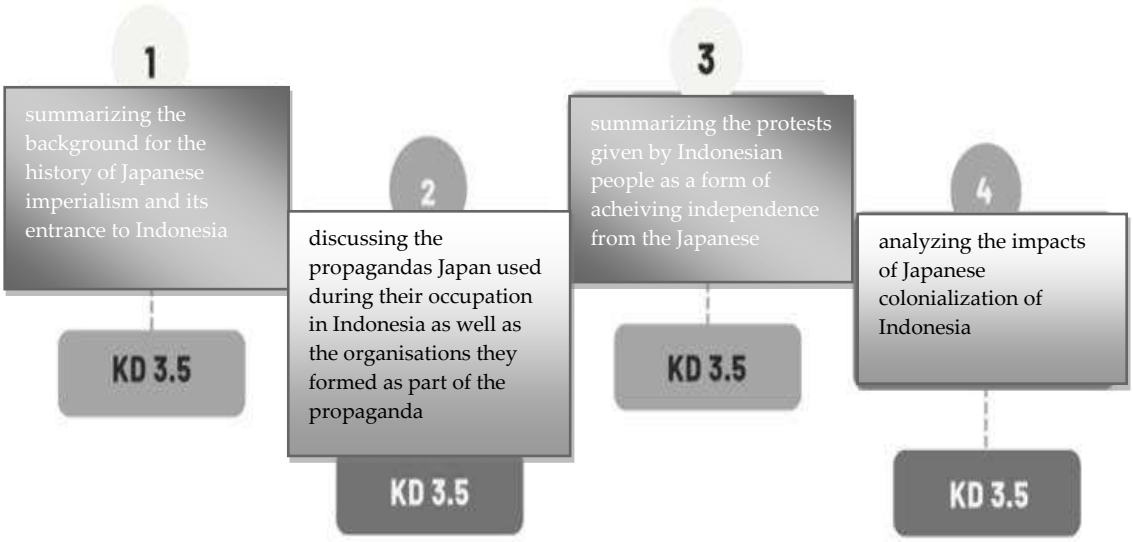

Figure 5. Analysis of the Intended Materials

In the material analysis shown above, it can be seen the research activities of observing and interviewing history teachers at the research location about the Competence Basis and the material to be developed, which are part of the 2013 curriculum. Curriculum analysis was also conducted, revealing that students at SMA Srijaya Negara in grade 10 use the Merdeka curriculum, while students in grades 11 and 12 use the 2013 curriculum.

Development

This study focuses on creating and developing a product in the form of an e-module using the Calibre application. The development steps begin with designing and conceptualizing the material, including selecting learning objectives, followed by the processing of said material and the creation of the e-module using the Calibre application itself, which involves designing the cover, creating the content, and adding elements such as photos, illustrations, backgrounds, color selection, and layout adjustments. Below is the initial display of the e-module, as seen in Figure 6:


MODUL AJAR SEJARAH
PENDUDUKAN JEPANG DI INDONESIA
KELAS XI SMA/MA
M. Reza Arviansyah


DAFTAR ISI
PENDUDUKAN JEPANG DI INDONESIA


DAFTAR GAMBAR
PENDUDUKAN JEPANG DI INDONESIA


PENDAHULUAN
A. Identitas Modul
B. Kompetensi Dasar
C. Deskripsi Singkat Materi
D. Petunjuk Belajar
PENDUDUKAN JEPANG DI INDONESIA

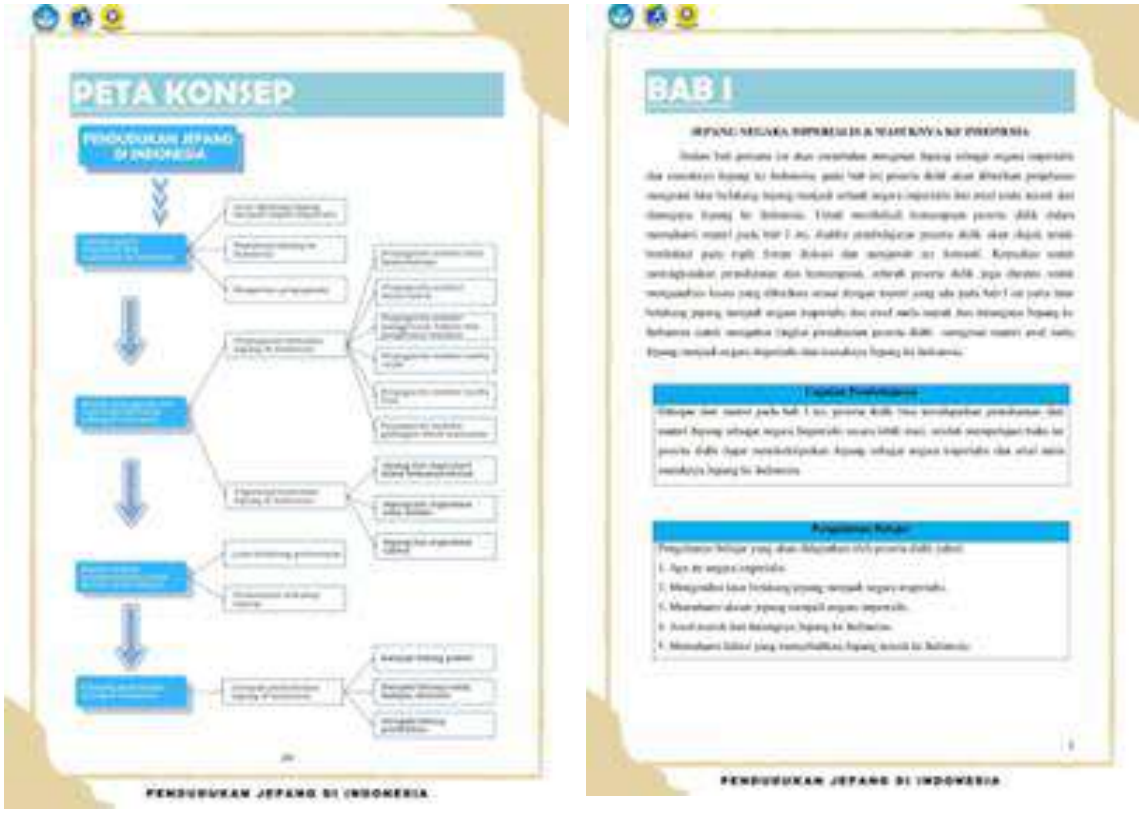

Figure 6. Initial look of the developed e-module

Evaluation

Self-evaluation was conducted on the developed e-module. Subsequently, an evaluation and scoring were carried out by experts regarding its several key aspects: Helen Susanti, M.A., an expert in history learning content, Yudi Pratama, M.Pd., an expert in learning media design, and Vitria Marsela, M.Pd., an expert in language structure, as shown in Table 3 below:

Table 3. Results of the Expert Validation Process

No	Aspects validated	Average
1.	Materials	4.7
2.	Media	4.6
3.	Language	4.1
	Total average	4.4 (very valid)

Based on Table 3, it can be observed that, in addition to obtaining an average score of 4.4, the validators also provided suggestions and feedback for improvement in this e-module. Various suggestions and feedback provided by the validators can be seen in Table 4 below:

Table 4. Summary of comments and advice from the expert validators

No	Comment from the expert	Before	After
1.	Provide more references to enrich the materials and give the e-module more factual strength—at least one reference per paragraph		
2.	The references need to be written more consistently		
3.	Wrong uses of capital letters and misplacement of several punctuations need to be addressed, as well as some mistakes in using italics and bold types		

Based on Table 4, the evaluation was conducted to measure the level of validity of the product, guided by the assessment of the validators. The evaluation was carried out according to various suggestions provided by the validators. Validators involved in the evaluation process were experts in history content, history learning media, and Indonesian language usage. After the evaluation and revision based on the received feedback, the developed e-module became suitable for field testing.

The next step involved field testing, consisting of individual and small group testing activities. The results obtained from the field testing process are presented in Table 5 below:

Table 5. Results of the individual and small group testing

No	Kind of test	Average
1.	One-to-one	4.3 (very valid)
2.	Small group	4.4 (very valid)
	Total average	4.35 (very valid)

Based on Table 5 above, the conducted field testing process has proven that the developed e-module in this study can be implemented in the learning process. As explained, the field testing process was conducted before the application of the developed media.

Next, field testing was conducted with 36 11th-grade Science 2 students at SMA Srijaya Negara Palembang. Initially, a pre-test and post-test were administered at the end of the learning process. In the pre-test stage, students obtained low scores and an overall low average. The recapitulation of the students' pre-test and post-test scores can be seen in Figure 7 and 8 below:

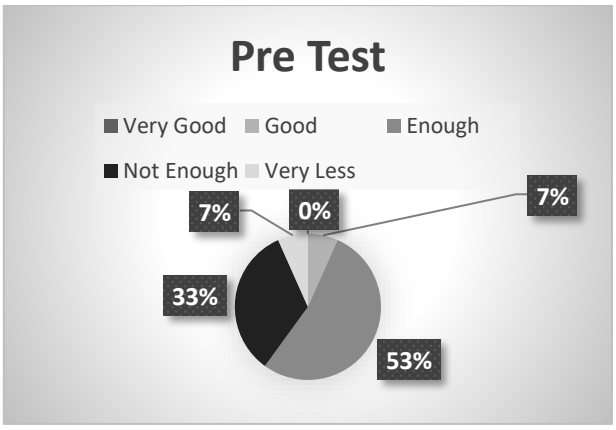

Figure 7. Result of the pretest session

Based on the recapitulation graph of pre-test scores above for the 36 participants, the majority of the students received scores in the relatively low range, with 16.53% falling in the 41-60 score range (considered adequate), while 10.33% scored in the 21-40 range (considered inadequate).

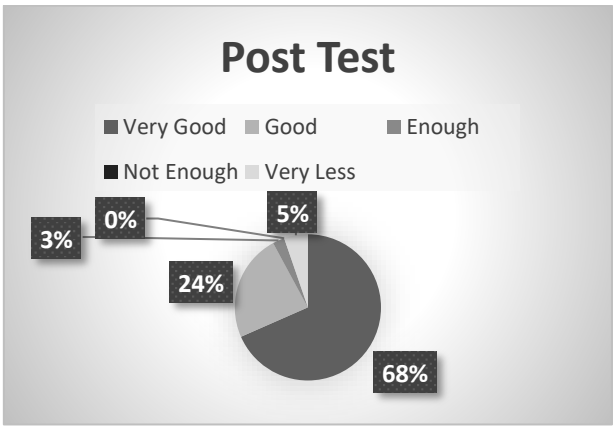

Figure 8. Result of the posttest session

The recapitulation graph of the post-test scores above for the 36 participants, meanwhile, shows a significant improvement compared to the pre-test results. The

majority of the students demonstrated an increase in their understanding of the tested material. Specifically, 68% of them achieved the highest scores in the 81-100 range (categorized as very good) while 9.24% achieved scores in the 61-80 range (categorized as good).

A comparison of the pre-test and post-test scores achieved by the student participants can be seen in Figure 9 below:

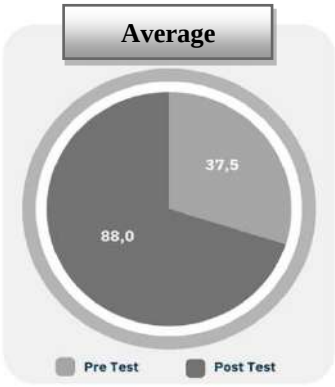

Figure 9. Comparison between the pretest and posttest results

The comparison graph between pre-test and post-test scores above illustrates an improvement in students' understanding of the material. The pre-test and post-test scores were calculated using the N-gain formula, and the results can be seen in Table 6 below:

Table 6. Average student scores in the pretest and posttest sessions

Pretest average score	Posttest average score	N-gain
37.5	88.0	0.80

Looking at Table 6, the analysis of individual improvements in their understanding shows an increase in the average score from 37.5 to 88.0. The average N-gain or score improvement reaches 0.80. Therefore, the use of case-based learning e-modules as instructional materials that this study was focused on has successfully and significantly improved students' understanding of the history of Japanese colonialism material, both for those with initially low understanding and those with a better understanding. This indicates the effectiveness of using e-modules to enhance students' understanding of the provided material.

Discussion

With the continuous development of the education sector, digitalization is progressing rapidly (Kalolo, 2019; Malahilla et al., 2023). Referring to the research results, the e-module-based case-based learning on the Japanese colonization of Indonesia provides new information for students, positively impacting learning

outcomes. The results obtained in the pre-test session for the 36 students involved had an average score of 37.5. Meanwhile, in the post-test session, completed by the same 36 students, there was a significant improvement in their test scores, with an average N-gain score of 88.0.

This improvement can be attributed to the students' enthusiasm in engaging with the learning material and their interest in the e-module on the Japanese colonization of Indonesia. This aligns with Antari's (2023) the opinion that the use of e-modules can enhance students' motivation and encourage critical thinking. Furthermore, as stated by Amartha (2022), e-modules can enhance students' independence in studying because the interactive and enjoyable nature of e-modules makes the learning process more active, leading to improved learning outcomes.

The increase in students' learning outcomes is evident from the 50.5% rise in the percentage comparison between pre-test and post-test scores. Some students experienced significant improvement, and this can be associated with the role of constructivist learning theory. According to Lin et al. (2021), a person's cognitive structure can develop and change when acquiring knowledge and experience. Research conducted by Khozaei (2022) supports the idea that students applying the constructivist learning theory achieve higher learning achievements compared to those using traditional learning approaches (Magdalena, et al., 2020; Pratiwi, 2022; Syarifuddin et al., 2021).

The influence of implementing the constructivist learning theory is notable because, during the classroom learning activities, students attentively followed the explanations presented through the e-module on the Japanese colonization of Indonesia, displayed using engaging PowerPoint slides. Consequently, the delivered material is absorbed effectively and becomes easy to remember (Tafakur et al., 2023). This aligns with a perspective from Bawamenewi (2019) that well-developed modules are systematically organized, making it easier for students to achieve the learning objectives.

The e-module on the Japanese colonization of Indonesia presents both advantages and disadvantages in the realm of education. On the positive side, it offers ease of access through a convenient Google Drive link, ensuring students can readily engage with the content. The comprehensive nature of the learning materials, utilizing a case-based approach with a blend of text, images, and videos, enhances the educational experience by making it engaging and appealing. Moreover, the e-module is designed with a high level of complexity, incorporating core competencies, indicators, and learning objectives that align with students' achievements, promoting a more profound understanding of the Japanese colonization of Indonesia.

However, the e-module on the Japanese colonization of Indonesia comes with its set of disadvantages. Firstly, it introduces device dependency, as students need electronic devices like smartphones or laptops to access the module. This may pose a challenge for those without such devices, creating a potential barrier to their engagement with the educational content. Additionally, the digital format of the module raises concerns about prolonged screen exposure, potentially leading to eye strain or fatigue for students who need to concentrate on the material continuously, whether on smartphones or laptops. These drawbacks highlight the importance of considering accessibility and the impact of digital learning on students' well-being in the context of e-modules.

CONCLUSION

Based on the research findings and the analysis conducted throughout the study, the conclusion regarding the development of an e-module on the history of the Japanese colonization of Indonesia at SMA Srijaya Negara Palembang using the Calibre application is that it is both valid and effective for use in history learning activities. The validity is evident from the assessment results obtained from the validators, encompassing content, media, and language aspects of the learning media, all yielding an average score categorized as highly valid at 4.4. The effectiveness is demonstrated by the average learning outcomes score of the students, which reached 88.0.

The electronic module developed in this study successfully meets the criteria for good validity and effectiveness as a learning resource, allowing history subjects to be used as alternative teaching material for both teachers and students to support their teaching and learning activities. The presence of technology-based teaching materials like this is expected to promote digital literacy skills, thereby further enhancing historical thinking abilities.

The development of electronic modules can have a positive impact on teachers specifically, transforming the learning styles from conventional to more diverse, engaging, and efficient using these modules in line with curriculum demands for IT-based teaching. Additionally, these electronic modules can be used for both face-to-face and online learning.

The developed e-module in this study meets the criteria of being valid and effective, making history a potential alternative teaching material for both teachers and students to support the teaching and learning process. The integration of digital technology-based teaching materials is expected to enhance digital literacy skills, ultimately improving historical thinking. Therefore, considering the application of science and technology in history education is crucial. A suggestion for future research would be to explore the development of e-modules using alternative

teaching methods such as problem-based learning. The diversity in e-module applications can be a solution to enhance students' digital literacy skills and create engaging history teaching materials aligned with 21st-century innovative learning approaches.

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Jurnal Inovasi Pembelajaran

JINoP. May, 2024, 10 (1): page 51-61
p-ISSN 2443-159, e-ISSN 2460-0873
https://doi.org/10.22219/jinop.v10i1.27138

Improving students' cognitive skill: The use of the project-based learning of STEM Model

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uploaded: 06/13/2023
revised: 12/29/2023
accepted: 03/13/2024
published: 05/31/2024

Lestari, I. T., Ambarwati, U., & Asih, T. (2024). The Improving students' cognitive skill: The use of the project-based learning of STEM Model. *JINoP (Jurnal Inovasi Pembelajaran)*, 10(1), 51–61. https://doi.org/10.22219/jinop.v10i1.27138

Abstract
Science learning emphasises the provision of direct experience to develop students' competencies in exploring and understanding the natural surroundings scientifically. However, the science learning process in SDN 2 Bulusan, Indonesia, remains directed at students' ability to merely remember various information without relating it to their natural surroundings. This impacted students' ability to understand science only to the extent of rote memorisation. There is a need for an approach that improves students' cognitive skills to achieve the desired ability. The objectives of this study are: (1) to explain the procedures of Project-based Learning (PjBL) in teaching Science, Technology, Engineering, and Mathematics (STEM); and (2) to improve scientific attitudes and students' cognitive learning outcomes. This research employed classroom action research (CAR) with two cycles for 13 fifth graders of SDN 2 Bulusan. The data was obtained through interviews, observation, and tests, which were analysed using source triangulation and technique triangulation. The results showed that: (1) PjBL STEM was carried out through reflection, research, discovery, application, and communication; and (2) students' cognitive learning outcomes have increased as shown through minimum completion criteria, which improved from 76.9% to 92.3%. This finding shows that PjBL STEM potentially improves the cognitive learning outcomes of Indonesian fifth-graders.
Keywords: CAR; Cognitive Learning Outcomes; PjBL STEM; Science.

INTRODUCTION

The 21st century requires high-quality human resources with multiple competencies. Lukum in Putriani & Hudaidah (2021) states that the three major competencies needed in the 21st century are the ability to think, act, and live. Education, in this case, is expected to improve the quality of human resources and serve as an investment in a nation's future (Hasibuan & Prastowo, 2019). This is because education comprises materials and teaching materials needed by students, one of which is Science.

Science is compulsory in primary schools because it can provide direct experience, actively involve students, and improve learning outcomes (Musyadad, 2019). This is in line with Dwiyanti et al. (2021), who states that Science embodies the process of obtaining information through logical and systematic investigations, which entails observation and experimentation. Besides its integration of processes, procedures, and products, Science learning in primary schools aims to create a generation with fundamental scientific knowledge, skills, and attitudes. However, this is at odds with the reality that Science learning in Indonesian primary schools practice passive learning due to the teacher-centred method (Fitriani et al., 2019). Teacher-centred learning is prone to students' boredom, which further affects their cognitive skills and their ability to understand the material well (Zamil & Udyaningsih, 2021).

Such a phenomenon is visible in the fifth-graders of SDN 2 Bulusan, Indonesia, where students' activities during Science learning were listening, taking notes, reading, and working on evaluation questions and assignments in the textbook. Apart from that, students' understanding is limited to memorisation with minimum literacy and comprehension ability. Based on our preliminary study, this can be seen from the students' scores below the minimum completion criteria. Only 5 students scored above 70% out of 13 students.

Science learning should emphasise direct methods to develop students' competencies in understanding their natural surroundings, rather than note-taking and memorisation. This notion follows the stage of cognitive development of primary school-age students stated by Piaget, namely, the operational stage. During this stage, the thought process is directed at real events observed by the child. In particular, children can carry out complex problem operations as long as the problem is not abstract (Juwantara, 2019). By targeting students' cognitive development, teachers' ways of teaching should be more effective, efficient, and targeted. Hence teachers need to design innovative learning models that are appropriate to the characteristics of students (Magdalena et al., 2023).

The Project-based Learning (PjBL) learning model is known to help students build knowledge and skills by using a project as the core of learning (Afriana et al., 2016). In PjBL, teachers and students are required to develop questions, so that students can comprehend the material in a meaningful way (Nyihana, 2021). PjBL is essential in improving the quality of student activities by garnering several different learning processes. Astuti et al. (2019) regard that the application of PjBL will increase students' abilities in conceptual learning. In their study, Nurhadiyati et al. (2021) found that PjBL influences the learning outcomes of fourth-graders. Surya et al. (2018) similarly found that the implementation of PjBL improved both learning outcomes and creativity of third-graders in Salatiga.

Besides choosing a learning model, teachers must also be able to select an approach that suits the chosen learning model used (Asih & Halisiana, 2022).

Approaches to Science learning must fit the characteristics of the 21st century to train problem solvers, innovators, and inventors, who can think logically and be independent. In this case, Science, Technology, Engineering, and Mathematics (STEM) is seen to fit that purpose because it teaches practical skills to increase students' interest in learning (Astuti et al., 2019; Kelley & Geoff, 2016). Learning STEM can build a cohesive and active learning system because all four are needed simultaneously to solve problems, in which students can be confident in uniting abstract concepts from each aspect (Khairiyah, 2019). A study by Davidi et al. (2021) shows that learning with a STEM approach has proven effective in improving the thinking skills of elementary school students in Wae Ri'i, Indonesia.

Concurrently, the PjBL STEM learning model is an approach that places students in groups to complete a project that integrates Science, Technology, Engineering, and Mathematics. According to Fazriyah (2019), PjBL learning steps entail 1) *reflection*, which brings the students into problem contexts and ignites investigation; (2) *research*, in which teachers guide students to carry out research; (3) *discovery*, which bridges research and information through the identification of project steps; (4) *application*, which students apply the obtained knowledge to solve problems; and (5) *communication* as the final stage where students present their learning and solutions.

A study by Elisabet et al. (2019) shows that PjBL can increase students' motivation and Science learning outcomes. Another study conducted on the fourth graders of SDN 2 Tahunan, Indonesia, also shows that is effective in increasing students' positive STEM learning experience (Nurul, et.al., 2021). Both studies were quantitative and similarly showed significant improvement in the subjects. As a novelty, this present study attempts to apply Classroom Action Research (CAR) to explore the process of the PjBL STEM model in improving students' learning.

METHODS

This present study employed Classroom Action Research (CAR), which focuses on the learning process that occurs in the classroom and aims to improve the quality of learning (Saputra et al., 2021). This research was carried out at SDN 2 Bulusan, Karangdowo, Klaten with research subjects of fifth graders for the 2022/2023 academic year, totalling 13 people.

The cycle model by Kemmis and McTaggart (Hopkins, 2011) was used, comprising the *planning*, *implementation*, *observation*, and *reflection* stages. This cycle does not occur only once, but several times until the expected goal is achieved. The following is the visualisation of the CAR cycle:

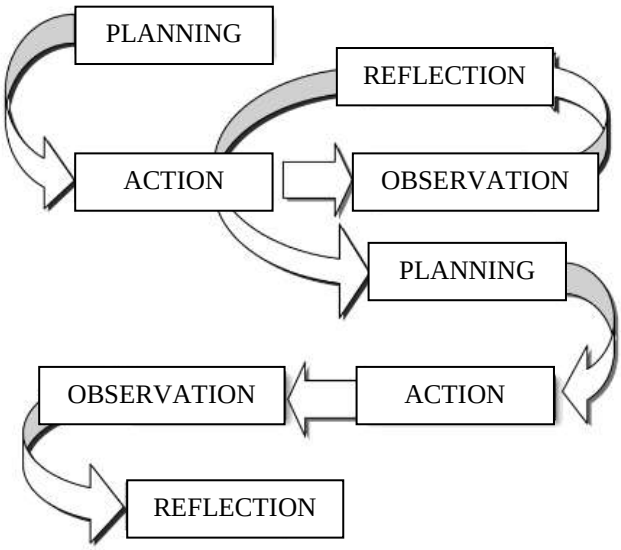

Figure 1. CAR Cycle by Kemmis dan Mc. Taggart

The data collection techniques used in this research included: 1) test and 2) non-test. Tests are used to measure learning outcomes from the PjBL STEM model about the water cycle; while non-test techniques include observation, interviews, and documentation. Observations were carried out to observe the implementation of the PjBL STEM model in improving students' cognitive ability; interviews were used to investigate the shortcomings of the learning process; and documentation included compiling the portfolios, such as students' data and grades. Following the data collection techniques, the research instruments included observation sheets, interview guidelines, and paper tests of multiple-choice questions and short answers.

According to Arikunto et al. (2017), valid data is results from detailed evaluation and corresponds to reality. Therefore, this CAR also employed triangulation in data collection techniques. This follows Sugiyono (2017), who states that validity can be obtained through the combination of various existing data collection techniques and data sources. The triangulation used in this research is source and technique triangulation. Triangulation of sources were the fifth-grade teachers, students, and observers; while the triangulation of technique included observation, interviews, and tests.

In this present study, the obtained data was analysed both quantitatively and qualitatively. Quantitative data was in the value of students' scores, and qualitative data was from the implementation process of PjBL STEM. The qualitative data was analysed through four steps, namely, data reduction, data presentation, data verification and conclusion drawing as developed by Miles and Huberman (Safira et al., 2021).

The effectiveness of this present study is indicated through both process and outcome while carrying out learning in the classroom (Suriani, 2020). Indicators of effective process are measured from teacher activities in implementing PjBL STEM with a target of 85%, and students' scores with a

target of 85%. If 85% of the students scored above 70%, it can be said that they have fulfilled the minimum completeness criteria. These criteria followed Agustina (2014) as summarised below:

Table 1. Students' minimum completeness criteria in PjBL STEM

No.	Percentage	Criteria
1.	≤ 49%	Fail
2.	50 – 59%	Poor
3.	60 – 69%	Fair
4.	70 – 79%	Good
5.	≥ 80%	Excellent

Source: Agustina (2014)

RESULTS AND DISCUSSION

The CAR in this present study was carried out in two cycles, each consisting of two meetings. Each meeting comprised four stages *planning, implementation, observation,* and *reflection.* At the *planning* stage, the researchers decided on the learning objectives, drafted lesson plans, tailored working sheets, prepared learning resources and media, and prepared research instruments. The *implementation* stage entailed the classroom application of the PjBL STEM model. During the *observation,* the researcher was assisted by two observers (tutor and colleagues), and the *reflection* stage guided the decision for the further cycle as shown through students' scores.

In particular, five steps comprising *reflection, research, discovery, application* and *communication* were applied during the *implementation* stage as argued earlier in this study. The increase in learning effectiveness is shown through differences in the results of Cycle I and Cycle II as illustrated by the following figure 2.

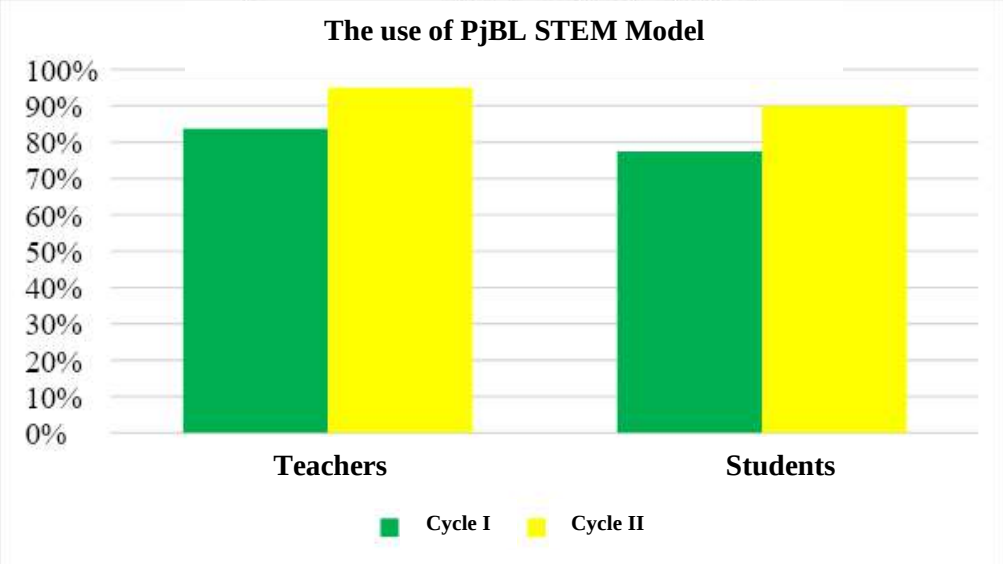

Figure 2. Differences in students' results

Looking at Figure 2 above, an increase (12.5%) in students' scores is readily apparent as also evidenced through observation and interviews with the STEM teacher. In Cycle I, students' scores were categorised as Excellent with an average of 3.3 or 82.5%. However, this number was not enough as it did not achieve the research target. This was partly caused by teachers' domination in the second and third steps, which are *research* and *discovery*, respectively. During the *application,* teachers were not seen to guide students in the task distribution to explore information and problem resolution. Therefore, Cycle II was deemed necessary to improve learning to ultimately achieve the research target of 85% through the implementation of the PjBL STEM model by teachers.

In Cycle II, particular improvements were made to the second and third steps. During the *research*, the teacher was asked to ignite students' critical thinking through questions, in which students were allowed to discuss in groups the form of research that would be carried out. Next, during *discovery*, the teacher provided several references for students to help them search for information. By so doing, the percentage of teachers using the PjBL STEM model increased in Cycle II with an average of 3.8 or 95% in the Excellent category, which reached the research target of 85%. This finding lends strong support to the notion by Handayani & Ayub (2021) who state that the steps in PjBL STEM provide meaningful Science learning. This can help students better acquire knowledge as guided by teacher creativity and scientific literacy (Afriana et al., 2016).

Furthermore, Figure 2 depicts students' responses to the use of the PjBL STEM model. In Cycle I, the average students' responses were 3.1 or 77.5%, categorised as Good, but had not yet reached the research target of 80%. This was because students were used to passively receiving material from the teacher, waiting for orders from the teacher, and getting confused by the distribution of group assignments. This condition was visibly improved in Cycle II where teachers' questions triggered students' motivation and guided their discussion and group work. Cycle II was also improved because teachers gave rewards or points to active students during the learning process. These improvements were also shown through students' responses which were increased to 3.6 or 90% (Excellent), fulfilling the research target of a minimum of 80%. This is in line with research conducted by Fatihah (2023) who found that the implementation of PjBL STEM boosts students' communication and responsive roles within group work. Such collaboration leads to idea production in the form of innovative work, which concurs with the values of PjBL that emphasise the project.

Overall, the findings show that learning using the PjBL STEM model can improve students' cognitive learning outcomes in science learning. Students' achievements in Cycle I and II were also far better than their Pre-cycle achievements. Following is the comparison of students' scores in Pre-cycle, Cycle I and Cycle II:

Table 2. The comparison of students' scores in pre-cycle, cycle i, and cycle ii

No	Category	Pre-cycle		Cycle I		Cycle II	
		No. of students	(%)	No. of students	(%)	No. of students	(%)
1.	Complete	5	38.4	10	76.9	12	92.3
2.	Incomplete	8	61.6	3	23.1	1	7.7

Based on the table, it is readily apparent that students' cognitive learning outcomes improved throughout Pre-cycle learning activities, Cycle I and II by using the PjBL STEM. This is shown through the index of learning completeness (70%), in which eight students scored 61.6% before the treatment. This index much improved in Cycle I to 76.9% with 10 achievers, and only three students scored below the targeted index. Such improvement consistently rose in Cycle II where 12 students achieved 92.3%, leaving only one student scored below the index. This finding is in line with Rahmi et al. (2022) who found that using PjBL STEM potentially improves student learning outcomes.

Figure 3 depicting students' positive changes in cognitive learning outcomes throughout cycles can be seen below:

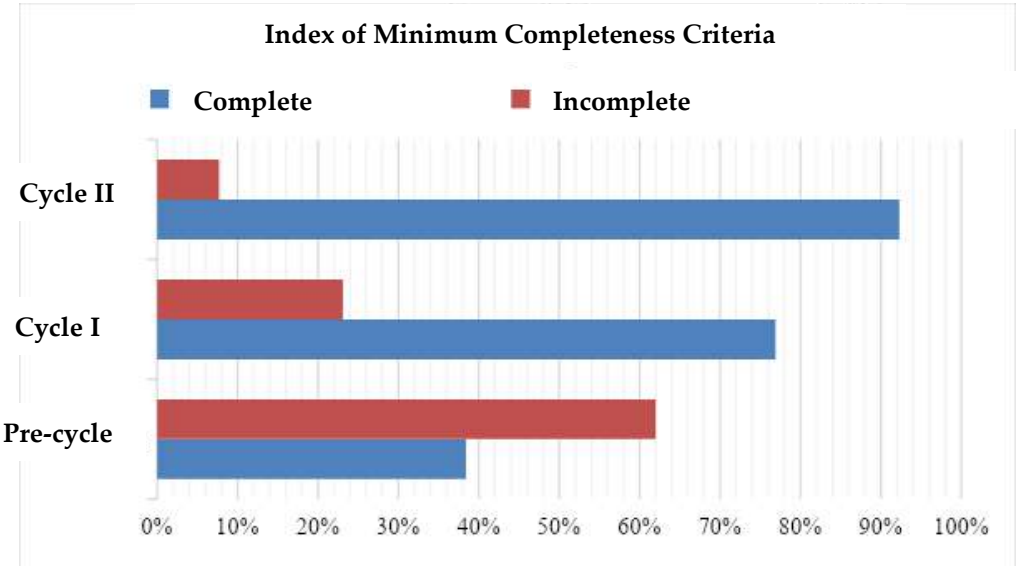

Figure 3. Comparison of students' achievements throughout cycles

Figure 4 illustrating the improvement as seen through classroom observation for teachers and students:

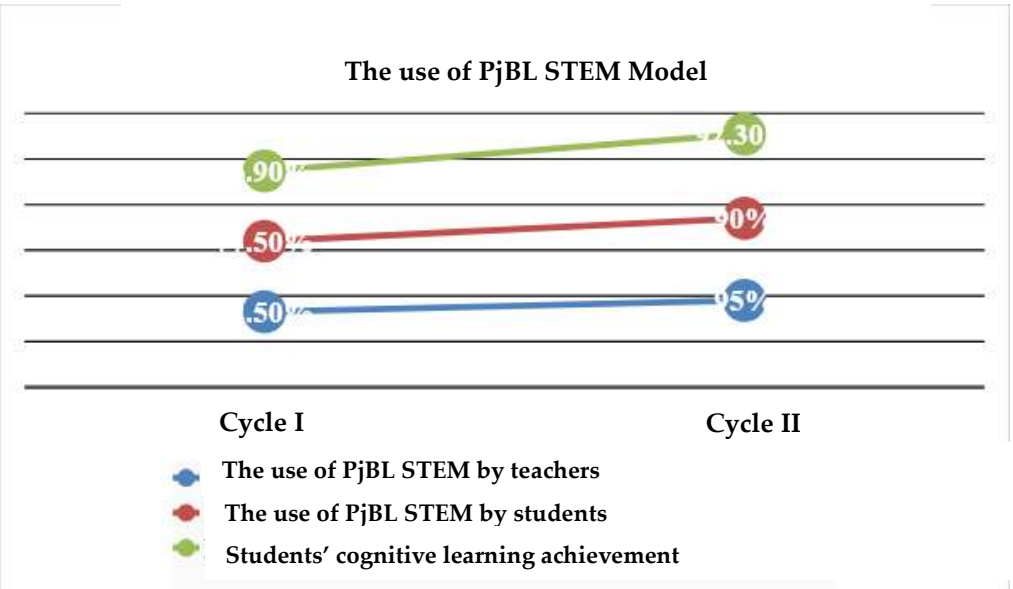

Figure 4. The improvements in teachers and students based on classroom observation

Based on the observation, PjBL STEM for the fifth graders was seen to record numerous advantages. First, it encourages students to learn actively and independently. The researchers observed that students did not receive information passively, but instead were involved in the process of designing, implementing, and evaluating projects related to the learning materials. This increases students' curiosity, creativity, and problem-solving skills.

Second, PjBL STEM was shown to instil a deeper understanding of science concepts. Through projects, students could apply the learnt theory to real situations and see its connection to other STEM fields. This helped them build more complete and meaningful knowledge connections. Third, PjBL STEM supported the development of the 21st-century skills required by students in the future, such as collaboration, communication, critical thinking, and creativity. This was apparent during group work where students learnt to collaborate in teams, communicate clearly, solve problems creatively, and think critically to find the best solutions.

Despite its advantages, PjBL STEM poses several disadvantages to consider. First, it requires careful preparation and planning from the teacher. Developing a project that is interesting, relevant, and appropriate to the level of student development requires extra time and effort. Second, PjBL STEM can be difficult to implement in large classes with limited resources. Limited space, tools, and materials can hinder the maximum implementation of the project.

Third, PjBL STEM calls for adaptations of assessment methods that are different from traditional learning. In the PjBL STEM model, the assessment does not only focus on the results of the project but also the learning process and skills shown by students during project work. This requires teachers to develop more complex and comprehensive assessment instruments.

By observing both advantages and disadvantages, teachers can utilize PjBL STEM effectively to improve the quality of science learning in fifth-grade elementary schools. PjBL STEM can be an interesting and meaningful learning alternative for students, but it needs to be supported by thorough preparation, appropriate implementation, and an effective assessment system.

CONCLUSION

This present study has shown that the PjBL STEM model can improve students' cognitive learning outcomes in science learning for Indonesian fifth-graders. This increase is evidenced by consistent improvement in Cycle I and II with 82.5% and 92.5%, respectively. Most students also scored above the minimum index of completeness criteria and showed learning enthusiasm as observed by the researchers. The findings of this present study offer both practical and theoretical implications as documented through the successful classroom implementation and support of the previous theory about the potential effectiveness of PjBL STEM for primary school students.

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Jurnal Inovasi Pembelajaran

JINoP. May, 2024, 10 (1): page 62-79
p-ISSN 2443-159, e-ISSN 2460-0873
https://doi.org/10.22219/jinop.v10i1.28626

E-module development using problem-based learning approach to learn data processing in training students' critical thinking

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uploaded: 08/16/2023
revised: 05/02/2024
accepted: 05/17/2024
published: 05/31/2024

Nurissamawati, B., Yuniawatika, Y., & Mas'ula, S. (2024). E-module development using problem-based learning approach to learn data processing in training students' critical thinking. *JINoP (Jurnal Inovasi Pembelajaran)*, 10(1), 62–79. https://doi.org/10.22219/jinop.v10i1.28626

Abstract

The research conducted on data processing material in mathematics subjects at the elementary school level identified issues related to the low critical thinking skills of students. The study aimed to create e-modules based on the Problem Based Learning (PBL) model to enhance the critical thinking skills of grade VI students, ensuring validity, practicality, and effectiveness. This research uses the R&D method with the ADDIE model. The validity of the e-module is obtained from expert validation followed by two trials to obtain practicality, and effectiveness obtained from the test. The validity test of the e-module product obtained an average percentage of 92.56%, categorized as very valid. The practicality test obtained an average percentage of 90.39% categorized as very practical and the effectiveness results through normality gain obtained a percentage of 76.33% categorized as effective. Thus, the e-module product is declared valid, practical, and effective and affects critical thinking skills and improvement in learning outcomes. However, the study's limitation lies in the focus on data processing material, separate from thematic learning, suggesting future research should emphasize real-life problems and diverse content to maintain student engagement, alongside schools providing reliable internet access for teaching materials.
Keywords: E-module; Mathematics; Data Processing; Critical Thinking Skills.

INTRODUCTION

Mathematics has an essential role in everyday life. Yuniawatika (2018), revealed that mathematics has many contributions in various lives. Mathematics is needed by students to have the capability to address challenges that arise in one's life (Azizah et al., 2018). Therefore, at every level of education students must learn mathematics. Mathematics is among the subjects that are essential to be taught at the elementary school level. One of the objectives of mathematics is to equip students with critical thinking skills in solving problems in everyday life (Anugraheni, 2019). By thinking critically, students are expected to possess the

skills to resolve issues both in the learning process and when facing problems in real-world situations.

One of the math materials at the elementary school level is data processing material. This data processing material is taught in grade VI elementary school. According to Uenah et al. (2022), a problem was obtained related to student difficulties in discussing class VI data management material. In this material there are still difficulties experienced by students, causing student learning outcomes in this material to be low, especially in grade VI. This is reinforced by the statement Himawan (2014), a problem was obtained related to student difficulties in discussing class VI data management material. In this material there are still difficulties experienced by students, causing student learning outcomes in this material to be low, especially in grade VI. This is reinforced by the statement Yusuf (2021), also stated that in the material for collecting and reading data, on average only 6 out of 17 grade VI students reached the standard of learning completeness . These problems occur because students experience problems such as not being able to process information, difficulty analyzing the results of data processing, presenting data in tables and diagrams (Priyantini et al., 2022).

Problems with data processing material were also found at Sukorejo Islamic Elementary School in Blitar City. Based on interviews and observations with the VIA class teacher at Sukorejo Islamic Elementary School on September 22, 2022, it is known that student learning outcomes on data processing material are still low. This is because students have difficulty in reading data as a result students have difficulty when finding the average of a data. Another problem experienced by students is that when they get problems in the form of story problems, students have difficulty analyzing and understanding the meaning of the problem. Therefore, when the teacher modifies the structure of the narrative problem from the example that has been delivered, students face difficulties in solving it. This eventually resulted in low student learning outcomes.

The difficulties that students experience when solving problems are influenced by their skills in critical thinking. Critical thinking holds significant importance as students who master critical thinking skills have the ability to solve the problems they face (Kurniawati & Ekayanti, 2020). So, low critical thinking skills will cause low student learning results. This statement aligns with findings from conducted research by Maulida et al. (2019), that out of 23 students only 2 students were classified in the critical category and finally had an impact on the midterm test results where more than all students were not complete. Therefore, in conclusion possessing critical thinking skills in mathematics holds significant importance for students.

Drawing from the outcomes of interviews with teachers of class VIA Sukorejo Islamic Elementary School, it is known that until now, only textbooks and student worksheets have been used by teachers during learning activities for data processing materials. The material will usually be explained first by the teacher in front of the class, then the teacher tells students to work on assignments from textbooks or student worksheets either independently or in groups. This makes the learning process tend to be passive and involves less student participation. The use

of textbooks and worksheets that do not present the connection between material and real life makes it difficult for students to comprehend concepts. The lack of teaching resources supporting the learning process results in low student skills in critical thinking. Whereas for students it holds significance to possess critical thinking skills in order to resolve issues in real situations in life. Moreover, to low critical thinking skills, the absence of creative and interesting teaching resources in supporting the process of acquiring knowledge also affects low learning outcomes. Furthermore, from the interview, it is known that the teaching resources utilized by teachers and students in class VIA are still in the format of conventional teaching resources. Teaching materials that have not been integrated with this technology make learning feel monotonous and cause students to feel bored. Prastowo (2015), argues that when educators only focus on using conventional teaching materials without the presence of creativity to develop innovative learning, the quality of learning will decrease. Therefore, teachers expect the existence of educational innovations capable of aiding teachers to produce technology-based learning activities and support students to actively participate and train skills in critical thinking.

Teaching materials are teacher support when delivering resources to students throughout their learning activities. Teaching materials function to achieve learning objectives and competencies after students learn a material (Rosilia et al., 2020). One shape of teaching material is modules. Acquiring knowledge experiences that are planned and made to fulfill certain objectives and are prepared as a whole and systematically are called modules (Sili et al., 2018). Along with technological developments, the presentation of modules is not only printed but also in electronic form such as e-modules. The module contains learning objectives, learning materials or substances, and assessment activities (Setyawati, 2022). E-modules contain various materials that are designed sequentially, interestingly, and in accordance with competencies as well as desires (Ramadanti et al., 2021). The utilization of e-modules as a support for teachers and students within the context of education and learning activities can train students critical thinking skills. This statement is reinforced by Nikita et al. (2018), where the average score from the pretest to posttest has shown an increase. Accompanied by increased skills in critical thinking, student learning outcomes also increase. E-modules are also more practical because they can be accessed at any time. Alongside teaching resources, careful selection of choice models can enhance student learning results (Pramana et al., 2020).

Forms of learning approaches one of them is the Problem Based Learning (PBL) model. With the PBL approaches, knowledge can be built by students independently and train skills in problem-solving (Novianti et al., 2020). According to research Cahyani et al. (2021), revealed that students' critical thinking skills have the potential to be trained through the implementation of the PBL learning approach. Furthermore, learning activities with problem solving will allow students to train their abilities in critical thinking. This is strengthened by the statement Rahayu et al. (2017), that with the execution of the PBL model, students' critical thinking skills and learning achievement will increase. There are 5 phase in

the PBL learning model, namely: 1) students are oriented to the problem, 2) Arranging students for learning, 3) providing guidance to individuals or groups experiences 4) fostering and producing work, 5) analyzing and assessing ways of resolving problems (Afridiani et al., 2020).

E-modules based on the PBL model as an innovative teaching material are designed by introducing practical, real-world issues that are adapted to the PBL stages enabling them to provide meaningful learning and train critical thinking skills. This is confirmed by meta-analysis conducted by Suharyat et al. (2023), that the utilization of e-modules based on PBL has high effectiveness to train students critical thinking skills. Furthermore, studies from Sujanem et al. (2022), also explained that the application of PBL-based e-modules has a significant impact on students' critical thinking skills. Several prior studies pertaining to the development of teaching materials include research from Noorruwaida et al. (2022), developing science e-modules based on authentic learning to enhance critical thinking skills of middle school students, Nia et al. (2022), developed a PBL approach for environmental conservation e-module to improve critical thinking skills of junior high school students, Turahmah et al. (2022), developed PBL- based e-modules in science learning to enhance critical thinking skills among middle school students, Ramadanti et al. (2021), developed an e-module grounded in PBL for teaching data presentation concepts to middle school students. Another research by Rahmawati (2019), developed PBL-based e-modules in history learning to enhance high school students' critical thinking skills. The novelty of this development research is to create technology-integrated teaching resources based on the PBL model in elementary school mathematics learning, especially data processing material in class VI that has suitable learning activities with syntax or stages in the PBL learning model, starting from problem presenting problems so that they can train students' critical thinking skills and includes content such as images, learning videos, google forms, and worksheets that can be accessed by the internet.

The aim of this research and development aims to develop teaching resources e-modules of data processing material based on PBL model to train critical thinking skills of grade VI elementary school students that are valid in accordance on resources experts, design experts and teachers, practical according to teachers and students and effective to use in learning activities. The development of the e-module will be used as a support for the process of active learning activities, presenting problems in accordance with the stages of PBL and training students' skills in critical thinking.

Based on this study, research will be carried out on the development of e- modules that contain learning data processing material for grade VI elementary school students. The e-module development will be used as a support for the learning activity process and train students' skills in critical thinking.

METHODS

The method utilized is the research and development (R&D) method. Salim & Haidir (2019), states that a series of processes or stages in developing new products and complementing existing ones, where the results can be taken into account, is called R&D. One of the development models is used in this study. The development model applied in this research and development is the ADDIE model which includes Analyze, Design, Development, Implementation, and Evaluation (Cahyadi, 2019). The ADDIE model is suitable for use in developing teaching materials because it has simple stages, but includes product testing and revision (Mulyatiningsih, 2016). The stages of the ADDIE model are described in the following scheme.

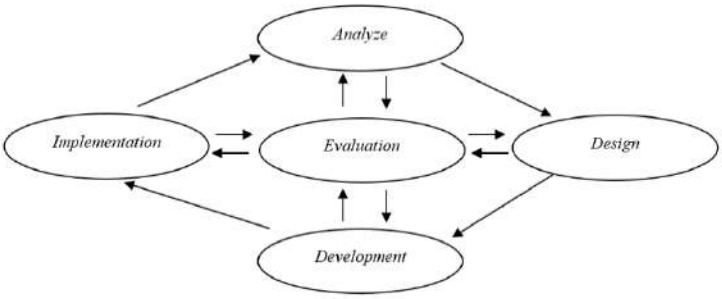

Figure 1. Stages of the ADDIE model (Ardiansyah et al. 2021)

In the utilizing e-module instructional materials in schools, the One Group Pretest Posttest Design research model is used. In this model, the research subject group will carry out a pretest which is then given treatment and carried out a posttest after treatment with the same measurements. The population and research subjects were carried out by all 6th grade students of Sukorejo Islamic Elementary School totaling 19 students. The methods for data collection applied consisted of observation, interviews, tests and questionnaires. The research instruments used include needs analysis questionnaire instruments, material expert validation questionnaires, design experts, teacher validation, teacher and student's user response questionnaires and test instruments. The assessment instrument is in the format of critical thinking skills analysis questions given to strengthen the teacher's argument pertaining to the low critical thinking skills and 10 questions.

The types of data analysis techniques used consist of both quantitative and qualitative data analysis. Quantitative data analysis was utilized for process needs analysis questionnaire data, critical thinking skills analysis, material expert validation questionnaire, design expert validation, and user validation, practicality questionnaire, and product effectiveness analysis. The data from the needs analysis questionnaire and student responses used a Guttman scale. While the data from the expert and user validation questionnaires use a Likert scale. The data from the critical thinking skills analysis test used the scoring criteria modified from Karim and Normaya (2015) on Table 3. Then the percentage value is sought using the formula from Rizky (2014) which was then categorized from Karim and Normaya

(2015) on Table 4. Furthermore, the pretest and posttest results were processed using gain normality.

The outcomes yielded by the collected data from the validation questionnaires of material experts, design experts, teachers, and user response questionnaires were calculated using the equation according to NF et al. (2022) on the Table 1 and Table 2 and categorized as follows.

Table 1. Criteria for categorized of validity

Achievement Rate (%)	Category
81 – 100	Very valid
61 – 80	Valid
41 – 60	Valid enough
21 – 40	Invalid
0 – 20	Very Invalid

Table 2. Practicality categorization criteria

Achievement Rate (%)	Category
81 – 100	Very Practical
61 – 80	Practical
41 – 60	Practical enough
21 – 40	Less Practical
0 – 20	Not practical

Based on the categorization in Table 2, the e-module data processing material based on the PBL model to train critical thinking skills is declared valid or feasible to use if the percentage of validity test results is> 60%. If the validity test results are ≤ 60%, then improvements are made based on suggestions and criticisms from experts and teachers to achieve the expected degree of validity. As for the categorization in Table 3, the e-module of data processing material based on the PBL model to train critical thinking skills is declared practical if the percentage of test results is > 60%. If the test results are ≤ 60%, then improvements are made based on student suggestions, to attain the anticipated standard of practicality.

The acquisition of data from the outcomes of the analysis of critical thinking skills is carried out modified scoring from Facione in Karim and Normaya (2015) on the to determine whether someone can be said to be thinking critically (Formula 1). Then the percentage value is sought using the formula from Rizky (2014) which is then categorized as follows.

Table 3. Scoring guidelines for students' critical thinking skills

Indicator	Description	Score
Interpretation	Write both known and questioned correctly	2
	Write known and questioned but not yet correct	1
	Did not write the known or questioned correctly	0
Analysis	Write down what must be done to solve the problem (making mathematical models, memorization, determining formulas, etc.) appropriately	2
	Write down what must be done to solve the problem (making mathematical models, modeling, determining formulas, etc.) but not yet correct	1
	Did not write what must be done to solve the problem (making mathematical models, modeling, determining formulas, etc.) correctly	0
Evaluation	Use ways, steps, or strategies in solving problems appropriately	2
	Uses ways, steps, or strategies in solving problems but not yet precise	1
	Does not use methods, steps, or strategies in solving problems appropriately	0
Inference	Draw conclusions appropriately	2
	Making conclusions but not yet correct	1
	Did not make a proper conclusion	0

$$NP = \frac{R}{SM} \; x \; 100\% \qquad (1)$$

Description:
NP = Percentage value
R = Student score from each indicator
SM = Maximum score of each indicator

Table 4. Category Percentage of Critical Thinking Skills

Value Interval (%)	Category	Analysis Result
$81{,}25 < X \leq 100$	Very High	Students' critical thinking skills are very high
$71{,}50 < X \leq 81{,}25$	High	Students' critical thinking skills are high
$62{,}50 < X \leq 71{,}50$	Medium	Critical thinking skills of moderate students
$43{,}75 < X \leq 62{,}50$	Low	Students' critical thinking skills are low
$0 < X \leq 43{,}75$	Very Low	Students' critical thinking skills are very low

Based on the categorization in table 4, the outcomes of the analysis of students critical thinking skills are low if the percentage results are in the interval $43.75 < X \leq 62.50$ and very low if the percentage results are in the interval $0 < X \leq 43.75$.

The data obtained from the outcomes of both the pretest and posttest results were processed with the normality gain equation. The outcomes of the calculation of each students n-gain score as an increase in learning outcomes are averaged and then categorized in the normality gain criteria, specifically the n-gain>0.7, including the high category, 0.3≤n- gain≤0.7, the moderate category, and n-gain<0.3, the low category (Mapilindo et al., 2021). After knowing the n-gain category, it is then transformed into a percentage format where if the percentage result of normality gain> 76%, then the application of e- modules in learning is said to be effective in learning.

The effectiveness of e-modules is known by analyzing pretest and posttest results with normality gain using the equation and categorized according to Mapilindo et al. (2021) on the Table 5, the effectiveness of e-modules is known by analyzing pretest and posttest results with normality gain using the equation and categorized (Maulidah, 2022) on Table 6 with formula (2).

$$N\text{-}Gain = \frac{S_{post} - S_{pre}}{100 - S_{pre}} \quad (2)$$

Description

N-Gain = gain normality test value

$Spost$ = post-test score

$Spre$ = pre-test score

Table 5. Gain Normality Criteria

Limitations	Criteria
0.7 ≤ N-gain ≤ 1	High
0.3≤N-gain≤0.7	Medium
N-gain<0.3	Low

Table 6. Normality Gain Interpretation Criteria with Percentage

Percentage (%)	Category
>76	Effective
56-75	Effective Enough
40-55	Less Effective
<40	Ineffective

In accordance with the normality gain criteria in table 5, it is evident that the n-gain score of 0.7 ≤ N-gain ≤ 1 is categorized as high. Furthermore, in table 6, the application of e-modules in learning is said to be effective if the average percentage of n-gain score is more than 76%. If the result of the normality gain percentage is <76%, it is necessary to make improvements so that it can achieve the expected goals. Qualitative data presented in the format of interview outcomes and recommendations or feedback by experts. Qualitative data analysis was conducted

through analyzing the outcomes of teacher interviews and input from experts and teachers descriptively. Analysis of the findings from teacher interviews was carried out to find out the problems during learning in class VIA Sukorejo Islamic Elementary School, Blitar City. Analysis of the results of suggestions and input from experts and users is used as material for revising the e-module product being developed.

RESULT AND DISCUSSION

The outcome generated from this study materializes as e-module teaching materials for data processing material based on the PBL model through the ADDIE development stage, specifically analysis, design, development, implementation and evaluation. At the analysis step, interviews were conducted with VIA class teachers, VIA class students filled out a needs analysis questionnaire in order to ascertain the conditions of students and problems in the learning activity process. The outcomes of interviews with teachers include 1) Student difficulties in math subjects, 2) Many difficulties are encountered in data processing material, 3) Lack of accuracy in calculating so that the final result is wrong, 4) Students lack understanding of concepts so that they cannot answer problems that are different from those exemplified, especially story problems, 5) Class VIA uses the 2013 curriculum, 6) The 2013 curriculum mathematics package book and student worksheets book are learning resources used in mathematics learning activities, 7) In the learning process, the methods used are lectures, memorization, and assignments, 8) Learning has used technology such as smartphones, LCDs, the internet, 9) Students like learning that utilizes the internet, 10) Support teaching materials that utilize technology because students are more interested and enthusiastic, 11) The majority of students have low skills in critical thinking so that they are less quick to absorb material and have difficulty solving a problem. This is reinforced by the outcomes of the requirements questionnaire analysis which indicates a percentage of 86.58% with the level of need being in the category of most needs (Wati et al., 2020). Thus, it was concluded that teachers and students of class VIA Sukorejo Islamic Elementary School, Blitar City need innovative teaching materials, which can support learning activities, especially in data processing material.

To strengthen the results of interviews related to students' low critical thinking skills, tests were conducted on all students of class VIA Sukorejo Islamic Elementary School. This study uses a test, namely a written test in the format of evaluation questions to determine critical thinking skills from student answers. The outcomes of the student critical thinking skills test can be presented as follows.

has been prepared in the Microsoft Word and Canva programs is then realized into a finished product by utilizing the Heyzine.com website. In product development, learning videos from Youtube that have been stored on Google Drive, E-LKPD from a live worksheet, problems and evaluation questions through Google Form. Next, enter the content in the design that has been made with Microsoft Word and then change the format to PDF. The PDF is then uploaded to the heyzine.com website to provide a flipbook display so that students are interested in learning using e-modules with smartphones.

Product development and e-module product results are presented in Figure 2 and Figure 3 presents the problem at the problem orientation stage accompanied by image content and continued with activity instructions at each stage of PBL. students do problem solving with PBL stages through the google form link located at the bottom. For the google form display can be seen in Figure 4**.**

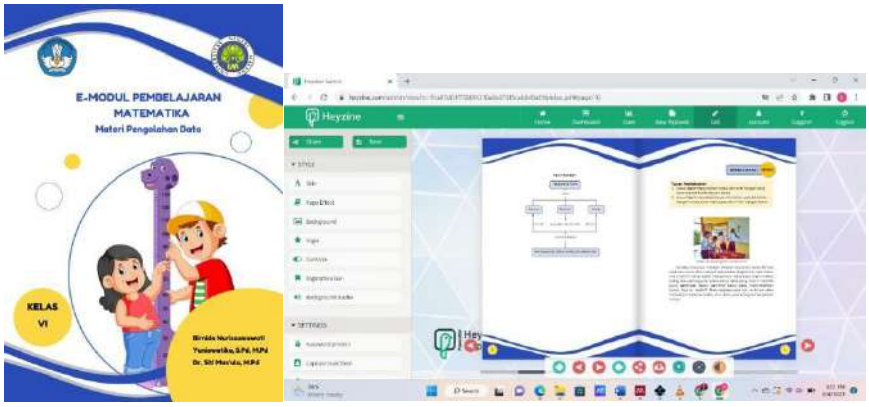

Figure 2. Cover design and e-module products on the heyzine.com website

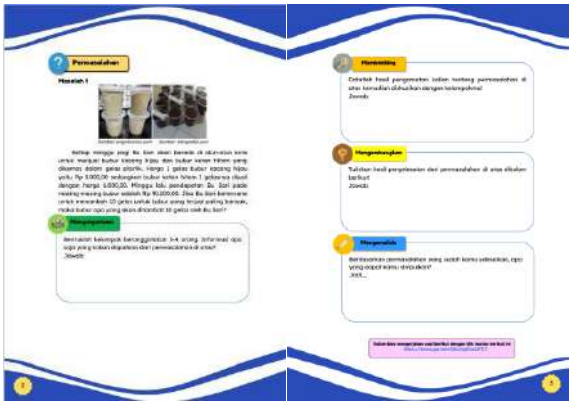

Figure 3. Image content at problem orientation stage

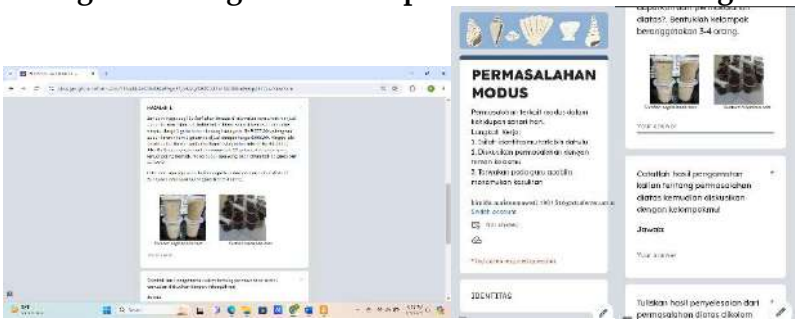

Figure 4. Google form view via laptop and smartphone

The development of e-modules of PBL-based data processing material to draw critical thinking skills of sixth-grade elementary school students was carried out in line with the necessities and traits of students. The readiness of e-modules is in accordance with the 2013 curriculum and utilizes smartphones as a medium. The e-module product is supported by pictures or illustrations, learning videos, and e-lkpd. E-modules are developed by utilizing heyzine.com so that the display is in the format of a flipbook. E-modules are extracted into html links to make it easier for

users without requiring a lot of storage space (Kumalasari et al., 2023). Link *e-modul*: https://heyzine.com/flip-book/01cc7e801b.html
The finished product was then validated. The PBL-based data processing material e-module to train critical thinking skills of grade VI elementary school students was validated by 3 validators, specifically material experts, design experts, and teachers as users. A recapitulation of the results of validation of the experts can be presented in Table 7.

Table 7. Recapitulation of Validation Results

No.	Validator	Validation Value	Category
1.	Material Expert	87, 32%	Very valid
2.	Design Expert	93, 75%	Very valid
3.	Teacher	96,63%	Very valid
	Average	**92, 56%**	**Very valid**

Based on the recapitulation table above, the percentage result is 92.56%, therefore it can be deduced that the e-module of data processing material built upon the PBL model to train critical thinking skills falls within a very valid category after revision based on expert suggestions. There are inputs provided by experts including the addition of an assessment rubric for evaluation questions as a reference for teachers in assessing, PBL stages are not only in the form of icons in learning activities but written information on the stages, rechecking related access links on the e-module, a series of activities arranged sequentially according to the PBL stages, each activity needs an explanation that directs students to the concepts learned, adding pictures or illustrations to some story problems and icon instructions on the e-module are adjusted to the display on the heyzine.com website.
The developed e-module product and tested for validity and revision shows a percentage of 92.56% with a very valid category. Although the value is quite high, it has not yet reached the maximum score. This implies that the e-module product has been created with the viability of content or content, presentation, PBL model, contextualization, cover and content appearance, as well as excellent language feasibility but the PBL model still needs a little improvement. According to the validator, the series of learning activities must be arranged sequentially according to the PBL stages. This reflects that the development of teaching materials should be organized systematically to achieve learning objectives. This is in line with the statement of Arum and Wahyudi (2016), that teaching materials are presented in a systematic way to achieve the objectives and competencies to be achieved. The e-module product is also developed with a simple design without reducing the attractiveness of the e-module, able to make students interested in learning. In line with the opinion of Winatha et al. (2018), students' interest and involvement in learning can be triggered by e-modules because of the attractive and simple design. Furthermore, e-module product development uses language that is accessible and comprehensible for students, proper grammar, spelling and sentence structure, and uses effective sentences and standardized terms. This is supported by the opinion of Sujiono and Widiyatmoko (2014), that module development must use Indonesian

language in accordance with Indonesian grammar rules and refer to the enhanced EYD.

Next, at the implementation stage, large-scale trial activities were carried out. While the small-scale trial took place at the development stage. The small- scale trial was conducted with class VIB totaling 5 students, while the extensive trial was conducted with all students in the VIA class totaling 19 students. Small-scale trials were conducted to determine access to links on the product, readability of writing, delivery of content, and test the practicality of the product. The large- scale trial was undertaken to test the practicality and effectiveness of the e-module. The collected data was subsequently used to assess the practicality and validity of the e- module product development. The recapitulation of the outcomes of the practicality of the e-module product developed (Table 8).

Table 8. Recapitulation of practicality score

No.	Test Phase	Practicality Score	Category
1.	Small Scale Trial	90%	Very practical
2.	Large Scale Trial	90,78%	Very practical
	Average	**90,39%**	**Very practical**

According to the table above, it can be observed that the average practicality value obtained from the small-scale trial and large-scale trial is 90.39%, which is very practical, which is obtained after making revisions based on teacher and student suggestions. There are suggestions given by students, namely ensuring that the links on the product can be accessed. In addition, it was also found that one student had problems using the e-module. This is because the student's smartphone screen is not suitable so it is difficult when opening the e-module. The practicality of the e-module reached a percentage of 90.39% after the revision, which can be categorized as very practical. The achievement of the percentage value is quite high, but it has not reached the maximum score. This means that the e-module can be utilized at any location and time by students, but it must be ensured that the links included within the e-module are accessible. Part of the evaluation of the practicality of teaching resources is the ease of use. This is in line with Sangka & Yasa (2022), who used the user-friendliness aspect in the e-module practicality test. E-modules received positive affirmation because with e-modules learning becomes less boring, more enthusiastic, and happy. Furthermore, the utilization of e-modules is very practical because it can be used anywhere and anytime. This is in line with the E-module is practical to carry around because it can be accessed with a smartphone and the file size is small so that students can access it anywhere and anytime (Muzijah et al., 2020).

The next phase is the evaluation which is conducted at the end of each research phase. At the analysis stage, problem evaluation is performed to determine development products that match the outcomes of the needs analysis. At the design stage, an evaluation is carried out, namely the design, content of e- module products, validation instruments, and evaluation instruments according to the suggestions of the supervisor. At the development phase, an evaluation was

conducted using input provided by material experts, design experts and users. At the implementation stage, an evaluation is conducted based on input from students. At the evaluation stage as the final stage in research and development, the developed product is reviewed to reduce the errors and shortcomings of the developed product at the previous stage. The final result obtained from this development activity is that the PBL model-based data processing e-module product to train critical thinking skills for grade VI elementary school is very valid and very practical to use. Next, to assess the efficiency of the e-module products in learning, pretests and posttests were conducted. The results of students' pretests and posttests were used to determine the normality gain score. After knowing the normality gain score of each student, the normality gain test was carried out. This test is used to determine the effectiveness of the treatment given. The following are the normality gain results from students' pretest and posttest scores (Table 9).

Table 9. Recapitulation of Gain Normality Results

No.	N	Average N-Gain Score	Average N-Gain Score Percent	Category
1	19	0.76	76.33	Effective

It is evident from the table above, the n-gain score shows an average of 0.76 with a high category. Furthermore, the average percentage of n-gain score reached 76.33%, which shows that the application of e- modules in learning is said to be effective.
The use of e-modules on data processing material based on the Problem Based Learning (PBL) model to train critical thinking skills of grade VI students is effective in the learning activities as evidenced by evaluation of learning outcomes by analyzing pretest and posttest scores. The improved learning results cannot be divided from the presence of learning activities in the e-module that uses the stages of PBL which is able to effectively cultivate students' critical thinking skills in problem solving. The PBL model is a learning approach that focuses on issues to train students critical thinking skills. This statement is strengthened by the opinion of Novianti et al. (2020), that PBL is referred to as a learning model where students are upskill to compile their understanding independently and develop skills in problem solving. Haryanti (2017), also revealed that the PBL model can familiarize students to develop their critical thinking skills. Referring to this opinion, the developed e-module contains PBL stages where at the beginning of the activity a problem related to everyday life is presented. In the settlement process, knowledge is built by students themselves so that learning becomes more meaningful. This statement aligns with the opinion of Zhafirah et al. (2021), the PBL model has advantages, namely simplifying the comprehension of concepts for students because knowledge is built from students themselves through solving problems related to real life so that they get benefits from learning. In addition, through problem solving activities, students can train their critical thinking skills. This aligns with the study of Sujiono and Widiyatmoko (2014), the use of PBL model in the module is effective in training students' critical thinking skills.

This e-module teaching material based on the PBL model has advantages and disadvantages including the PBL-based e-module product is a product developed utilizing the use of smartphones which elicits enthusiasm and interest from students with using e-modules in learning. This is evidenced during the small-scale and large- scale experiments, students were enthusiastic and excited when they received the e-module link and accessed it. The e-module product can also be downloaded for free and opened repeatedly in PDF form. In addition, e-modules do not require large storage space, because they do not require applications that need to be downloaded, but e-modules are accessed through the heyzine.com website. The e-module product has an attractive flipbook display with a combination of colors that students like. The activities in the e-module are accompanied by pictures and videos at the end of each learning activity thus preventing students from becoming bored in using the e-module. The instructions on the e-module are also clear, simplifying the utilization of the e-module for students. Furthermore, the activities in the e-modules use the PBL model which includes orienting students to the problem, organizing, developing, and analyzing. In addition, the content in the e-module is designed to train students' critical thinking skills.

The PBL model-based data processing material e-module has shortcomings. The disadvantages of this e-module product are that the content within the e-module is only limited to data processing material in class VI with KD Permendikbud No.37 of 2018 so that if it is used in data processing material with a different KD it cannot. The use of this e-module must be within a stable internet range, so if it is not within a good internet range, there will be problems accessing the e-module or doing learning activities in the e-module.

CONCLUSION

The research and development that has been carried out produces an e-module product for data processing based on the Problem Based Learning (PBL) model to train critical thinking skills of grade VI students. Based on the results of the validity of the e-module product, it shows a validity value with an average of 92.56% which falls into the highly valid category. The results of the e-module practicality test resulted in a percentage of 90.39% with a very practical category. The outcomes of effectiveness through normality gain resulted in an average n-gain score of 0.76 with a high category and the average percentage of n-gain scores reached 76.33% with an effective category. Thus, it can be stated that the e-module product is very valid according to material experts, design experts and teachers. The e-module is also very practical according to teachers and students and effective to use in the learning process and train students' critical thinking skills.

The limitation of this research is that the model used to develop e-modules for sixth grade elementary students is a PBL model with a focus on data processing material and separate from thematic learning. Based on the results of this study obtained, it is suggested the development of e-module teaching materials for data processing materials based on the PBL model to train critical thinking skills, needs to pay attention to the problems chosen so that they are related to real situations or students' daily lives. In addition, it is necessary to add varied content to the e-

module teaching materials that can be developed according to the developer's ability with a note that it still adapts to the material raised. With this, it is expected that students will not be bored, excited, and actively participate in learning activities. In addition, to ensure that learning activities run well, schools should provide a smooth internet network so that there are no obstacles in accessing the links in the teaching materials. This research is not perfect because it has shortcomings, namely its use must be within the reach of the internet. So that for further research and development can modify the product better than the one produced.

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Jurnal Inovasi Pembelajaran

JINoP. May, 2024, 10 (1): page 80-97
p-ISSN 2443-159, e-ISSN 2460-0873
https://doi.org/10.22219/jinop.v10i1.25708

Development of multimedia-based learning videos to increase learning motivation in history for grade XI social science students in senior high school

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uploaded: 04/04/2023
revised: 04/16/2024
accepted: 05/18/2024
published: 05/31/2024

Romualdi, K. B., & Sudrajat, A. (2024). Development of multimedia-based learning videos to increase learning motivation in history for grade XI social science students in senior high school. *JINoP (Jurnal Inovasi Pembelajaran)*, 10(1), 80–97. https://doi.org/10.22219/jinop.v10i1.25708

Abstract

Students' motivation during history learning processes in the classroom is influenced, among other factors, by teachers' innovation in teaching. However, there are still teachers who lack innovation, resulting in decreased motivation for students to learn history. This study aims to develop and assess the feasibility of a product in the form of multimedia-based learning videos on the topic of Islamic Maritime Kingdoms, as well as to analyze its effectiveness in increasing the learning motivation of Grade XI Social Science students. The type of research used was research and development with ADDIE design. This study involved 2 experts, 2 teachers, and 75 students divided into 15 students for small-scale trials and 60 students for large-scale trials and extensive testing. Data collection was done through questionnaires using survey techniques and interviews. Data analysis techniques included quantitative and qualitative descriptive analysis, as well as descriptive statistics. The research results indicated that the product developed by the researcher was feasible for use as a learning media. Additionally, multimedia-based learning videos were also effective in increasing students' motivation to learn history.

Keywords: Video Learning; Multimedia; Learning Motivation; History; Maritime Kingdoms.

INTRODUCTION

The condition of motivation in learning becomes an important aspect that can affect the learning process of students in the classroom. Often, the learning process runs less optimally in certain subjects not because students' learning abilities are incapable, but because of their lack of learning motivation, causing them not to strive to exert their best abilities (Emda, 2017). Moreover, even if a student has high academic grades, it does not necessarily mean that they already be motivated toward the desire to acquire knowledge. It can also be caused by external factors, such as family pressure from parents (kompas.com, 2018). The

low quality of teachers using innovative media also contributes to the issue of learning motivation in the classroom (Surodiana, 2020).

In the observations conducted by the researcher using observation guidelines to assess classroom conditions at Santo Paulus High School in Pontianak, it was found that there were students in Grade XI Social Science who were less motivated during history lessons. This issue arose because, during history lessons, the teacher still dominated classroom learning through lecture-based methods. The dominance of the teacher's role through lecture-based methods has caused some students to appear unfocused, engaging in activities such as talking to their peers, feeling drowsy, and discreetly using their mobile phones under the desk drawer. Even during presentations and teacher explanations, the material felt less engaging as the PowerPoint slides lacked supporting illustrations. When the teacher reviewed the material by asking questions to the students, only two to three students responded.

The student handbook used as a learning source at Santo Paulus High School in Pontianak is also very limited. The book used is a package book with minimal content about maritime kingdoms during the Islamic era in Indonesia, which does not stimulate the imagination about maritime affairs. Additionally, the book does not highlight the maritime aspects of the Islamic kingdoms in Indonesia. The book used repeats more material from the Indonesian History class in Grade X, which mainly discusses the political and social aspects of the Islamic kingdoms' era. This also contributes to the decreased learning motivation of students because they feel like they are repeating the same history material as when they were in Grade X.

The presentation of the above issues emphasizes that teachers fundamentally need to innovate to provide an enjoyable school experience for students (Antara News, 2021). Such innovation can also be used as a tool to introduce new teaching materials that are more focused and in-depth. The utilization of learning innovations is fundamentally one of the skills that a teacher needs to possess nowadays. This is because, in the concept of 21st-century education, teachers are expected to no longer rely on old patterns during classroom teaching, such as methods dominated by lectures (Yoa, 2021).

21st-century education, accompanied by technological advancements, according to Habib et al. (2020) makes the management of education impossible to handle with conventional methods such as lectures. Several studies also indicate that lecture-based methods have an impact on students' learning attitudes. For example, a study conducted by Muminin et al. (2021), revealed that students tend to become bored with the lecture-based method employed by educators or teachers. Students also have trouble in understanding the material. It is as if their brains are like a "trash bin" being constantly forced to accept a lot of abstract material. Therefore, teachers need to create optimal learning conditions by delivering the material creatively (Yulia & Ervinalisa, 2017).

Therefore, it can be understood that teachers must constantly introduce learning innovations to boost students' learning motivation. One of these innovations is the use of instructional media (Mishra & Sharma, 2005). Teachers who teach history

subjects in schools also need the ability to creatively manage instructional media (Fitri & Yefterson, 2021). Moreover, history is a discipline that deals with past events; therefore, students require media to obtain concrete representations and based on psychological studies, according to Rohani in Sastramiharja et al. (2021). Students tend to find it easier to understand something in concrete form rather than abstract.

Several existing studies have shown that videos are among the various instructional media that can affect students' learning motivation (Sastramiharja et al., 2021). This was explained that that the use of video media has been proven to increase motivation in learning history among Grade XI high school students. During the pre-cycle phase, the percentage of students' motivation to learn history was only 43.90%, and then it increased to 85.37% (Chasanah et al., 2021). Another study showed that the use of animated video media received positive responses from Isen Mulang High School students, who felt interested in learning history (Angela & Triadi, 2022). The product offered in this research is multimedia-based learning videos.

Videos packaged by combining several elements (multimedia) have the potential to help students understand the messages in instructional materials and increase their imagination of content. Research conducted by Juannita & Mahyuddin (2022) showed that interactive multimedia-based learning videos can make children's learning more diverse, thus making learning more engaging, motivating, and providing learning experiences for children. This is also supported by research titled "Interactive Multimedia-Based Learning Videos on the Cognitive Aspects of Early Childhood," which shows that this media can make learning more diverse, thus making it more engaging and providing learning experiences for children (Aryani & Ambara, 2021). However, there have not been any non-interactive multimedia-based learning videos developed on the topic of Maritime Kingdoms during the Islamic era in Indonesia.

The use of multimedia-based videos will shift boring learning into an enjoyable one, thus increasing students' learning motivation (Aryani & Ambara, 2021). Moreover, if multimedia-based learning videos are uploaded to platforms like the social media platform YouTube, it makes it easier for students to access them anytime and anywhere, and they can even be replayed multiple times. In more detail, Rusman (2012) emphasizes the advantages of video media, namely: (a) the conveyed material can be evenly delivered to students, (b) it is capable of explaining a process, (c) not constrained by space and time, (d) the media can be paused or tailored to needs, (e) capable of leaving a profound impression on students.

Based on the research by Dwyer as cited in Mamin & Arif (2018) video could capture 94% of message/information channels that can reach the soul through senses such as sight and hearing, and people can understand as much as 50% of the content they perceive through human senses via program broadcasts. The use of video media can also help students obtain a more concrete learning experience (Sastramiharja et al., 2021). Considering the advantages of video as a learning media, history teachers can use this media in the classroom. Meanwhile, the

concept of multimedia will help teachers to produce instructional videos that combine several elements such as photos, images, videos, text, sound, and animations, making the presentation "richer" and attracting students' attention to learn.

Building on the discussion above, this research aims to develop and assess the feasibility of a multimedia-based learning video product and analyze its effectiveness in increasing the learning motivation of Grade XI Social Science students, with a case study at Santo Paulus High School in Pontianak. The results of this research, along with its product, are expected to be an innovative offering for the use of instructional media, particularly by history teachers.

METHOD

The research model applied in this study was research and development, often known as Research and Development (R&D). The R&D procedure implemented in this research followed the stages of the ADDIE method. The five stages of the ADDIE technique included analysis, design, development, implementation, and evaluation.

Data was collected from the validation assessment results by subject matter experts, media experts, teachers, as well as students in both small and large-scale trials. Meanwhile, to measure the product's effectiveness on students' history learning motivation, the researcher used a one-group pretest-posttest experimental design model. The process of gathering data for the feasibility test and effectiveness test stages was conducted through questionnaires. Meanwhile, interviews were used for needs analysis.

The sample for the small-scale trial consisted of 15 students from Class XI IPS C, determined using a voluntary sampling technique. Meanwhile, the large-scale trial and extensive testing involved 60 students from Class XI IPS A and XI IPS B. The technique used to determine the sample for these trials was purposive sampling. In addition to obtaining product feedback through student evaluations, the large-scale trial supplemented with extensive testing was conducted to measure the effectiveness of the product in enhancing history learning motivation.

The data analysis techniques applied in this research include quantitative, qualitative, and descriptive statistical analyses, including difference testing. However, before conducting the difference testing, the researcher first conducted prerequisite tests by examining the normal distribution of data using the Kolmogorov-Sminov test. However, due to some data not following a normal distribution, hypothesis testing used the Wilcoxon Signed Rank Test technique with the assistance of SPSS 26 software. The product's feasibility assessment is based on converting scores on a five-point scale, referring to Table 1.

Table 1: Conversion of five-point scale values based on reference benchmark assessment (PAP)

Interval	Score	Category
x > *Xi* + 1,80 Sbi	x > 4.21	Very Good
Xi + 0.60 Sbi < x ≤ *Xi* + 1.80 Sbi	3.40 < x ≤ 4.21	Good
Xi – 0.60 Sbi < x ≤ *Xi* + 0.60 Sbi	2.60 < x ≤ 3.40	Average
Xi – 1.80 Sbi < x ≤ *Xi* – 0.60 Sbi	1.79 < x ≤ 2.60	Poor
x ≤ *Xi* – 1.80 Sbi	X ≤ 1.79	Very Poor

Meanwhile, the determination of motivation quality is measured by adopting the Reference Benchmark Assessment I (PAP) from a book written by Suharsimi Arikunto (2016) as follows.

Table 2. Quality of students' history learning motivation

Motivation Scale	Criteria
90-100	Very High
80-89	High
70-88	Adequate
60-69	Low
0-59	Very Low

RESULTS AND DISCUSSION

Results

The product successfully developed in this study is a multimedia-based learning video on the maritime kingdoms during the Islamic era in Indonesia, which is capable of increasing students' motivation to learn history. The development product, which has reached the implementation stage and has been revised, can be accessed on the website https://youtu.be/-p7wJXo2uBw.

Analysis Stage

The first step according to the ADDIE procedure is to conduct an analysis. The analysis in this research comprises two types: problem analysis and needs analysis. According to the researcher's study in the problem analysis, it was found that many teachers still predominantly used lecture methods supported by PowerPoint presentations, which contained more text and minimal illustrations. As a result, students appeared to be less motivated. Some were immersed in talking to their peers, some were lowering their heads to the table, and others were playing with their smartphones in class. When the teacher posed questions, only 2 or 3 students in each class expressed their opinions.

Meanwhile, in the needs analysis, through interviews with teachers, the researcher found that teachers indeed mostly used lecture methods, PowerPoint presentations, and history textbooks, although occasionally interspersed with other activities such as interactive discussions or student presentations. According to teachers, the use of lecture methods and PowerPoint presentations is more effective and efficient in the preparation process. Specifically, the preparation for

implementation also does not incur significant costs. The use of textbooks provided by the school is considered very helpful by teachers.
Therefore, instructional media such as videos are needed to help teachers provide sharper visual imagination to students about the maritime kingdoms during the Islamic era in Indonesia, as well as to enhance students' motivation to learn history.

Design Stage
The second stage involves the researcher creating the instructional media design in the form of a video based on the analysis results. Initially, the researcher developed a lesson plan (RPP), followed by the creation of multimedia-based videos using applications such as PowToon, Filmora, and mp3.cut. Finally, the researcher prepared assessment instruments to be used for product validation involving experts from lecturers, teachers, and students. The multimedia-based video developed by the researcher contains material about the maritime kingdoms during the Islamic era in Indonesia, particularly focusing on the Sultanates of Aceh, Ternate, and Tidore. The video's duration is 10 minutes and 33 seconds and was then uploaded to YouTube.
The initial form of the video product created by the researcher is as follows (Figure 1, Figure 2).

1) Introduction Section

Figure 1. Initial introduction section display

Figure 2. Display of introduction section regarding material coverage

In the introduction section of the video, it features a female teacher greeting the audience (left image). This greeting process is an initial step to establish

communication with the audience, believed to create a friendly atmosphere with the viewers, in this case, students. Then, there is a part showing the teacher introducing the progress of the Nusantara Kingdoms by using the maritime aspect (right image), which is part of the effort to provide an initial stimulus to the students.

In the introduction section, it also presents the coverage of the material included in the video. The material is limited to the maritime kingdoms during the Islamic era, which include the Sultanates of Aceh, Ternate, and Tidore. Other maritime-based sultanates could also be included in the video. However, this limitation is necessary considering that a video with excessive duration may cause students to experience boredom. The selection of the sultanates discussed is based on the major trade routes during that time.

2) Content Section

In the content section, includes material on the maritime kingdoms during the Islamic era in Indonesia, covering the Sultanates of Aceh, Ternate, and Tidore. The content section includes elements of information in the form of text, video illustrations, and animated illustrations supported by dubbing and background music. The images representing the initial development of the video worked on by the researcher can be seen below (Figure 3):

Figure 3. Display of material about the sultanates of aceh, ternate, and tidore

3) Closing Section

Figure 4. Display of video closing section

The conclusion of the video (Figure 4) contains an invitation to students to realize the importance of maritime potential during the kingdom era. This section also features video illustrations of the natural environment and seas in the Maluku Islands, which were part of the Indonesian spice route during the kingdom era.
Multimedia-based instructional video products can essentially be used both in a classroom setting and independently. This is because multimedia-based instructional videos can be uploaded to YouTube and then viewed. The multimedia product model is presented linearly, meaning the multimedia is run sequentially from start to finish. Navigation used in linear presentation typically includes Play, Pause, and Stop.

Development Stage

1) Instrument Validation

The initial step undertaken by the researcher in the validation process is to validate the questionnaire instrument used for subject matter experts, media experts, teachers, as well as students. Based on the testing in this stage, it was stated that the questionnaire instrument is considered feasible for use as an analysis tool in the research by incorporating some suggestions, including:

1) In the motivation attitude instrument, it is unnecessary to use the word "I".
2) Each item in the motivation attitude instrument should include the words "need", "preferably", and/or "ought to".

2) Material Expert Validation

This stage aims to obtain data on the feasibility, suggestions, and criticisms so that the developed instructional video has quality in terms of content. Material validation includes assessment of aspects such as content, language and typography, and usefulness. The validation results from material experts are presented in Table 3:

Table 3. Results of Material Expert Validation Assessment

No.	Assessment Aspect	Score
1.	Material Aspect	38
2.	Language and Typography	9
3.	Benefit Aspect	13
Total Score		**60**
Average Score		**4.61**
Criteria		**Very Good**

The summary of assessments from material experts, as seen in Table 3, indicates that the product scored a total of 60 points. The average score obtained is 4.61. Therefore, it can be concluded that overall, the assessment of the multimedia-based instructional video product by material experts is categorized as "very good." Material experts also provided mandatory improvement suggestions for the product developed by the researcher. The revised product based on the assessment by material experts can be seen Figure 5-8.

Figure 5.
Display at Minute 5:50 Before Revision

Figure 6.
Display at Minute 5:50 After Revision

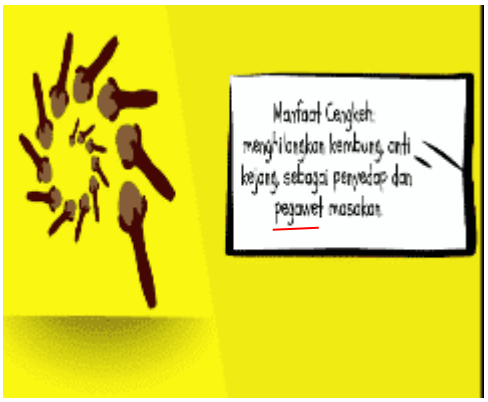

Figure 7.
Display at Minute 8:29 Before Revision

Figure 8.
Display at Minute 8:29 After Revision

3) Validation by Media Experts

This stage is carried out to obtain information on the feasibility, suggestions, and criticisms so that the designed instructional video has quality in terms of media. Media validation includes assessment of aspects such as audio, visual, usage, and benefits.

Table 4: Assessment Results of Validation by Media Expert

No	Assessment Aspect	Score
1.	Audio Aspect	25
2.	Visual Aspect	33
3.	Usage Aspect	16
4.	Benefit Aspect	12
Total Score		**86**
Average Score		**4.09**
Criteria		**Good**

Based on Table 4, the results of media expert validation received a score of 86. Thus, the average score obtained is 4.09. Therefore, overall, the multimedia-based learning video product based on media expert validation is considered "good." Media experts also provided mandatory improvement suggestions for the researcher's product design. The revised product based on the media expert assessment can be seen as follows (Figure 9 -11).

Figure 9. Adding subtitles

Figure 10. Adding supporting sources

Figure 11. Adding editing team

4) History Teacher Validation

The purpose of history teacher validation is to obtain information and assessments regarding the developed media before it is finally tested on students. Two history teachers validated this product, both from different regions. The assessment results from these two teachers are presented in Table 5.

Table 5: Assessment Results of Validation by Teacher I

No	Assessment Aspect	Score
1.	Material Aspect	37
2.	**Media Aspect**	42
	Total Score	**79**
	Average Score	**4.65**
	Criteria	**Very Good**

Based on Table 5, it is known that the assessment result of the product from the validation by Teacher I received a score of 79. Thus, the average score obtained is 4.65. Therefore, overall, the multimedia-based learning video product, based on validation by Teacher I, is classified as "very good." Teacher I also provided two improvement suggestions for the product developed by the researcher. First, to optimize the voice dubbing power. Second, to perform optimal image cropping at minute 7:47.

Figure 12. Display of Revised Voice Dubbing

Figure 13. Layout of Illustrations Before Revision

Figure 14. Layout of Illustrations After Revision

Meanwhile, the validation results for multimedia-based history learning videos conducted by teacher II can be seen in Table 6.

Table 6: Assessment Results of Validation by Teacher II

No	Assessment Aspect	Score
1.	Material Aspect	40
2.	Media Aspect	43
Total Score		**83**
Average Score		**4.85**
Criteria		**Very Good**

The summary of the validation results by Teacher II presented in Table 4 shows a score of 40 obtained for the product under development by the researcher. Based on this score, the average score achieved for the material aspect by Teacher II is 5, indicating that the assessment is categorized as "very good."

Implementation Stage

1) Small-Scale Trial

The next stage was carried out once the product developed by the researcher had been assessed and corrections made based on feedback from subject matter experts, media experts, and teachers. A small-scale trial was conducted involving 15 out of 30 students from class XI IPS C at Santo Paulus Pontianak Senior High School. The results at this stage were as Table 7:

Table 7. Results of small-scale trial assessment

No	Assessment Aspect	Score
1.	Content Aspect	4.46
2.	Media Aspect	4.21
Total Score		**8.67**
Average Score		**4.33**
Criteria		**Very Good**

The recapitulation of the small-scale trial assessment as seen in Table 7 shows that the average score obtained for the product is 4.33. Therefore, it can be concluded that overall, the multimedia-based learning video product based on the assessment of the small-scale trial involving 15 students is categorized as "very good." During this small-scale trial process, some students provided suggestions for improvement. The improvement mainly concerns the selection of music for the background. According to these students, the tempo of the music used is too fast.

The necessity for this improvement can also be observed from the assessment results, where the background music received the lowest average score. This revision is also needed to align with one of the principles of instructional video design, which is that the product should help students understand the instructional message (Riyana, 2007).

2) Large-Scale Trial

The next step involved the researcher conducting a large-scale trial. This trial phase was carried out in class XI IPS A, involving all students in one class, totaling 30 individuals. The selection of class XI IPS A was based on the output of interviews with educators, which was then reinforced through classroom observations. The teacher explained that this class needed special attention in terms of learning motivation.

Table 8. Results of large-scale trial assessment

No	Assessment Aspect	Score
1.	Content Aspect	4.27
2.	Media Aspect	4.23
	Total Score	**8.5**
	Average Score	**4.25**
	Criteria	**Very Good**

Table 8 shows the recapitulation of the assessment of the product based on the large-scale trial conducted by the researcher, yielding a score of 4.25. Therefore, it can be concluded that the overall assessment of the multimedia-based learning video product in the large-scale trial categorizes it as "very good."

Evaluation

The process conducted to assess the development product is referred to as an evaluation step (Cahyadi, 2019). The evaluation applied in this research consists of formative and summative evaluations. Formative evaluation carried out involves feasibility testing and making revisions according to feedback from experts, teachers, and students. Meanwhile, summative evaluation is conducted to measure or assess the effectiveness of the product in supporting the learning process, specifically the motivation of students in learning history. The results of the summative evaluation to assess the effectiveness of the product in enhancing students' motivation in learning history can be seen in the following review.

1) Measurement Results of Motivation

The tool utilized in observing and measuring learning motivation is a questionnaire containing 20 attitude motivation questions, which has been validated for use by instrument experts. Subsequently, the questionnaire was distributed to 60 students from classes XI IPS A & B. Based on the responses related to students' history learning motivation before and after using multimedia-based learning videos, the results are listed in **Table 9.**

Table 9. Motivation Results Before and After Experiment

Description	Total Score	Average Score
Before	4.156	69.3
After	4.613	76.9

The table above shows that the average motivation score of 60 students from Santo Paulus Pontianak Senior High School, classes XI IPS A and B, before receiving treatment was 69.3 (rounded to 69). Meanwhile, the average motivation score after receiving treatment was 76.9 (rounded to 77). Based on these measurement results, it can be observed that the use of learning videos effectively increases students' motivation in learning history, especially for students of classes XI IPS A and B at Santo Paulus Pontianak Senior High School.
The measurement results of the quality of student learning motivation through trend tests are presented in **Table 10.**

Table 10. Quality of Students' History Learning Motivation Before Experiment

Interval	Quality	Average
90-100	Very High	
80-89	High	
70-79	Adequate	
60-69	Low	69
0-59	Very Low	

Through the presentation of Table 10, it can be understood that the mean motivation score for students' history learning before receiving treatment is 69, falling within the interval 63-83, thus categorized as "Low." Meanwhile, in the class after the experiment, namely:

Table 11. Quality of students' history learning motivation after experiment

Interval	Quality	Average
90-100	Very High	
80-89	High	
70-79	Adequate	77
60-69	Low	
0-59	Very Low	

It appears that the average or mean score of students' history learning motivation after receiving treatment is 77 (rounded from 76.88), falling within the interval 70-79, thus categorized as "Adequate." This is an improvement on the previous score of 69, which fell within the "Low" category. Therefore, it can be concluded that the use of the product developed by the researcher is effective in increasing learning motivation for history among students of class XI IPS at Santo Paulus Pontianak Senior High School.

2) Difference Test

From the two types of data processed in the normality test, it was found that the data before the experiment did not follow a normal distribution, while the data after the experiment followed a normal distribution. Therefore, in the difference test using the Paired Sample concept, the Wilcoxon Signed Rank Test (non-parametric) was applied. The test results can be seen in Tables 12 and 13.

Table 12. Results of non-parametric wilcoxon signed rank test ranks

Description		N	Mean Rank	Sum of Ranks
Before – After Experiment	Negative Ranks	9[a]	15.00	135.00
	Positive Ranks	51[b]	33.24	1695.00
	Ties	0[c]		
	Total	60		

Table 13. Results of wilcoxon signed rank test statistics

Description	Before - After
Z	-5.748[b]
Asymp. Sig. (2-tailed)	.000
a. Wilcoxon Signed Ranks Test	
b. Based on negative ranks.	

The rank from the Wilcoxon test results shows that there are 51 positive data out of a total of 60, meaning that out of the 60 students studied, 51 experienced a positive increase in motivation to learn history. The mean rank is 33.24, and the total sum of positive ranks is 1695, which is significantly higher compared to the number of students experiencing a decrease. The results of the test also demonstrate that the Asymp. Sig score of this research is 0.000, which is less than 0.05. This indicates that the null hypothesis (Ho) is rejected while the alternative hypothesis (Ha) is accepted. Therefore, based on the Wilcoxon Signed Rank Test results, it can be concluded that the use of multimedia-based learning videos on the topic of Islamic maritime kingdoms is effective in increasing the level of motivation to learn history among Grade XI IPS students at Santo Paulus Pontianak High School.

Discussion

This research yields two findings. First, multimedia-based learning videos are considered feasible for use as one of the history learning media. This confirms previous research indicating that multimedia-based learning videos are feasible for use as history learning media (Safira & Batubara, 2021). However, the 2021 study stopped at the stage of validating the product's feasibility without examining its impact or effectiveness on specific variables such as student motivation. Therefore, this research attempts to assess the effectiveness of the developed product.

The effectiveness of the developed product emerges as the second finding in this study. During the effectiveness test phase, it was revealed that there was an increase in students' motivation to learn history after involving multimedia-based learning media. The measurement results of motivation indicate that the theory by Sanjaya (2008), which mentions the advantages of learning videos in stimulating students' motivation to learn history, is accurate. This finding is also consistent with research results showing that interactive multimedia-based

learning videos can make children's learning more varied, thus making learning more engaging, motivating, and providing learning experiences for children (Juannita & Mahyuddin, 2022). The theoretical study by Syaripuddin, Ahmad, & Awang (2019) also suggests that the use of videos in teaching in the 21st century is crucial and can enhance students' learning motivation.

The multimedia elements developed in the researcher's product can also aid the learning process, especially in enhancing motivation to learn history. This situation aligns with the findings of Samat & Azis (2020), who state that multimedia components can assist the learning process and boost students' learning motivation. Therefore, the presence of multimedia can offer a diverse range of rich learning experiences for students (Baglama et al., 2018).

A weakness in the multimedia-based learning video product lies in the limitation of material regarding the era of Islamic maritime kingdoms. This can be observed from the feedback of subject matter experts, who indicated that other Islamic kingdoms are relying on the maritime sector that could be discussed. However, the researcher acknowledges that including material from additional kingdoms would further lengthen the video, potentially causing students to become fatigued.

An advantage of the product developed by the researcher is its ability to increase student's motivation to learn history. This is because the use of learning videos can capture students' attention and help them understand the learning material better. Videos can enhance students' focus (Palaigeorgiou et al., 2019). Additionally, videos can serve as a reference source for class discussions. The video duration is set at 10 minutes and 33 seconds because short-duration videos provide more flexibility for teachers. Moreover, they can provide direct guidance in the learning process according to students' learning pace (Yudianto, 2017).

CONCLUSION

The result of this research and development is a multimedia-based learning video feasible for supporting teachers in delivering material, especially regarding the Islamic maritime kingdoms in Indonesia, to Grade XI Social Science students in senior high school. Furthermore, the product developed by the researcher is also effective in enhancing the learning motivation of Grade XI Social Science students. The content of the video is specifically focused on the maritime aspect, considering that the student guidebooks still primarily cover the material of the kingdoms from Grade X, which mainly deals with political, social, and historical aspects.

One limitation of this study is the lack of statistical generalization. This is due to the research being conducted in only one school and using voluntary sampling to collect respondents. Therefore, for future research to strengthen statistical generalization, it is recommended that researchers conduct effectiveness tests in more than one school and employ random sampling to represent a larger population, thus allowing the results from the sample to be used as general statements.

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Jurnal Inovasi Pembelajaran

JINoP. May, 2024, 10 (1): page 98-114
p-ISSN 2443-159, e-ISSN 2460-0873
https://doi.org/10.22219/jinop.v10i1.32927

The development of an interactive e-worksheet using wizer.me on social studies learning for grade 7 at junior high school

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uploaded: 03/27/2024
revised: 04/29/2024
accepted: 05/18/2024
published: 05/31/2024

Sahida, D. S., & Wiradimadja, A. (2024). The development of an interactive e-worksheet using wizer.me on social studies learning for grade 7 at junior high school. *JINoP (Jurnal Inovasi Pembelajaran)*, 10(1).98-114. https://doi.org/10.22219/jinop.v10i1.32927

Abstract

In the learning process, obstacles are often found such as students having difficulty understanding the material, boredom while studying, and a lack of motivation to learn. This results in the learning process being less than optimal. Based on pre-research activities at SMPN 3 Krian, Sidoarjo District. Based on pre-research activities at SMPN 3 Krian, Sidoarjo, the learning process in class did not use teaching materials in the form of the electronic worksheet so students had difficulty understanding the material and were bored during the learning process This research aims to develop an interactive e-worksheet based on wizer.me to overcome these problems. This research method is Research & Development using the ADDIE model with analysis, design, development, implementation, and evaluation steps. As the result of this research, the author succeeded in developing an interactive e-worksheet based on wizer.me which involves students with e-worksheet in the learning process. students will not only see and hear but there will be interaction or reciprocity between students and the e-worksheet. This interactive e-worksheet can help students understand the material and increase learning motivation. Based on the research results, this e-worksheet is very feasible and can be used in social studies learning so that it can help students understand the subject matter.

Keywords: E-Worksheet; Interactive Electronic Worksheet; Interactive Learning; Social Studies Learning; *Wizer.Me*

INTRODUCTION

Social Sciences is one of the subjects at the junior high school level. This social studies subject is important because it teaches students to be good citizens and provides insight and social skills that will be useful for them in socializing with the people in their environment (Wiradimadja, 2021). However, in the field problems are often found in social studies learning. Among them are students having difficulty understanding the learning material and a lack of motivation to learn due to the teacher's presentation of the material which tends to be monotonous (Efiyanti et al., 2019; Farika et al., 2020; Jacub et al., 2020). Apart from that, students tend to

focus on teachers and books. This situation causes students to get bored and pay less attention to the explanation of the material, so students are less able to understand the lesson material (Zahra & Erianjoni, 2022). This problem also occurred at Junior High School 3 Krian.

Based on the initial interviews with social studies teachers at junior high school 3 Krian, there are problems in social studies learning, including students having difficulty understanding the subject matter, especially the material "knowing where you live". This is proven by the students' learning outcomes which tend to be low. From the results of interviews with students, it is known that they are bored when learning activities take place. Apart from that, according to students, the student worksheets used are still printed so students find them less interesting. Regarding this problem, the teacher also stated that he had not implemented ICT (Information and Communication of Technology) technology in social studies learning. However, based on the TPACK (Technological Pedagogical Content Knowledge) framework, technology integration is needed to develop learning activities. TPACK is a theoretical framework that integrates technology, pedagogy, and learning materials (Sintawati & Indriani, 2019). Therefore, in this study, the researcher discusses the development and use of E-Worksheets. The development of this E-Worksheet follows the implementation of TPACK which integrates technology into learning.

Based on the learning style test results data, it is known that most students have a visual learning style. However, based on the information obtained, teachers rarely use teaching materials that support visual learning styles. Abdurrahman & Kibtiyah (2021) states that failure to understand learning styles can cause students to have difficulty understanding the material and tend to get bored easily. Viyanti et al., (2021) believes that learning that is less able to accommodate learning styles causes students to have difficulty understanding the delivery of material by the teacher. These problems result in social studies learning activities not running well. So, the solution that can be done is to develop an interactive E-Worksheet. E-Worksheet is teaching material in the form of an electronic worksheet and can be accessed online (Adawiyah et al., 2021). According to Dachi & Perdana (2020); Prastowo (2015), Student worksheets are worksheets that contain material, summaries, and instructions for assignment activities carried out by students so that learning objectives are achieved. One platform that can be used to develop e-worksheets is wizer.me. The e-worksheet developed by researchers contains learning media in the form of video and audio to meet students' learning needs.

Researchers use the wizer.me website to develop e-worksheets because it has various advantages. According to Putri & Indrawati (2021) The wizer.me website has advantages and disadvantages. The advantages of wizer.me are: (1) provides an attractive theme display, (2) is easy to use, (3) can be accessed for free or for a fee, (4) has a wide variety of questions, (5) can be accessed online via smartphone or laptop, and (6) completing and submitting assignments online. Meanwhile, the disadvantages of wizer.me are: (1) the themes provided are limited so you cannot design your own, (2) if you use the free wizer.me, only teachers can see students'

grades, and (3) for technologically clueless students, they need assistance when using it.

Previous research by Safitri (2022) development of interactive e-worksheets using wizer.me to overcome the problem of students having difficulty understanding the material. Research by Dewi et al., (2023) namely the development of interactive e-worksheet using wizer.me to improve student learning outcomes. Research by Mayasari et al., (2023) namely developing e-worksheets using wizer.me to overcome the problem of students having difficulty understanding the material. Based on previous research, the e-worksheet being developed is not equipped with an audio feature. Meanwhile, this e-worksheet is equipped with audio so that it can help students with an auditory learning style to understand the material or receive information. The material developed in previous research was limited to learning videos. Meanwhile, the material on the e-worksheet developed in this research is more diverse, using video and audio forms so that students can receive information according to their learning style.

The presence of video and audio makes students more interested and easier to understand the material presented (Harefa & La'ia, 2021). The various features available in wizer.me can enable teachers to create e-worksheets creatively and can be adapted to material needs (Fredlina & Dewi, 2022; Safitri, 2022). The advantage of e-worksheets is that they make them easier for teachers and students to use because they are designed in digital form and are interactive so that learning activities are more meaningful (Putra et al., 2022). Meanwhile, the disadvantage of e-worksheets is that they must use tools in the form of gadgets or IoT (Internet of Things) and they can only be used if they are connected to an internet network, so students need supporting facilities. Apart from that, students who have not mastered the use of IoT will have a little difficulty when using e-worksheets (Diani et al., 2019). To overcome this deficiency, in each class, there is Wi-Fi as a means of supporting learning activities.

This research is important to be able to overcome problems that occur in schools. Researchers developed interactive e-worksheets based on wizer.me because students had difficulty understanding the subject matter and were bored while studying, so teaching materials in the form of e-worksheets were needed to overcome these problems. Therefore, this research aims to develop an interactive e-worksheet based on wizer.me and test the feasibility of an interactive e-worksheet based on wizer.me in social studies learning. It is hoped that this research will contribute to complementing previous research regarding the development of e-worksheets, especially for social studies learning, and solving student learning problems at Junior High School 3 Krian.

METHODS

This research uses the Research & Development (R&D) method. The model used is ADDIE with stages including, Analysis, Design, Development, Implementation and Evaluation (Branch, 2009; Kawete et al., 2022). This research was conducted at Junior High School 3 Krian, because based on needs analysis, there were problems in social studies learning, namely students had difficulty understanding the material and felt

bored, so teaching materials were needed to help overcome these problems. The research stages are in Figure 1.

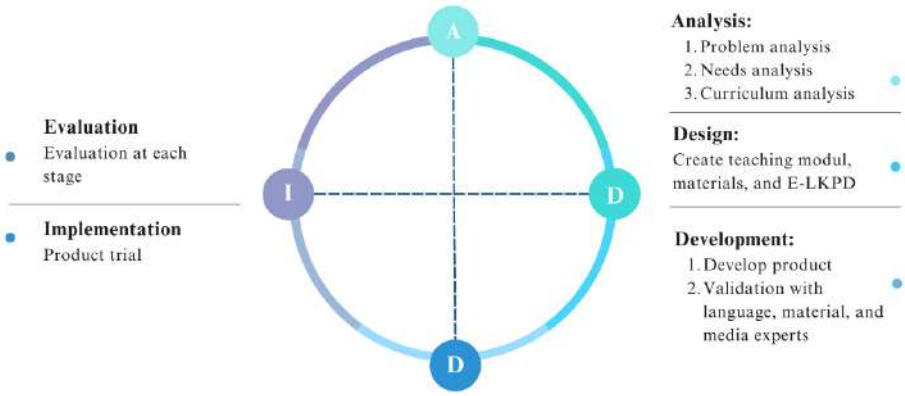

Figure 1. ADDIE flowchart adapted from Branch (2009)

In the first stage, researchers carried out problem analysis, curriculum analysis, and needs analysis. In the second stage, researchers began to develop designs or elements and frameworks for teaching modules, materials, and e-worksheets. In the third stage, the researcher develops the product according to the design in the previous stage. The products that have been created are then subjected to validation tests with material, language, and media experts. The validator used has the criteria of having at least 5 years of experience and being an expert in their field. The validators are material experts, namely lecturers from the Social Studies Education Study Program, Universitas Negeri Malang, language experts, namely Indonesian language teachers at Junior High School 3 Krian, and media experts, namely lecturers from the Department of Geography, Universitas Negeri Malang. After obtaining the validation results, the researchers improved the product based on notes from the validators' suggestions. The fourth stage, after the validation results were obtained and declared feasible by the validator, researchers then implemented the product or limited trials on 36 grade 7 students. In the fifth stage, researchers carry out evaluations at each stage of development to determine the feasibility of the product.

The types of data for this research are qualitative and quantitative. Qualitative data was obtained from notes on recommendations and suggestions by validators and trials. Quantitative data is obtained from validation results in the form of numbers by material experts, media language, and test subjects. The data collection technique uses an instrument in the form of a questionnaire with a Likert scale of 1-4. Students' trial assessment instruments or questionnaires were adopted from research by Prayoga et al., (2022). The questionnaire has been tested for validity and declared valid with a value of $r_{count} > r_{table}$. The reliability test results obtained a Cronbach alpha value of 0.83 which is classified as a high degree of reliability. This means that the instrument is valid and reliable for use in obtaining data and can be trusted for data collection. The data that has been obtained is then processed using the following formula (1).

$$p = \frac{\sum x}{\sum xi} \times 100\% \quad (1)$$

Information:
p = validity percentage
x = assessment score in one item
xi = ideal assessment score in one item
100% = constant

After obtaining the validation test results and student responses, the results were interpreted based on Table 1.

Table 1. Criteria for assessing the feasibility test for adaptation of Yuniarti et al., (2021)

Percentage	Criteria	Statement
81% – 100%	Very worthy	Very suitable for use without needing revisions
61% – 80%	Worthy	Worth using with minor revisions
41% – 60%	Decent enough	Quite suitable for use but needs revision
21% – 40%	Not worth it	Not suitable for use so it needs a lot of revisions
0% – 20%	Very inadequate	It is not suitable for use so it cannot be used and needs total revision

RESULT AND DISCUSSION

Result

The product produced in this research is an interactive e-worksheet based on wizer.me. This research was conducted at Junior High School 3 Krian, Sidoarjo Regency, East Java. The results of this research explain the e-worksheet development process.

a. Analysis

This research analysis includes problem analysis, curriculum analysis, and needs analysis. Problem analysis was carried out through interviews with social studies teachers at Junior High School 3 Krian. The problem with social studies learning is that students have difficulty understanding the material. This is known from the students' learning outcomes which tend to be low. According to students, it is known that they feel bored when learning activities take place. Apart from that, according to students, the worksheets used are still printed so students find them less interesting. Meanwhile, based on the results of interviews, it is known that teachers rarely use teaching materials according to their needs and learning styles so they are less able to support learning activities. Researchers also conducted curriculum analysis to determine the material developed in the e-worksheet. Based on the curriculum analysis, it turns out that students have difficulty understanding the material "knowing where you live" in theme 1. Based on the needs analysis obtained through interviews with social studies teachers, it is known that the

learning process is still limited to textbooks and limited use of technology. Meanwhile, students prefer technology-based learning. Needs analysis was carried out by distributing a learning style test questionnaire adopted from to serve as a guide for developing e-worksheets that refer to students' learning styles. The learning style data is shown in Figure 2.

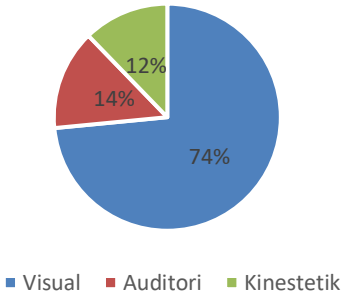

Figure 2. Student learning style test results

From this data, it is known that students with a visual learning style are 74%, followed by auditory 14% and kinesthetic 12%. In Figure 2 it is clearly seen that most students have a visual learning style. Meanwhile, in normal learning activities, teachers rarely use teaching materials according to the visual learning style. Therefore, researchers developed e-worksheets by adapting to visual learning styles.

b. *Design*

Researchers prepare designs or frameworks for teaching modules, materials, and e-worksheets. In the first stage, researchers began to develop teaching modules. Teaching modules are learning sequence sheets that contain objectives, steps, and assessments that are tailored to the learning topic. The second stage, preparing material for Theme 1 with the sub-theme "getting to know where you live". The third stage, the researcher designed a storyboard displaying the e-worksheet (Figure 3).

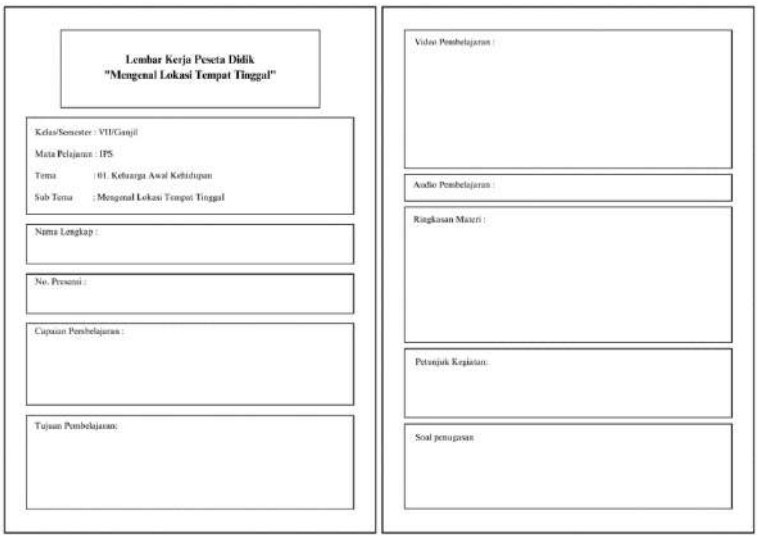

Figure 3. *Storyboard* e-worksheet

c. *Development*

Researchers began developing the product according to the previous stages until the product in the form of an e-worksheet was completed. The product development process uses tools in the form of Canva, Inshoot, YouTube, audio editor and wizer.me. In the first stage, researchers created material packaged in the form of learning videos using Canva to create layouts and images to make the appearance more attractive. In the second stage, researchers used inshoot to create and edit learning videos. The third stage, after the learning video has been completed, the researcher uploads it to the YouTube page so that it is easily accessed by students. The fourth stage, the researcher created learning materials in audio form using an audio editor. In the fifth stage, researchers began to compile e-worksheets on the wizer.me platform. The e-worksheet that has been developed can then be accessed online via smartphone and computer or laptop. After the e-worksheet has been developed, validation tests are carried out on material, language, and media experts. The purpose of the validation test is to determine feasibility based on assessments from experts. The first validation test carried out is a material validation test to determine the suitability and accuracy of the material with the learning needs contained in the teaching module. The results of the recapitulation of quantitative data from material validation are presented in Table 2.

Table 2. Recapitulation of quantitative data for material validation

No	Components to be assessed	Score
1	Suitability of material to learning achievements	3
2	Suitability of material to learning objectives	4
3	The material is presented systematically	3
4	The material presented is easy to understand	4
5	Suitability of e-worksheets with learning achievements	4
6	Suitability of e-worksheets to learning topics	4
7	Suitability of e-worksheets with learning objectives	4
8	Suitability of e-worksheets to the needs and characteristics of students	3
9	Systematic presentation of e-worksheets	4
10	The presentation of material in e-worksheets adds to students' insight	4
11	Suitability of e-worksheet difficulty level with students' cognitive development and skills	3
12	Suitability of e-worksheets to phenomena around students	3
	Total Score	43
	Percentage	89,6%

The recapitulation results from material validation obtained a total score of 43 with a percentage of 89.6%. Based on the feasibility criteria in Table 1, the results of this test show that the material validation is declared "very feasible" without the need for revision. This means that the material on the e-worksheet is declared ready to be used in social studies learning activities at school. However, the material validator

provided notes of suggestions as material for improvement so that the material on the e-worksheet being developed could be better. Suggestions given by the material validator, (1) add the negative impacts of volcanic activity, and (2) provide sub-definitions of the map and then sub-components of the map. Next, the researcher improved the product according to suggestions from the validator which are presented in Figure 4.

Figure 4. Material improvements

After the material validation test, a language validation test is then carried out to obtain comments, suggestions, responses, and information regarding the language in the product being developed. Language validation is used to evaluate the language used in the product. The following recapitulation results from language validation are presented in Table 3.

Table 3. Recapitulation of quantitative language validation data

No	Components to be assessed	Score
1	Use good and correct language rules	4
2	The language used is easy for students to understand	4
3	Accuracy of sentence structure	3
4	Correct use of terms	3
5	The language used is communicative and informative	3
6	Sentences are structured clearly	4
7	The sentences used are able to convey information and commands well	3
8	Suitability of language to the cognitive level of students	3
9	The language used is able to encourage students to think critically	3
10	The language used is effective and efficient	4
11	The use of the term in is correct	3
12	The use of uppercase and lowercase letters is correct	3
13	The spelling is correct	3
14	The use of punctuation and symbols is correct	3
	Total score	39
	Percentage	81,3%

Based on the results of the recapitulation of language validation test data, a total score of 39 was obtained with a percentage of 81.3%, which shows that the criteria are "very suitable" for use without the need for revision. These results obtained the same criteria as the material validation results. The language used in e-worksheets is considered to contain no words or sentences that are ambiguous or difficult for students to understand. However, the language validator provides notes of suggestions to correct errors in writing letters and punctuation correctly. According to the language validator, overall, the writing is following linguistic rules. The language used is also effective, efficient, and following PUEBI (*Pedoman Umum Ejaan Bahasa Indonesia*).

Next, the researcher carried out a media validation test to obtain an assessment and determine the suitability of the product. The results of the quantitative data recapitulation from media validation are in Table 4.

Table 4. Recapitulation of quantitative media validation data

No	Components to be assessed	Score
1	Complete identity on e-worksheet	2
2	Appropriate layout of e-worksheet components such as title, learning outcomes, learning objectives, work instructions and question variations	2
3	Clarity of the flow of instructions for use	3
4	Systematic presentation of e-worksheets	3
5	The attractiveness of the e-worksheet display	3
6	The attractiveness of the theme and color of the e-worksheet display	3
7	The presentation of font types in e-worksheets is clear and easy to read	3
8	Suitability of choosing the size of e-worksheet writing	3
9	The images presented in the e-worksheet are clear	3
10	Ease of using e-worksheets	4
11	Creativity and innovation in e-worksheet media	3
12	E-worksheet media can motivate students	3
	Total Score	35
	Percentage	72,9%

Based on the results of media validation, a total score of 35 was obtained with a percentage of 72.9%, which shows that the criteria are "suitable" for use with slight revisions. This means that the media used is stated to be good, but there are several minor improvements. There are several suggestions given by the validator, including, (1) providing the identity column for full name and presence number separately, (2) changing the text font type to make it more attractive, and (3) changing the map image in question number 1 because the map image is used is not following map rules. Then the researcher improves the product or media according to suggestions from the validator in Figure 5.

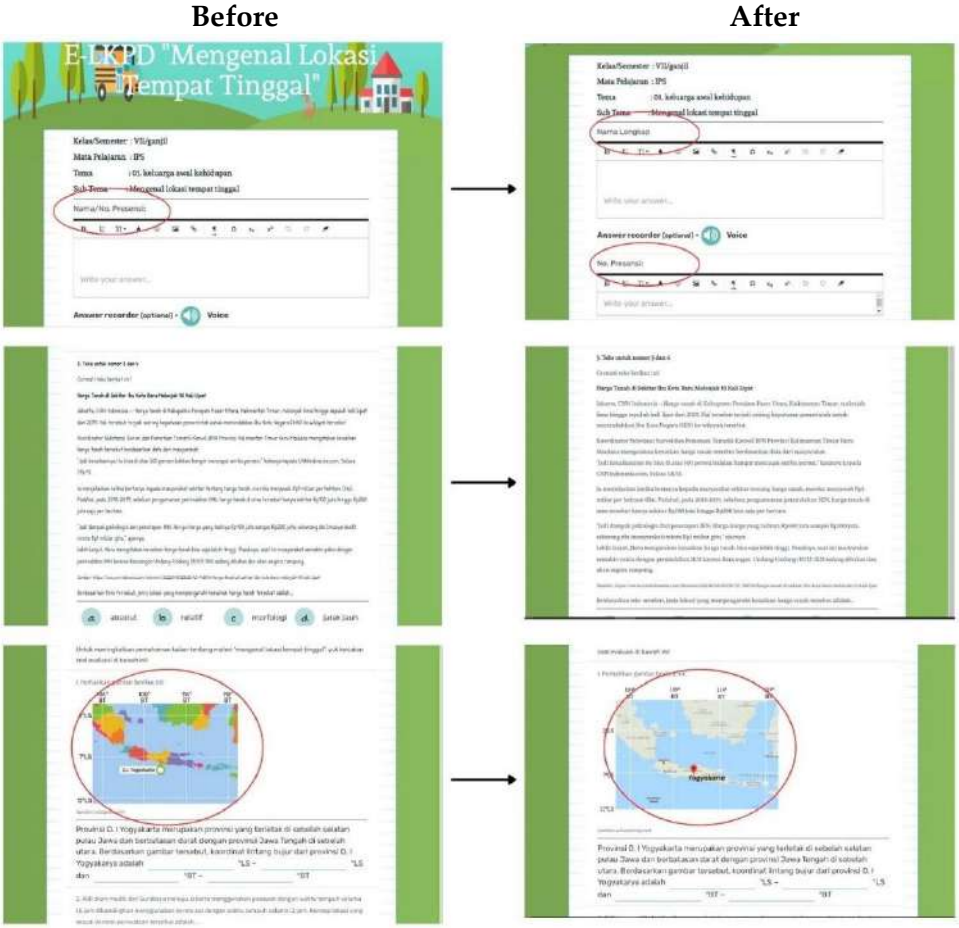

Figure 5. Improved media display

d. *Implementation*

After obtaining the validation results and obtaining appropriate criteria by the validator, the researchers then carried out a limited trial on 36 class 7B students at Junior High School 3 Krian. Trials are carried out to collect data and determine the level of product suitability based on the results of student assessment responses. The trial was carried out face-to-face so that researchers could accompany and monitor the activities directly. In the initial stage, researchers shared an e-workshop link that could be accessed via smartphone. Then the researcher provided explanations and directions in using the e-workshop and accompanied students during the activity. After implementing the e-workshop in learning, the researcher distributed questionnaires to obtain research data from students. The results of the recapitulation of trials on students are presented in Table 5.

Table 5. Recapitulation of quantitative data from trials on students

No	Components to be assessed	Score
1	The attractiveness of the e-worksheet display	131
2	Writing readability	122
3	Image clarity	126
4	Attractive color	119
5	Voice clarity	124
6	Material is easy to understand	126
7	Clarity of material description	123
8	e-worksheets provide enthusiasm for learning	121
9	Ease of use	124
	Total Score	1116
	Percentage	86,11%

Based on the results of the recapitulation of student trials, a total score of 1116 was obtained with a percentage of 86.11% which was classified as "very feasible" criteria. This means that students can use e-worksheets well. They can understand the instructions contained in it and can also operate or work independently. These results prove that interactive e-worksheets based on wizer.me can be used in social studies learning activities in schools. Students also gave positive comments regarding this e-worksheet, namely that the e-worksheet presented was interesting because there were learning videos and varied types of questions so that students did not get bored and were more interested in using it. Apart from that, e-worksheets are also easy to use. Researchers also received suggestions from students regarding e-worksheets, namely adding quizzes to e-worksheets. However, because the proposal given was not large enough, the researchers did not make these changes.

e. *Evaluation*

Evaluation is a process to measure and determine the feasibility of the product being developed. This research carries out formative evaluation, namely evaluation carried out at each stage of the research starting from the analysis stage to product implementation to improve the product. At the analysis stage, an evaluation of the results of the problem, curriculum and needs analysis is carried out. The design stage is evaluating the design of teaching modules, materials, and e-worksheets. The development stage evaluates the validation results obtained from expert validators. The implementation stage evaluates the results of the implementation and student responses.

Discussion

Based on the research results, the researchers succeeded in developing e-worksheet with the R&D steps with the ADDIE model. In the analysis stage, material, curriculum and needs analysis were carried out. In the design stage, researchers designed teaching modules, materials, and e-worksheet. In the development stage, the researcher began to develop the product according to the design of the previous stage. After the product had been developed, it was then subjected to validation

tests with material, language, and media expert validators. In the implementation stage, the researcher conducted a product trial on 36 students of grade 7B at Junior High School 3 Krian. Then in the evaluation stage, the researcher carried out evaluations at each stage of development.

The development of interactive e-worksheet based on wizer.me can be used in learning activities because it has met the eligibility criteria of material, language, media expert validators and test subject whose results are in Table 6.

Table 6. Feasibility test results

Feasibility test	Percentage	Criteria
Material Validation	89.6%	Very worthy
Language Validation	81,3%	Very worthy
Media Validation	72,9%	Worthy
Product trial	86,11%	Very worthy

Based on the results of the assessment by expert validators, there are notes of suggestions and researchers have made improvements to the product according to the suggestions given. Based on the feasibility test results in Table 6, it can be concluded that the interactive e-worksheet based on wizer.me is very feasible and can be used in social studies learning. The results of this test prove that students can translate the information presented on the e-worksheet, so that they can understand the lesson material. Lailiah et al., (2021) stated that using e-worksheets via gadgets can increase enthusiasm during learning and make it easier for students to understand the material. Previous research conducted by Aliyah & Wiradimadja (2023); Arsyisyah et al., (2023); Habsyi et al., (2022); Oktaviani et al., (2023) shows that the use of e-worksheets can improve students' understanding. However, the development of e-worksheets in previous research did not study students' learning styles. Meanwhile, researchers conducted a study of learning styles to adapt e-worksheets to students' learning needs. This learning process is based on cybernetic learning theory. Nur'alimah (2022) explains the concept of cybernetic theory, namely the use of technology in learning to convey learning information quickly and precisely. Nasrul (2023) adding to this theory the learning process is very important, but what is more important is the information system to facilitate the delivery of material to students. The results of this research are similar to development research by Safitri (2022) which shows that the e-worksheet development based on wizer.me is very suitable for use in social studies learning. She also explained that through this e-worksheet, students are more active during learning so that a pleasant learning atmosphere is created. In learning activities, the use of e-worksheets can be adjusted to suit students' needs. Nisak (2021) stated that teaching materials are an important factor so that teaching materials are needed according to the material and characteristics of students. In line with Eliyanti et al., (2020) believes that good teaching materials should be in accordance with the needs or characteristics of students so that learning in class can run effectively and can improve students' skills.

As explained by Dale (1969); Sumiharsono & Hasanah (2017) in the cone of experience theory, it states that students can learn through their own direct experience, observing and listening through learning media and language. Based on the theory of the cone of experience, learning using e-worksheets is included at levels number 7 (seeing videos), 8 (seeing pictures), 9 (listening), and 10 (reading). Based on the theory of the cone of experience, learning activities through e-worksheets reach the visual stage. Where students can process and remember knowledge up to 30% (Dale, 1969; Sari, 2019). In line with Apriyanto et al., (2022); Rahmi & Alfurqan (2021); Rohmah & Syifa (2021) stated that audio-visual media can encourage interest in learning because the material is presented in a varied manner and is easy to understand and remember so that students do not get bored while studying. Audie (2019); Dale (1969) states that learning that is concrete and involves more senses can provide a better learning experience.

The e-worksheet developed by this researcher contains learning videos, audio, material summaries, activity instructions and assignment questions. According to Prastika & Masniladevi (2021) e-worksheets that contain videos, images and explanations increase students' interest in using them. The e-worksheet also contains assignments that students can complete. Having tasks in worksheets can train students' reasoning and problem-solving skills in everyday life (Widiyanti & Nisa, 2021). Using an e-worksheet based on wizer.me is considered more interesting as evidenced by the responses of students who are interested in using e-worksheets. In line with previous research conducted by Hidayat & Aripin (2023); Indriani et al., (2022); Putri & Amini (2023) shows that students are more interested in using E-worksheet because it is presented with an attractive appearance, not boring, and easy to use. The development of e-worksheets by this researcher has advantages, including (1) the appearance of e-worksheets is more attractive with the background themes available on wizer.me. In line with Fatmawati et al., (2022) stated that colorful and illustrated teaching materials are preferred by students, so they are more interested in participating in learning activities. According to Andini et al., (2022) an e-worksheet display that is made attractive can encourage students' enthusiasm for participating in learning activities. (2) The material presented by researchers is equipped with various media, namely learning videos and audio. According to Harefa & La'ia (2021), better understanding of material through video and audio in the learning process. Through video and audio, students can listen to explanations and can see visually with pictures or illustrations related to the material. (3) The types of questions are varied so that students do not get bored when working on them. Daryanto et al., (2022) stated that students will not easily get bored with various types of questions.

CONCLUSION

Based on the results of this research, it shows that Wizer.me-based interactive e-worksheets in social studies learning are feasible and can be applied. This is known from the results of feasibility tests and trials which obtained very feasible criteria. These results prove that this e-worksheet can be implemented in social studies learning because it can meet needs according to students' learning styles. This e-

worksheet is presented interestingly because there are videos, audio, and various types of questions so that students do not get bored or bored while learning is taking place. Apart from that, this e-worksheet helps students to understand the lesson material. Overall, researchers have made improvements according to input and suggestions. The suggestion given by the students was to add a quiz to the e-worksheet. However, researchers did not make these improvements because the suggestions given were not very significant. Therefore, these suggestions can be used as material for further development as material for improving the e-worksheet.

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Jurnal Inovasi Pembelajaran

JINoP. May, 2024, 10 (1): page 115-129
p-ISSN 2443-159, e-ISSN 2460-0873
https://doi.org/10.22219/jinop.v10i1.29103

Development of science, technology, engineering, and mathematics (STEM) based chemistry e-module learning materials on the topic of reaction rate of learning

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Abstract

Teaching materials are important components in learning, so they need more attention. This study aimed to determine the validity and response of the target audience to a STEM-based chemistry e-module on reaction rate. The research used the ADDIE development model, which consists of five stages: Analyze, Design, Develop, Implement, and Evaluate. However, this research was limited to the implementation stage through trials with a small group. The research instruments used were interview guidelines, student needs questionnaire sheets, validation sheets, and teacher and student response questionnaire sheets. The subjects of this study were 3 expert lecturers, 2 expert chemistry teachers, and 30 students of class XII IPA at SMA Negeri 2 Sentajo Raya. The results showed that the STEM-based chemistry e-module on reaction rate material was feasible to use with a validity value of 89.6% (very feasible criteria). Based on the responses of the target audience, it can also be concluded that the e-module is feasible to use with a teacher response percentage of 92% and students 88%. This means that e-modules are feasible to use as teaching materials on reaction rate materials at SMAN 2 Sentajo Raya.
Keywords: Teaching Material; Reaction Rate; STEM.

uploaded: 09/07/2023
revised: 05/02/2024
accepted: 05/18/2024
published: 05/31/2024

Oktariani, O., & Saputri, E. R. (2024). Development of Science, Technology, Engineering, and Mathematics (STEM)-Based Chemistry E-module Learning Materials on the Topic of Reaction Rate. *JINoP (Jurnal Inovasi Pembelajaran)*, 10(1). 115-129. https://doi.org/10.22219/jinop.v10i1.29013

INTRODUCTION

One of the supporting factors to support an adequate learning process is teaching materials. Teaching materials are a collection of learning materials given to students to be mastered and used by students as learning resources (Agustina, 2018). By using teaching materials, teachers and students will find it easier and more helpful to carry out the learning process in class.

In the digital age, printed teaching materials are being replaced by more practical teaching materials that can be carried anywhere. Technological advancements have

made humans more creative, aiming to make everyday life easier. In the field of education, the role of this technology is also very much needed so that the teaching and learning process is expected to be more maximized. If technology is used properly, it can expand, strengthen, and improve the quality of education (Budhwar, 2018). One of the roles of technology in education is e-books, which are digital versions of traditional books. E-modules are a specific type of e-book. E-modules are printed modules that have been converted into a digital format (Sugihartini & Jayanta, 2017). E-modules are more practical for students to use because they can be accessed on their smartphones or mobile phones, which are more widely carried by people today than printed books. This supports the function of the module itself, which is designed for self-directed learning that can be used anywhere and anytime.

Based on interviews with chemistry teachers at SMA Negeri 2 Sentajo Raya, students have only been using textbooks and worksheets as teaching materials in chemistry classes, which has not been very effective in stimulating their interest in the subject. Teachers have also expressed that many students struggle with chemistry due to the perception that it is a difficult subject. One particular topic that students find challenging is reaction rate, with some even scoring below the minimum passing grade (KKM) of 70. To address these issues and enhance the learning process, it is crucial to implement innovative teaching approaches that align with student characteristics and the subject matter (Oktariani, O; Febliza, 2019). Therefore, an approach is needed that can help students build a strong conceptual understanding. One of them is through the STEM approach. Based on the research, The implementation of STEM-based learning can enhance students' critical thinking skills compared to conventional learning (Khoiriyah et al., 2018). Similar to which shows that the STEM approach is able to improve students' understanding of concepts, critical thinking skills, and collaboration skills (Sandi, 2021). Another research conducted shows that the use of STEM in learning activities applied in teaching materials, in this case e-modules, is able to improve students' reasoning skills, improve critical thinking abilities, and increase understanding of the basic concepts of material (Lestari, 2021).

Previous research has shown that the STEM (Science, Technology, Engineering, and Mathematics) based modules on the topics of colligative properties and chemical equilibrium that were developed are worthy of further development and have received positive feedback (Arisya et al., 2021). This research has produced a chemistry learning module that has been validated by subject matter experts, media experts, and high school chemistry teachers, with a high validity category and a very good student response category.

In light of the aforementioned background, the researcher deems it necessary to conduct a study aimed at developing and validating STEM-based (Science, Technology, Engineering, and Mathematics) Chemistry E-Module Teaching Materials. The novelty of this research lies in the creation of an electronic module that can be easily accessed and utilized anytime, anywhere, and is equipped with stages that aid in fostering 21st-century skills among students.

METHODS

This research is classified as Research and Development (R&D) research. In accordance with its objectives, the research aimed to develop STEM-based chemistry e-module teaching materials specifically focused on reaction rate. The development process employed the ADDIE model, which stands for Analysis, Design, Development or Production, Implementation or Delivery, and Evaluation.

The research was conducted in several stages. The first stage involved a needs analysis to identify teaching requirements in high schools for supporting the chemistry learning process. This analysis incorporated input from teachers and students, as well as document analysis, including the curriculum, learning tools, and relevant research articles. The second stage focused on product development, where a draft of the e-module was created. This was followed by a validation stage where subject matter and media experts evaluated the developed e-module. Finally, the implementation or limited trial phase was conducted at SMA Negeri 2 Sentajo Raya, Kuansing Regency.

The participants in this research included chemistry teachers who provided responses during the needs analysis stage and user feedback on the e-module under development. Thirty students from the 11th grade Science stream at SMAN 2 Sentajo Raya participated in the needs analysis, while 30 students from the 12th grade Science stream provided user feedback on the e-module. Additionally, three subject matter experts who are lecturers served as validators to assess the feasibility of the e-module.

The research instruments used were an interview guide, a student needs questionnaire, a validation sheet, and a teacher and student response questionnaire. Data processing and analysis for the needs analysis interviews involved standardizing the interview data into a single written transcript. Conclusions were then drawn from the results of the needs analysis interviews. The student needs questionnaire utilized a Guttman scale. "Yes" answers were assigned a value of 1, and "no" answers were assigned a value of 0 for the questionnaire's alternative answers. This assessment was conducted as a checklist using the Guttman scale (1).

$$P = \frac{f}{n} \times 100\% \quad (1)$$

note:

P = percentage

f = frequency

P = 100

n = answers

Categories for interpreting the results of the needs analysis percentage are obtained from modifications to the research results (Munggaran, 2012). These categories are presented in Table 1.

Table 1. Needs analysis percentage category

Percentage	Category
0– 1,9%	Not needed
2% – 25,9%	A small number need it
26% – 49,9%	Less than half need
50%	Half need
50,1% – 75,9%	More than half need it
76% – 99,9%	Most need it
100%	Everyone needs it

The data obtained from the validation of the e-module by experts is a score on a Likert scale of 5 (5,4,3,2,1) with the descriptions of very good, good, fair, poor, very poor. The formula used to calculate data from experts is as follows (2):

$$P = \frac{F}{N} \times 100\% \quad (2)$$

Note:
P = percentage number of questionnaire data
F = total score obtained
N = maximum number of scores

Next, the percentage (%) of eligibility obtained is then interpreted into categories based on table 2:

Table 2. Eligibility criteria

Scoring	Criteria
81≤ P ≤ 100%	Highly Suitable
61≤ P < 81 %	Suitable
41 ≤ P < 61 %	Moderately Suitable
21 ≤ P < 41 %	Unsuitable
0 ≤ P < 21 %	Highly Unsuitable

(Arikunto, 2012)

The data obtained from e-module user responses are scores on a Likert scale of 5 (5,4,3,2,1) with the information strongly agree, agree, moderately disagree, disagree, strongly disagree. The formula used to calculate data from experts is as follows (3):

$$P = \frac{F}{N} \times 100\ \% \quad (3)$$

note:
P = Percentage figure of questionnaire data
F = Total score obtained
N = Maximum number of scores

Then, the results of these percentages can be grouped into score inter-percentage criteria according to the Likert scale so that conclusions can be obtained about the responses of teachers and students. The criteria for score interpretation according to the Likert scale are as table 3:

Table 3. User response interpresentation criteria

Scoring	Interpresentation Criteria
81 ≤ P ≤ 100%	Highly Practical (attractive/good/suitable)
61 ≤ P < 80 %	Practical (attractive/good/suitable)
41 ≤ P < 60 %	Appopriate (Practical/attractive/good/suitable)
21 ≤ P < 40 %	Not practical (Practical/attractive/good/suitable)
0≤ P < 21 %	Highly not practical (Practical/attractive/good/suitable)

(Parmin, 2012)

RESULT AND DISCUSSION

Analyze

Based on the results of interviews with chemistry teachers, the results of reducing interview transcripts concluded that: During the chemistry learning process in class, students tend to have difficulty understanding the chemistry material presented by the teacher. Students consider chemistry material to be difficult material. The teacher said that one of the materials that students considered difficult was reaction rate. In the chemistry learning process, students only use textbooks and worksheets. Students have never used electronic modules during the chemistry learning process. In chemistry learning, teachers have applied innovative learning models but not all models have been implemented.

Based on a student needs questionnaire distributed to 30 class 93.3% of students had difficulty understanding the reaction rate material through the teaching materials and methods applied by the teacher; 100% of students use textbooks and worksheets in chemistry learning; 93.3% of students are interested in reading chemistry books in electronic form (Digital); 96.6% of students need alternative teaching materials that can be used to study reaction rate material more easily and interestingly; In chemistry learning, only 16.6% of students have used the module.

Based on the results of the needs analysis, almost all students think that the reaction rate material is difficult material. Reaction rate is a chemical science that requires the study of macroscopic, microscopic and symbolic aspects. The concept of reaction rate taught without involving the microscopic aspects will create difficulties/obstacles to constructing a meaningful concept of reaction rate (Nur'ain et al., 2015; Sumargo & Yuanita, 2014).

During the learning process, the teaching materials used by students are in the form of textbooks and worksheets, almost all students have difficulty understanding the reaction rate material through the teaching materials and methods applied by the teacher. In teaching chemistry, teachers have not been able to find a suitable model for learning reaction rates. Innovative learning is learning that is designed in a different way from the learning that teachers usually do (conventional). Innovative learning is more oriented towards student-centered learning. The learning process is planned, structured and conditioned according to student needs (Uno & Muhammad, 2011).

STEM learning is a form of innovative learning that can be used to develop various skills needed by students to face the challenges of the 4.0 era. STEM can help students develop thinking skills, gain comprehensive knowledge and face various problems in everyday life. In the STEM approach, students are directly involved in the process of discovering the concepts being studied (Miyarso, 2021).
From the results of the needs analysis, it was also found that 96.6% of students needed alternative teaching materials that could be used to study reaction rate material more easily and interestingly. From the results of the needs analysis, almost all students are interested in reading chemistry books in digital form, and only 16.6% of students studying chemistry have ever used modules in learning. From the explanation of the needs analysis, it can be concluded that teaching materials are needed that can help make understanding difficult material easier, one of which is using e-modules. To overcome this problem, the solution that can be done is to develop a STEM-based chemistry E-module teaching material that can help students understand reaction rate material.
E-modules can help make learning more interesting because they can add pictures or videos. E-modules can also help students understand lesson material because there are consistent study instructions and understanding of concepts. Students can repeat or study the material according to their needs, because the modules can be studied independently at home without the help of other people (Fauziah et al., 2023; Yudha & Rahmi, 2023).

After carrying out needs analysis activities, the next stage is to carry out an analysis of the material that will be included in teaching materials in accordance with the 2013 curriculum. The teaching materials will contain material on reaction rates which will be studied by class XI students in the odd semester. Based on the curriculum analysis and content standards, it can be concluded that the basic concepts of reaction rate material that must be included in the module are:
CHAPTER I Concept of Reaction Rate and Collision Theory
a. Molarity
b. Understanding Reaction Rate
c. Understanding Collision Theory
CHAPTER II Factors that Affecting Reaction Rate
a. Concentration
b. Temperature
c. Surface area
d. Catalyst
CHAPTER III Reaction Rate Equations
a. Reaction Rate Equation
b. Meaning of Reaction Order

Design
After carrying out the stages of analyzing student needs, the author decided to create a teaching material to support students in the chemistry learning process, especially regarding reaction rate material. The stages carried out are as follows:

a. Collecting references to be used as content material for products that will be developed in the form of STEM-based teaching materials on reaction rate material.
b. Designing E-modules according to E-module components. Where the E-module component consists of:
    1) The cover contains the title and image related to the material.
    2) Foreword, table of contents, list of images, and list of tables which can make it easier to use the e-module.
    3) Study instructions which include teacher instructions and student instructions.
    4) Competencies achieved in the form of KI, KD, indicators of competency achievement, and learning objectives as well as a concept map in the material.
    5) Contents / Description of the reaction rate material
    6) Activity sheets/student activities to support learning activities
    7) Evaluation sheet containing questions that have been studied to measure students' ability to understand the reaction rate material.

The components of the learning module are as follows; 1) There are learning objectives; 2) Teaching Materials; 3) Exercises presented to apply the skills and competencies being studied; 4) The existence of feedback which is an indicator shows the quality of the training carried out by students (Ibrahim, 2010).

Select supporting applications to produce the developed teaching materials.
In developing STEM-based chemistry e-module teaching materials, the Canva and Heyzine applications were selected. Canva is a graphic design website that makes it easy for users to create creative designs online. Canva allows users to easily customize the e-modules they create and create attractive designs without hiring a designer. In the learning concept, this can help increase the effectiveness and variety of teaching and learning, which can be enjoyable for students and teachers (Irkhamni et al., 2021).
Heyzine is a free flipbook-based digital book-making application that includes text, images or both with access via electronic devices such as computers and cellphones (Humairah, 2022). According to (Khomaria & Puspasari 2022), *heyzine flipbooks* is an application that can convert PDFs into books, magazines and brochures digitally by adding videos, images, audio, animations, links and other interesting things. Based on the description presented, the conclusion regarding *heyzine flipbooks* is a tool that can be used to create flipbooks by providing a more interesting PDF reading experience and pages that can be opened like a book.

Development
In the next stage, namely the product development stage, at this stage the overall STEM-based chemistry E-module is developed based on the E-module design that has been created. Furthermore, at this stage a validation process is also carried out on the E-module to find out whether the product being developed is suitable for use by students as teaching material.

The results of the validation of STEM (Science, Technology, Engineering and Mathematics) based chemistry E-module teaching materials on reaction rates can be seen from several aspects which are described as Table 4.

Table 4. Material validation results

No	Aspects	V1	V 2	V3	Mean
1	Content Eligibility	85%	85%	95%	88,3%
2	Presentation	87%	87%	95%	89,6%

*V1 : Validator 1
*V2 : Validator 2
*V3 : Validator 3

From the validation results, it was found that the feasibility of the E-module content obtained a percentage of 83.3% with a very feasible category. Meanwhile, the presentation aspect obtained 89.6% with a very decent category. This corresponds to the percentage criteria (Arikunto, 2012) where the percentage of 81-100% includes very feasible criteria.

The first aspect assessed by material experts is the suitability aspect of the content. This aspect received validation with the criteria "very feasible". These results are in line with research (Nugraha & Syafi, 2020) In terms of the appropriateness of the content, the content is also assessed as very good, by looking at the relevance of the teaching content to the competencies and needs of students.

The second aspect is the appropriateness of presentation. This aspect received validation with the criteria "very feasible". The research results are in line with (Lestari et al., 2018) revealed that learning material must be coherent, consistent and balanced between chapters in the material. Furthermore (Pawestri & Zulfiati, 2020) revealed that learning material must be appropriate to the level of students' abilities in order to make it easier for students to understand the material.

Table 5. Media validation results

Aspects	V 1	V 2	V 3	Mean
E-modul interface	83,3%	90%	83,3%	85,5%
E-modul design	83,3%	93,3%	83,3%	86%

*V1 : Validator 1
*V2 : Validator 2
*V3 : Validator 3

In the media validation results (Table 5), the e-module content design aspect obtained the highest percentage, namely 86% with very feasible criteria. In the display aspect, the E-module obtained a percentage of 85.5% with very feasible criteria. This is in accordance with (Arikunto, 2012) if the percentage is higher, namely 81-100%, then the criteria are very feasible.

Table 6. Language validation results

No	Aspects	V1	V 2	V3	Mean
1	Readability	86,6%	93,3%	100%	93,3%
2	Use of terms and symbols	95%	95%	100%	96,6%

*V1 : Validator 1
*V2 : Validator 2
*V3 : Validator 3

In language validation (Table 6), it was found that the aspect of using terms and symbols obtained the highest percentage of 96.6%, and with very appropriate criteria. Meanwhile, the readability aspect also received high validation of 93.3% with very adequate criteria. The higher the percentage value obtained, the E-module being developed is suitable for use.
In aacordance with research from (Nugraha & Syafi 2020), which also scores very well for readability. This high readability value shows that the module developed is easy for users to use, where the text contained in the e-module can be read clearly, the language used is easy to understand, and the e-module was developed in communicative language so it will not cause boredom when using language which seems stiff and formal. Every instruction and presentation of information contained in the e-module is useful (Sugianto et al., 2018).
The validation results described above show that the STEM-based chemistry e-module teaching material on reaction rates is suitable for use in the next stage, namely user response testing.

Table 7. Overall validation results of e-module

No	Validator	Material Validation	Media Validation	Language Validation
1	Validator 1	81,4%	83,3%	91,4%
2	Validator 2	86,4%	92,2%	94,2%
3	Validator 3	95%	82,2%	100%
	Total	262,8%	257,7%	285,6
	Mean	87,6%	86%	95,2%
Grand total average			89,6%	

From the validation results, it was found that language validation had the highest percentage value of 95.2% with a very feasible category. Meanwhile, material and language validation has a percentage of 87.6% and 86% which are still in the very feasible category. This 81-100% criterion is included in the very feasible category. Based on Table 7, it can be seen that the overall validation results of the STEM (Science, Technology, Engineering and Mathematics) based chemistry e-module teaching materials on reaction rate material obtained 89.6% in the "very feasible" category. The higher the percentage value obtained, the E-module developed is suitable for use in chemistry learning, especially in reaction rate material. Based

on the results above, it can be concluded that the E-module has been declared valid by experts so that it is feasible and can be tested in the field.

Implementation

The implementation stage is the product trial stage that has been validated by material and media experts. In this stage, the first thing to do is ask for feedback or assessment responses from teachers in the field of chemistry regarding the electronic module that has been created, then the next stage is to try it out on students to find out the student's response after using the electronic module.

Teacher Response to the E-Module

The results of the assessment by the chemistry teacher can be seen in Table 8.

Table 8. Teacher Response Test Results for E-modules

Aspects	Percentage	Criteria
Content Eligibility	90%	Highly Suitable
Electronic Module Presentation	93,3%	Very good
Language Suitability	100%	Highly suitable
Use of Electronic Modules	100%	Highly Practical
STEM	80%	Highly suitable
Graphic Eligibility	90%	Highly Suitable
Total Score	92%	Highly Suitable

Based on the table above, it can be seen that the overall percentage of teacher response test results obtained a score of 92% with the criteria "Highly Suitable". The results of the teacher's responses for several aspects are 90% appropriateness of content, 93.3% appropriateness of presentation, 100% appropriateness of language, use of E-modules 100%, STEM 80%, and appropriateness of graphics 90% with the criteria for these six aspects, namely "Highly Suitable." In accordance with (Parmin, 2012) the higher the percentage obtained, the E-Module being developed is suitable for use and testing on students.

Based on the results of the teacher's response to the e-module being developed, it can be concluded that the STEM-based E-module is declared feasible and can be tested on students in chemistry learning, especially reaction rate material.

Practical teaching materials are teaching materials that are easy to use and in the form of the teaching materials themselves. Teaching materials themselves can be in print and electronic or digital form. Digital teaching materials are one thing that can make teaching materials more practical in terms of ease of use. Likewise, the practicality of digital teaching materials is very good. Digital teaching materials can be in the form of electronic modules (e-modules), which are not only digital, but these e-modules can also be accessed on the Internet (Usman et al., 2020).

The results of student participants' responses to the e-module developed can be seen in Table 9.

Table 9. Results of student responses to e-modules

No	Scoring Aspects	Percentage	Criteria
1	Ease of Understanding the Material	92,2%	Very good
2	Learning Independence	84,6%	Very good
3	Learning Activeness	82,0%	Very good
4	Interest to learn	86,0%	Very good
5	Electronic Module Presentation	91,0%	Very good
6	Use of Electronic Modules	88,3%	Very Practical
	Total Score	88,0%	Highly Suitable

Based on the table above, it can be seen that the overall percentage of student responses to the E-module obtained a score of 88% with the criteria "very feasible". The results of student responses for several aspects, namely the aspect of ease in understanding the material 92.2%, learning independence 84.6%, active learning 82%, interest in learning 86%, presentation of electronic modules 91% and use of electronic modules 88.3% with The criteria for these six aspects are "very feasible". The higher the percentage obtained, the E-module developed is very suitable for use by students in learning chemistry, especially in reaction rate material.

E-modules can increase students' understanding, motivation and interest in learning, because the presentation can be modified in each lesson, developed as interesting and effective as possible according to students' needs and their learning environment (Kastolani, 2018).

By implementing STEM education, students can develop scientific thinking processes regarding problems. Students will be trained to think logically, creatively and disciplined (Ernawati & Sujatmika, 2021; R. Kelley et al., 2019). One approach to learning that helps in various areas of life cannot be separated from developing human abilities in the field of natural sciences. Apart from that, it is also necessary to develop learning activities that can include science, technology, engineering and mathematics, which is often abbreviated as STEM. Implementing STEM education can develop students' scientific thinking about problems. Students are trained to think logically, creatively and disciplined (Flynn et al., 2019).

STEM modules can help students create innovations based on the cases given and the benefits of the innovations created. Modules influence learning motivation, as previous research revealed that sigil-based e-module learning media influences student learning motivation in graphic design subjects (Putri & Purmadi, 2020; Syahirah et al., 2020). Learning through a STEM approach can increase understanding of chemical concepts because students are more active in their learning (Pujiati, 2020). This shows that learning through a STEM approach can help students better understand the concept of reaction rate to meet student needs. Apart from that, from the children's experience after they learn directly with the STEM approach, it turns out that it can increase their motivation to learn. Learning

using a STEM approach can build positive experiences for children and can lead to a better mindset in learning (He et al., 2021; Park et al., 2018). Therefore, by providing STEM learning that focuses on problem solving with the Engineering Design Process can increase the possibility of developing a strong foundation for further learning in the future.

Based on the validation of the e-module with material, media and language experts, the research results obtained were 89.6% with very feasible criteria. The percentage of product validity can be seen from the material aspect of 87.6% material, 86% media and 95.2% language with very appropriate criteria. This means that according to experts the product is suitable for use in terms of material, media and language aspects. For user responses, the e-module can be used well with a score of (92% of teachers and 88% of students). The STEM-based chemical E-module product in the resulting reaction rate material compares favorably with previous researchers in terms of the language aspect. This E-module obtained the highest score, namely 95.2%, which meets the criteria of being highly suitable on research on the Development of STEM-Based Chemistry E-module Teaching Materials. In this Reaction Rate Material, it is directly proportional to other researchers because it has high product feasibility and very good response. In this way, the process of creating this module can be continued to the next stage so that it can be used and useful in the chemistry learning process.

The development of this STEM E-module has advantages compared to other researchers because in every learning activity there are examples or phenomena presented in real everyday life and in the E-module projects are presented that students must work on which focus on solving problems using the Engineering Design Process. The Engineering Design Process (EDP) approach is used because the learning process is closely related to everyday life, namely by focusing the learning process on solving problems in real life, so that students can understand the material studied based on their learning experiences.

This research stage needs to be continued if the e-module being developed is to be used on a large scale. This is because product testing is still being carried out on a small scale and needs improvements according to user input. Apart from that, it is necessary to carry out a product implementation stage to prove whether this e-module product can help improve student understanding and overcome problems in learning chemistry.

CONCLUSION

Based on the research that has been carried out, the STEM (Science, Technology, Engineering and Mathematics) based chemistry e-module teaching materials on reaction rates are suitable for use according to the validation results, namely 89.6% with very feasible criteria. The percentage of product validity can be seen from the material aspect of 87.6% material, 86% media and 95.2% language with very appropriate criteria. This means that according to experts the product is suitable for use in terms of material, media and language aspects. Based on the results of responses from potential users of STEM (Science, Technology, Engineering and Mathematics) based chemistry e-module teaching materials on the reaction rate

material that has been developed, it is stated that it is very feasible. This is in accordance with the assessments of teachers and students, where teachers and students are 92% and 88% respectively. This means that based on the results of responses from prospective users, the E-module is suitable for students to use as teaching material for chemistry learning, especially in reaction rate material at SMAN 2 Sentajo Raya. To be able to see the effectiveness of e-modules in improving student understanding, further research is needed.

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Jurnal Inovasi Pembelajaran

JINoP. May, 2024, 10 (1): page 130-146
p-ISSN 2443-159, e-ISSN 2460-0873
https://doi.org/10.20961/jinop.v10i1.27191

The development of steam-based LKPD - PjBL acid-base solution material to improve creative thinking ability

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Abstract

This study aims to determine the validity, practicality, and effectiveness of STEAM–PjBL-based LKPD products. The research method used is research and development (R&D) with the ADDIE development model. The developed LKPD was tested on 24 class XI IPA 2 MAN 1 Banjarmasin students. The results showed that the LKPD developed was included in the very valid category in content, presentation, language, and design assessment, with an average score of 95.5%. The LKPD that was developed also fulfilled practicality aspects with very practical categories on individual readability tests, small group readability tests, student response questionnaires, and teacher responses, as well as observation sheets on teacher abilities in managing classes. LKPD has also fulfilled the aspect of effectiveness, as seen from the results of the average N-gain percentage of 76%. So that students' creative thinking skills are included in the high category. The results of this study indicate that the product developed, namely the STEAM-PjBL-based LKPD, has met the aspects of validity, practicality, and effectiveness.
Keywords: LKPD; STEAM – PjBL; Creative Thinking; Acid-Base.

uploaded: 06/15/2023
revised:21/10/2023
accepted:22/01/2024
published: 31/05/2024

Hamid, A., Nana, N., Syahmani, S., & Rusmansyah, R. (2024). The Development of STEAM-Based LKPD - PjBL Acid-Base Solution Material to Improve Creative Thinking Ability. *JINoP (Jurnal Inovasi Pembelajaran)*, 10(1). 130-146. https://doi.org/10.22219/jinop.v10i1.27191

INTRODUCTION

The 21st-century skills that a person must master are problem-solving and creative thinking. It is always hoped that these skills will be developed in every lesson so that students can face the challenges of the global world (Suryandari et al., 2018). A good education can improve the quality of human resources. The 4Cs (creativity, critical thinking, collaboration, and communication) are essential skills in education. According to Meador (1997), creative thinking has four indicator aspects, namely (1) Fluency, (2) Flexibility, (3) Originality, and (4) Elaboration. According to Hamid et al. (2021), and Salamah & Sumarsilah (2018), creative thinking is the process of a person generating an original, aesthetic, and constructive idea from known facts and experiences. This new idea is an innovation and development of previous

experience that has never been realized. Creative thinking skills are one of the levels of high-level thinking needed in social life (Fajaruddin, 2022).

Creative thinking is a student skill that must be taught and developed to improve their ability to solve problems creatively (Sinurat et al., 2022). Developing creative thinking is also stated in the National Education System Law Number 20 2003. The goal of national education is the development of the potential of students to become human beings who are devoted to God Almighty, have noble character, are knowledgeable, healthy, capable, creative, independent, and become democratic and responsible citizens. Strengthening creative thinking in the learning process at school internalizes students' traits or tendencies to be creative (Damayanti et al., 2020).

Humans always face problems, so creativity is needed. Creative thinking adjustments can be taught in education (Malik et al., 2023). Educational institutions are the right place to develop students' creative thinking abilities. One of the goals of education is to transform students into creative humans. Creative people are original in their thinking, develop new ideas, and elaborate on a concept (Pangestu, 2021).

Creative thinking today is still low (Umami et al., 2021), revealing that Indonesia in the results of a survey conducted by International Benchmarking such as PISA (Program for International Student Assessment) in 2018 showed that Indonesia was ranked 72nd out of 77 countries in science and mathematics. TIMSS (Trends in International Mathematics and Science Study) also shows that Indonesia ranks 69th out of 76 countries. The TIMSS and PISA results show that students are less creative. This is because PISA and TIMSS questions are characterized by situational questions requiring reasoning and creativity requiring reasoning and creativity (Sari & Afriansyah, 2022).

Research by Romayanti et al. (2020) said that students are less interested and curious in learning, which affects their creative thinking abilities. One way to improve creative thinking skills is to learn actively and effectively. This can be achieved by developing STEAM–PjBL based LKPD (Students' Worksheet) teaching materials. The LKPD (Students' Worksheet) is developed on the conditions and situations of learning activities (Apriani et al., 2021). Previous studies show that integrating STEAM–PjBL into the learning process can improve the quality of teaching and learning (Sigit et al., 2022).

The appropriate learning model for overcoming problems in creative thinking is project-based learning (Aprilia et al., 2023). PjBL is a model that uses projects as the core of its learning (Furi et al., 2018). The PjBL learning model allows teachers to direct their lessons through project work (Ambiyar et al., 2020). PjBL is a student-focused learning model that provides students with valuable learning experiences. PjBL is constructivist and collaborative learning that allows students to work together to solve a problem (Rohman et al., 2022).

The STEAM approach is an approach that combines five scientific disciplines that teachers can apply in different learning environments. STEAM offers activities that involve students in design and engineering tasks to explore students' science and mathematics skills through creativity, expression, and visual aspects that also

support logical thinking (Rohman et al., 2022). The STEAM method can be integrated into a project-based learning model by presenting children with daily activity problems that must be solved in groups (Harjanty & Muzdalifah, 2022). The advantages of STEAM-integrated PjBL were also stated by Santi et al. (2020), who stated that the PjBL model could improve 21st-century skills by integrating it with the STEAM approach. A study by (Annisa et al. (2018) shows that applying STEAM – PjBL can improve creative thinking skills in chemistry material. Integrating the STEAM learning model with PjBL strengthens creative thinking more effectively (Hehakaya et al., 2022). Integration STEAM with the PjBL model has been successfully used to develop students' soft skills related to 21st-century skills (Aprilia et al., 2018).

STEAM-integrated project-based LKPD can activate active and practical learning activities, help students understand learning material well, and help students understand subjects well and develop creative thinking skills to face real problems in the environment (Izzania et al., 2021). The results of this research are supported by Fitriyah and Ramadani (2021), which reveals that the STEAM-based PjBL model can significantly improve creative thinking abilities. This aligns with research by Siew & Ambo (2020) and Hanif et al. (2019), who said that STEAM–PjBL is a teaching and learning model that is reliable, valid, appropriate, and effective for increasing creativity. Applying the STEAM–PjBL approach has stimulated students' creative thinking (Budiyono et al., 2020).

According to Sudarmo (2016), chemistry is a branch of natural science that studies the structure and properties of matter (substances), changes in matter (substances), and the energy associated with these changes. Chemistry is closely related to life so that humans can see and experience something related to chemistry daily (Hamid, 2018). According to some students, the subject matter of acids and bases is too much and difficult to understand (Kaukaba et al., 2022). The material of acid and base solutions is very closely related to everyday concepts. Hence, learning chemistry is a mental activity that requires high thinking abilities and creative ideas from students in learning (Annisa et al., 2018).

The LKPD developed is based on STEAM – PjBL to improve creative thinking skills, where students will carry out practical work on natural indicators of acid-base solutions, and the materials used are easy to find in the environment. Then, students use the Canva application to create a project in the form of a poster. Students can develop creative thinking when making projects because they need creative ideas in project planning. Thus, the development of STEAM – PjBL -based LKPD can be a solution to improve students' creative thinking abilities. This is in line with research by Chistyakov et al. (2023), who say that STEAM–PjBL positively affects teaching, learning, motivation, and student engagement. Apart from that, PjBL can also improve learning based on competency and creativity. Creative thinking skills have been formed while students work on learning tasks (Demitra et al., 2023).

METHODS

Research and development (R&D) methods are used in the design of the LKPD being developed. The LKPD is designed based on STEAM-PjBL and aims to measure students' creative thinking abilities by conducting a pretest and posttest before and after using the LKPD. This research uses the ADDIE development model, which consists of the following five parts: a) Analysis, b) Design, c) Development, d) Implementation, and e) Evaluation.

The data collection techniques used in this research are tests and non-tests, namely interviews and questionnaires. The data obtained was then analyzed to test validity, practicality, and effectiveness. The formula (1) and criteria for assessing media validity used are as follows (Table 1).

$$\text{Validation score} = \frac{number\ of\ scores\ obtained}{number\ of\ maximum\ score\ (total)} \times 100\% = \cdots\% \quad (1)$$

Table 1. Validity level criteria and test instruments

Interval Score	Validity Criteria	Note
85 < V ≤ 100	Very Valid	No Revision
70 < V < 85	Valid	Minor Revision
50 < V < 70	Less Valid	Major Revision
V < 50	Invalid	Cannot be used

(Aiken, 1985; Yunita *et al.*, 2021).

For the validity of the test instrument, use the formula of Aiken's V statistics and it is formulated as follows (2).

$$V = \frac{\Sigma s}{\{n(c-1)\}} \quad (2)$$

Notes:

s = r-lo
r = number given by an appraiser
lo = lowest validity assessment number (in this case = 1)
c = highest validity assessment number (in this case = 5)
n = number of assessors

A test instrument is reliable if it provides consistent results when tested many times. Reliability is measured using Alpha Cronbach's formula, which is as follows (3).

$$r_{11} = \frac{k}{(k-1)}\left(1 - \frac{\Sigma\sigma b^2}{\sigma t^2}\right) \quad (3)$$

Note:

r_{11} : Instrument reliability
k : Number of question items
$\Sigma\sigma b^2$: The amount of variance in the scores for each question item
σt^2 : Total score variance

The criteria for a research instrument are said to be reliable using the Alpha Cronbach technique if the reliability coefficient is > 0. The Alpha Cronbach reliability interval is presented in Table 2 below.

Table 2. Alpha cronbach's reliability interval

Interval *Alpha Cronbach* (α)	Reliability Criteria
$0.90 \leq \alpha \leq 1$	Very High
$0.70 \leq \alpha < 0.90$	High
$0.50 \leq \alpha < 0.70$	Medium
$\alpha < 0.50$	Low

(Irmawati *et al.*, 2021).

Practicality data analysis is based on readability surveys, teacher and student response questionnaires, and teacher ability questionnaires in managing the classroom. The formula (4) and criteria for assessing practicality are as follows (Table 3).

$$\text{Practicality score of teaching materials} = \frac{number\ of\ scores\ obtained}{number\ of\ maximum\ score\ (total)} \times 100\% \quad (4)$$

Table 3. Practicality level criteria

Interval Score	Practicality Criteria	Note
$81\% < \times \leq 100\%$	Very Practical	Used without revision
$61\% < \times \leq 80\%$	Practical	Can be used with minor revisions
$41\% < \times \leq 60\%$	Quite Practical	It is recommended not to use
$21\% < \times \leq 40\%$	Less Practical	Can not be used
$00{,}00\% < \times \leq 20\%$	Impractical	Can not be used

(Arikunto, 2013; Riyana *et al.*, 2022).

Effectiveness analysis uses test instruments to measure students' creative thinking abilities. The percentage calculation is based on the analysis of each indicator by evaluating the results before and after testing. The assessment formula (5) and criteria are as below (Table4).

$$\text{SKBK} = \frac{T}{T_t} \times 100\% \quad (5)$$

Note:

%SKBK = percentage of creative thinking ability score
T = total score obtained by students
T_t = total score

Table 4. Criteria for creative thinking ability

Interval Score	Criteria
81% - 100%	Very creative
61% - 80%	Creative
41% - 60%	Quite Creative
21% - 40%	Less Creative
< 21%	Very Less Creative

(Anggela *et al*., 2022).

N-gain is calculated by the formula developed by (Hake, 1998) (6).

$$g = \frac{Xposttest - Xpretest}{Xmax - Xpretest} \quad (6)$$

Note:

g	:	*Gain* score
$X_{pre\text{-}test}$	:	*Pre-test* Score
$X_{postest}$	:	*Post-test* Score
X_{max}	:	Maximum Score

N-gain is calculated after obtaining the gain value for each student's data. The N-gain value is then interpreted based on the criteria in table 5 below.

Table 5. *N-Gain* data creative thinking ability

N-gain (g)	Criteria
g < 0,3 or expressed as a percentage g < 30%	Low
0,3 < (g) < 0,7 or expressed as a percentage 30% < (g) < 70%	Medium
g > 0,7 or expressed as a percentage g > 70%	High

(Maulidy & Mitarlis, 2022).

RESULT AND DISCUSSION

The development results in a STEAM-PjBL-based LKPD (Students' Worksheet) product on acid-base solution material to improve students' creative thinking abilities. This research was conducted to evaluate validity, practicality, and effectiveness. LKPD (Students' Worksheet) is a benchmark for improving students' creative thinking abilities.

Analysis stage

The analysis stage of this research is analyzing the need to develop teaching materials. Some of the analyses carried out are as follows.

a) Needs analysis

In the needs analysis, researchers surveyed students and chemistry teachers at MAN 1 Banjarmasin to determine the need for developing teaching materials regarding the influence of printed teaching materials on students' thinking abilities.

b) Problem identification

In identifying the problem, the researcher receives the results of the needs analysis; the results obtained include:

(1) Teaching materials in the form of LKPD **(**Students' Worksheet**)** are not optimally maximized in the learning process.
(2) The LKPD teaching materials provided by the teacher are less attractive because the LKPD display is only in text format so students are less interested and enthusiastic in learning.

Planning Stage (Design)
The planning stage in developing an LKPD is selecting an acid-base solution LKPD design, developed based on the feasibility and use of appropriate materials. The planning stages are as follows:
1) Preparation of 8 parts of the LKPD design, namely: (1) cover; (2) foreword; (3) brief explanation of PjBL, STEAM, and creative thinking; (4) concept map; (5) explanation of KD, indicators and learning objectives; (6) short material; and (7) PjBL stage; (8) bibliography. The cover design and foreword can be seen in the Figure 1.

Figure 1. Cover design and foreword

The following figure is a brief explanation of STEAM – PjBL and creative thinking and a concept map, as well as an explanation of KD, indicators, and learning objectives, which can be seen in the Figure 2.

Figure 2. Concept map design, definition of STEAM–PjBL and kd as well as indicators and learning objectives

The next figure is a LKPD design with short material, PjBL steps and a bibliography can be seen in the Figure 3.

Figure 3. Material design, PjBL syntax, and bibliography

Development Stage

The development stage creates a final LKPD draft based on input from experts or validators. This stage is divided into two parts: expert validation and readability testing (Table 6).

Table 6. LKPD validation results by validator

Assessment Aspects	Validator I	II	III	IV	V	Average	Validation Score	Note
Contents	60	58	55	53	57	56,6	94,34%	Very valid
Presentation	45	43	41	43	45	43,4	96,45%	Very valid
Language	70	67	64	63	70	66,8	94,86%	Very valid
Design	40	39	35	39	40	38,6	96,5%	Very valid
Rata-rata							**95,5%**	**Very valid**

Table 6 above shows that the LKPD (Students' Worksheet) reached an overall percentage of 95.5%. Based on a validity value of 95.5%, it is classified in the "very valid" category for use as teaching material in the teaching and learning process. The validity of the test instrument in the form of discourses that measure students' creative thinking abilities is four discourses by the indicators of creative thinking abilities, which are analyzed using the Aiken coefficient. The average score obtained is 0.94, so it can be said that the question is "valid. Meanwhile, the reliability test of the test instrument was carried out on 23 chemistry education students. The results obtained were 0.65, so it can be said that these questions are suitable for use in research. The percentage results from the readability questionnaire can be seen in table 7 below.

Table 7. Results of individual trial readability questionnaire review aspects

Review Aspects	Obtained Score	Maximum Score	Percentage
Display and content	50	60	83,4%
Material content and language	70	75	93,4%
Average	**60**	**67,5**	**88,89%**

The percentages obtained from the small group readability test are shown in table 8 below.

Table 8. Results of small group test readability questionnaire review aspects

Review Aspects	Obtained Score	Maximum Score	Percentage
Display and content	93	100	93%
Material content and language	113	125	90,4%
Average	**103**	**113**	**92%**

Table 8 above shows the results of 88.89% for individual readability of the developed LKPD. Meanwhile, the results were 92% on the small group readability questionnaire. Based on these percentages, both percentages show that the LKPD is very practical in the "very good" category.

Implementation Stage

The implementation stage was carried out to determine the practicality of the LKPD being developed, namely with teacher and student response questionnaires and teacher observation sheets in classroom management. Teacher response questionnaires were distributed after the learning process. The results of the teachers' responses are shown in Table 9 below.

Table 9. Results of teacher response

Respondent	Average Score	Maximum Score	Note
1	4,8	5,0	Very Good
Average	**96%**		Very Good

The results of filling out the teacher response questionnaire gave an average score of 4.8 with a percentage of 96%, which was included in the "very practical" category. The results of student responses can be seen in Table 10 below.

Table 10. Results od students' response

No.	Respondent	Average	Assessment Criteria
1.	1	4,3	Very Positive
2.	2	4,5	Very Positive
3.	3	4,0	Positive
4.	4	4,4	Very Positive
5.	5	4,5	Very Positive
6.	6	4,3	Very Positive
7.	7	4,3	Very Positive
8.	8	4,5	Very Positive
9.	9	4,6	Very Positive
10.	10	4,6	Very Positive
11.	11	4,6	Very Positive
12.	12	4,6	Very Positive
13.	13	4,5	Very Positive
14.	14	4,5	Very Positive

No.	Respondent	Average	Assessment Criteria
15.	15	4,3	Very Positive
16.	16	4,4	Very Positive
17.	17	4,8	Very Positive
18.	18	4,1	Positive
19.	19	4,6	Very Positive
20.	20	4,6	Very Positive
21.	21	4,7	Very Positive
22.	22	4,4	Very Positive
23.	23	4,8	Very Positive
24.	24	4,8	Very Positive
	Average	**4,5**	**Very Positive**
		89,75	

The results of the student response questionnaire reached an average of 4.5 with a percentage of 89.75%, which was included in the "very practical" category.

Table 11. Teacher results in managing the class

Activity	Learning 1		Learning 2	
	Percentage Score	Category	Percentage Score	Category
Introduction	90%	Very Good	93%	Very Good
Syntax 1: define the basic question	83%	Very Good	86%	Very Good
Syntax 2: designing project completion steps	93%	Very Good	100%	Very Good
Syntax 3: preparation of the project implementation schedule	80%	Good	86%	Very Good
Syntax 4: project completion with teacher facilitation and monitoring	93%	Very Good	100%	Very Good
Syntax 5: preparation of reports and presentations/project publications	80%	Good	90%	Very Good
Syntax 6: evaluate project processes and results	90%	Very Good	96%	Very Good
Closing	88%	Very Good	93%	Very Good
Time Allocation	86%	Very Good	93%	Very Good
Average Percentage	**87%**	**Very Good**	**93%**	**Very Good**

Based on Table 11 above, it can be seen that the assessment given by the observer for lesson 1 was 87% and for lesson 2 93%, which shows that the teacher's ability to manage the class is in the "very good" category. So, it can be said that the LKPD developed is included in the "very practical" category.

Figure 4. Learning implementation process

Figure 5. Student posters' design using the canva application

Figure 4 is a teaching and learning activity carried out in class XI IPA MAN 1 Banjarmasin, and figure 5 is a student project, namely a poster. This poster design shows students' creativity very well. Students try new things and are not afraid to experiment in creating poster designs. This is in line with research by Sutaphan & Yuenyong (2023), that assessment can focus on students' creative thinking skills which can be seen through their project design process. Project-based learning has the potential to enable students to research, plan, design, and reflect on the creation of projects.

Evaluation Stage

The evaluation stage is the final stage in the ADDIE development model; at this stage, an evaluation is carried out on the LKPD developed in the learning process activities by initial expectations or not. This evaluation stage includes formative evaluation and summative evaluation. Formative evaluation is carried out when the

LKPD is validated by validators, student response questionnaires, and when research is ongoing. Then a summative evaluation was carried out after the research was completed, namely finding out the effect of the LKPD on improving students' thinking abilities after students used the LKPD during the learning process.

Table 12. ***N-gain*** **score per aspect**

Creative Thinking	Question Number	Pre-test	Post-test	N-Gain	N-Gain (%)	Category
Fluency	1	40,83	88,34	0,,80	80%	High
Flexibility	2	37,5	84,16	0,74	74%	High
Originality	3	36,67	83,34	0,73	73%	High
Elaboration	4	39,16	86,67	0,78	78%	High

1) Fluency

The students' ability level on the pre-test was 40.83, and the score on the post-test was 88.34 with an N-gain value of 80%. This percentage of N-gain value is in the "high" category (Table 12). The fluency indicator is used in creative thinking ability test questions; it is hoped that students can answer the questions with as many ideas as possible accompanied by reasons. This is in line with research by Febrianingsih (2022), the aspect of fluency in thinking, namely being able to answer questions by providing ideas relevant to the problem and complete and precise answers. According to Rohmantika & Pratiwi (2022), the fluency aspect of students can answer questions with supporting ideas.

2) Flexibility

The students' ability level on the pre-test was 37.5, and the score on the post-test was 84.34 with an N-gain value of 74%. This percentage of N-gain value is in the "high" category. The flexibility indicator is used in creative thinking ability test questions. It is hoped that students can answer test questions by offering different solutions. This is in line with research by Saleh et al. (2023), flexibility, namely the ability to produce various thoughts or answers, see the situation from several perspectives, look for different options or ways, and apply different strategies or ways of thinking. Creative people tend to have flexible thought processes. It is easy to let go of old thought patterns and replace them with new ones.

3) Originality (Authenticity)

The students' achievement level on the pre-test was 36.67, and the score on the post-test was 83.34, with an N-gain value of 73%. This percentage of N-gain value is in the "high" category. Creative Thinking Test questions use originality indicators, which are expected to be able to answer questions by creating unique new ideas. This is in line with research by Saleh et al. (2023), that the capacity to generate renewable ideas. According to Rohmantika & Pratiwi (2022), the originality aspect is where students are required to solve problems with their ideas and sentences.

4) Elaboration

The students' achievement level on the pre-test was 39.16, and the score on the post-test was 86.67 with an N-gain value of 78%. This percentage of N-gain value is in the "high" category. The creative thinking ability test questions use development

indicators, which are expected to be able to answer questions by developing ideas that students accept. This is in line with research by Febrianingsih (2022), namely the elaboration aspect when students can answer questions with correct and detailed answers.

CONCLUSION

The results of research development state that the LKPD developed can be applied in teaching and learning activities and is said to be valid from content, presentation, language and design. Validation results from validators with a percentage of 95.5%. The results of developing LKPD are very practical, with a percentage of 88.89% in individual trials, a percentage of 92% in small group trials, a percentage of 89.75% in student response questionnaires, a percentage of 96% in teacher response questionnaires, a percentage of 87.03% with an average of 4.35 (very good) on teacher observations in managing the class. The LKPD developed meets the effective category for improving students' creative thinking abilities with an N-gain value per aspect, namely 80% in the fluency aspect, 74% in the flexibility aspect, 73% in the originality aspect, and 78% in the elaboration aspect and an average N-gain value of 76%.

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Jurnal Inovasi Pembelajaran

JINoP. May, 2024, 10 (1): page 147-163
p-ISSN 2443-159, e-ISSN 2460-0873
https://doi.org/10.20961/jinop.v10i1.32683

Development of historical comic strip learning media in indonesian national movement materials

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uploaded: 03/13/2024
revised: 05/29/2024
accepted: 05/31/2024
published: 05/31/2024

Aryasaha, D. F., & Suryadi, A. (2024). Development of Historical Comic Strip Learning Media in Indonesian National Movement Materials. JINoP (Jurnal Inovasi Pembelajaran), 10(1). https://doi.org/10.22219/jinop.v10i1.32683

Abstract

The study aims to (1) analyze the conditions of history learning at SMA N 12 Semarang, (2) describe the development of historical comic strip learning media, and (3) analyze the feasibility of historical comic strip learning media. The research uses the Research and Development with a modification of the 4D development model. Several stages are passed in this research, including definition, design, and development. The results of this research are (1) students need learning media, (2) development of historical comic strip learning media in Indonesian National Movement materials entitled "Story of Athar" with manual sketches, digitalization, and digital coloring until finalization, (3) feasibility validation product, namely 94% from material experts, 96% from media experts. The effectiveness of learning media in increasing students' interest in learning is obtained from the results of the gain score using the formula for the difference between pre-test and post-test scores of 32,26%. Based on the results of this research, the scores of increasing students' interest in learning in class XI F 11 are included in the High category because the gain score is 0,767 and is in the range g > 0,7.

Keywords: Learning Media; Comic Strips; History Learning; Indonesian National Movement.

INTRODUCTION

Education is a bridge for every individual to achieve success. To reach the pinnacle of success, each individual must be motivated by a good education according to their needs. The Preamble to the Constitution of the Unitary State of the Republic of Indonesia of 1945 also gave a mandate to Indonesia to "Educate the life of the Nation," which means that all residents in Indonesia must reach an intelligent stage of life through the stages of education. According to Pristiwanti et al. (2022), education has a broad meaning, namely life. This means that education is all knowledge learned throughout life that can influence the growth of each individual positively. According to Mahmudah & Putra (2021), implementing good education

will also produce efficient educational results. Therefore, education providers, namely schools, also play a role in creating a high-quality generation. In Moto (2019), it is explained that schools should be able to create a comfortable and enjoyable learning atmosphere so that students can play an active role in teaching and learning activities, which will produce a competent generation. Then, to achieve this, students must also take part, namely by studying hard.

Learning is an activity in the form of changes in the new behavior of each relatively constant individual. Learning is not only limited to writing, reading, and listening, as well as doing assignments or tests, but learning is an activity that produces changes in behavior as a result of learning, which contains an interactive learning process with the surrounding environment with continuous changes (Setiawati, 2018). In a good learning process, students get stimulus from learning in class. Therefore, learning in class is essential to support students in receiving the material presented by the teacher. Studying and learning are two interrelated things; learning can be said to be a form of activity carried out by each individual by practicing so as to produce new changes, while learning is a system or process for teaching each individual according to what has been planned, implemented, and evaluated (Faizah, 2017). Therefore, in order for the learning process to be carried out well, the learning system must be effective. Effective learning is learning that, in the process, achieves previously planned learning objectives (Anis et al., 2021).

From a learning perspective, the curriculum includes content, objectives, and learning materials that are used as references in classroom learning (Suryaman, 2020). The Indonesian Minister of Education, Culture, Research and Technology, Nadiem Makarim Anwar, initiated a new curriculum, namely the independent curriculum. In the independent curriculum concept, students are required to be independent in the learning process, and they are given the freedom to gain knowledge from formal or non-formal education (Manalu et al., 2022). Then Ayundasari (2022) added that the independent curriculum has advantages recognized by the Ministry of Education and Culture, Research and Technology. The independent curriculum is a project-based learning process with the aim of developing students' abilities and character. The existence of a new curriculum will, of course, also have an impact on changes to the components of the learning system in school subjects. As with history lessons in the independent curriculum, there are new changes in both learning objectives, curriculum structure, and the scope of the material. In the independent curriculum, there is no longer a division between Indonesian history and specialization history, so the material for both is combined into one subject, namely history.

In this case, it will undoubtedly be a challenge for the teacher to convey all the material to students without eliminating essential material. This is because teachers have the responsibility to convey historical material. Besides that, teachers must also convey historical material using effective methods, strategies, models, and media so that the material can be conveyed optimally (Asmara, 2019). Likewise, teachers at SMA Negeri 12 Semarang feel that the components that support history learning, such as media, models, and strategies, must be made appropriate to the material to be delivered so that students can understand historical material

optimally and efficiently. Based on an interview on August 10, 2023, with the history teacher at SMA Negeri 12 Semarang, namely Mr. Nasta'in, S. Pd., data was obtained that the history material presented in the class had not been implemented optimally by the history teacher. In this interview, the history teacher said that in the learning process in class, the teacher explained the material using the lecture method. Then, the media used were textbooks and worksheets. Apart from that, students occasionally looked for reference sources on the internet. Furthermore, the history teacher added that if there were new learning media that could be applied in schools, it would undoubtedly support the learning process so that learning in class could be carried out optimally. Students could maximally accept the material presented.

Furthermore, this was strengthened after the researchers carried out a second observation on September 11, 2023, namely by collecting data by distributing questionnaires to students and history teachers. On September 11, 2023, researchers distributed a questionnaire in the form of history learning needs using a combination of words, pictures, and graphics that would be easy to understand and understand to students in class XI.F.11. Then data was obtained that 60% of students said they agreed and 37 12% said they strongly agreed. From this data, researchers interpreted that students still needed learning media with a combination of words, pictures, and graphics. The learning media chosen must be appropriate and efficient in accordance with developments in science so that good learning media will be created (Yanto, 2019). Apart from that, the use of learning media in delivering material is also part of the way to create learning conditions in the classroom that are effective, efficient, and interesting (Jayusman & Shavab, 2020). There are various learning media, one of which is comics.

Comics are a series of messages or stories expressed visually and can be seen in the form of sequential and framed images (Hardiyanti et al., 2019). According to Maharsi (2011) in Saputro and Haryadi's (2018) research, comic media can be grouped into several types, including comic books, graphic novels, comic strips, webcomics, and compilation comics. Of the five types of comics, comic strips were chosen as one of the media that can be said to have the potential to support the objectives to be conveyed because, in comic strips, there are visual elements with text or narrative that are short, concise, but still clear and do not lose the essence of the material being presented. to be delivered. Comic strips are information media that depict a simple story listed in several panels and are usually used in articles, textbooks, short stories, and narratology courses (Famsah & Ambarwati, 2022).

Comic strips can be used as a practical learning medium according to the material to be conveyed. This is reinforced by the opinion of Nadiyah et al. (2019), who stated that comic strip learning media is designed with an attractive story structure and appearance so that students become interested in reading the comic. If students read the comic, then they will not immediately learn the material that was included in the comic strip. Then, in implementing learning in class, using comic strip learning media requires a learning strategy so that learning objectives can be achieved optimally. The strategy applied in the process of delivering material using comic strip media is to use the principles of constructivism. According to Susilo

(2020), constructivism is a principle that explains that teachers have an essential role as guides in the learning process. Students can develop their knowledge and understanding by being active in class, whether asking questions, giving opinions, or communicating with each other.

In line with historical material, comic strips can interpret historical material with a wide range of material content, and what was previously abstract can become concrete (Tiara et al., 2020). In this research, the historical material chosen was the Indonesian National Movement, which is history material for Class XI's odd semester. Based on an interview with Mr. Nasta'in, S.Pd. A teacher at SMA N 12 Semarang on August 10, 2023, said that there was so much material on the history of the Indonesian national movement that if this learning were carried out using conventional media, namely the teacher explaining in front and the students just listening, it would certainly take a long time. On the other hand, students who listen to material from the teacher do not fully pay attention, so it can be said that in learning activities in class, students still lack interest in learning history. This was reinforced when researchers conducted observations at SMA N 12 Semarang. Many students were still busy talking with their friends, so students ignored the teacher when explaining the material. Thus, an appropriate strategy is needed to carry out learning with this material so that students can receive all the material in this chapter, namely by using learning media so that students not only get information in the form of material from the teacher's delivery but also from learning media as well.

Then Mr. Nasta'in added that because there was too much material, the learning method designed would use a group system. So, students will group and discuss the sub-chapters of the material that the teacher has distributed. However, the learning media that Mr. Nasta'in has implemented is in the form of PowerPoint, worksheets, and textbooks; no other media has been implemented in the class taught by Mr. Nasta'in. Based on the background of the problem above, it is the basis for researchers to be able to carry out research by developing learning media in the form of historical comic strips in the classroom learning process, which is structured with the title "Development of Historical Comic Strip Learning Media in Indonesian National Movement Materials for class XI SMA N 12 Semarang in Academic Year 2023/2024".

METHODS

This research uses the Research and Development research method. Research and development is a research method used to produce a product and test its effectiveness (Soegiyono, 2011). Apart from that, Research and Development research or R&D research is also a research process that focuses on user needs and then develops a product to meet user needs so as to produce a learning product such as learning modules, learning media, student worksheets and teaching modules (Wijayanti & Sungkono, 2017). In this study, the research and development steps carried out by the researcher used a design designed by Thiagarajan (1974) in Soegiyono's book (2022: 37-38). Thiagarajan stated that the research and

development steps are Define, Design, Development, and Dissemination, also abbreviated as 4D. This can be made more explicit by looking at the following figure 1.

Figure 1. Research and development steps
(Source: Soegiyono's 2022)

Based on Figure 1, there are several steps in research and development, according to Thiagarajan. The first is Define, which contains steps to determine what product will be developed. At this stage, the researcher analyzes what is needed; this is done through literature studies and direct research stages in the field. The second is design, which contains steps on how to create a design for a predetermined product. Third, Development, which contains steps regarding manufacturing, which is initially still a design, then becomes a product and continues with periodic validity tests until producing a product that complies with previously determined provisions. Fourth, Dissemination, which contains the dissemination of final products to the public for use according to their needs. In this research, according to Thiagarajan, the research and development methods used are Define, Design, and Develop.

RESULT AND DISCUSSION

Analysis of history learning conditions and alternative media needs material

In Research with the title "Development of Historical Comic Strip Learning Media in Indonesian National Movement Materials for class XI SMA N 12 Semarang in Academic Year 2023/2024, the research has been carried out to obtain the data needed. The data obtained was then continued with an analysis process to determine the needs and necessity of developing Historical Comic Strip learning media to support learning activities, especially material on the history of the Indonesian national movement. The development of historical comic strip learning media is considered necessary to overcome the problems that exist at SMA Negeri 12 Semarang. This Research uses a Research and Development (R&D) approach with a 4D development model.

The development of Historical Comic Strip Learning Media started from an analysis of students' needs, which was carried out at the initial observation, namely on August 10, 2023. At that time, researchers conducted interviews with the history teacher at SMA Negeri 12 Semarang, namely Mr. Nasta'in, S. Pd., regarding history learning and history learning media used at SMA Negeri 12 Semarang. The results of the interview on August 10, 2023, showed that Mr. Nasta'in only used learning media in the form of PPT or PowerPoint; then, for teaching methods, he also used

the lecture method. Apart from that, the media used also ranges from the internet and textbooks to student handbooks, and there is no innovative learning media to support learning in the classroom. Furthermore, Mr. Nasta'in also added that the current history material is so dense because there are no longer particular history subjects. In the Merdeka curriculum, the history subjects are combined into one and are called "History" subjects. Therefore, if the material is presented only in PPT and the lecture method is used, it is considered unable to fulfill the learning objectives. Therefore, auxiliary media is needed so that the material can be conveyed to all students.

Continuous observation as pre-research was also carried out again on September 10, 2023. The researcher came to the school to distribute questionnaires to students regarding their learning media needs. This observation was carried out directly on all students in class XI F 11, which had a total of 36 students. However, two students were absent, namely, the first was at an MPK meeting, and the second was sick. This research used a learning media needs analysis questionnaire. The results of this need analysis questionnaire showed that students said that there were still few learning media used during learning, especially in history subjects, such as the material on the history of the Indonesian national movement. This material is carried out for two lesson hours, with one lesson hour lasting 45 minutes. The method used by the teacher in this lesson is dividing students into several groups and continuing with interactive discussions.

Based on these conditions, it becomes a problem for students, namely the lack of students' understanding of the entire material; this is because students only understand the material assigned to their group; furthermore, regarding the teaching materials used by students in the learning process, namely in the form of textbooks and student handbooks. It is felt that the material on the history of the Indonesian national movement is still poorly understood by students; this is because students only receive a brief explanation of the material from the teacher, and assignments are given to students in the form of interactive discussions without being presented in front of the class because they have very little lesson time. Meanwhile, there is so much material on the history of the Indonesian national movement that not all of it has been conveyed.

Apart from that, this comic strip was also chosen because the form of a comic strip, which consists of one page, makes students feel lighter when reading. However, even though it is only on one page, this historical comic strip covers complete material according to the learning material; it is just packaged. in the form of a historical comic strip. In this comic strip, there are as many sub-chapters as there are materials on the history of the Indonesian national movement. Then, besides being able to help in the learning process in class, this historical comic strip learning media is also an innovation in the learning media at SMA Negeri 12 Semarang.

Development of historical comic strip learning media

Learning activities in class are expected to be interactive, fun, and inspiring and can increase students' motivation to be able to participate in learning activities in class actively; apart from that, learning activities can also be a forum that can encourage

students' creativity and independence in developing interests. and talent and also supports the physical and psychological development of students (Mirza et al., 2017). This learning activity is also inseparable from the teacher's role in preparing learning methods, materials, and media so that later, the learning material delivered to students can be conveyed optimally.

Based on the results of observations carried out by researchers at SMA Negeri 12 Semarang, especially for class XI Phase F, data was obtained that the learning process in class still uses a lecture-based learning method using learning media in the form of PPT. Then, when distributing questionnaires regarding students' learning needs and interests, data was obtained that students needed innovative learning media so that later, they could increase students' interest in learning. According to Luthfia et al. (2022), it is stated that learning media is one of the components in supporting learning activities in the classroom so that students can more optimally receive the material presented by the teacher and become a means of making it easier for teachers to convey material to students. Apart from that, according to Asfihani (2019), learning media is a teaching aid that assists teachers in carrying out the learning process for students in class. Furthermore, according to Pritandhari (2017), there are several benefits to learning media, as follows:

a. The learning process in class will foster students' attraction and increase their learning motivation.
b. Students can understand the meaning of learning materials more clearly, which will help them understand the learning objectives well.
c. c. The learning process will vary because it uses learning media; not only does the teacher explain the learning material to students, but the teacher also uses media to support the learning process.
d. Students become more active, meaning they not only listen to the teacher's explanations but can also explore the material's content using learning media.

Based on the results of the questionnaire distributed by researchers, students need learning media to support the learning process in class. According to Hutahaean et al. (2023), the learning process that utilizes learning media to support learning in the classroom is believed by teachers to increase motivation and help students master the material in the learning media. Learning media has a vital role in increasing students' motivation in the learning process; apart from that, learning media also encourages teachers and students to be more creative, which in turn can produce effective and active learning (Ghazalah et al., 2023). Meanwhile, according to Sanjaya (2014) in Wahyuni et al. (2023), several functions of learning media are stated, namely, (1) communicative function, meaning that learning media can facilitate communication between teachers and students; (b) motivational function, meaning that learning media can increase students' learning motivation because it has attractiveness in the presentation process; (c) meaningful function, meaning that learning media can trigger students' cognitive thinking about the meaning of learning material by analyzing and creating a product inspired by learning media; (d) perception level function, meaning that students have the same views as those conveyed by the teacher in the learning process in class; (e) individuality function,

meaning that learning media becomes a means to meet the needs of students according to the interests and learning styles of each student.

According to Pritandhari (2017), when you want to create learning media, it should be adjusted to the characteristics of the students; after that, it should be adjusted to the material to be delivered. When researchers distributed questionnaires regarding student needs, many said that students liked it if learning media used a combination of words, images, and graphics, not just writing, especially in the material on the history of the Indonesian national movement. Therefore, the researcher proposed a solution to This problem by developing historical comic strip learning media. According to Zalmansyah (2013), comics are images that are humorous or can be said to be funny and are usually printed or published through print media such as magazines or newspapers. Furthermore, Nadiyah et al. (2019) argue that comics are a collection of characters in cartoon form who play a story character with a plot sequence that is appropriate to the content of the material to be conveyed, then connected with pictures with the aim of giving the impression of entertainment to the readers.

According to Khair et al. (2021), comic learning media is a supporting tool for teachers to explain learning material in class. Apart from that, with this comic learning media, students can learn more independently without waiting for an explanation from the teacher. Then this comic learning media also helps teachers facilitate learning activities. On the other hand, by using comic learning media, the teacher can explain the material in two ways. The teacher explains the material and is assisted by using comic learning media to help students understand. Secondly, students can learn independently using comic learning media if the teacher does not attend class or is unable to attend so that students can study on their own. Then Sofyani (2023) also added that comic learning media has a vital role in instruction, namely in fostering students' interest in learning. Apart from that, learning media also has several functions to support learning activities. Comic learning media is a learning media with a visual form that uses the five senses, especially students' sense of sight, to be able to receive messages or learning materials delivered by teachers through stories in learning media comics (Nugraheni, 2017). In this research, the learning media proposed by the researcher and the hope is that it will be a solution to the problems at SMA Negeri 12 Semarang, namely the development of historical comic strip learning media.

According to Wahyuni et al. (2023), comic strips are comics that consist of three to six panels, have a storyline that is easy to understand, and only focus on one main idea of a story. According to Ariska et al. (2020), there are several advantages of comic strip learning media, namely: (a) they are concrete, meaning that comic strips are more realistic in showing learning material when compared to learning media using verbal media. ; (b) Practical to carry, in this case, comic strip learning media can be taken anywhere, including to class; this is because not all learning media objects, events, and objects that support learning material can be brought into the classroom so they require learning media that can be brought to class by creating drawings or photos related to the object; (c) This comic strip learning media can overcome students' limitations in observing the learning process using the five

senses. Comic strip learning media consists of a collection of images that form a story based on the learning material to be conveyed. The advantages are that comic media contains visual or visible elements and has a strong storyline. The various images outlined in this comic medium emotionally carry readers away according to the storyline, thus making readers continue reading the comic until the storyline is finished (Asfihani, 2019). Then Kusnida et al. (2015) added that comic strip media can be used as a tool for communication or a means to convey messages and stories to readers.

In the process of developing historical comic strip learning media on the history of the Indonesian national movement, researchers created comic strips in printed or visual form. Furthermore, because the material on the history of the Indonesian national movement is quite dense, the researcher divides the material into eight material sub-chapters, as follows.

1. The Rise of Eastern Nations (Asian Nationalism)
2. The emergence of the National Embryo of Indonesian Nationalism
3. National Movement Organization
4. World War I and its Influence on Indonesia
5. Youth Congress and Women's Congress
6. Press and Literature Bring Progress
7. Global Economic Crisis
8. World War II and the End of the Colonial Period in Indonesia

It is quite easy to use this comic strip learning media. The instructions for using historical comic strip learning media on the history of the Indonesian national movement are as follows.

1. Students first form groups of eight.
2. Distribute this comic strip to each group (each group gets one material).
3. Each group carries out a discussion with one of its group teams.
4. Present the results of each group's discussion, followed by a question-and-answer session.
5. Good luck.

Feasibility of historical comic strip learning media

The feasibility of learning media can be assessed using validation test data from experts. In this research, two stages of validation or feasibility testing were carried out: material validation with a validator, Mr. Ganda Febri Kurniawan, M.Pd., and media validation with a validator, Mr. Atno. A more complete explanation follows.

a. Materials expert

The material expert validator in this research is a history education lecturer, namely Mr. Ganda Febri Kurniawan, M.Pd. The validation results that material experts have tested are carried out to determine the suitability of historical comic strip learning media in terms of material. Then, based on the validation results of this learning media, it is assessed from the aspects of relevance of the material, aspects of material organization, and aspects of usefulness, as follows.

The first stage of validation was carried out on October 30, 2023. Based on the material expert assessment questionnaire with a total score of 29.00 out of a total of 10 indicators, it obtained 58%. It was included in the "sufficient" category of the Likert scale with five alternative answers. The types of errors, suggestions for improvement, and revisions that need to be carried out by researchers include (Table 1).

Table 1. Material improvement

Error Type	Improvement Suggestions	Revisions Made
Lack of historical facts contained in the comic strip narrative	- Add a QR code in the form of a voice-over regarding material on the history of the Indonesian national movement according to the sub-chapter and include it in the comic strip. - Please fix it according to the suggestions given	Adding historical facts to the comic strip narrative by adding reference sources from the comic strip material
The composition of the comic strip still needs to be clarified so that readers understand its contents.		The structure of the comic strip is clarified.
The use of language applied in comics is still poorly understood.		The grammar in comic strips is made in accordance with Indonesian language rules so that readers can understand the meaning of the content of the comic strip material.
		Create a QR code that contains material on the history of the Indonesian movement adapted to the sub-chapters of comic strip material.

Furthermore, the comments and suggestions given by Mr. Ganda Febri Kurniawan, M.Pd., namely that this comic is good and exciting but needs improvement according to the suggestions. The conclusion from the first stage of material validation testing is that it can be tested with revisions according to suggestions.
The second stage of validation was carried out on November 10, 2023. Based on the material expert assessment questionnaire with a total score of 47.00 from a total of 10 indicators, it obtained 94%. It was included in the "very good" category on the Likert scale with five alternative answers in the second stage of validation. At this point, the material expert said that there were no errors that were too important to

change, then added a comment that this media was worthy of being tried out in the field so that it could be concluded that the historical comic strip learning media with the title "Story of Athar" was worthy of being tried out.

b. Media expert

The media expert validator in this research is a history education lecturer, Mr. Atno, S.Pd., M.Pd. The validation results tested by media experts are carried out to determine the suitability of historical comic strip learning media from a media perspective. Then, based on the validation results of this learning media, it is assessed from the aspects of writing appearance and image display, namely as follows.

The first stage of validation was carried out on November 2, 2023. Based on the material expert assessment questionnaire with a total score of 36.00 from a total of 10 indicators, it obtained 72%. It was included in the "good" category on the Likert scale with five alternative answers. The types of errors, suggestions for improvement, and revisions that need to be carried out by researchers include (Table 2).

Table 2. Material improvement

Error Type	Improvement Suggestions	Revisions Made
The title is Story of Arya because if you read it openly by a historical person, it will trigger the perception that this comic is a story from the Aryan nation. Therefore, it is better to change the name of the character	- Character names changed - The size of the character's eyes is adjusted to the character of the Indonesian character	Replacing the name of the main character, namely Arya, with a character name that matches the historical material of the Indonesian national movement, in this case, the researcher changed the title of this comic to "Story of Athar."
The characters in this comic strip look like Japanese characters, or what are usually called anime characters,		The characters in this comic strip have been further refined, starting from the shape of the face, eyes, nose, and other components, so that they can support the spread of this comic strip story, especially in material on the history of the Indonesian national movement.
The panels in this comic strip are still too small, so readers cannot read this comic strip clearly.		The panel size is increased.

Furthermore, Mr. Atno, S.Pd., M.Pd., made comments and suggestions, namely improving the title and description of Arya's character. The conclusion from the first stage of material validation testing is that it can be tested with revisions according to suggestions.

The second stage of validation was carried out on November 10, 2023. Based on a media expert assessment questionnaire with a total score of 48.00 out of a total of 10 indicators, it obtained 96%. It was included in the "very good" category on a Likert scale with five alternative answers. In this second stage of validation, media experts said that the product created by this researcher was in accordance with the directions given in the 1st stage of the validation test. Apart from that, media experts also added comments and suggestions, namely that the name of this comic strip learning media has been changed to "Story of Athar," and the characters are also like Indonesian characters, so this comic strip is ready to be tested.

Effectiveness of using historical comic strip learning media

A limited effectiveness test was conducted involving 34 students in class XI F 11, who were used as samples. The testing system uses Pre-Test – Post-Test so that students will be given Pre-Test questions before using the historical comic strip learning media with the title "Story of Athar" and then Post-Test questions after using the historical comic strip learning media with the title "Story of Athar." This test aims to determine students' interest in learning history, especially material on the history of the Indonesian national movement. The increase in students' interest in learning in the form of pre-test and post-test data will be analyzed using the gain score formula. The response from students can be seen from the results of the assessment of the feasibility of the historical comic strip learning media with the title "Story of Athar" as well as from the results of the analysis of students' interest in learning about history learning, especially material on the history of the Indonesian national movement using the historical comic strip learning media with the title "Story of Athar." The results of student responses show that students' interest in learning after implementing the historical comic strip learning media with the title "Story of Athar" is higher in each measurement indicator. This can be seen from the attachment, which recapitulates the results of the student's learning interest questionnaire before and after using the learning media developed by the researcher.

The implementation of historical comic strip learning media with the title "Story of Athar" in class XI F 11 was carried out twice. At the first meeting, a Pre-Test was carried out before the learning activities began using historical comic strip learning media with the title "Story of Athar." After the pre-test was carried out, the researchers introduced the historical comic strip learning media product, "Story of Athar," to students by explaining the procedures for using this learning media. Next is the group division; because this comic strip consists of eight sub-themes, the groups are divided into eight groups. Then, each group discussed according to the sub-themes obtained; their discussion continued with each group coming forward one by one to present the results of their discussion using historical comic strip

learning media with the title "Story of Athar." On the first day, according to the teaching module, four groups came forward for the presentation. At the second meeting, the learning activities carried out by the class of Athar". Based on the results of the gain score calculation, it was concluded that the development of historical comic strip learning media with the title "Story of Athar" could increase students' interest in learning in history subjects, especially material on the history of the Indonesian national movement.

The impact of learning media regarding improving learning media is carried out using a comparative method so that after carrying out the comparison it can be seen the value/score of increasing students' interest in learning in history subjects, especially material on the history of the Indonesian national movement in class XI F 11. Based on the results obtained during the process from the initial and final measurements carried out in class, it can be concluded that the development of historical comic strip learning media with the title "Story of Athar" in material on the history of the Indonesian national movement can increase students' interest in learning with grades/scores increasing by 32.26% in class XI F 11. A recapitulation of students' learning interest scores can be seen in the attachment; apart from that, it can be seen briefly through the following recapitulation (Table 3).

Table 3. Recapitulation of the results of assessing students' learning interest

No.	Statement	Amount	Average	Enhancement
1.	Students learning interests before using learning media	2366	57,99%	32,26%
2.	Students' interest in learning after using learning media	3682	90,25%	

(Source: secondary data processed by researchers, 2023)

The score before and after using the historical comic strip learning media with the title "Story of Athar" can be found using the following gain score formula.

$$g = \frac{skor\ post\ test - skor\ pre\ test}{skor\ ideal - skor\ pre\ test}$$

$$g = \frac{3682 - 2366}{4080 - 2366}$$

$$g = \frac{1316}{1714}$$

$$g = 0{,}767$$

The results of calculations using the gain score show that the historical comic strip learning media with the title "Story of Athar" in history subjects, especially material on the history of the Indonesian national movement, is able to increase the learning interest of class XI F 11 students at SMA Negeri 12 Semarang by 0.767. The increase in interest in learning in class XI F 11 is included in the High category because the gain value is in the range of g > 0.7.

CONCLUSION

Based on the results of the research and discussion described, it can be concluded that the initial condition of history learning at SMA Negeri 12 Semarang is that

teachers use the lecture method. Students listen and then take notes on what the teacher says. The condition of students is still passive when in class; they still do not seem to want to learn independently, especially learning history. Furthermore, the media used in schools still uses PPT media. The results of the media need questionnaire analysis show that students want to learn media that uses a combination of words, images, and visual or printed graphics. The development of historical comic strip learning media with material on the history of the Indonesian national movement with the title "Story of Athar" began with making a manual sketch first, then digitizing digital coloring until finalization. This development uses a 4D model (Define, Design, and Development). Material experts and media experts validate the feasibility of learning media. The material expert percentage results were 94% in the outstanding category; the media expert percentage results were 96% in the outstanding category. Furthermore, the effectiveness of using historical comic strip learning media on students' interest in learning is obtained from the results of the gain score using the formula for the difference between pre-test and post-test scores of 32.26%. So, it can be concluded that there is an increase in students' interest in learning in class students' interest in learning.

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Jurnal Inovasi Pembelajaran

JINoP. Mei, 2024, 10 (1): page 1-18
p-ISSN 2443-159, e-ISSN 2460-0873
https://doi.org/10.22219/jinop.v10i1.22114

Respiratory system pocket book with android-based augmented reality technology

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Abstract

Biology is an abstract, elusive science, one of which is respiratory material. It requires a media that can visualize objects on a two-dimensional book of biology to a three-dimensional one with a learning video. Research aims to develop, describe kal, and describe the teacher's assessment and student response to the results of the product developed. This research and development using model 4D consists of define, design, foresight, and develop ate. The result of this realization is the production of a medium of pocket books and apps downloaded on android smartphone platforms, able to present in real, tangible, three-dimensional objects to respiratory matter. The media was declared worthy by the validator of materials and media experts with an average rating score on final validation at 84.68% and 93.17%. Trials in the field as practical tests were obtained an assessment result from teachers by 85.36%, student responses of small groups and large groups are 86% and 83.65%. Also, it is also noted that a media pocket book and applications using this augmented reality technology are worthy to be used by students in studying the human respiratory system for grade 11th MIPA SMAN 1 Kota Jambi.

Keywords: Augmented Reality; Pocket Book; Respiratory System; Android.

uploaded: 08/08/2022
revised: 01/23/2024
accepted: 03/28/2024
published: 30/05/2024

Siburian, J., Dina, R. R., Sanjaya, M. E., Sembiring, D. A. E. P., & Contreras, J. A. M. (2024). Respiratory system pocket book with android-based augmented reality technology. *JINoP (Jurnal Inovasi* Pembelajaran), 10(1), 1–18. https://doi.org/10.22219/jinop.v10i1.22114

INTRODUCTION

The advancement of human civilization is shaped by the existence of technology, which significantly expedites all human endeavors. One area where technology has not failed to make an impact is education, as it has contributed to the enhancement of educational standards. Technology can serve as a tool, either in the form of hardware or software, to assist teachers in their instructional activities with pupils in the classroom. Computers and laptops equipped with application development software can provide support to the field of science (Nento & Manto, 2023). The

benefits of technology, specifically, lie in its ability to enhance the creation of educational resources, serve as a hub of knowledge across many disciplines, and function as an instructional tool (Salsabila et al., 2021). Speaking of educational mechanisms, the main focus that will be realized can support teachers-centric learning activities or teacher center-based learning implemented with the help of technology that provides benefits as a means of facilitating teachers and students to optimize education improvement (Mokalu et al., 2022).

The level of education in Indonesia remains low, as indicated by polls that highlight the urgent need for substantial attention to improve the quality of education. Based on the study conducted by Kurniawati (2022) in 2018, Indonesia ranks 74th out of 79 nations in the Programme for International Student Assessment (PISA) 2019, indicating a low position in the higher secondary education system (SMA). The inadequate education in Indonesia stems from the subpar academic achievements of pupils, which can be attributed, in part, to the teachers' ineptitude in pedagogy and the efficacy of their teaching methods. According to Kemendikbud (2020) the decline in the quality of education among students is attributed to professors who merely act as facilitators and fail to prioritize the development of students' critical thinking skills. Technology has the ability to enhance the quality of education by providing interactive educational technologies, which can serve as valuable resources in the learning process (Sofyan & Hidayat, 2022).

The student utilizes a smartphone device for the learning process, which enhances the acquisition of information due to its user-friendly features. Hutami et al., (2023) state that cellphones have the advantage of unrestricted usage in various locations, enabling the development of engaging learning methodologies. Smartphone devices offer not only convenient communication, but also a wide range of beneficial applications for scientific research. Rohmani, et al., (2021) assert that smartphones, when utilized correctly, facilitate convenient access to educational resources. One effective approach is to create technology-based learning materials that can be seamlessly integrated with smartphones. Students have the ability to utilize smartphones as a tool for engaging in educational activities. Utilizing learning media is strongly advised for educational endeavors as it has the potential to impact students' learning processes and outcomes, while also fostering more student engagement in the learning process (Indryani et al., 2022).

A smartphone is a device that can enhance learning interest by offering capabilities that facilitate the display of educational content accompanied by engaging graphics, animations, and videos. The use of smartphone features enhances the appeal and engagement of students with learning needs that are best supported by smartphone-assisted learning (Maknuni, 2020). Smartphones can be used to create learning media that cater to diverse learning abilities. These abilities are particularly relevant for comprehending abstract material, complex concepts, and circuits, as smartphones allow for practical visualization of such content (Ikbal et al., 2021). Thus, in order to enhance students' learning capacity, it is important to

possess a smartphone device that can effectively activate cognitive processes, emotions, and learning engagement (Rafael & Enstein, 2022).

The students' learning abilities vary, with some grasping concepts quickly with minimal explanation, while others require further explanations. Additionally, there are pupils who benefit from supplementary resources to aid in comprehension. Differences in abilities among students can be attributed to the rate at which they comprehend learning materials. This rate can be categorized as either high or low levels of understanding (Gumilar & Aulia, 2021). Variations in students' aptitudes will result in variations in their understanding of the subject matter. Therefore, it is imperative to augment sensory stimulation by offering learning resources that can boost the efficacy of learning (Turhusna & Solatun, 2020). Students may encounter conceptual errors as a result of variations in their understanding of the content, as well as the teaching methods employed by teachers, which heavily rely on media or traditional learning tools like printed books with two-dimensional visuals and tablets. According to Bakhruddin et al., (2021), the utilization of learning media can enhance students' comprehension and mastery of fundamental ideas pertaining to truth, reality, and accuracy. Consequently, students' comprehension of the subject matter will be enhanced when they can mentally perceive three-dimensional representations, such as visualizing organs and physiological processes occurring within the human body (Indrawan et al., 2021). Augmented reality technology can enhance the depiction of three-dimensional objects by boosting the user's perception and creativity when interacting with the created media (Dewi et al., 2017).

Augmented reality (AR) technology can be utilized as an innovative tool for creating educational material. It can be seamlessly linked with smartphone users to enhance the user experience of AR goods. Putri and Arifitama (2020) stated that the rapid advancement of technology has made it increasingly convenient for smartphone users to utilize it as a medium for learning. Ismayani (2020) suggested that AR technology has significant potential for integration into learning, enhancing the appeal and clarity of learning activities. This pertains to the convenience of accessing AR technology media solely through an Android smartphone by students, resulting in a heightened level of memory retention related to the studied information. AR technology offers a distinct learning experience by providing students with a different perspective. This technology allows students to engage with media in real-time while learning (Nawir & Hamdat, 2021).

AR technology can be accessed using a smartphone to display a dead object that seems to be real with the help of a camera. AR technology is a technique that involves a system in combining the real world with the virtual world, the object that appears from the virtual will be displayed to the reality world in real time (Hawari & Putra, 2022). AR technology is heavily focused on the visualization of an object, learning content that enables stimulating in-depth processing of the content presented through visualisation (Buchner & Hofmann, 2022).

Based on observations and interviews, grade 11th students of MIPA 7 SMAN 1 Kota Jambi showed the importance of understanding the concept of respiratory system

material by visualizing illustrations on 2D (dimensional) images in textbooks as the primary resource in school learning. The research was conducted in order to produce innovative learning media, as inspiration for teachers and to make learning activities on respiratory material more effective and effective.

The topic in the biology subjects about the human respiratory system belongs to abstract matter, where students do not directly see the organs and processes of the respiratory mechanisms that occur in the human body. According to Raida (2018), the students' difficulties in studying biological material are due to the abstract nature of the material, the difficult concepts to understand, the compact material. Based on the data obtained, students have difficulty studying respiratory material using only package books as the primary source in learning. With the characteristics of the package book that are less illustrative and too compact in material explanations resulting in students often not carrying books while studying in class.

Based on the information obtained from interviews with teachers in the field of study, the minimum completion criteria for biology subjects was 67. While students who only reach minimum completion criteria were about 60-70%. It can be concluded that there are still students who have not reached the level of completion. So it was necessary to make efforts so that the learning objectives can be achieved to the maximum by increasing the learning outcomes of students through a more effective and effective teaching process.

The media development in question utilizes AR technology, employing markers as a means of identification. When designing apps using Unity, the Blender program is utilized for the creation of 3D objects, which are subsequently exported to the Unity application system. Subsequently, it will be merged with a two-dimensional image that corresponds to the created three-dimensional objects. The 3D Objects will be stored in the Unity database. When utilizing the program, it will exclusively present 3D objects on the smartphone screen that are kept in the system database and correspond to their markers as detected by the device's cameras (Perwitasari, 2018).

The study elucidates the advantages of augmented reality (AR) in creating an Android-based pocket book for teaching breathing techniques to eleventh-grade high school students. It also examines the qualifications and evaluations of teachers involved in the project, as well as the responses of students to the outcomes of the developed media. Through the utilization of augmented reality technology, we create pocket books as physical print media and Android applications as digital ICT media. This technology allows for the virtual presentation of 3D objects and videos. This effort aims to enhance the understanding of grade 11th students at SMAN 1 Jambi regarding the respiratory system by providing visual depictions. It is anticipated that this approach will positively impact the students' learning outcomes.

METHODS

The research conducted was focused on Research and Development (R&D) with the aim of creating a product in the form of a printed pocket book and an android platform application. The content of the product specifically targeted the respiratory system and was meant for eleventh-grade high school students. The research employed the methodology of Research and Development (R&D). This strategy greatly facilitated researchers in the production, development, and evaluation of a product's effectiveness (Sohilait, 2020).

The device was built as a pocket book and an Android application with augmented reality technology, specifically focusing on the respiratory system. The study and creation of the respiratory system pocket book involves utilizing augmented reality technologies on the Android platform. The primary applications utilized for this project include Unity, Blender, Canva, and Microsoft Word. The research and development model employed is a 4D model, comprising of four stages: (1) stage define, (2) design, (3) develop, and (4) disseminate (Panggabean & Andis, 2020) as shown in Figure 1.

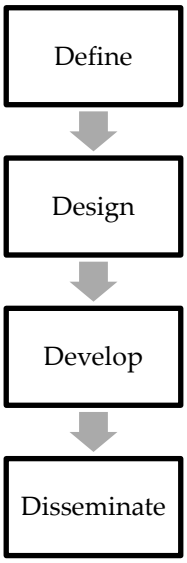

Figure 1. Phases of 4D model

The defining phase was conducted to ascertain the primary issues by comprehensive study from start to finish, material analysis, and analysis of learning objectives. The planning phase has been completed to ascertain the design specifications of the product to be developed, including tailoring the product to meet the requirements of the student during the defining stage. The development phase followed the design phase, during which the already designed product underwent validation by a panel of media and material specialists. Following the validation process, the product undergoes testing on a test group comprising teachers and students. The last stage of the 4D model involved dissemination, which in this study was accomplished through the utilization of the YouTube

platform. The product was released through video tutorials that primarily provided an introduction to the generated medium.

Data collection on this research and development was as follows: 1) qualification tests by material experts and media experts; 2) field tests to know the evaluation of teachers field of study; 3) field tests on student response as a small group with 6 students in grade 11th MIPA 7, SMAN 1 Kota Jambi; 4) field trials on student responses as a large group with 15 students in grade 11th MIPA 7, SMAN 1 Kota Jambi; 5) widespread dissemination using the YouTube platform with the channel name Rini Rahma Dina.

The instruments used for testing the media's validation of expert validators (media and material experts), the evaluation of teachers in the field of biology studies, and the student's response to the indicators are structured according to the needs in the assessment as well as the advice available in the instruments. The racket provided contains some written statements to the expert validator and test subject. The type of lift used is closed with the options as the answer has been specified to make it easier for respondents to fill in the lift (Sugeng, 2022). As for the discount guidelines for each sheet of expert validation and teacher assessment as well as student response using the likert scale by Sugiyono (2013) as shown in the Table 1.

Table 1. Criteria for validator, teacher assessments and student responses

Score Criteria	Category
4	Very Good
3	Good
2	Bad
1	Very Bad

The process of data analysis consists of two distinct stages: descriptive qualitative analysis and quantitative analysis (Ulfa et al., 2022). The acquired data is subsequently evaluated utilizing approaches that involve describing the data in terms of percentages. This methodology employs the process of converting quantitative data (scores) into percentages. The subsequent percentage outcome is interpreted into qualitative categories. Regarding the formulation employed in data processing, it is based on the range of values provided by Riyanto and Hatmawan (2020) as follows (1).

$$\text{Score range} = \frac{Highest\ Score - \text{Lowest Score}}{\text{Scoring Category}} \quad (1)$$

Then the range of values obtained is presented with the formula submitted by Wahyuningtyas and Yahya (2021) as follows (2):

$$PS = \frac{n}{N} X\ 100\% \quad (2)$$

Description:
PS = Percentage
n = Number of scores obtained
N = Number of maximum scores

The result of the data analysis obtained is known the validity of the product developed in this study. Product eligibility category refers to Sugiyono (2013) as in Table 2.

Table 2. Media qualification level categories

Score Criteria	Percentage (%)	Category
4	81,25-100	Very Worthy
3	62,5-81,15	Worthy
2	43,75-62,4	Worthless
1	25-43,65	Very Worthless

In addition to quantitative data, there are quality data such as notes of suggestions or comments from both validators, teachers and students. It is meant to create products that are tailored according to the needs of students in learning.

RESULT AND DISCUSSION

Define

The research commenced with the defining step, which involved doing preliminary analysis, material analysis, and analysis of learning objectives. Regarding the initial analysis, it was discovered that students said that relying on the package book as the main resource for learning did not assist them in comprehending the content related to the human respiratory system. Specifically, 52.4% strongly agreed, 42.9% agreed, and 4.8% disagreed with this statement. 52.4% of the respondent strongly agreed that the textbook used in school did not effectively convey visual illustrations, while 47.6% agreed. During the interview, the teacher mentioned that many students did not carry textbooks to school due to the ineffectiveness of bulky textbooks. A majority of students, 52.4%, strongly agree with this sentiment, while 38.1% agree and 9.5% disagree. All of the respondents, totaling 100%, had not utilized augmented reality technology as a medium for learning.

An analysis was conducted on the activities and backgrounds of students, based on interviews with the biology teacher. It was found that students struggled with understanding illustrations of respiratory devices in the print book, as well as the processes and abnormalities of the respiratory system. This difficulty arose from the inability to observe these processes firsthand. The students' responses were consistent, with 76.2% finding it challenging to visualize the anatomy of human respiratory organs, whereas only 23.8% did not find it difficult. Dutta, et al., (2022) the use of augmented reality technology can improve the learning experience, critical thinking, and various skills and knowledge acquisition of students with learning difficulties based on their characteristics. It can also enhance their learning agility, motivation, and cognition.

The analysis focused on identifying the specific conceptual needs of students in relation to the respiratory system. This analysis was based on their competence in accessing and understanding learning materials. The lesson plan was designed for a biology class in grade 11th MIPA 7 at SMAN 1 Kota Jambi. The main topic of the

lesson is the human respiratory system, covering both theory and concepts. Table 3 displays the Fundamental Proficiency for the subject of the respiratory system.

Table 3. Basic competence and it's indicators

Basic Competence	Indicators
3.8 Analyses the relationship between the structures of the organ-building tissue of the respiratory system in relation to the bioprocesses and dysfunctions that may occur in the human respiratory systems.	3.8.1 Identifying the structure of the human respiratory system 3.8.2 Explaining the structure and function of the respiratory organ in humans 3.8.3 Explaining the process of exchange of O_2, CO_2 from the alveoli to the capillaries, the content of substances in cigarettes that can interfere with the human breathing system 3.8.4 Analysis of respiratory mechanisms in human beings 3.8.5 Analysis on respiratory disorders 3.8.6 Explains the influence of smoking on breathing health 3.8.7 Explanation of the relationship between unclean environmental air conditions 3.8.8 Explains the association of smoking behavior with the structure of human respiratory organs

The analysis of learning objectives was conducted in accorandce with the Basic Competence of the curriculum, which aligns with the materials being taught. The lesson plan aimed to enhance students' cognitive understanding of the respiratory system in humans. It enabled students to articulate the function of the respiratory system, identify the specific organs comprising it, visually represent the components of the breathing system, analyze the factors influencing respiratory frequency, elucidate the process of oxygen and carbon dioxide exchange in the alveoli and body tissues, and explain the binding reaction of oxygen and carbon dioxide in the blood. Hence, this development was specifically developed and organized to align with the intended objectives outlined in the lesson plan.

Design

The outcomes of analysis served as the foundation for media design. Planning was the process of finding learning media products that were designed to enhance the effectiveness and efficiency of learning activities. The outcome of this research project is a pocket-sized book that combines printed media with an Android-based application utilizing augmented reality technology. Optimizing the utilization of ICT can enhance the caliber of education by facilitating convenient access to diverse learning resources (Anggereini et al., 2018). With the help of AR technology, it provides the interactivity of displaying 3D objects or images like holograms (Liao, 2019).

The android operating system was selected by the pupils of grade 11th MIPA 7 SMAN 1 Kota Jambi as it is the most commonly used platform on smartphones. Smartphones using the Android operating system have gained more popularity among fans due to its classification in the entry-level category (Daeng et al., 2017). Augmented reality technology has the ability to enhance students' comprehension of abstract items, making the learning experience more pleasurable and beneficial (Shakeel et al., 2019).

The design and development of pocketbooks involved the utilization of Microsoft Word, Canva, and Photoshop software, whereas applications were developed using Unity and Blender software. Pocketbooks developed as a novel approach to utilizing packaged books or textbooks as the main tool for learning. The typical pocket book is appealing due to its user-friendly nature, vibrant colors, and captivating illustrations (Wati et al., 2019). The Unity application is a program that can create media using innovative augmented reality technology and can visualize abstract objects on materials taught in schools. This is because in building media with augmented reality technology can be created with Unity 3D software based on desktop and multi-platform (Famukhit, 2018). The steps involved in the process were as follows: first, a pocket book was designed using software such as Microsoft Word and Photoshop. The design was then printed in A6 size. Next, a 3D object that matched the illustration on the pocket book was created using Blender Software. After that, an Android-based application was programmed by incorporating the 3D objects using Unity Software and coding scripting in the C# language. Finally, the already designed application was rendered into an Android application.

The augmented reality (AR) technology employed in creating these media utilizes markers as reference points. When designing applications using Unity, the Blender application is utilized for 3D object design, which is then exported to the Unity Software system. Subsequently, it will be merged with a two-dimensional image that corresponds to the created three-dimensional objects. The 3D objects will be stored in the Unity database. Hence, while utilizing the program, it will exclusively present 3D objects as tangible entities on the smartphone screen. These objects must already be saved in the system's database and correspond to their markers through the relevant cameras (Perwitasari, 2018).

Develop

The outcome of this research is a portable book and an Android application that utilizes augmented reality (AR) technology. The developer's media combines printed media with ICT media, utilizing AR technology to increase communication by including advanced digital data imaging through an interface (Zaki et al., 2019). The "Human Respiratory System Pocketbook" is a printed pocket book that features a 2D image marker. This marker can be scanned using the "human respiratory system AR" Android application, allowing users to access augmented reality content related to the book (Figure 2).

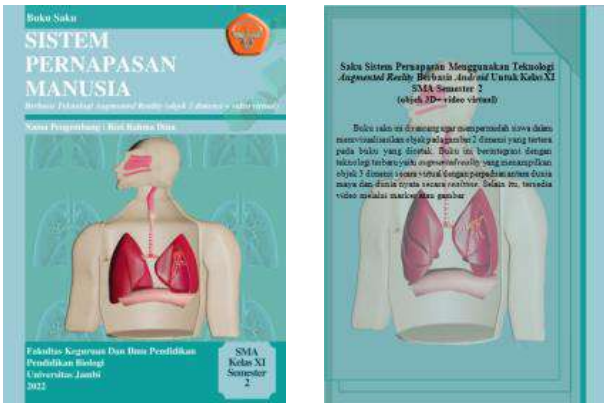

Figure 2. Book cover of human respiratory system based on augmented reality technology (AR)

This application was designed specifically for Android smartphones and can only be installed on devices that support the Android platform. Users can monitor their usage by referring to the pocket book and utilizing the developer-provided applications. After installation, users can utilize the application to scan 2D illustrations in a pocket book and then view 3D objects, text, sound, and video in real-time through the camera (Tumini & Romadhon, 2022). The display of the application can be seen in Figure 3.

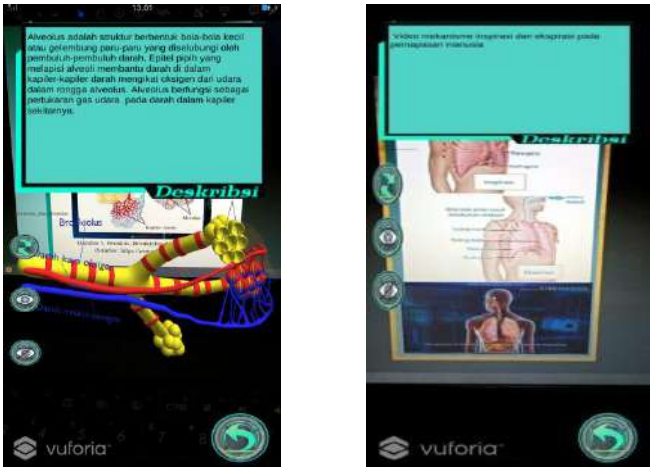

Figure 3. Display of 2D images when were scanned using an application that displays 3D objects and videos in real time

The objective of media creation was to create pocket books and apps utilizing Android-based augmented reality technology in order to enhance the value of this material. The development step involved conducting an eligibility test with a validator. The media will be amended according to the suggestions and comments provided by the validator. Upon being deemed eligible, the media commenced testing on certain users, including biology teachers and grade 11th students from SMAN 1 Kota Jambi.

The efficiency of the validation conducted on the respiratory system pocket book employing augmented reality (AR) technology, specifically built for android, may be determined by evaluating the opinions of subject matter experts and media

experts. The validation of this material was conducted by two groups of experts: (1) learning media experts who possess expertise in the field of media learning in print and ICT, and (2) material experts who possess expertise in the subject matter of the respiratory systems in the biology curriculum for grade 11th in high school. The correspondence of the media to the needs of students in learning activities refered to the results of the qualification assessment. According to Indrayani et al., (2021), validating the authenticity of a development product necessitates the use of a meticulously designed instrument that meets the criteria for validity and can be verified by an expert who possesses the necessary expertise in the instrument's components. The purpose of the trial was to ascertain the authenticity of a product, specifically a pocket book and an Android software called "Human Respiratory System AR" that utilizes augmented reality technology. Proficient evaluation of the material considering multiple factors, specifically the reliability of the substance or information, the manner in which it is presented, and the language used (Indriyani et al., 2016). While the materialists do some aspects of cover, content, and physical as well as appearance, and programming (Arif & Rukmi, 2020; Mawaddah et al., 2019).

The material expert's final stage validation results revealed an average score of 84.68%, meeting the highly eligible requirements. The material expert evaluates many characteristics such as content or material validity, presentation, and language. The educational media developed for eleventh-grade high school students focuses on the human respiratory system. When presenting information, it is important to consider the validation results of the material. These results indicated the worthiness of the medium in conveying information. A high validation value suggested that the material presented in the media is reliable and can be effectively used by teachers and students for learning purposes (Mashuri & Budiyono, 2020). Based on research by Pauziah & Laksanawati, (2023), validation of material against media using augmented reality technology with an average of 83% classified as highly suitable for use in the field, then for a score of 84.68% based on the assessment by expert validators of material developed by researchers can be represented can be used on the field. By performing 3 validations showed an increase in the number of scores and the percentage of each aspect like Table 4.

Table 4. Result of expert validation

Aspect	Validation steps (%)		
	1	2	3
Content qualification	65	75	85
Display	57,14	71,42	85,71
Language	50	66,67	83,33
Average (%)	57,38%	71,03%	84,68%
Criteria	Worthless	Worthy	Very Worthy

The final stage validation results by media experts showed an average score of 93.17% with highly eligible criteria. The aspects assessed by the media experts include the pocket book aspects (sample, content and physical), and the

Application (display and programming). According to a study conducted by (Sari et al., 2023) the media validation of augmented reality technology in terms of programming achieved a score of 90.5%, which is considered highly qualified and does not need any revisions. Additionally, the programming aspect of the technology received a validation score of 91.25% from a media expert, indicating its suitability for practical use. Arif and Rukmi, (2020) did a study on pocket book validation, which assessed the cover, content, and physical features of previous research. The study found that the pocket book received a score of 85%, indicating its validity as a learning medium and its suitability for usage in the field. This research have achieved a validation rate of 94.44% for pocket books, which falls into the highly commendable category. This result is based on the examination of indicators and enhancements made by the validator, making the pocket books suitable for practical usage. The media validation process resulted in an overall improvement, with a final score of 93.17%. This improvement was observed through three rounds of validation, which showed an increase in scores and percentages for each facet, as shown in Table 5.

Table 5. Media validation by expert

Scoring Aspect	Validation step (%)		
	1	2	3
Pocketbook			
Cover	50	66,66	83,33
Content	50	75	100
Physical	75	75	100
Android-based Augmented Reality (AR) Application			
Display	55	65	95
Programming	56,25	75	87,5
Average (%)	57,25%	71,33%	93,17%
Criteria	Worthless	Worthy	Very Worthy

The media and materials that have undergone validation within this category demonstrate exceptional performance in the exam. Subsequently, an evaluation was conducted with the respondents, namely biology teachers, focusing on various aspects of the subject of study. The media expert's final stage validation results revealed an average score of 93.17%, indicating a highly qualifying outcome based on the criteria. The media specialists assessed many factors such as relevance, language, substance, evaluation, and display. These aspects received a score of 85.36%. The material was then presented to both large and small groups of students for further evaluation. According to Faisal et al., (2019), this aspect has been tested and shown to be very suitable for evaluating technology-based learning media that contain informational knowledge. Therefore, the ratings given by respondents can accurately represent the appropriate learning product. The values provided by the respondents can be observed in Table 6.

Table 6. Evaluation results of subject teachers

No	Evaluation Aspect	Teacher Response (%)
1.	Relevance	100
2.	Language	75
3.	Content	87,5
4.	Evaluation	75
5.	Display	89,29
	Average (%)	85,36
	Criteria	Very Worthy

The students' responses were analyzed to assess the feasibility of the product utilizing Android-based augmented reality technology. The evaluated factors encompass visual aesthetics, composition, and educational value. The students, serving as respondents, rated several aspects in two groups: a small group of 6 people and a big group of 15 people. The scores obtained by the respondents were 86 and 83.65, respectively, when converted into highly qualified categories. According to these findings, all components of the assessed educational product warrant utilization in the classroom learning process. The survey assessed the worth of a learning product based on the credibility of its reviews. It aimed to enhance the quality of learning by providing students with an engaging and visually appealing learning experience (Faisal et al., 2019). Given the scores and % scores for each aspect, as shown in table 7.

Table 7. Result of student responses

No	Evaluation Aspect	Small group Test (%)	Large group Test (%)
1.	Display	83,86	82,92
2.	Content	84,72	83,87
3.	Learning scenario	89,59	84,17
	Average (%)	86	83,65
	Criteria	Very Worthy	Very Worthy

Disseminate

The objective of media distribution is to disseminate pocket book products and applications through the use of widely available Android-based augmented reality technologies. The release has been conducted on May 7th, 2022, using the YouTube platform under the developer account named Rini Rahma Dina. Regarding the method of its dissemination: 1) A product presentation video presented as a pocket book and an android app utilizing augmented reality technology, accessible to YouTube users. 2) The uploaded video is accompanied by a description box that provides comprehensive information about the product development process. It also includes a link to a Google Drive folder where the generated product can be accessed. 3) Both the video and the complete information were submitted to the research channel. According to Suryadi & Sofya, (2023), YouTube offers a vast platform for sharing knowledge by showcasing items as a means of introducing them to the public. This allows YouTube users to independently access the

products made by researchers, along with detailed information. The YouTube app was chosen as a platform to offer convenient introductions and tutorials on expanding the product's accessibility to a wide audience, without any constraints of time or location (Ihsan et al., 2023). The product distribution has been furnished with comprehensive details regarding augmented reality technology and instructions on how to utilize the product. Over the span of one month, this stage has garnered 115 views, along with 74 likes and 44 comments as shown in Table 8.

Table 8. Result of media distribution

Viewed	Liked	Commented
115	72	44

CONCLUSION

The discussion led to the conclusion that the end result of this developmental research is a pocket book-shaped learning tool in the form of a printed medium and an android application. This tool focuses on the sub-material biology sub-subjects of the human respiratory system and utilizes augmented reality (AR) technology. By utilizing this media, students acquire distinctive expertise and cutting-edge technology through the virtual observation of 3D objects and video-based learning. Furthermore, they are provided with workouts and evaluation games within the program. The evaluation of the material and media experts' validator indicates that the category is highly suitable for testing by instructors and students, as well as for conducting a user practicality test. Afterwards, the product was extensively disseminated through the utilization of the YouTube platform in order to reach a diverse array of internet visitors. Given that study restrictions solely pertain to practicality testing, it is advisable to continue developing media until the point of implementing student learning outcomes. Due to the study constraints, the current medium solely focuses on the sub-material of the respiratory system. However, future research may aims to create AR-based learning media that encompasses a broader variety of materials.

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INDEKS PENGARANG

INDEKS SUBJEK

JINoP (Jurnal Inovasi Pembelajaran)

P-ISSN 2443-1591 E-ISSN 2460-0873
Volume xxxx, Nomor xxx, bulan tahun, pp. xx-xx
http://ejournal.umm.ac.id/index.php/jinop

Judul singkat, jelas, lugas menggambarkan isi keseluruhan yang berfokus pada inovasi pembelajaran [Maksimum 14 Kata, TNR, BOLD, Sentence Case]

Penulis 1[1)*], Penulis 2[2)] dst. [TNR 12, tanpa gelar dan tidak boleh disingkat]

[1]Nama Institusi, Alamat, Nama Kota, Negara. [penulis 1, TNR 10]
[2]Nama Institusi, Alamat, Nama Kota, Negara. [penulis 2, TNR 10]

penulis _1@abc.ac.id*; penulis _2@abc.ac.id; penulis _3@abc.ac.id [TNR 10]
*Penulis Koresponden

No. Handphone : .....

ABSTRAK [Times New Roman 10pt, bahasa Indonesia]

Abstrak ditulis dalam bahasa indonesia berisikan latar belakang umum, tujuan penelitian, metode/pendekatan penelitian, hasil penelitian dan kesimpulan/saran. Abstrak ditulis dalam satu alenia, tidak lebih dari 200 kata. Bahasa penulisan sesuai PUEBI/tata bahasa Indonesia [Times New Roman 10, spasi tunggal].

Kata kunci: Kata kunci mencerminkan kandungan esensi artikel, disusun Alfabetis, jumlah 3-5 kata/frase dipisahkan dengan tanda koma.

ABSTRACT [Times New Roman 10pt, bahasa Inggris]

Abstrak ditulis dalam bahasa Inggris yang berisikan latar belakang umum, tujuan penelitian, metode/pendekatan penelitian,hasil penelitian dan kesimpulan/saran. Abstrak ditulis dalam satu alenia, tidak lebih dari 200 kata. Bahasa penulisan sesuai tata bahasa Inggris [Times New Roman 10, spasi tunggal].

Keywords: Kata kunci mencerminkan kandungan esensi artikel, disusun Alfabetis, jumlah 3-5 kata/frase dipisahkan dengan tanda koma.

diunggah: , direvisi: , diterima: ,dipublikasi:

Cara sitasi: Penulis. (Tahun). Judul. JINoP (Jurnal Inovasi Pembelajaran), Vol(No), Halaman. doi:https://doi.org/10.22219/jinop.v?i?.ID Artikel

PENDAHULUAN [TNR 12 Spasi 1]

Pendahuluan (berisi latar belakang, permasalahan sesuai konteks penelitian, hasil kajian pustaka, yang semuanya dipaparkan secara terintegrasi dalam bentuk paragraf-paragraf, dengan persentase 15-20% dari keseluruhan artikel) Tinjauan pustaka yang relevan dan pengembangan hipotesis (jika ada) dimasukkan dalam bagian ini. [Times New Roman, 12, normal spasi 1].

Paragraf kedua disarankan untuk mengulas penelitian terdahulu yang relevan dengan topik penelitian, jelaskan kekurangan pada penelitian terdahulu, sehingga perlu adanya penelitian yang saudara lakukan. Tunjukkan adanya bagian yang menyebutan kebaharuan/ keunggulan inovasi pembelajaran dalam naskah artikel ini. Bandingkan. Bagian ini harus mencakup tentang tujuan penelitian dan sumbangsih hasil penelitian yang diharapkan nantinya.

Gunakan tinjauan pustakan yang relevan serta terbaru minimal 5 tahun. Penulisan rujukan diwajibkan menggunakan software mendeley dengan metadata yang sudah dibenahi aturan penulisannya sesuai *APA Style*. Menggunakan bahasa penulisan yang harus sesuai dengan tata bahasa/ PUEBI.

METODE [TNR 12 spasi 1]

Metode menjelaskan paparan dalam bentuk paragraf tentang rancangan penelitian, sumber data, teknik pengumpulan data, jenis data rancangan penelitian dan teknik analisis data yang secara nyata dilakukan peneliti**,** dengan persentase 10-15% . Menggunakan bahasa penulisan yang harus sesuai dengan tata bahasa/ PUEBI**.** [Times New Roman, 12, spasi 1].

HASIL DAN PEMBAHASAN [TNR 12 spasi 1]

Sub heading 2 [TNR 12 spasi 1, sentence case]

Hasil penelitian berisi paparan hasil analisis yang berkaitan dengan pertanyaan penelitian, sedangkan pembahasan berisi pemaknaan hasil dan perbandingan dengan teori dan/atau hasil penelitian sejenis, dengan persentase 40-60% dari keseluruhan artikel.

Dalam pembahasan diulas tentang temuan pemtinng sesuai tujuan penelitian. Hasil penelitian dan kejelasan data digambarkan dengan gambar yang gharus disebutkan pada badan naskah. Hasil penelitian digambarkan dengan tabel 1 (tabel berikut:), grafik/gambar 1 (grafik/gambar berikut:) , dan/atau bagan 1 (bagan berikut:). [Times New Roman, 12, spasi 1].

Tabel 1. Nama tabel [contoh tabel 1 TNR 12]

		95%CI	
Condition	*M*(*SD*)	LL	UL
Letters	14.5(28.6)	5.4	23.6
Digits	31.8(33.2)	21.2	42.4

[isi tabel TNR 10pt, spasi 1]

Gambar 1. Nama gambar [contoh gambar 1, TNR12, Spasi 1]

Hasil analisis harus berkaitan dengan tujuan penelitian, serta dilakukan Pemaknaan hasil/temuan , dibandingkan dengan penelitian sejenis sebelumnya dn teori yang ada. Kemungkinan tindak lanjut kegiatan dapat juga disampaikan pada bagian ini.

SIMPULAN [Huruf TNR 12, Spasi 1]

Berisi temuan penelitian yang berupa jawaban atas pertanyaan penelitian atau berupa intisari hasil pembahasan, yang disajikan dalam bentuk paragraf . Saran / rekomendasi tindak lanjut penelitiann dapat disampaikan pada bagian ini [Times New Roman, 12, spasi 1].

DAFTAR PUSTAKA [WAJIB MENGGUNAKAN MENDELEY]

Penulisan pustaka hanya yang disitasi hanya dalam naskah ini dan diurutkan secara alfabetis dan kronologis. Sejumlah 80% daftar pustaka WAJIB dari Jurnal yang bereputasi baik, dan dapat dilacak. Pustaka minimal 7 tahun terakhir (85%) dengan jumlah Minimal 25 referensi. Penulisan daftar pustaka wajib menggunakan mendeley/Endnote yang sudah diedit metadatanya, pilih *APA Style* untuk model penulisan referensi.

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Petunjuk Penulisan Artikel
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Ketentuan Umum

1. Yang dimaksud dengan "Naskah" dalam pedoman ini adalah artikel hasil penelitian tentang inovasi pembelajaran di semua bidang studi dan jenjang pendidikan mulai dari SD sampai Perguruan Tinggi.
2. Penulis naskah wajib membuat dan menandatangani surat pernyataan bermaterai yang menyatakan bahwa naskah yang ditulis merupakan hasil karya sendiri dan belum pernah dipublikasikan di media lain.
3. Naskah dapat di diunggah dan register lebih dulu melalui laman website : http://ejournal.umm.ac.id/index.php/jinop/user/register

Ketentuan Penulisan Naskah

1. Bahasa yang digunakan dalam penulisan naskah adalah Bahasa Indonesia atau Bahasa Inggris.
2. Naskah diketik di atas kertas A4 dengan margin kiri 4 cm, margin atas, bawah dan kanan 3 cm, menggunakan tipe huruf Times New Roman, ukuran huruf 12, dan spasi 1.
3. Jumlah halaman naskah adalah 10 sampai dengan 15 halaman.
4. Sistematika Penulisan:

a. JUDUL [Times New Roman 14 bold]
Penulisan judul menggunakan kalimat singkat, namun cukup untuk menggambarkan isi (substansi) naskah secara keseluruhan. Judul tulisan berbahasa Indonesia terdiri dari maksimal 14 kata, sedangkan apabila berbahasa Inggris terdiri dari maksimal 12 kata.

b. Nama Penulis [Times New Roman 12 bold]
Nama penulis dicantumkan tanpa gelar, kemudian disertai alamat korespondensi (instansi), dan alamat surat elektronik (email). Apabila terdapat lebih dari satu penulis maka dituliskan seperti penulis Utama. Untuk penulis utama harap menyertakan nomor HP yang bisa dihubungi.

c. ABSTRAK dan Kata Kunci [Times New Roman 10 bold]
Abstrak terdiri dari maksimal 200 kata. Abstrak mencerminkan permasalahan, tujuan, metode penelitian, hasil dan saran. Abstrak ditulis dalam Bahasa Indonesia dan Bahasa Inggris, menggunakan huruf jenis Times New Roman ukuran 10, spasi 1. Kata kunci disusun secara alfabetis, mencerminkan kandungan esensi artikel, dibuat sejumlah 3-5 kata/frase.

d. PENDAHULUAN [Times New Roman 12 bold]
Pendahuluan (berisi latar belakang, konteks penelitian, hasil kajian pustaka, dan tujuan penelitian, yang semuanya dipaparkan secara terintegrasi dalam bentuk paragraf-paragraf, dengan persentase 15-20% dari keseluruhan artikel) Tinjauan pustaka yang relevan dan pengembangan hipotesis (jika ada) dimasukkan dalam bagian ini. [Times New Roman, 12, normal].

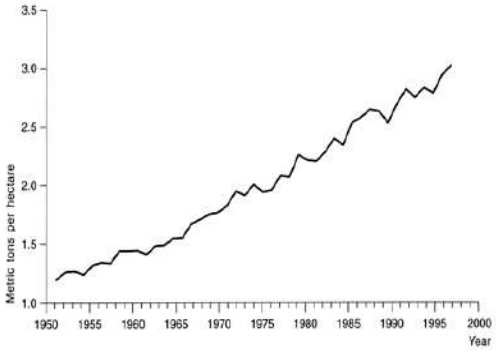
e. METODE [Times New Roman 12 bold]
Metode menjelaskan paparan dalam bentuk paragraf tentang rancangan penelitian, sumber data, teknik pengumpulan data, dan analisis data yang secara nyata dilakukan peneliti, dengan persentase 10-15% [Times New Roman, 12, normal].

f. HASIL dan PEMBAHASAN [Times New Roman 12 bold]
Hasil penelitian berisi paparan hasil analisis yang berkaitan dengan pertanyaan penelitian, sedangkan pembahasan berisi pemaknaan hasil dan perbandingan dengan teori dan/atau hasil penelitian sejenis, dengan persentase 40-60% dari keseluruhan artikel); Kemungkinan tindak lanjut kegiatan dapat juga disampaikan pada bagian ini Hasil penelitian dapat dilengkapi dengan tabel 1 (bukan tabel berikut:), grafik/gambar 1 (bukan grafik/gambar berikut:) , dan/atau bagan 1 (bukan bagan berikut:). [Times New Roman, 12, normal].

Tabel 1. Nama Ttabel [contoh tabel 1 TNR 12]

		95%CI	
Condition	*M*(*SD*)	LL	UL
Letters	14.5(28.6)	5.4	23.6
Digits	31.8(33.2)	21.2	42.4

[isi tabel TNR 10pt, spasi 1]



Gambar 1. Nama gambar [contoh gambar 1, TNR12, Spasi 1]

g. SIMPULAN [Times New Roman 12 bold]
Berisi temuan penelitian yang berupa jawaban atas pertanyaan penelitian atau berupa intisari hasil pembahasan, yang disajikan dalam bentuk paragraf . Saran dapat disampaikan pada bagian ini [Times New Roman, 12, normal].

h. Daftar Pustaka.
Daftar Pustaka ditulis dengan sistematika dan ditulis secara berurut sesuai abjad. Tanda baca koma diganti dengan tanda baca titik; tidak dicantumkan halaman kutipan; kutipan yang ada dalam batang tubuh (artikel) wajib dicantumkan di daftar pustaka begitu juga sebaliknya kutipan yang ada dalam daftar pustaka wajib ada di batang tubuh (artikel). 80% daftar pustaka **WAJIB dari Jurnal dan** 20% bisa dari buku dengan memerhatikan keterbaruan daftar pustaka minimal 7 tahun terakhir.

Contoh Penulisan Daftar Pustaka

Rujukan Buku:

Noddings, N. 2012. *Educating for Intelligent Belief or Unbelief*. New York: Teacher College Press.

Rujukan Artikel dalam Buku Kumpulan Artikel

Margono. 2012. Manajemen Jurnal Ilmiah. Dalam M.G Waseso & A. Saukah (Eds.), *Menerbitkan Jurnal Ilmiah* (hlm. 46-50). Malang: UMM Press.

Rujukan Berupa Buku yang Ada Editornya

Rusli, Marah. 2015. *Sosiologi Pendidikan: Kajian Berdasarkan Teori Integritas Mikro-Makro* (Arnaldi. S Ed.) Malang: UMM Press.

Rujukan dari Buku yang Berasal dari Perpustakaan Elektronik

Dealey, C. 2014. *The Care of Wounds: A Guide for Nurses*. Oxford: Blackwell Science. Dari NetLibrary, (Online), (http://netlibrary.com), diakses 26 Agustus 2012.

Rujukan dari Artikel dalam Internet Berbasis Jurnal Tercetak

Mappiare-AT, A., Ibrahim, A.S. & Sudjiono. 2015. Budaya Komunikasi Remaja-Pelajar di Tiga Kota Metropolitan Pantai Indonesia. *Jurnal Ilmu Pendidikan*, (Online), 16 (1): 12-21, (http://www.umm.ac.id) diakses 28 Oktober 2009

Rujukan dari Artikel dalam Jurnal dari CD-ROM

Krashen, S., Long, M. & Scarcella, R. 2017. Age, Rate and Evantual Attainment in Second Language Acquisition. *TESOL Quarterly*, 13: 543-567 (CD-ROM: *TESOL Quarterly-Digital*, 2007).

Rujukan Artikel dalam Jurnal atau Majalah:

Wentzel, K. R. 2016. Student Motivation in Middle School: The Role of Perceived Pedagogical Caring. *Journal of Educational Psychology*, 89 (3), 411-419.

Buku Terjemahan:

Habermas , Jurgen. 2017. *Teori Tindakan Komunikatif II: Kritik atas Rasio Fungsionaris*. Terjemahan oleh Nurhadi. Yogyakarta: Kreasi Wacana.

Rujukan dari Dokumen Resmi Pemerintah yang diterbitkan oleh Lembaga tersebut

Undang-Undang Sistem Pendidikan Nasional (UURI No. 20 Tahun 2003 dan Peraturan Pelaksanaannya. 2003. Jakarta: Departemen Pendidikan Nasional.

Rujukan dari Koran tanpa penulis

Jawa Pos, 27 Mei 2015. "Komitmen Mendikbud Segarkan Pramuka". Halaman 3.

Rujukan dari Internet:

Winingsih, H. Lucia. 2013. *Peningkatan Mutu, Relevansi dan Daya Saing Pendidikan*. Jakarta: Pusat Dokumentasi dan Informasi Ilmiah-Lembaga Ilmu Pengetahuan Indonesia PDII-LIPI, diakses 2 Desember 2014 on-line www. Pdii.lipi.go.id/katalog/index. php/search catalog /byld/257453.

Rujukan Berupa Skripsi, Tesis, atau Disertasi.

Mulyana, Yoyo. 2015. *Keefektifan Model Mengajar Respons Pembaca dalam Pengajaran Pengkajian Puisi*. Disertasi tidak Diterbitkan. Bandung: Fakultas Fakultas Bahasa dan Seni Universitas Pendidikan Indonesia.

Musaffak. 2013. *Peningkatan Kemampuan Membaca Kritis dengan Menggunakan Metode Mind Mapping*. Tesis tidak Diterbitkan. Malang: PPs UM.

5. Pustaka acuan yang digunakan adalah maksimal 7 tahun terakhir dengan jumlah minimal 15 buah dan minimal 80 % diantaranya berasal dari jurnal ilmiah.
6. Redaktur berhak mengubah tulisan pada naskah sepanjang tidak mempengaruhi materi atau isi pokok pembahasan.
7. Segala sesuatu yang menyangkut perizinan pengutipan atau penggunaan *software* komputer untuk pembuatan naskah atau ihwal lain yang terkait dengan HaKI yang dilakukan oleh penulis artikel, berikut konsekuensi hukum yang mungkin timbul karenanya, menjadi tanggung jawab penuh penulis artikel.

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