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Penyunting menerima sumbangan tulisan dari guru dan dosen yang belum pernah dimuat dalam media lain. Naskah ditulis dalam kertas A4 spasi satu antara 10-15 halaman, sesuai dengan format yang tercantum pada halaman belakang (“Petunjuk Penulisan artikel JINoP”). Penulis akan mendapatkan nomor bukti penerbitan sebanyak 2 eksemplar.

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## Development of a digital canva-based interactive e-module by using geogebra for high school statistics material

Nidya Rizkiani <sup>1)\*</sup>, Jumroh<sup>2)</sup>, Lusiana<sup>3)</sup>, Stevan Vucelja<sup>4)</sup>, Ibon Mugica Uriszar<sup>5)</sup>

<sup>1,2,3</sup> Mathematic Education Department, Faculty of Teachers Training and Education, Universitas PGRI Palembang Jl. Jendral Ahmad Yani Lorong Gotong Royong 910 Kec. Seberang Ulu 1, Palembang, Indonesia.

<sup>4</sup> Information technologies - software engineering Department, Technical Faculty, University of Novi Sad, Novi Sad, Zrenjanin, Serbia

<sup>5</sup> Degree in Business Administration and Management from the Faculty of Economics and Business, University of the Basque Country – UPV/EHU, Vitoria Gasteiz, Basque country, Spain.

[ndya.rzk19@gmail.com](mailto:ndya.rzk19@gmail.com) ; [jumrohdahlan@gmail.com](mailto:jumrohdahlan@gmail.com) ; [lusiana@univpgri-palembang.ac.id](mailto:lusiana@univpgri-palembang.ac.id) ; [stevan.vucelja@tfzr.rs](mailto:stevan.vucelja@tfzr.rs) ; [imugica029@ehu.eus](mailto:imugica029@ehu.eus)

\*Correspondence author

### Abstract

The Merdeka Curriculum has an up-to-date flow of learning objectives in statistics material, especially data presentation. However, most students still need help presenting data because teaching materials at school only use printed books. This research aims to produce digital-based interactive e-module development products using the application Canva-assisted Geogebra in high school statistics material that meets the criteria of being valid, practical, and having potential effects. The research method used is R & D (research and development). The development model in this research refers to the ADDIE model, which consists of stages of analysis (analysis), level design (plan), level of development (development), level implementation (implementation), and stage evaluation (evaluation). The trial was conducted on 41 class XI students at SMA Negeri 11 Palembang. Data was obtained from validation questionnaires for validity, student response questionnaires for practicality, and student learning outcomes tests to see potential effects. The results of the research obtained that Canvas digital interactive e-module product assisted by Geogebra on high school statistics material was categorized as very valid (88.04%), efficient (90.26%), and had an effect which was categorized as good (86.81%). The results of this development should be used as teaching materials and learning media in presenting statistical material, especially the scatter diagram sub-material data. It is hoped that teachers can apply the results of this research in presenting statistical material in class, especially the scatter diagram sub-material.

**Keyword :** Digital Interactive E-Modules; Canva; Geogebra.

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## INTRODUCTION

One of the policy programs set by the Indonesian government in the field of education today is the independent curriculum (Widarti et al., 2025). The independent curriculum with extracurricular learning provides students with various content standards with sufficient time to explore concepts and strengthen competencies (Mendikbudristek, 2022). By the Learning Objectives Flow (ATP) in the independent curriculum, there are updates to the class 11 statistics material, one of which is the addition of a sub-material scatter plot which is by the objectives, namely that students can draw, interpret, and determine the direction and shape of scatter diagrams (Mendikbudristek, 2023). The independent curriculum recommends digitizing learning media (Lutfiana, 2022). Digital learning methods are expected to provide a more exciting and interactive learning atmosphere (Ahmad et al., 2025).

Digitalization of learning requires teachers to be able to use technology optimally to facilitate extraordinary learning outcomes (Kristanto et al., 2025). However, in reality, the learning process carried out by teachers is still not optimal due to the limited ability to master technology, so the learning process still runs in one direction (Oktavia & Qudsiyah, 2023). In line with the opinion of Hafizah Samosir(2023), Based on observations at schools, it was found that teaching and learning activities carried out by teachers still use learning media in printed books. Mathematics subjects in statistics still run in one direction, causing a lack of student motivation. Statistics is challenging to learn and understand because it focuses on calculating data (Rosyidah & Mustika, 2021;Hakim et al., 2020). This is what makes students often feel bored while studying because most teachers still use printed modules as a monotonous learning medium (Hafizah & Samosir, 2023).

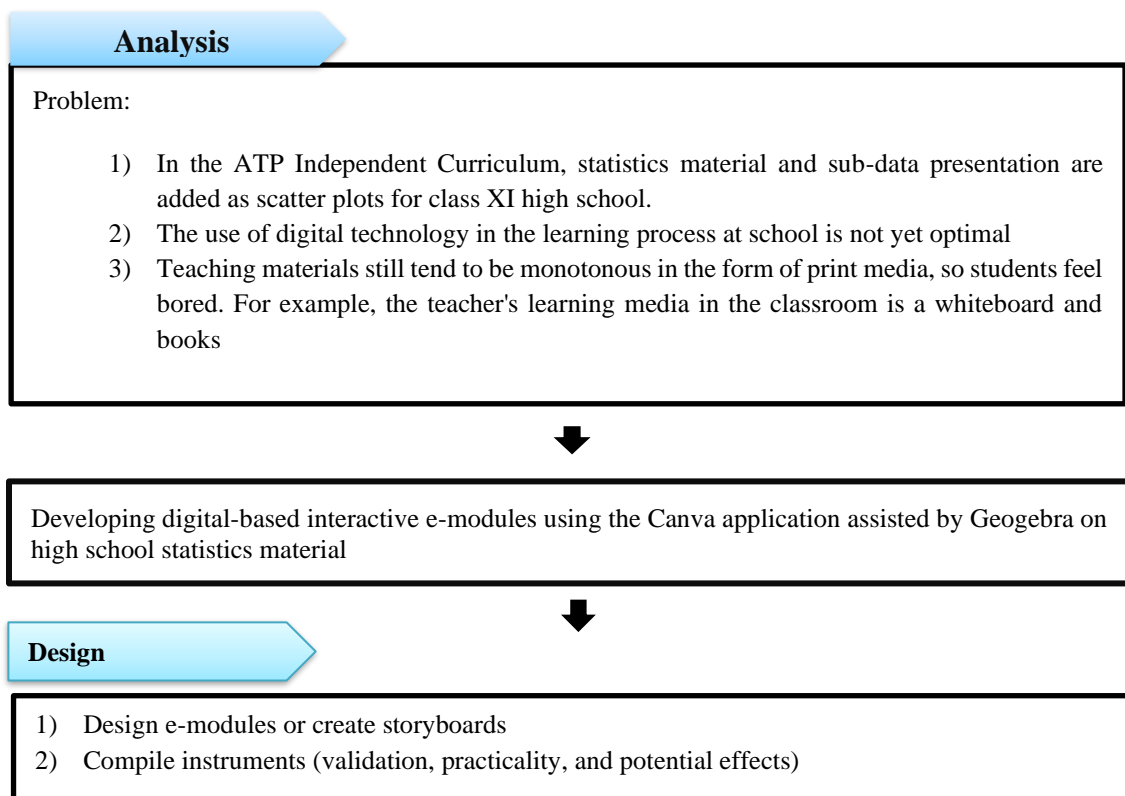
One way to attract students' interest in learning is by changing the learning process to digital (Pratiwi & Indana, 2022). In line with Khalid et al (2024) opinion, digital learning, including various technology-based tools and resources providing alternatives for teaching and learning, can overcome students' boredom with learning. According to Irawati & setyadi (2021) one form of digital-based learning media in the journal is the E-module, in line with the opinion of Sagge and Bacio (2024), Which states that e-modules are digital instructional materials or learning media systematically designed and presented in electronic digital form. The advantage of E-modules is that they are interactive and contain images, videos, audio, and quizzes, which can help students understand the material by visualizing the learning material in digital form (Nurhayati et al., 2021). E-modules can be read anywhere because they are converted into digital form, which can be displayed on a computer screen or similar and is able to reduce misconceptions that occur in mathematics learning (Jayanti & Pertiwi, 2023; Maulina et al., 2023). Interactive e-module learning media can be created by applying Canva and GeoGebra.

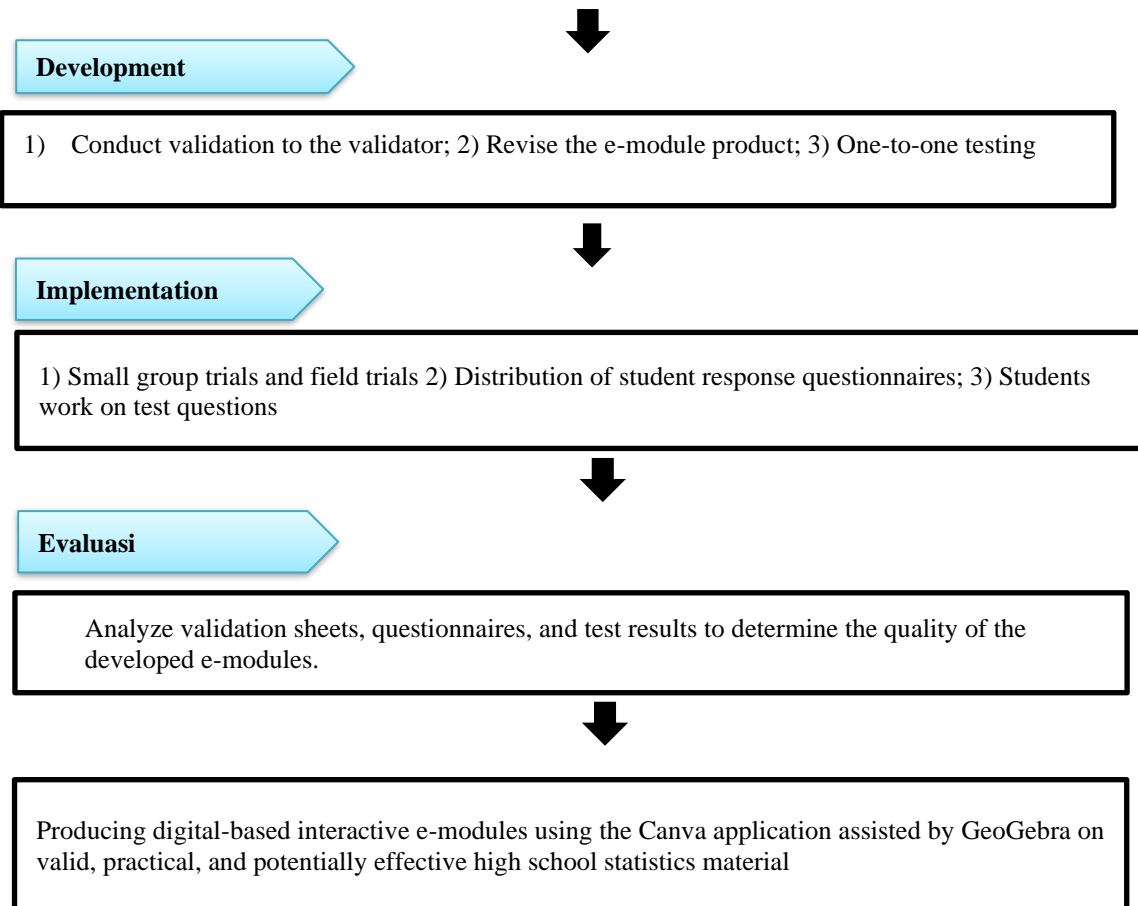
Canva is an application that can be used on laptops and Android devices. It uses the internet to create various types of designs, such as presentations, resumes, posters, pamphlets, brochures, graphics, line info, banners, flyers, certificates, diplomas, invitation cards, and YouTube thumbnails (Siregar et al., 2021). Meanwhile,

Geogebra is a learning media that can solve mathematical problems, especially geometry, algebra, statistics, and calculus (Ryandi & Santri, 2022; Safitri et al., 2020). Relevant research to this research can be found in Maulina et al (2023) Who developed an e-module using Canva on mathematical induction material with the research subjects being class XI high school students Agustianingsih et al (2021), Also conducted similar research by developing teaching material using Geogebra and focusing on the Addie model. These two relevant studies only used one application as media in their research. Hence, the researchers wanted to innovate by combining two applications simultaneously, namely Canva and Geogebra, as digital-based interactive media. Digital learning is essential so that the process of teaching and learning activities runs smoothly because it can generate students' interactive power and optimize teachers' role in using technology in the learning process. This research aims to determine the validity, practicality, and potential effects of e-modules developed as an innovative form of interactive learning media used in the learning process

## METHODS

Research carried out uses the type of R&D (research and development). According to Ramandanti et al. (2021), in their journal, R&D-type research aims to create a product such as teaching materials, learning media, learning schemes, assessments, and the like. The model used in this research is A.D.D.I.E., which consists of 5 stages: Analysis, Design, Development, Implementation, and Evaluation. More details on the research and development stages used can be seen in Figure 1 below.





**Figure 1. Detailed product research and development stages**

The subjects in this study came from 3 experienced validators, namely two lecturers who are qualified in the use of technology and one mathematics subject teacher who is qualified in teaching statistics. In addition, data also came from 41 students of class XI of S.M.A. Negeri 11 Palembang. The data in this study were collected using validation sheets, student response questionnaire sheets, and tests. The assessment for the validation questionnaire sheet and student responses used a Likert scale by providing a checkmark with five levels of scores. The assessment for the test is in the form of multiple choice using the minimum criteria completion standard (K.K.M.) for mathematics subjects set by S.M.A. Negeri 11 Palembang class XI. Also, the questions in the test are in the form of multiple choice.

#### Validation sheet

Used as a measurement of the validity of the e-module being developed by researchers, the following (Table 1) is a validation sheet grid according to Sintawati and Margunayasa (2021).

**Table 1. Validation sheet grid**

No	Aspect	Indicator
1	Self Instruction and Self Contained	Clarity of objectives and learning outcomes Suitability of content Compilation of materials Presentation of sample questions and practice questions
2	Stand Alone	Independence in using e-modules
3	Adaptive	Compliance with technological developments
4	User Friendly	Easy to use
5	Organization	Clarity of instructions
6	Attractiveness	Attractive appearance of the material presented Clarity of animation, image, and video displays Interactive activities
7	Letters and Picture	Suitability of color and image text sorting  Consistency of use of fonts, colors, and images Placement of templates Use of language in e-modules

Student response questionnaire sheet

Used to see the practicality of the developed e-module product. The following is a [Table 2](#) for student response questionnaire grids according to [Handayani et al. \(2024\)](#).

**Table 2. Grid of Student Response Questionnaire Instrument**

No	Aspect	Indicator
1	<i>Ease of Use Aspect</i>	Ease of accessing media Ease of interaction Appearance Ease of understanding Ease of reading letters Clarity of material and information
2	<i>Benefit Obtained Aspect</i>	Increased interest and enthusiasm understanding of material ease of learning activities

Test

They are used to review the potential effects of the developed e-module. The potential effects in question are obtained from analyzing students' answers when working on test questions contained in the e-module.

This study applies quantitative descriptive data analysis techniques. The formula for calculating the questionnaire, practicality, and potential effects is as follows:

$$P = \frac{f}{N} \times 100\%$$

(Annisa et al (2020); Nurhandayani et al (2022); Pradilasari et al (2020))

Description:

P = Score value

f = Total score results obtained

N = Maximum Score

## RESULTS AND DISCUSSION

This research produces a product in the form of a digital-based e-module using the Canva application assisted by Geogebra on the statistical material of the scatter plot sub-material or scatter diagram for grade XI high school students that has been validated by validators consisting of two lecturers and one educator. The product has been field tested in grade XI high school during the learning process. The trial was carried out for four days through 3 phases. The first phase, namely the one-to-one test, was carried out on May 17, 2024; the second phase, namely the small group, was carried out on May 18, 2024, and the third phase, namely the field test, was carried out on May 20 and 21, 2024. The results of this product development are as follows:

### 1) *Analysis*

In the needs analysis, the researcher conducted a literature study on the problems that occurred previously; the researcher found several problems in the form of statistics, which were considered difficult to learn and understand because they felt bored having to calculate data besides teachers still used learning media in the form of printed (Rosyidah & Mustika, 2021; Hafizah & samosir, 2023). Based on the results of the curriculum analysis, it was found that there was a novelty in the flow of learning objectives in grade 11, namely in the statistical material. According to Mendibudristek (2023), in the learning objectives of grade 11, there is an additional sub-material in statistics, namely describing, determining direction and shape, and interpreting scatter plots or scatter diagrams.

Then, based on the results of the media analysis carried out by selecting and reviewing the appropriate software for making e-modules, it was found that Canva and Geogebra are software that can increase and generate students' interactive power in learning. Canva and Geogebra are software that can provide intuitive interactions; in Canva, there are various attractive graphic design templates, while the use of Geogebra can help the learning process and solving specific mathematical problems, namely geometry, algebra, statistics, and calculus (Safitri et al., 2020; Wibowo, 2023). Based on the results of these three analyses, the researcher wants to develop an interactive e-module based on digital Canva, in which Geogebra assists with high school statistics material.

### 2) *Design*

After the analysis process, the researcher makes a design or designs it by creating a storyboard. According to Setyaningrum et al (2024), a storyboard is very much needed in designing a product because it can make it easier to interpret and

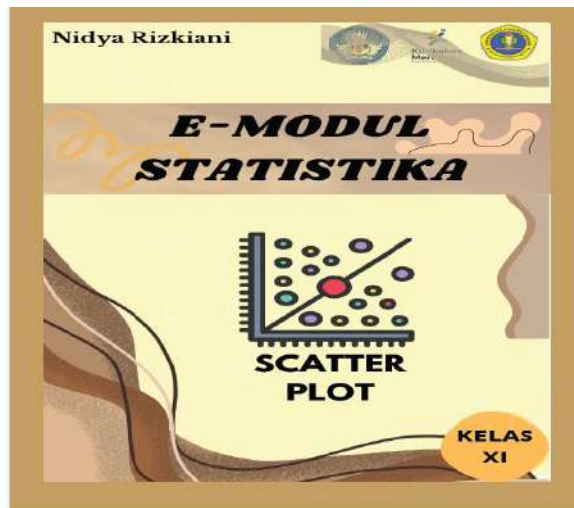
recognize the materials or components that must be made or arranged so that the development procedure follows the predetermined ideas. Furthermore, the product is realized using Canva according to the components contained in the storyboard. The number of slides in the e-module is 24 slides. The interactives in the e-module are the following buttons: the table of contents, which contains the destination page numbers, the use of Geogebra, and the completion of practice questions. The results of this product design can be seen in the [table 3](#).

**Table 3. Product design results**

**Product design results or Prototype 1**

**Introduction**

It consists of 7 slides: cover, foreword, module description, table of contents, module identity, use of e-module, and concept map. Here are the design results of the e-module cover:



**Cover E-modul**

**Core Section or Material**

In the e-module, there are learning activities 1 and 2; each part of the learning activity consists of an explanation of the learning material, sample questions, and answers to sample questions. The results of the design of the core section of the two-slide e-module include the following:



**E-module material**



**Examples of e-module questions**

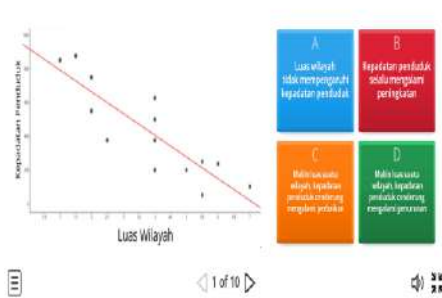
**Practice Question Section**

The developed e-module product has two practice questions; before answering the question, the user must enter his name. The results of the two-slide practice design include:



**Form slides before practice**

Berikut ini gambar tentang hubungan luas wilayah (Km<sup>2</sup>) dengan kepadatan penduduk (jiwa) yang diambil dari 15 data. Pernyataan yang tepat sesuai dengan diagram tersebut adalah



**Practice questions**

However, in the results of prototype two or after the e-module product was revised, there were two additional slides in the e-module design results, so the resulting product totaled 26 slides; this addition is in the instructions section for completing practice questions 1 and 2, so as not to confuse students in answering questions. This is in line with the opinion of Irawati (2021), that instructions for completing questions are needed before answering questions so that they can know the rules or procedures for answering questions and feel transparent about the process.

3) *Development*

The first stage in the development stage is to validate the feasibility of a product being developed. According to Aprianka et al (2021), validation in development is essential to measuring the feasibility assessment of the product that has been made. The results of this validation are shown in the table 4 below.

**Table 4. Validation results**

No	Rated aspect	Validator Assessment			Average	Category
		Validator 1	Validator 2	Validator 3		
1	Self-Instruction and Self Contained	81,81%	100%	83,63%	88,48%	Very worthy
2	Stand Alone	86,67%	93,33%	93,33%	91,11%	Very worthy
3	Adaptive	80%	100%	100%	93,33%	Very worthy
4	User Friendly	90%	100%	100%	96,66%	Very worthy
5	Organization	80%	100%	80%	86,66%	Very worthy
6	Attractiveness	76%	100%	88%	88%	Very worthy
7	Letter And Picture	76,66%	93,33%	80%	83,33%	worthy
	Jumlah	80%	97,93%	86,20%	88,04%	Very worthy

Based on Table 4, the average of the first to sixth aspects is included in the very feasible category, while the seventh aspect is included in the feasible category. The results of the calculation of the average score from the three validators and the average of all aspects assessed are 88.04%, included in the very feasible category. After conducting validation, the researcher then made revisions according to the validator's suggestions and comments; there were nine components or nine slides that needed to be fixed, 3 of which were according to validator 1; practice questions do not need to use animated backgrounds because they are not suitable for high school students. This is supported by the opinion of Bariah et al (2023), the selection of any media without exception, even animation, must consider several things, namely learning objectives, the level of student development at each level of education, and the availability of devices. This can be seen in the figure 2 and 3.

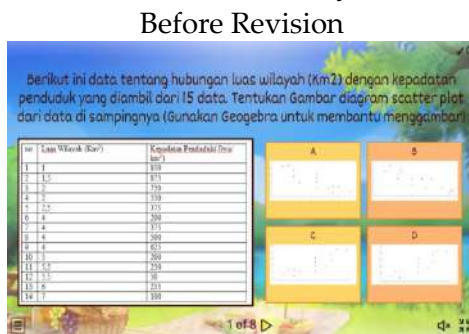


Figure 2. Background before revision

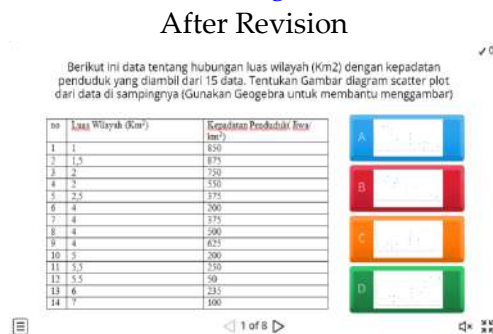


Figure 3. Background after revision

Based on comments and suggestions from validator 1, there are suggestions for adding instructions before working on the practice questions. Researchers must make revisions by adding one slide of instructions regarding the procedure for working on the practice questions before the e-module practice slide; this is supported by the opinion of Irawati (2021), that instructions for working on questions are needed before answering questions so that they can know the rules or procedures for answering questions and not feel confused in working on them. This can be seen in the figure 4 and 5:



Figure 4. View of the practice questions before revision

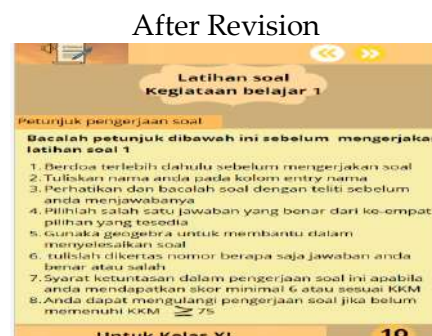


Figure 5. View of the practice questions after revision

Then, according to comments from validator 3, there was an error in writing the foreword, where the foreword was not written in just one paragraph, and there was no gratitude addressed to the supervisor. According to Sabrina (2019), a good

foreword has three parts or three paragraphs: the first part is the opening in the form of gratitude to God and gratitude to the parties involved, the second part is the content, and the third part is the closing (Figure 6 and 7).

Before Revision

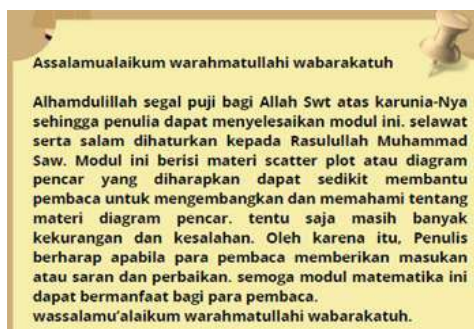


Figure 6. Foreword before revision

After Revision

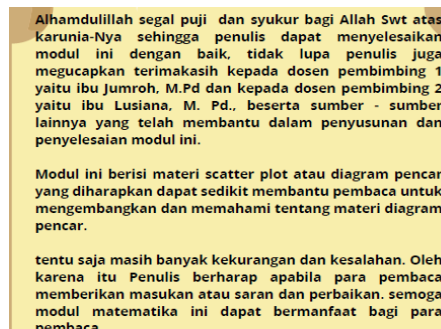


Figure 7. Foreword after revision

Then, after making revisions and producing prototype 2, the researcher conducted a one-to-one test to assess product use and to find out whether there were still errors in the product or learning media that had been developed—the results of comments or opinions given by students in the one-to-one test (Table 5).

Table 5. One to one test results

Student name	Comments or opinions
MH	The e-module is excellent and easy to use, and I can easily understand its material.
PN	The e-module's appearance is attractive; it can raise my enthusiasm for learning, and I can interact easily with it.

Based on Table 5 above, the comments or suggestions of students in the questionnaire responses from both students did not experience obstacles in using the product or learning media. According to Sari (2022), if there are no problems with the product being developed in the one-to-one test, researchers can continue testing the product in small groups and field trials.

#### 4) Implementation

Product trials were implemented in this study through small group tests and field tests. In the small group test, the product was tested on ten students divided into two groups of 5 students each. This trial measured the practicality of the product or learning media developed based on the results of the student response questionnaire after using the e-module product. This is in line with the opinion of Anggraini et al (2021), small group trials were conducted to see the attractiveness and practicality of the products developed. The results of the small group test are as follows (Table 6).

**Table 6. Small group test**

Aspect	Ease of Use (Max Score: 275) 5-point x 11 Questions x 5 Student)					Benefits Obtained (Max score: 100) 5-point x 4 Questions x 5 student)				
	1	2	3	4	5	1	2	3	4	5
Group	-	-	4	24	27	-	-	3	7	10
	-	1	2	15	37	-	-	-	6	14
Group 1	-	1	6	39	64	-	-	3	1	24
Group 2	-	2	18	15	320	-	-	9	5	120
				6					2	
Number of student responses				496						181
Number of scores obtained				90,18%						90,5%
Total score										90,34%
Average Practicality:										<b>Very Practical</b>

Table 6 shows that the average percentage calculation for the ease-of-use aspect in the small group 1 and 2 tests obtained a percentage score of 90.18% and a percentage score of 90.5% for the benefits obtained. The percentage of practicality obtained was 90.34%, with an efficient category. In the results of the student questionnaire, one student chose or gave a score of 2 or less in agreement with the response questionnaire that had been distributed. After being analyzed in depth, the student chose the answer less agree with number 9 because the font size selection was improper. This aligns with Asri's opinion [Asri \(2022\)](#) that choosing the wrong font size and type in e-modules can cause errors when interpreting and understanding the material. However, in the product developed by the researcher, when Canva is zoomed in, the writing or letters will be visible.

Furthermore, the researcher conducted a field trial on 1 class consisting of 27 grade XI students, carried out in two meetings. This trial reviewed the potential effects of the product developed through student learning outcomes after completing the exercises. According to [Mufida \(2022\)](#), the field test aims to see the value of student learning success in completing the test questions contained in the product and also aims to perfect the product being developed. This measurement looks at the recapitulation of learning outcomes in the form of scores obtained by students after answering the practice questions at the end of learning activities 1 and 2 in the e-module. The product or learning media developed has a potential effect if the student's score reaches learning completion according to the KKM criteria, namely 75. The student learning outcomes in exercises 1 and 2 in the e-module are as follows ([Table 7](#)).

**Table 7. Average student score results**

Activity	Average Score	Total Score Exercise	Category
Learning 1	2367,5	87,69%	Good
Learning 2	2320	85,93%	Good
Average of activities 1 and 2		86,81%	Good

Table 7 shows that the average value of student practice in Learning Activity 1 is 87.69%, and in Learning Activity 2 is 85.93%. The overall average of learning activities 1 and 2 is 86.81%, with a good category, meaning that the developed e-module product has a potential effect with a good category.

Some questions are below completion, namely question number 7. The researcher conducted an in-depth analysis regarding the reasons for the average percentage of question number 7 below completion; the researcher found that students still needed help interpreting or drawing conclusions from the problems in the scatter diagram image. This aligns with Mustain (2019), in his research, which found that 90% of students still need help with interpreting questions on data presentation images. According to Latifah (2021), the level of understanding of graphic images in high school students in interpreting still needs to be higher. Meanwhile, the researcher found the reasons for the average percentage of question number 10 below completion: most students still have difficulty determining and reading the direction of the relationship from the scatter diagram image. This was also expressed by Hada (2021), who said that most students still have difficulty reading and determining negative and positive directions in data presentation diagrams.

##### 5) Evaluation

This stage aims to analyze the difficulties and obstacles in making e-modules. In the e-module exercise, two questions did not reach the scatter plot material: the indicator analyzing the distribution pattern of the image presented and the indicator showing the direction and shape of the scatter diagram based on the image presented. Further researchers hope to study these indicators more deeply.

In addition, other difficulties that must be faced in developing products are difficulties in the internet network system. Researchers must provide wifi access to students via the researcher's cellphone in order to provide students with the convenience of accessing or opening the Canva e-module link because some students need a quota or the internet network that students have is unstable. According to Sugianto (2023); Rahama et al (2023), the main obstacle in implementing digital learning is the stability of the internet network because digital learning can be carried out correctly if the location provides internet and a stable signal.

This study is in line with research conducted by Maulina et al (2023), which suggested that mathematics teaching materials require a lot of innovation, one of which is digitizing learning using Canva. Agustianingsih et al (2021), found that

modules that use the Geogebra application in the learning process can be used as a learning media, a tool to develop teaching materials, and also help in solving mathematics problems.

## CONCLUSION

The e-module developed in this study has met the valid criteria of 88.04%, categorized as very feasible or very valid based on the validation sheet questionnaire, included in the practical criteria of 90.34%, categorized as very practical based on the student response questionnaire, and has a potential effect of 86.81% has a potential effect with a good category based on student learning exercises. So, this interactive digital e-module can be used by teachers as a source for delivering statistical material in class, especially the scatter diagram sub-material. This e-module product can increase students' interactive power and interest in learning in learning. When using this e-module product, the condition of the surrounding internet network should be noted because this media requires a reasonably strong internet network to facilitate users in accessing learning media or products that are developed. Here is the link to the product resulting from the development of the interactive e-module that has been developed: [https://www.canva.com/design/DAGAzimZDPQ/XMW2BiidW9s2exgYKRHvRQ/edit?utm\\_content=DAGAzimZDPQ&utm\\_campaign=designshare&utm\\_medium=link2&utm\\_source=sharebutton](https://www.canva.com/design/DAGAzimZDPQ/XMW2BiidW9s2exgYKRHvRQ/edit?utm_content=DAGAzimZDPQ&utm_campaign=designshare&utm_medium=link2&utm_source=sharebutton)

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## Development of an integrated statistics pocket book on culture and Islamic value

Andi Asma<sup>1)\*</sup>, Kadir<sup>2)</sup>, Arhanuddin<sup>3)</sup>, Muhammad Tahir<sup>4)</sup>

<sup>1,2,3,4</sup> Primary Islamic School Teacher Education, Faculty of Tarbiyah and Teacher, Manado State Islamic Institute, Jl. S. H. Sarundajang, Manado, Indonesia

[andi.asma@iain-manado.ac.id](mailto:andi.asma@iain-manado.ac.id)\*; [kadir@iain-manado.ac.id](mailto:kadir@iain-manado.ac.id); [arhanuddin@iain-manado.ac.id](mailto:arhanuddin@iain-manado.ac.id), [muhhammad.tahir@iain-manado.ac.id](mailto:muhhammad.tahir@iain-manado.ac.id)

\*Correspondence author

### Abstract

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This research discusses the development of a statistical pocketbook integrated with Islamic values and culture to enhance students' understanding and appreciation of statistics within a cultural and religious context. This research aims to develop a statistical pocket book that meets valid criteria. This research uses the Research and Development (R&D) method. The development model used is ADDIE which consists of 5 development stages, namely: (1) analysis stage, (2) design stage, (3) development stage, (4) implementation stage, (5) evaluation stage. However, this development research only uses four stages, namely (1) analysis, (2) design, (3) development and evaluation. This research was conducted at FTIK IAIN Manado. Data collection was carried out using questionnaires and tests. Instruments were a marketing/content expert validation sheet and a media/design expert questionnaire validation sheet. Based on the results of the questionnaire analysis, the results obtained were that the statistics pocket book integrated with Islamic values and culture met the valid criteria for use in statistics learning, seen from the assessment results for validation by content/material experts (85%) with very valid categories and media/design experts (91 %) is also in the very valid category, the average percentage of the practicality test is 91% in the very practical category. So, the Statistics pocketbook that has been developed is valid and practical for use in learning because it is integrated with Islamic values and culture.

**Keywords:** Integration; Islamic Culture; Istiqra'; Statistics Pocket Book; Values.

### INTRODUCTION

In the context of the development of life in the 21st century, education has a very important role in equipping individuals with the abilities and skills needed to face the challenges of the times (Nudiati, 2020). One form of adaptation needed is the development of 21st century abilities, such as the ability to learn and innovate, as well as the ability to think critically, literacy, numeracy, collaboration and creativity (Wijaya, 2016; Kemendikbud., 2020). The process of achieving 21st century capabilities cannot be separated from education.

Education is an activity carried out deliberately, regularly and planned with the aim of changing or developing a person's behavior according to what is desired (Hadi, 2021). Education is expected to improve an individual's self-quality to shape all aspects of life (Hartatik, 2020). In the context of developing 21st-century capabilities, education plays a role (GLN, 2017; Fuadi, 2020). Subjects such as mathematics and statistics have a role in developing critical and analytical thinking processes.

Statistics is a branch of science that plays an important role in various areas of society in the current digital era, including social science, economics, political science and other fields. Skills in statistics are very necessary in data analysis, decision making, and research in various disciplines (Irvandi, 2020; Buulolo, 2020). Considering the important role of statistics in education, including applying statistical concepts and techniques in various fields of science, developing critical thinking skills in analyzing data, evaluating arguments based on statistical evidence, and making decisions based on relevant information, as well as developing statistical literacy (Andriatna, 2021; Amalia & Wildani, 2020). Therefore, lecturers are expected to be able to create a pleasant statistics learning atmosphere for students and determine learning that is in accordance with the curriculum as an effort to improve the quality of education (Fikri et al., 2021; Angga et al., 2022). Apart from that, lecturers are expected to be oriented towards achieving 21st-century abilities for students through learning innovation.

Developing teaching materials is one form of lecturer innovation in learning (Setiyadi, 2022; Safithri, 2023). Teaching materials that are integrated with culture related to science, technology, religion and statistics have the potential to make it easier for students to study statistics which have been considered difficult and abstract (Idris, 2020). Facts in the field show that students experience difficulties in understanding quantitative research, where statistics learning is still dominated by procedural problems and ignoring Islamic concepts, values and culture, which is an obstacle for students in gaining skills that should be mastered from statistics courses which are part of requirements for completing their studies. Among other obstacles lecturers face in teaching statistics is the difficulty of obtaining reference books (Anggraini, 2021). Statistics textbooks that have been developed in various research studies are still based on learning methods such as CTL, generative learning and problem-based learning (Ida, 2020). The context of integrating Islamic values and culture is important to ensure that statistical approaches do not conflict with Islamic religious values and beliefs (Khairiani, 2021). This will help in preparing students, researchers and practitioners who want to apply statistical concepts in a context that is in accordance with Islamic values and culture.

One form of teaching material that is suitable for the current situation and conditions is a pocketbook that can be taken anywhere so that when students want to read the material or work on questions, they can immediately open it. Based on several studies relevant to this research, namely a character-based mathematics pocket book on trigonometry material that is suitable and interesting for use in mathematics learning (Cahyono, 2018), a pocket book as a mathematics learning

medium in study programs is also worthy of being developed as a learning medium (Piramika, 2018), Hots-Based Mathematics Handbook Design is suitable for use in learning and can increase interest in learning (Sinaga, 2022). The use of pocket books supports the development of 21st century abilities (Nafidah, 2022). So, the development of a pocket book that is integrated with Islamic values and culture can fill gaps in education, especially for those who want to understand statistics in accordance with Islamic values and culture that are easily accessible. The integration of Islamic values and culture has been known in various general sciences (Rusdiana, 2014) such as science including mathematics. The noble values taught in Islam (Abdusysyagir, 2014) include consistency, honesty, patience, and so on. The magic of the numerical arrangement of numbers can be integrated into learning (Kurniati, 2017).

The integration of Islamic values and culture in statistics education remains largely unexplored, with limited teaching resources specifically designed for this purpose. Prior research and interviews with several statistics lecturers at FTIK IAIN Manado reveal a significant gap: there is an absence of instructional materials, especially pocketbooks, that incorporate Islamic perspectives within the statistical curriculum. This lack presents both a challenge and an opportunity, as such resources could bridge the gap between statistical concepts and the Islamic cultural context, enhancing both engagement and relevance for students.

The development of a statistics pocketbook integrated with Islamic values and culture aims to fill this gap, aligning statistical education with students' religious and cultural backgrounds. This contribution is expected to address the pressing need for contextually relevant teaching materials at IAIN Manado and beyond, advancing academic and educational literature in both Islamic and statistical fields. Consequently, this research aims to develop a statistics pocket book that integrates Islamic values and culture and meets valid criteria for increasing learning outcomes.

## METHODS

This research is research and development with a statistics pocket book product integrated with Islamic values and culture. The development model is the ADDIE (Analyze, Design, Develop, Implementation and Evaluation) model (Sugiyono, 2018; Budiyo, 2017; Sudaryono, 2013). An overview of the ADDIE Model can be seen in Figure 1. However, this research has limitations in that this research has not carried out the implementation stage.



Figure 1. Schematic of the ADDIE model

The research procedures carried out in the research are as follows:

#### 1. Analysis Stage

At the analysis stage, what is done is analysis of student needs and curriculum analysis. Analysis of student needs was carried out by interviewing one of the statistics lecturers. Meanwhile, curriculum analysis is carried out by analyzing existing curriculum documents and learning tools. The results of the two analyzes are then combined to formulate the right solution

At this preliminary analysis stage, apart from interviews and document analysis, the researcher also conducted a cultural survey which could be integrated into the book development process which is integrated with culture such as the game of Tok Tok. The game "Tok Tok" can be integrated into learning descriptive analysis to make statistical concepts more interactive and interesting. Islamic values such as *istiqra'* in descriptive analysis. In relation to descriptive analysis, it can be integrated through a more spiritual and reflective approach to data collection and analysis.

#### 2. Design Stage

After carrying out the analysis process and producing a formulation and solution in the form of developing a statistical pocket book integrated with Islamic values and culture, then proceed to the design stage. The things that are done at the design stage are preparing the framework for the product to be developed and preparing a validation questionnaire.

In preparing the framework for the pocket book, the pocket book is prepared to cover basic statistical topics, such as descriptive and inferential statistical concepts which are integrated with Islamic values and culture. This framework includes chapters that are easy to understand, short and connected with relevant real examples, for example, the use of the concept of average (mean). Each chapter in this pocket book is equipped with an explanation of how the statistical concept is applied. The pocket book design considers the use of layout, size that is practical to carry, as well as the use of attractive colors, graphics, and illustrations.

The Product Validation Questionnaire is designed to evaluate the feasibility and effectiveness of the book being developed. This questionnaire contains several questions that assess several aspects of the product, such as the quality of the content, structure and layout and connection with Islamic culture and values.

#### 3. Development Stage

At the development stage, what is done is to prepare the product based on the framework that has been prepared and test the validity of the product until a valid product is obtained. This validation stage was carried out by involving lecturers with Islamic religious education, statistics lecturers as media experts and material experts.

The validation results from experts will produce a revised pocket book that meets the valid criteria. At this stage the book was tested on 2 students to get responses/input. The results of the repair of the pocket book meet practical criteria.

The next step is evaluation

#### 4. Evaluation Stage

The evaluation stage is not the final stage of development research using the ADDIE model. However, this stage is integrated into other stages in the ADDIE model. At

this stage, the evaluation stage is carried out by conducting self-evaluation in terms of analysis results and design or product framework. Apart from that, an evaluation is carried out in the form of a product validity test which is carried out until a valid product is obtained (Tegeh, 2014).

The data collection techniques used were questionnaires and tests. Questionnaire techniques are used to assess the validity of the product being developed, while tests are carried out to carry out evaluations. The data collection instruments used were content validation questionnaires and design/media validation. The questionnaire was prepared based on a Likert scale (Arifin, 2010) with the conditions as in table 1.

**Table 1. Likert scale**

Score	Category
1	Very Poor
2	Poor
3	Good
4	Very Good

After the data is collected, the percentage is calculated for each validator assessment. The calculation uses the formula (1) (Asma, 2023).

$$\% = \frac{\sum \text{score per item}}{\text{maximum score}} \times 100\% \tag{1}$$

After obtaining the product validity percentage, the percentage is then interpreted into the qualitative category (Retnawati, 2016; Azwar, 2019) with the conditions as in Table 2.

**Table 2. Validity categories**

Final result	Category
$0,80 < V \leq 1,00$	Very Valid
$0,60 < V \leq 0,80$	Valid
$0,40 < V \leq 0,60$	Acceptable
$0,20 < V \leq 0,40$	Less than acceptable
$0,00 < V \leq 0,20$	Invalid

A product is said to have met the minimum criteria if it has reached the valid category. The product must be revised if it has not reached the valid category. Next, a limited trial was carried out to test practicality. The percentage obtained was then confirmed as the percentage of conformity with the parameters (Arikunto, 2006) (Table 3).

**Table 3. Practicality level categories**

Percentage (%)	Categori
85-100	Very practical
70-84	Practical
60-69	Fairly practical
50- 59	Less than fairly
<50	Impractical

At this stage, the final product was tested on second semester students of the Tarbiyah and Teacher Training Faculty of IAIN Manado. If the average minimum

completion rate for students was 80%, it could be said that the pocket book was practical to use.

## RESULT AND DISCUSSION

The development model used in developing this product in the form of a pocket book is the ADDIE model which is a systematic learning model. This model consists of 5 steps, namely: (1) Analysis, (2) Design, (3) Development, (4) Implementation and (5) Evaluation. The development of a statistics pocket book that is integrated with Islamic values and culture begins with the analysis stage, namely analyzing the needs of second semester students at the Tarbiyah and Teacher Training Faculty of IAIN Manado for a statistics pocket book that can be used for the results of the analysis stage including (1) the results of the needs analysis, students, and the results of curriculum analysis. The results of the analysis of student needs show that in the statistics learning process students still do not play an active role. This is because the learning process does not yet have a reference book. Based on the results of interviews with statistics lecturers, lecturers still have difficulty finding reference books. (2) The results of curriculum analysis show that student demands from curricula such as the MBKM curriculum are too high. If this is linked to the analysis of student needs and current conditions as explained in the introduction, it can be concluded that students need teaching materials that are simpler and easier to carry. Therefore, this research will be carried out to develop a statistical pocket book integrated with Islamic values and culture.

The design and development stages results are a product framework and validity questionnaire. The framework of the statistics pocket book integrated with Islamic values and culture is divided into 3 parts, namely introduction, core and conclusion. This pocket book was developed based on a statistics learning design. Furthermore, this cover was designed and validated by media experts. The design for a pocket book cover using Canva can be seen in [Figure 2](#)

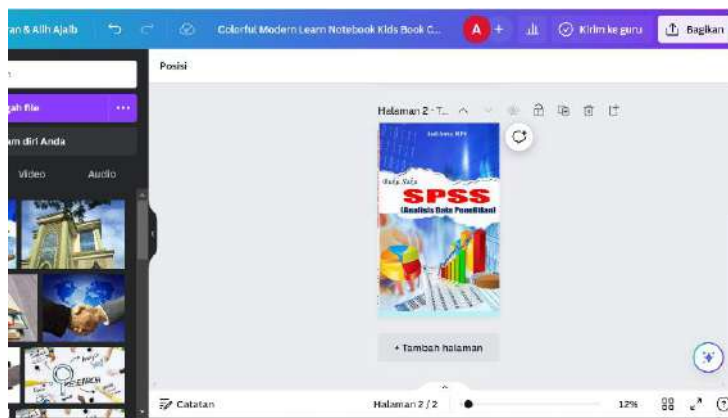


Figure. 2 Pocket book cover

At the implementation stage, an expert validation test was carried out by the validator on the content and design of the pocket book. After the expert validation test was carried out, a limited trial of the pocket book was carried out as well as a practical test of the textbook on second semester students at FTIK IAIN Manado.

Expert validation of the contents of the Statistics Handbook which is integrated with Islamic values and culture, by involving lecturers with Islamic context criteria, having an Islamic education background, having experience using statistics as a tool in research, and having teaching experience in statistics courses. The following validation results for the content can be seen in [table 4](#).

**Table 4. Content validation results of the statistics pocket book**

No	Criteria	Score	
		V1	V2
1	Quality statistics pocket book cover	4	5
2	The attractiveness of the pocket book cover design	4	4
3	Clarity of description of material in each chapter	4	4
4	Material accuracy description in each chapter	4	4
5	Examples clarity of questions in each chapter	4	5
6	Accuracy in solving sample questions in each chapter	5	4
7	Suitability of sample questions to research objectives	4	4
8	Suitability of practice questions to research objectives	4	5
9	Accuracy of practice questions	5	5
10	Suitability of bibliography with material presentation	5	4
	<b>Total</b>	<b>42</b>	<b>43</b>

Based on the data in table 4 above, the percentage of validator assessments of the content of validator 1 (84%) and validator 2 (86%) is 85% on average. With some input from content validators to add to chapter III and the addition of culture-based practice questions to chapter II. For design validation by two design validators.

**Table 5. Validation of the statistics pocket book design**

No	Criteria	Score	
		V1	V2
1	Accuracy of the title of the statistics pocket book with the content of the material in each chapter	4	5
2	The attractiveness of the pocket book cover design	4	5
3	Consistency in the use of fonts, letter shapes, spacing for titles, subtitles, material, example questions and practice questions in each chapter	4	5
4	Clarity of written material, example questions, and practice questions in each chapter	4	4
5	Completeness of components in each chapter	5	5
6	The interesting way of presenting the material in each chapter	5	5
7	Accurate placement of charts, tables, or illustrative images	5	4
8	Clarity of the material presentation order	5	4
	<b>Total</b>		<b>37</b>
		<b>36</b>	

Based on the data in [table 5](#) above, the percentage of assessments by expert validators regarding the pocket book design for validator 1 (90%) and validator 2 (92%) is calculated. Furthermore, there are several suggestions regarding the design of the pocket book, namely the placement of images in the chapter on statistics. After

receiving revisions from the expert validator regarding the content and the expert validator regarding the design, revisions were made to the improvements provided by expert validators I and II. Next, a limited product trial was carried out in the form of a statistical pocket book integrated with Islamic values and culture for second semester students at FTIK IAIN Manado. Limited trials were carried out when teaching educational statistics in class. After the limited trial was carried out, the next stage was to carry out a practical test by giving questionnaires to the 5 students involved in the limited trial. The following practical test results can be seen in [table 6](#).

**Table 6. Practicality trial**

No	Criteria	Score				
		1	2	3	4	5
1	The attractiveness of the cover and contents of pocket book	4	5	4	5	5
2	The Content Framework at the beginning of the chapter helps you understand the content	4	5	4	5	5
3	Consistency of font and its size	4	5	5	5	4
4	Clarity of learning objectives	4	4	5	4	4
5	Clarity of material, example questions and practice questions in each chapter	5	5	4	5	5
6	The example questions provided help you understand the material well	5	5	4	5	4
7	The order of material in each chapter helps you understand the material well	5	5	4	4	4
	Total	31	34	30	33	31
	Percentage	88	97	86	94	88

From the results of the practicality test, the average percentage of the practicality test was 91%. The final stage is the evaluation stage. At this stage, students are given a test in the form of essay questions to see an increase in their ability to understand statistics through a pocket book that is integrated with Islamic values and culture. Based on the validation results, both content validation and media/design validation, the product or statistics pocket book which is integrated with Islamic values and culture has met the minimum criteria and even achieved very valid criteria. The suggestion given by the validator is that it is necessary to add examples related to culture and references in the pocket book being developed. This shows that the statistics pocket book can be said to be suitable in terms of material and appearance in learning which allows it to be easily accessed by students or those who need references. In [Piramika \(2018\)](#) research, it is stated that the pocket book as a mathematics learning medium in study programs is also worthy of being developed as a learning medium, and is in accordance with the research results that

the Hots-Based Mathematics Pocket Book design is suitable for use in learning and can increase interest in learning (Sinaga, 2022).

The resulting statistics pocket book can be used like a reference book even though it is small. The development of pocket books that are integrated with Islamic values and culture can fill gaps in education, especially for those who want to understand statistics in accordance with Islamic values and culture that are easily accessible. The integration of Islamic values and culture has been known in various general sciences (A.Rusdiana, 2014) such as science including mathematics. The noble values taught in Islam (Abdusysyakir, 2014) such as consistency, honesty, patience and so on. The magic of numerical arrangement of numbers that can be integrated into learning (Kurniati, 2017).

If related to statistics, then *istiqla'* can be compared to inductive reasoning or the census method, where research is carried out on each element of the existing sample. Meanwhile, *istiqla'* is a type of inductive reasoning applied in statistics, namely taking several samples from a population to draw a conclusion that can be generalized to the entire population. In statistics, the terms sampling error or margin of error are known (Ary, 2010; Jabir, 2001) while in Islam the term *istiqla'* is known (Mua'arif, 1996). This shows that the Islamic values and context regarding decision making or samples can be classified as a type of integration of statistical material. Learning by integrating culture and Islamic values is able to improve learning outcomes because it can build a critical attitude towards quantitative information (Ramadhan & Santosa, 2023). The results of other research are in accordance with this research that integrating Islamic values in the mathematics learning process is very easy and practical to use (Nurjanah, 2021). This means that learning that is integrated with Islamic culture and values has a positive effect on student learning outcomes in mathematics learning. Thus, the integration of local culture and Islamic values has various positive impacts, namely strengthening student character, so that lecturers are expected to be able to design learning according to the cultural context found in their everyday environment.

## CONCLUSION

Based on the results of development and testing, it can be concluded that the statistics pocket book integrated with Islamic values and culture has met the valid criteria, and is practical for use in statistics learning. The content validation results are in the very valid category and the media/design validation is also in the very valid category and the practicality test results are in the very practical criteria. Suggestions for further research are to conduct further research regarding the practicality and effectiveness of the pocket books produced. Apart from that, another suggestion is to develop a more interactive ebook-based pocket book to maximize gadget use among students.

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## Development of interactive e-modules with stem approach using canva application to improve students' critical thinking ability in physics learning

Yunita<sup>1\*</sup>, Rahma Diani<sup>2)</sup>, Hendri Noperi<sup>3)</sup>, Yessy Velina<sup>4)</sup>

<sup>1,2,3</sup>Physics Education Department, Faculty of Tarbiyah and Teacher Training, Raden Intan Lampung State Islamic University, Jl. Endro Suratmin, Sukarame, Bandar Lampung, Indonesia

<sup>4</sup>Departement of Interdisciplinary Environment, Graduate School of Human and Environmental Studies, Kyoto University, Yosidahonmachi, Kyoto, Japan

[yunita040421@gmail.com](mailto:yunita040421@gmail.com)<sup>1\*</sup>; [rahmadiani@radenintan.ac.id](mailto:rahmadiani@radenintan.ac.id)<sup>2)</sup>; [hendrinoperi@radenintan.ac.id](mailto:hendrinoperi@radenintan.ac.id)<sup>3)</sup>, [yessy.velina.76z@st.kyoto-uac.jp](mailto:yessy.velina.76z@st.kyoto-uac.jp)<sup>4)</sup>

\*Correspondent Author

### Abstract

This study aims to determine the feasibility, response, and improvement of students' critical thinking skills towards learning using e-modules. This type of research is development research using Sugiyono's development model with 10 stages, namely potential and problems, data collection, product design, design validation, design revision, product trials, product revisions, usage trials, final product revisions, and mass production. The research was conducted at SMPN 6 Krui and MTsN 2 Lampung Tengah, with the research subjects being 88 students in class VIII. The instruments used in this study were validation sheets, student response questionnaire sheets and critical thinking ability tests. Based on the results of the study, the validation results of interactive e-modules with the STEM approach from material experts amounted to 92% and media experts amounted to 90% with the category very feasible to use in learning. The response of students to the attractiveness of the e-module in the field trial was 90% and the educator was 89% with a very interesting category. The results of improving students' critical thinking skills obtained N-gain 0.71 including the high category. Thus the e-module developed is categorized as feasible to use as an alternative physics teaching material.

**Keywords:** Critical Thinking Skills; Interactive E-Modul; STEM Approach.

### INTRODUCTION

One of the life skills that need to be developed through the educational process is thinking skills (Zubaidah, 2018). Critical thinking is a way of thinking that uses the mind to solve a problem by first understanding the problem, expressing opinions or arguments clearly and being able to draw conclusions from existing problems. (Prameswari et al., 2018). Critical thinking in teaching and learning activities can be

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done by students who are able to answer how and why questions using a concept. Critical thinking is very important for students because it allows them to solve social, scientific, and practical problems effectively (Wahdaniyah et al., 2018). (Wahdaniyah et al., 2023). By thinking critically, students are expected to have the ability to solve problems encountered in everyday life (Nurissamawati et al., 2024). In the midst of the increasing complexity of the world, the ability to think critically is no longer just an option but a necessity. The ability to analyze information in depth, evaluate various perspectives and make the right decisions (Das, 2018). The theory of critical thinking used in this study is critical thinking proposed by Ennis, there are 6 indicators of critical thinking which are acronymized as FRISCO (*Focus, Reason, Inference, Situation, Clarity, Overview*) (Yudha, 2019).

Based on the results of observations that researchers have made on the science learning process in class VIII of SMPN 6 Krui and MTsN 2 Lampung Tengah, it is found that the critical thinking ability of class VIII 1 students at MTs Negeri 2 Lampung Tengah, totaling 32 students, obtained an average score of 57.34 with low criteria from KKM 76 in physical science subjects and at SMPN 6 Krui, totaling 48 students in class VIII A obtained an average score of 55.80 out of 25 students. Similarly, in class VIII B, 23 students obtained a score of 55.14 with low criteria from KKM 70 with this critical thinking ability of students still in the low category because they scored below the Minimum Completion Criteria (KKM) that has been determined. Students feel less interested in learning science Physics , because educators still use the lecture method and *teacher centered*. So that resulted in the ability critical thinking of these students is low . One of the keys to someone skilled in solving problems is the need for critical skills based on competence, if someone does not have good competence then he will have difficulty in solving problems (Jamaludin et al., 2022).

STEM (*Science Technology Engineering Mathematics*) is a learning approach that is believed to be in line with the spirit of Curriculum 2013. The implementation of STEM in learning in Indonesian schools is intended to prepare Indonesian students to acquire 21st century skills, namely critical thinking skills, creative and innovative, able to solve problems and make decisions, and able to communicate and collaborate (Izzati et al., 2019). This is in line with Nailul Khoiriyah's research, which revealed that STEM (*Science Technology Engineering Math*) learning obtained a 95% confidence level and was significant in helping students to improve their critical thinking skills (Khoiriyah & Wahyudi, 2018). Integrated STEM lessons need to engage students in real-world situations and nurture their interest (Zeid & Chin, 2014 ;Zeid & Chin, 2014). The selection of good learning models and methods needs to be chosen so that students feel motivated and enthusiastic about learning physical science (Noperi & Sarwanto, 2021). Furthermore, in an educational journal, it is stated that through STEM learning, the results of analyzing students' critical thinking skills are well developed (Yusuf et al., 2022). The importance of critical thinking skills for students, so it is necessary to empower them by using learning modules in the learning process. Empowerment of critical thinking skills is

explicitly outlined in the classification of matter and its changes in the learning module (Yunida et al., 2021). This research and development is to develop an interactive e-module with a STEM approach using the Canva application to improve students' critical thinking skills in physics learning. This e-module development is equipped with interactive elements such as interactive quizzes, google forms, animations, images, student worksheets, Instagram feeds, and videos of learning materials. The STEM approach in the e-module is presented in daily life problems that can train students' ability to think critically.

The development of increasingly sophisticated technology proves that the world has entered the era of the industrial revolution 4.0. This era emphasizes the *pattern of digital economy, artificial intelligence, big data, robotics*, and so on or commonly known as the phenomenon of disruptive innovation (Mulyono, 2023). Along with the development of the globalization era characterized by the production and use of rapid information and technology, the concept of learning implementation has shifted towards efforts to realize modern learning (Diani & Syarlisjisman, 2018; Shabrina & Diani, 2019). One of the roles of technology in education is e-books, which are digital versions of traditional books (Oktariani et al., 2024). E-modules or electronic modules are independent learning devices that are systematically organized, displayed in electronic form containing audio, animation, and navigation (Seruni et al., 2019; Lukitoyo & Wirianti, 2020). E-modules have become a prevalent tool in education, offering a variety of benefits for students and educators (Evenddy & Gailea, 2024). E-modules are considered interactive if there are images, audio, video, animation, and also equipped with tests or quizzes that can be used as evaluation materials for teachers (Fauzi & Hayya, 2022). Some of the benefits of learning using e-modules are: 1) e-modules are developed following the development of science and technology, which makes it easier for students to utilize technology in learning well (Lastris, 2023), 2) e-modules are designed using electronic formats so that they can be used through various devices such as computers, laptops and smartphones. This will certainly make it easier for teachers to share teaching materials that can be studied by students, especially during distance learning. In addition, the use of e-modules is also useful for limiting the use of paper (Wulandari et al., 2021). 3) The use of e-modules can increase student participation and motivation in the learning process, this is based on the results of investigating the results of several calculations of learning interest in ethnoconstructivism electronic modules that have been carried out, it can be seen that the use of electronic modules on student learning interest has a good impact. (Kurniawan et al., 2020; Sholeh et al., 2023). The application of e-module teaching materials is stated to have an effect in improving learning outcomes, analytical skills, critical thinking, student confidence, scientific attitudes, and student competency achievement (Permana & Kurniasih, 2021; Prawita et al., 2019).

Making learning media in the form of e-modules can use various applications, one of which is Canva (Muchlis & Yunus, 2023). Canva is a graphic design application that allows users to create the desired appearance by displaying various elements such as text, video, animation, images, audio, graphics, and others. Canva has features that are easy to use by all educators, it contains features that help educators

in managing interactive learning (Susanti & Ummah, 2021). Canva can be integrated to drive learning, this can attract learners' active participation and interest in reading, especially in subjects that require observation of natural phenomena that can be seen through videos. Canva provides features that educators can use to create learning media (Sholeh & Susanti, 2020).

Based on the results of the needs analysis of science teachers at SMPN 6 Krui on November 2, 2022 and MTs Negeri 2 Lampung Tengah on January 4, 2023, it can be seen that, in learning, educators only use teaching materials in the form of package books, and LKPD. Educators also stated that the completeness of the material in the content of chapter 2 Effort and Simple Aircraft was incomplete, the technique of delivering material in the student handbook was difficult to understand and limited examples of problems in everyday applications. Educators also stated that educators rarely use modules, especially electronic modules or interactive modules with a STEM approach in learning activities. Educators have never made interactive modules in delivering material to students. Based on the background description, the researcher will conduct "Development of Interactive e-Modules with STEM Approach Using Canva Application to Improve Students' Critical Thinking Skills in Physics Learning.

## METHODS

This type of research is development research (*Research and Development*). The method used in this research and development uses Sugiyono's development model. The steps of research and development are shown in Figure 1.

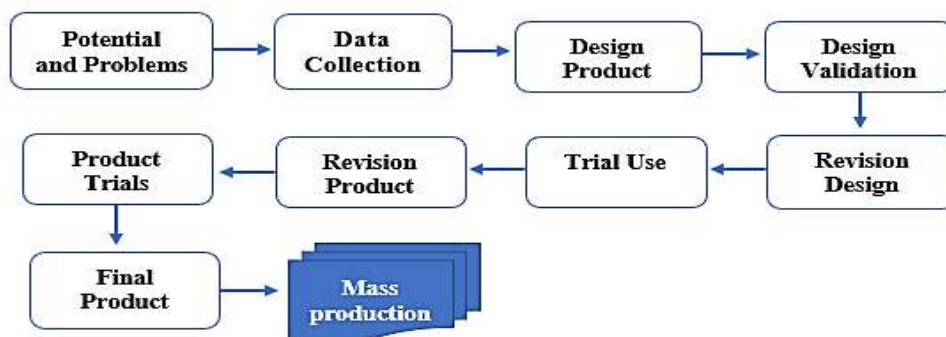


Figure 1. Sugiyono's development design (Sugiyono, 2013)

This research was conducted in two schools including SMPN 6 Krui and MTs Negeri 2 Lampung Tengah . The subjects of this study were VIII grade students, totaling 88 students. The data collection methods used were observation, interview, and critical thinking skills test. The research instruments used include a needs analysis questionnaire instrument, a validation questionnaire for media experts and material experts, a response questionnaire for educators and students, and critical thinking skills questions. The type of data analysis technique used consists of quantitative and qualitative data analysis. Quantitative data analysis is used for needs analysis questionnaire data, critical thinking ability analysis, media expert validation questionnaire and material experts, as well as educator and learner response

questionnaires. Questionnaires given to educators and learners use Likert scale measurements . likert and attractiveness criteria can be seen in [table 1](#) and [table 2](#).

**Table 1. Likert scale criteria**

Criteria	Interval
Very Interesting	5
Interesting	4
Interesting enough	3
Not Interesting	2
Very Unattractive	1

(Sugiyono, 2013)

From the calculation of the score of each statement, the presentation of the answers of all respondents is sought by the formula (1):

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

Description:

$P$  = Percentage of Feasibility

$\sum x$ = Number of respondents' answers in one item

$\sum x_i$ = Number of Ideal values in the Item

**Table 2. Criteria for attractiveness**

Criteria	Interval
Very Unattractive	$80\% < P \leq 100\%$
Interesting	$60\% < P \leq 80\%$
Interesting enough	$40\% < P \leq 60\%$
Not Interesting	$20\% < P \leq 40\%$
Very Unattractive	$0\% < P \leq 20\%$

(Ayardini, 2022)

Analysis of the improvement of students' critical thinking skills was carried out using the Normal Gain Test (2):

$$N\text{-gain} = \frac{\text{score posttest} - \text{score pretest}}{\text{score ideal} - \text{score pretest}} \tag{2}$$

The criteria for low, medium, and high in the N-Gain Test can be seen in [Table 3](#).

**Table 3. N-gain criteria**

N-gain	N-Gain
High	$0.7 \leq N\text{-gain} \leq 1$
Medium	$0.3 \leq N\text{-gain} \leq 0.7$
Low	$N\text{-gain} < 0.3$

(Aziza et al., 2021)

In this research uses the *independent sample t-test* hypothesis test. The application of the *t-test* aims to compare the suitability of the average research results with certain criteria

from two groups that are not paired with each other (Herispon, 2020). The *t*-test calculation process is carried out through the SPSS version 24 for windows program. The formula equation using the *t*-test (3).

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2} \left( \frac{1}{n_1} + \frac{1}{n_2} \right)}} \quad (3)$$

Description:

$\bar{x}_1$  = mean of the first sample

$\bar{x}_2$  = second sample mean

$n_1$  = amount of data of the first sample

$n_2$  = second sample data count

$S_1$  = standard deviation of the first sample

$S_2$  = standard deviation of the second sample

## RESULTS AND DISCUSSION

The results of this research and development are in the form of interactive e-modules with a STEM approach using the Canva application to improve students' critical thinking skills in physics learning. This research and development was carried out at MTs Negeri 2 Lampung Tengah and SMP Negeri 6 Krui, this interactive E-module product contains Effort and Simple Aircraft Class VIII material. This research and development was carried out using the development procedure according to Sugiyono which was carried out from stage 1 to stage 10. The data from each stage of the research and development procedure carried out obtained the following results .

### Potential and Problems

The potential in this study is to develop interactive e-module teaching materials with a STEM approach using the Canva application to improve students' critical thinking skills in physics learning . The problems that researchers found at SMPN 6 Krui and MTsN 2 Lampung Tengah were obtained from analyzing the needs of teachers and students in learning physical science, the following are the results of the analysis of teacher needs can be seen in table 4.

**Table 4. Teacher needs analysis results**

Aspects	Teacher Needs Analysis Results
The use of learning resources on effort and simple aircraft	<ol style="list-style-type: none"> <li>1.All teacher respondents have other handbooks to teach simple effort and aircraft material.</li> <li>2.One teacher respondent stated that the textbooks had shortcomings, such as few sample questions and practice questions, and the material was too instant.</li> <li>3.Two of the teacher respondents did not use modules in learning, one teacher respondent only used phet media and LKPD and one teacher respondent used learning videos.</li> </ol>
Implementation of learning activities on effort and simple	<ol style="list-style-type: none"> <li>1.The methods used by the two teacher respondents were demonstration and lecture.</li> <li>2.All teacher respondents did not use the module to help make it easier for students to understand.</li> </ol>

Aspects	Teacher Needs Analysis Results
aircraft	3. One teacher respondent only did an online practicum using the phet application to show the force and weight force on the lever material. And one teacher respondent used a learning video
Limitations and difficulties felt by teachers in learning material	4. All respondents stated that they have laboratories and libraries at school, but have not utilized them optimally, due to the unavailability of practicum support tools on the material.
Efforts and simple planes	5. Only a small number of students are enthusiastic about learning physics.
The need for E-modules in learning	All teacher respondents need interesting e-modules so that students feel interested and happy to learn physics.

The following are the results of the learner needs analysis, which can be seen in [table 5](#).

**Table 5. Results of student needs analysis**

Aspects	Results of Student Needs Analysis
Availability of materials and learning resources for Simple Machines and Airplanes	<ol style="list-style-type: none"> <li>1. All student respondents had a textbook provided by the school. 30% of the respondents use the internet to look up things they can't find in books.</li> <li>2. 80% of the total number of respondents thought that they had difficulty learning simple effort and aircraft material from the book. This is because the presentation of the book is too verbal. In addition, all student respondents stated that they were not given a module to study the material.</li> </ol>
Implementation of learning activities on effort and simple aircraft	<ol style="list-style-type: none"> <li>1. 87% of the total number of respondents stated that their physical science teachers did not use special teaching materials to teach material Effort and simple aircraft, Teachers only use textbooks to teach material effort and simple aircraft. While 13% of the total number of respondents stated that their physical science teacher used special teaching materials Phet to teach the material of effort and simple aircraft.</li> <li>2. 87% of the total respondents stated that the physical science teacher taught the material of effort and simple aircraft with the lecture method.</li> </ol>
Limitations and difficulties felt by students in learning business material	<ol style="list-style-type: none"> <li>3. 75% of the total number of respondents stated that they were not enthusiastic when participating in physical science learning.</li> </ol>

Aspects	Results of Student Needs Analysis
and simple airplanes	4.83% of the total number of respondents stated that they found it difficult to learn the material of effort and simple aircraft because it was confusing and there were many formulas.
The need for e-modules in learning	5.90% of the total number of respondents stated that the difficulty in understanding the material was due to the teacher's teaching method which was too fast and boring. 100% of the total number of respondents stated that they need alternative teaching materials that are interesting and interactive, that are able to explain the material, and contain activities so that students can understand the material of Effort and simple aircraft easily.


### Data Collection

After the potential and problem process is complete, the next stage is to collect information. Gathering information is very important to find out the needs of students for products developed through development and research. The first stage is to collect problems that exist in MTs Negeri 2 Lampung Tengah and SMPN 6 Krui to teachers and students, especially class VIII in physical science subjects in the form of interview results. The next stage is designing learning tools such as the preparation of KI and KD, Indicators tailored to critical thinking skills, learning objectives, compiling syllabus and lesson plans, compiling materials according to the 2013 curriculum VIII grade Physics Science book, compiling critical thinking skills tests, looking for sources of Physics journals related to the development of Interactive e-module teaching materials using Canva Applications, as well as other sources relevant to the research (Liu & B, 2023).



### Product Design

After the needs analysis, the next step is product design. In detail, the interactive e-module design is presented in table 6.

**Table 6. Interactive e-module design results**

No	E-module Design Display	Description
1	Front cover (Cover) 	The front cover contains images related to the material of effort and simple aircraft, namely the use of pivoting wheels found on car tires in the wheat harvesting process which is the use of simple aircraft tools.



No	E-module Design Display	Description
6	 <p>Instagram Feed Design</p>	In each learning activity there is also material presented with Instagram feeds. Learners can access it by swiping the image/swipe left as in Instagram posts in general.
7	 <p>Competency Test</p>	At the end of each lesson there are questions presented in google form, students can measure their learning achievements using e-modules on simple effort and aircraft material.

### Design Validation

The e-module product that has been designed, then validated by 2 material expert validators, 2 media expert validators and 2 research instrument expert validators (Rahmawati et al., 2022). The results of the material expert validation are as table 7.

**Table 7. Results of validation by material experts**

No	Indicator	Material Validator		Percentage	Criteria
		V1	V2		
1	Content Feasibility	93%	92%	92%	Very Feasible
2	Presentation	92%	90%	91%	Very Feasible
3	Language	96%	92%	94%	Very Feasible
4	STEM approach	85%	90%	87%	Very Feasible
5	Critical Thinking	85%	90%	87%	Very Feasible
Average percentage				92%	Very Feasible

Based on the results of the material expert analysis data, it can be seen that the results of the material validation obtained an average percentage of the total aspect of 92% stated in very feasible criteria. Media expert validation intends to see the quality of the feasibility of the product developed. The results of media expert validation can be seen in [Table 8](#).

**Table 8. Media expert validation results**

No	Indicator	Media Validator		Percentage	Criteria
		V3	V4		
1	Layout	80%	80%	80%	Very Feasible
2	Graphics	96%	86%	91%	Very Feasible
3	Typography	100%	90%	95%	Very Feasible
4	Presentation Support	98%	84%	91%	Very Feasible
5	Usage	100%	80%	90%	Very Feasible
Average percentage				90%	Very Feasible

Based on the results of the data above, an assessment was obtained from two media expert validators from each aspect. So that the average percentage obtained from two validators is 90% grouped in very feasible criteria.

### Design Revision

After the product design is validated through the assessment of material experts and media experts, the validator provides suggestions / input so that the resulting product is better than before. Suggestions from material validators on interactive e-modules ([Table 9](#)).

**Table 9. Comments from validators**

Validator	Comments provided
V1	1. The display on the e-module cover must be equipped with words to improve students' critical thinking skills. 2. Change KD and indicators according to critical thinking indicators and objectives.
V2	3. Add interactive quizzes to learning activities 1 and 3.
V3	-
V4	-

**Product Trial**

After the e-module has been validated and revised, the next step is the product trial. This trial is intended to find out how students respond to the attractiveness of the STEM approach interactive e-module using the Canva application to improve students' critical thinking skills in physics learning. on the material Effort and simple aircraft. The test subjects consisted of 10 students of class VIII MTs Negeri 2 Lampung Tengah. Based on data from small group product trials on 10 class VIII students, an average of 90% was obtained in the very attractive category.

**Product Revision**

After conducting a small-scale trial, it was found that the interactive e-module with a STEM approach using Canva application to improve students' critical thinking skills in physics learning was declared very interesting, but there were obstacles in accessing the e-module, namely signal strength must be good and stable.

**Trial Usage**

After product testing is successfully tested, then the product in the form of an Interactive e-module is applied to real conditions for a wide scope and field trials are carried out on class VIII students of SMPN 6 Krui and MTs Negeri 2 Lampung Tengah totaling 88 students and educators / totaling 3 science teachers, Regarding the results of product trials are as follows (Table 10).

**Table 10. Usage test results**

No.	Assessment Aspect	Class			Percentage	Category
		VII I 1	VIII A	VIII B		
1	Interest	94%	94%	93%	93%	Very Interesting
2	Material	93%	91%	91%	91%	Very Interesting
3	Language	91%	89%	91%	90%	Very Interesting
Average Percentage					90%	Very Interesting

Based on data from the field trial results at MTs Negeri 2 Lampung Tengah and SMP Negeri 6 Krui class VIII. Of the three aspects, the overall average was 90% with very interesting criteria. This situation shows that the module developed by the researcher is very feasible to be used as teaching material in the learning process. Previous research shows that students' involvement in the learning process and students' perceptions of learning materials greatly affect their learning outcomes (Yulianti, 2024).

After the small-scale trial and field trial, the product was tested again to educators. Respondents in the educator trial amounted to 3 science teachers, 1 teacher at MTsN 2 Lampung Tengah and 2 teachers at SMPN 6 Krui (Table 11).

**Table 11. Educator trial results**

No	Assessment Aspect	Science Teacher			Percent age	Category
		G 1	G 2	G3		
1	Material	90 %	86 %	93 %	89%	Very Interesting
2	Presentasi	100 %	83 %	86 %	89%	Very Interesting
2	Language	95 %	80 %	95 %	90%	Very Interesting
3	View	96 %	84 %	80 %	86%	Very Interesting
Average Percentage					88%	Very Interesting

From the results of the educator's response, the total average number of aspects was obtained with a percentage of 88%, grouped in a very interesting statement, so it is feasible to use as an alternative teaching material for physical science.

#### **Final Product Revision**

This revision was carried out after the e-module product had been tested on a wide scale to students. In terms of field trials that obtained a percentage of all aspects of the attractiveness of e-modules by students, namely 90% and obtained a percentage of 88% from educators with an interesting category of e-module products that have been developed, and there are no revisions, so in this case the e-modules are suitable for use as teaching materials. Learning devices are said to be good if they meet the valid criteria and have been validated by several parties, expert validators and practitioners (Wenno et al., 2022).

#### **Mass Production**

This development research produces products in the form of interactive e-modules with a STEM approach using the Canva application to improve students' critical thinking skills in physics learning. This e-module is mass-produced using a website that can later be accessed by students, the following is a link to an interactive e-

module with a STEM approach: <https://edugrafisweb.blogspot.com/2023/10/e-modul-interaktif.html> Learners can visit the web by clicking the link or searching for it with the keyword edugrafisweb on Google. Operating the e-module using an android device, laptop or computer also increases students' interest in learning and is easy to use.

### Critical Thinking Ability Analysis Results

Researchers conducted learning activities in the subject Physical Science on the material of Effort and Simple Aircraft at MTs Negeri 2 Lampung Tengah in class VIII. 1 and at SMP Negeri 6 Krui class VIII A and B. Before learning using e-modules with a STEM approach using the Canva application to improve students' critical thinking skills in physics learning. Then at the end of learning, students work on posttest questions independently. The results of the average pretest score on each indicator of critical thinking of students in class VIII.1 VIII.A and VIII.B can be seen in [table 12](#).

**Table 12. Pretest results**

No	Indicator	Average	Number of Students	Category
1	<i>Focus</i>	3,52	88	Less Critical
2	<i>Reason</i>	4,86		Less Critical
3	<i>Inference</i>	4,03		Less Critical
4	<i>Situation</i>	3,35		Less Critical
5	<i>Clarity</i>	3,75		Less Critical
6	<i>Overview</i>	3,58		Less Critical
Total Average		3,85		Less Critical

Based on the data obtained on the pretest assessment before learning using the e-module, it can be seen that the critical thinking ability of class VIII students at MTsN 2 Lampung Tengah and SMPN 6 Krui obtained an average value of the overall critical thinking indicator of 3.85 with less critical criteria. with this the researcher will conduct learning using interactive e-modules with a STEM approach using the Canva application to improve students' critical thinking skills in physics learning.

The following are the average results of the posttest scores of students' critical thinking skills after learning using interactive e-modules with a STEM approach using the Canva application to improve students' critical thinking skills in physics learning. Can be seen in [table 13](#).

**Table 13. Post-test score results**

No	Indicator	Average	Number of Students	Category
1	<i>Focus</i>	8,47	88	Critical
2	<i>Reason</i>	8,49		Critical
3	<i>Inference</i>	8,13		Critical
4	<i>Situation</i>	8,58		Critical

No	Indicator	Average	Number of Students	Category
5	Clarity	7,93		Critical
6	Overview	7,84		Critical
Total Average		8,24		Critical

Based on the data obtained on the post-test assessment after learning using interactive e-modules, it can be seen that the critical thinking ability of students has changed, obtained the average value of the overall critical thinking indicator is 8.24 with critical criteria.

#### N-Gain Test Analysis Results

The increase in critical thinking skills was analyzed using the N-gain test after being given a *pretest* and *posttest*. The following normalized gain test results can be seen in [table 14](#).

**Table 14. N-gain test results**

No	Indicator	Average N-gain score per indicator	Category
1	Focus	0,76	High
2	Reason	0,71	High
3	Inference	0,69	Medium
4	Situation	0,79	High
5	Clarity	0,67	Medium
6	Overview	0,66	Medium
Average		0,71	High

Based on the results of the n-gain test analysis of critical thinking skills in the three classes including class VIII.1 VIII.A VIII.B in two schools, the average n-gain of 0.71 was converted in percent form to 71.% in the high category. Based on the interpretation of the effectiveness of the n-gain value of 71.1% obtained, it is classified into the moderately effective category. The results of this analysis are not much different from the research conducted by Nurul Latifah, Ashari et al in 2020, in a study entitled the development of physics e-modules to improve students' critical thinking skills. Learning outcomes at the stage of application of *pretest* values obtained an average value of 33.19 and *posttest* values obtained an average of 73.47. The increase in students' critical thinking skills obtained by N-gain 0.602 is included in the medium improvement category ([Latifah et al., 2020](#)). In this case, the use of e-modules affects students' critical thinking skills by utilizing technological media.

#### Hypothesis Test Analysis Results

The research hypothesis test used an *independent sample-t test* with a significance level of 5% (0.05). The purpose of hypothesis testing is to determine whether or not there is a difference in the average *posttest* score of the control class and the experimental class. The results of the hypothesis test can be seen in [table 15](#).

**Table 15. Sample t-test results**

Independent Sample t-test					
	Mean	Std. Dev.	t	Sig. (2-tailed)	
Equal variances assumed	11.287	1.0961	10.297	.000	
Equal variances not assumed	11.287	1.1460	9.850	.000	

The data above shows that Sig.  $0.00 < 0.05$ , which means that  $H_0$  rejected and  $H_1$  accepted. The results of this statistical test indicate that there is a difference in the average posttest score from the control class and the experimental class on the critical thinking skills of students in physics science learning using teaching materials using interactive e-modules in the experimental class and LKPD teaching materials in the control class to train and improve students' critical thinking skills.

## CONCLUSIONS

Based on the results of research and analysis that has been carried out, interactive e-modules with a STEM approach using the Canva application to improve students' critical thinking skills in Physics learning are declared effective for improving critical thinking skills. The e-module developed in this study also meets the criteria of feasible, interesting, effective, thus this interactive e-module can be used as an alternative teaching material used by students and educators to support learning activities, by utilizing technology. The use of e-modules can only be accessed when connected to the internet network, the ability of a computer or *smartphone*, affects the speed of accessing efficiently. The development of this interactive e-module can still be further developed such as embedding interactive applications such as: Speech to text, Google Maps, Quiz and other third-party platforms, which can be adapted to learning materials, and school levels or grade levels.

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## Role playing as contextual learning to improve mathematical communication skills of *madrasah ibtidaiyah* students

Wirdatul Hasanah<sup>1)\*</sup>, Sintha Sih Dewanti<sup>2)</sup>, Listriyah<sup>3)</sup>

<sup>1,2</sup>Elementary School Teacher Education, Faculty of Education and Teacher Training, UIN Sunan Kalijaga Yogyakarta, Jl. Laksda Adisucipto, Sleman, Yogyakarta, Indonesia

<sup>3</sup>MI Tahfidz El Muna Q, Jl. Kyai Ali Maksum, Bantul, Yogyakarta, Indonesia

[23204081011@student.uin-suka.ac.id](mailto:23204081011@student.uin-suka.ac.id)\*; [sintha.dewanti@uin-suka.ac.id](mailto:sintha.dewanti@uin-suka.ac.id); [listria55@gmail.com](mailto:listria55@gmail.com)

\*Correspondence author

### Abstract

Among the efforts to improve Mathematical Communication Skills (MCS) is to innovate learning models. This research aims to develop contextual role-playing learning products to improve *Madrasah Ibtidaiyah* (MI/ primary school) students' MCS on valid and practical fraction material. The research and development (R&D) model of Define, Design, Development, and Dissemination (4D) was employed. The research subjects were second graders at MI Tahfidz El Muna Q, totaling 28 students. The instruments included validation guidelines, practicality guidelines, and MCS tests. Product effectiveness is tested using N-Gain. The results showed that the number of students completing the MCS after contextual role-playing learning was 89.28%, which is in the high category. The average N-Gain value obtained was 0.79, which is also in the high category. These findings show that contextual role-playing learning can potentially improve MI students' MCS, especially in fraction material.

**Keywords:** Contextual Learning; Mathematical Communication Skill; Role-Playing.

### INTRODUCTION

One of the mandatory subjects that forms the basis of learning at the next level is Mathematics (Wulandari et al., 2020) due to its application in daily life, work, and science development. Mathematical mastery is expected to start at the elementary school level (Arianti et al., 2019) in terms of students' cognitive ability to find patterns, solve problems, draw conclusions, and as a means of communicating thoughts (Lagur et al., 2018). Mastery of material and technical skills in using formulas alone is not enough to develop overall mathematical skills (Fauzan et al., 2023). However, Mathematics is somehow scary and boring (Hidayat et al., 2020). According to Indonesian Teacher Council, Mathematical competencies include communication skills, reasoning, problem-solving, connections, and forming positive responses to Mathematics (Hodiyanto, 2017). The council further states that Mathematical Communication Skills CS (MCS) include students' skills in using and communicating the language of Mathematics. Elliot and Kenney stated that MCS

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consists of aspects of writing, drawing, and mathematical expressions (Utami et al., 2020), which can help students express mathematical ideas in their language that other people can understand, both orally and in writing (Wandari & Fardillah, 2021).

Students' MCS are still low (Gunur et al., 2019) due to the lack development in mathematical communication (AS et al., 2020). One of the factors causing low MCS is the application of learning models that do not facilitate students' development (Lagur et al., 2018), particularly in mathematical skills, self-concept, self-efficacy, and self-confidence (Dewanti & Muna, 2023). The low level of MCS is caused by classical and conventional learning. Hence, efforts should be made to increase success in learning Mathematics including innovating the learning models used (Arianti et al., 2019).

Concurrently, contextual learning is an effective approach to improving MCS (Sugandi & Bernard, 2018). This method connects the learning materials with students' real life in the family, community, or country (Agus, 2019). In contextual learning, students are allowed to connect the material studied with everyday life. They work in groups, which aims to help them interact and convey ideas, to improve their MCS (Brinus et al., 2019).

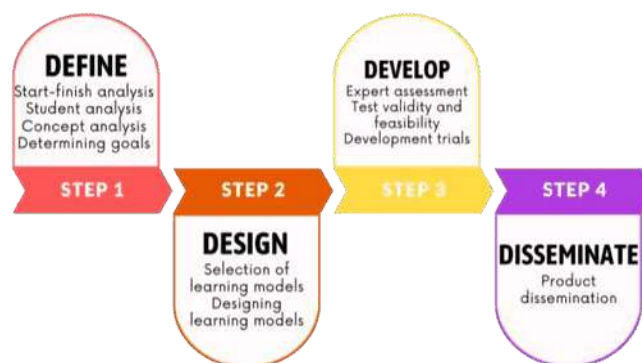
It is stated that role-playing is an active play activity that involves behavior and language in the context of certain situations. Through this activity, students can develop social skills, follow procedures, experiments, and language (Fika et al., 2019). They are also given space to imagine through role-playing which influences their cognitive and social development (Anggarani et al., 2022). Role-playing involves collaboration between players through face-to-face social activities relying on direct communication (Fika et al., 2019). It can also develop good communication skills, involve students in various contexts, improve their ability to express themselves, and increase their curiosity about the material being studied (Sit, 2012).

The Indonesian Council of Teachers of Mathematics (NCTM) states that fraction material is the core and challenge in the basic Mathematics curriculum (Hariyani et al., 2022). Fraction material is specifically chosen for this study since it is considered difficult by students. Some fraction operations, such as division, are challenging because they can produce a result that is larger than the original number being divided (Warsito et al., 2019). Learning fraction operations requires a systematic and structured approach (Sukirwan et al., 2018).

Based on the results of an interview with one of the teachers at MI Tahfidz El Muna Q, it is known that the mathematics learning process still uses conventional methods, namely the lecturing method. This causes students to become bored and uninterested in learning. The teacher also stated that with the lecture method, students lack mastery of the material presented. However, this method is still used due to limited time and facilities, as well as the clarity of targets that must be completed. Based on the description above, the authors developed a contextual learning model to improve students' MCS in fraction material.

## METHODS

This study employed R&D design with a 4D model developed by Thiagarajan, Semmel, and Semmel. The model comprises four stages: (1) define, (2) design, (3) develop, and (4) disseminate (Silalahi et al., 2021). The participants in this study were 28 second-grade students at MI Tahfidz El Muna Q (Figure 1).



**Figure 1.** 4D development stages

The Define stage facilitated Needs Analysis. At this stage, researchers conducted interviews with the second-grade teacher at MI Tahfidz El Muna Q and distributed questionnaires to the students. Interviews with the teacher included questions about the problems in the learning process, student characteristics, mastery skills, material to develop, and learning objectives. Topics covered included the learning models used, media and teaching materials, as well as student responses during learning. The analysis of student needs was carried out by distributing questionnaires to students to gather their feelings about participating in Mathematics learning.

The Design stage was product creation, specifically a contextual learning model aimed at improving MCS. At this stage, the researcher determined the learning media, the learning format, and the initial product design. The media used in this research was a contextual role-playing learning guide arranged systematically. The learning format was contextual role-playing. The initial product design involved determining the narrative or context of daily life as material for a role-playing script. The Development stage was the final production, consisting of two steps: expert validation and development trials. The developed product was validated by experts, whose suggestions were used as input for improving the product. The researcher made revisions based on the validators' suggestions. After revisions, the researchers conducted product trials. These trials were carried out with the second-grade students at MI Tahfidz El Muna Q.

The research instruments used were (1) mathematical communication ability tests, (2) product validation guidelines, and (3) practical guidelines for implementing learning. The instrument for assessing MCS is a multiple-choice test containing indicators such as (a) presenting daily events in mathematical terms, (b) formulating mathematical questions based on stories or statements, (c) connecting real objects, tables, pictures, and diagrams with mathematical concepts, and (d) explaining

mathematical situations, concepts, and relationships using real objects, pictures, tables, and graphs.

Meanwhile, the product validation guidance instrument contains indicators including (a) supporting theory, (b) learning model syntax, (c) support system, (d) social system, (e) instructional impact, and (f) reaction principle. The instrument guiding the practical implementation of learning contains indicators including (a) students' feelings towards the learning process, (b) students' interest in participating in learning using the developed model, and (c) assessment of the novelty of the developed product in learning. A product can be said to be valid if it conforms to each aspect of the predetermined indicators. The product validity criteria can be seen in [Table 1](#).

**Table 1. Criteria for the validity of the contextual role-playing learning model**

Klik atau ketuk di sini untuk memasukkan teks.

Interval score	Validity criteria	Information
$1,00 \leq X < 1,75$	Not valid	Can be used with multiple revisions
$1,75 \leq X \leq 2,50$	Fairly valid	Can be used with quite a lot of revisions
$2,50 \leq X < 3,25$	Valid	Can be used with minor revisions
$3,25 \leq X < 4,00$	Very valid	Can be used without revision

The practicality of the product can be assessed based on (1) the practicality evaluation carried out by experts and (2) the teacher's response after implementing the lesson. The practicality criteria for the product being developed can be seen in [Table 2](#).

**Table 2. Criteria for the practicality of the contextual role-playing learning model**

Interval score	Practicality criteria
$X > 85$	Very practical
$70 < X \leq 85$	Practical
$X \leq 70$	Not practical

Last, the Dissemination stage is the final stage in the 4D development model. At this stage, researchers disseminated products that have been declared valid, effective, and suitable for use by the target audience. The effectiveness of the product can be tested by analysing the scores from the mathematical communication ability test results after students receive the learning.

Testing the effectiveness of the developed product can be done by analysing scores from the MCS tests after using contextual role-playing learning. The indicator of product effectiveness is that at least 85% of students who took the test received a score of 75 or higher. The potential effect of the developed product was then tested using the N-Gain value by calculating the difference between the pretest and posttest scores for MCS ([Hake, 1998](#); [Maknun & Herman, 2024](#)).

**Table 3. N-Gain score criteria**

Criteria	Gain score
High	$0,7 < g \leq 1,00$
Medium	$0,3 < g \leq 0,7$
Low	$0 < g \leq 0,3$

## RESULTS AND DISCUSSION

The product developed in this research is a contextual role-playing learning model on fraction material. The 4D process is explained further in the following sub-sections.

### Define

The results of interviews conducted by researchers with the second-grade teacher at MI Tahfidz El Muna Q showed that the teacher experienced difficulties when explaining Mathematics content. The teacher stated that the learning model used was still conventional, relying on the lecture method. This method made students feel bored and not enthusiastic about participating in learning.

However, the teacher felt overwhelmed if every lesson used practical methods or specific media. The teacher also mentioned that the second-grade students were interested in learning that involved practical methods or specific media. MCS is one of the essential mathematical competencies that students must develop. The material studied was fractions.

Based on the questionnaire given to second-grade students at MI Tahfidz El Muna Q, it was shown that learning Mathematics has been less interesting. Mathematics was still considered a difficult subject by students.

### Design

The product developed was a contextual role-playing learning model designed to teach fractions through role-playing activities with students (Figure 2).

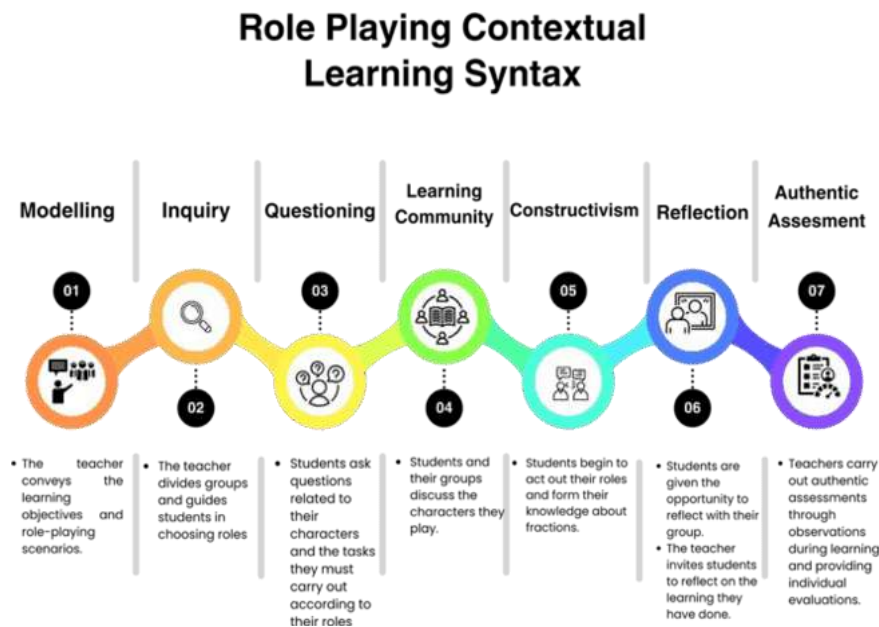


Figure 2. Steps for contextual role-playing learning

The teacher asks students to form four groups which are assigned different tasks, each group consisting of 7 students. Next, the teacher appointed a student to play the role of a birthday person. Group 1 served as the birthday cake team, group 2

served as the beverage team, group 3 served as the pizza and pastry team, and group 4 served as the documentation team. Here is one of the scripts in the role-playing, the birthday cake team (Figure 3).

**Birthday Celebration**

**Players:** Narrator, Teacher, birthday person, birthday person's friends (4 students are Zidna, Fara, Nana, and Sarah)

**Narrator:** One sunny day, May 4th, our friend celebrated his birthday by bringing a delicious cake to school. The cake was adorned with colorful frosting and sprinkles, making it irresistible to everyone who saw it. As she entered the classroom, she could not wait to share this special treat with her friends.

**Birthday Person:** "Hello friends, today is my birthday and I want to share a cake with you."

**Birthday friends (4 students):** "I want it!"

**Birthday person:** "Okay, then we will divide this cake into five equal parts." (The Birthday person cuts the cake into five equal parts). "Well, now each part of this cake is one-fifth of the whole cake."

**Teacher:** "Very good, you have divided the cake into five equal parts, and each part is one-fifth of the whole cake."

**Zidna:** "Wow, I understand now. So, if I take two pieces of cake, that means I get two-fifths of the whole cake."

**Nana:** "And if I take one piece of cake, that means I get one-fifth of the whole cake."

**Fara:** "It's fun. I can also get the same big pieces of cake as the other friends."

**Sarah:** "Thank you for sharing this cake fairly. We get an equal share."

**Narrator:** "By sharing cake with friends, they can understand the concept of fractions better and have fun."

**Teacher:** "Well done, students! You have done a good role-playing about fractions. Now, who can explain again what you have learned today?"

(Students take turns explaining the concept of fractions that they have understood through role-playing.)

**Teacher:** "Perfect. You have understood the concept of fractions well."  
So, now let's continue with practice questions so that you understand better."

**Figure 3. Role-playing scenarios**

Further, the authentic assessment given by the teacher is in the form of quiz questions with the help of Quizziz. The quiz questions are in the form of questions related to the context of birthday celebrations and food distribution in everyday life. To see students' answers, teachers use QR scan Quizziz because students are limited in using Android in boarding schools.

### **Development**

Product validation in the form of a contextual role-playing learning design is carried out by experts using a validity test sheet with predetermined validity criteria. The results of validation from experts can be used as a guideline for revising the product being developed. The results of the learning model validation are presented in Table 4.

**Table 4. Validation results of the products developed**

Aspect	Expert validation results	Information
Supporting theory	3.50	Highly valid
Model syntax	3.00	Highly valid
Social system	2.50	Valid
Reaction principle	2.50	Valid
Support system	2.5	Valid
Instructional and accompanying impacts	3.15	Highly valid

The practicality of the product in the form of a contextual role-playing learning design was tested based on practicality scores by experts and the implementation of contextual role-playing learning carried out by teachers on fraction material. The results of the practicality test can be seen in [Table 5](#).

**Table 5. Product practicality test results**

Validator	Practicality Level	Category
Expert	84	Practical
Teacher	82	Practical

The results of expert and teacher validation in [Table 5](#) show that the contextual role-playing learning developed is included in the practical category.

### Dissemination

The effectiveness of the developed product can be assessed based on the pretest and posttest scores for MCS administered to 28 second-grade students at MI Tahfidz El Muna Q. The pretest and posttest scores are documented in [Table 6](#).

**Table 6. Mathematical communication ability scores**

Indicator	MCS Score			The number of students		Percentage of completion
	Pretest	Posttest	N-Gain	Completed	Not Completed	
Presenting everyday events in mathematical terms	34.75	87.39	0.80 (High)	25	3	89.28
Formulate math questions based on stories or statements	37.67	86.67	0.78 (Medium)			
Connect real objects, pictures, diagrams, and tables with mathematical concepts	37.52	87.37	0.79 (Medium)			
Explain situations, concepts and mathematical relationships with real objects, pictures, tables and graphs	36.45	88.60	0.82 (High)			
Average score	36.64	87.50	0.79			

According to [Table 6](#), it can be seen that out of the 28 second-grade students at MI Tahfidz El Muna Q who were tested, 25 students achieved a score of  $\geq 75$ , while 3 students scored  $< 75$ . This indicates a completion rate of 89.28%. Still based on [Table 6](#), the average pretest score was 36.64, and the average posttest score was 87.50. These results demonstrate an improvement in MCS following the implementation of contextual role-playing learning. These results are in line with research conducted by [\(Hutapea et al., 2019\)](#) which shows that there is an increase in students' MCS through contextual learning which is higher than conventional learning. Testing whether contextual role-playing learning products can improve MCS is determined based on the N-gain value after testing contextual role-playing learning products for 3 meetings. According to [Table 6](#), the N-Gain value for indicators such as presenting everyday events into mathematical ideas is 0.80, and for explaining situations, concepts, and mathematical relationships with real objects, pictures, tables, and graphs is 0.82. These values indicate a high level of improvement in these areas following the implementation of contextual role-playing learning. These results are in line with research conducted by [Ahdhianto et al. \(2020\)](#) and [Dori et al., \(2018\)](#). The posttest scores of students in the experimental class with indicators for expressing everyday events in symbols or mathematical language were higher than the posttest scores of students in the control class. This is because, during learning, teachers stimulate students with context-oriented questions or problems related to everyday situations. Students are also allowed to increase interaction with peers to build their communication.

The indicator of formulating mathematical questions based on stories or statements has an n-Gain value of 0.78, which is in the medium category. The recommended learning model for improving MCS in the aspect of formulating questions based on stories or Mathematics is the Cooperative Integrated Learning Reading and Composition (CIRC) learning model. This is because the application of the CIRC model can facilitate students in reading, writing, communicating, and even arguing and debating in the classroom [\(Ariyana & Suastika, 2022\)](#). Another learning model that can improve MCS in the aspect of formulating questions is learning with the help of interactive learning video media based on Brain-based Learning (BBL). This is in line with research conducted by [Salsabillah et al. \(2024\)](#), [Solihah et al. \(2021\)](#) and [Adiansha et al. \(2018\)](#). Learning with interactive learning videos based on BBL shows an increase in MCS. This is because students who use interactive learning videos are better able to articulate mathematical understanding, ask better questions, and participate actively in class discussions. The BBL model focuses on brain performance to help students communicate mathematical concepts. When the brain functions optimally, learning becomes effective and students' thinking abilities can be active and directly involved in the learning process.

The indicator connecting real objects, pictures, tables, and graphs with mathematical concepts has an N-Gain value of 0.79, which is in the medium category. The recommended learning model to improve MCS in the aspect of connecting real objects, pictures, and diagrams into mathematical concepts is the take-and-give learning model. This is in line with the research results [\(Ningsih et](#)

al., 2022) which stated that the answers of students in the experimental class on the aspect of connecting real objects were better than the answers of students in the control class. This is because, in take-and-give learning, students carry out activities to find their partners and tell each other the questions they have obtained. Through these activities, students begin to be trained to connect images to mathematical ideas. In contrast, students in the control class did not receive this treatment. Based on the N-Gain value of the 4 indicators of MCS, the average N-Gain value was 0.79 with a percentage in the medium category, indicating that contextual role-playing learning is effective in improving students' MCS, especially in fraction material with a medium level of effectiveness.

## CONCLUSION

The product developed is a contextual role-playing learning model designed based on needs analysis and developed using a 4D development model. This role-playing contextual learning design has met the criteria for validity, practicality, and effectiveness. It has been demonstrated that the role-playing contextual learning model can enhance Mathematics learning by making it more engaging. Specifically, it improves MI students' MCS in fraction materials. Using this method requires careful preparation and effective classroom management to ensure active participation from all students. It is hoped that future research can design contextual role-playing learning that is simpler and does not require a long time to implement. This research also examines the use of contextual role-playing learning for MCS only. Future researchers are expected to be able to study contextual learning in other Mathematics competencies.

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## Development of video tutorials on building construction and utilities subjects assisted by Bandicam application for grade XI students at vocational high school

Hadi Suryono<sup>1)\*</sup>, Putu Sudira<sup>2)</sup>

<sup>1</sup>Civil Engineering and Planning Education, Engineering Faculty, Universitas Negeri Yogyakarta, Kampus Karang Malang Yogyakarta, Indonesia.

<sup>2</sup>Doctoral Study Programme of Technology and Vocational Education, Postgraduate Program, Universitas Negeri Yogyakarta, Jl. Colombo No 1 Yogyakarta, Indonesia.

[hadisuryono.2022@student.uny.ac.id](mailto:hadisuryono.2022@student.uny.ac.id)\*; [putupanji6402@gmail.com](mailto:putupanji6402@gmail.com)

\*Correspondence author

### Abstract

The implementation of Building Construction and Utilities learning for class XI in Vocational High School (VHS) has faced several challenges including student understanding, teachers' competency, and learning media. This study aims to result in a product, including the feasibility test and effectiveness on the topic of door and window frame details drawing assisted by the Bandicam application. We employed the Research and Development (R&D) model of 4D Thiagarajan. The trial was conducted on 14 students of the Building Information and Modeling Design (DPIB) expertise program class XI with input from 2 experts and 1 teacher. The data was collected through interviews, observations, and questionnaires. The obtained data was analysed using quantitative and qualitative descriptive analysis and descriptive statistics. The results show that the 4 video products were feasible and effective as seen from the improvement of student learning outcomes in the subject of building construction and utilities.

**Keywords:** 4D; Bandicam; Learning Media.

### INTRODUCTION

Among the subjects in the Building Information and Modeling Design (*Desain Pemodelan dan Informasi Bangunan/ DPIB*) expertise program for grade XI at Vocational High School (VHS) is Building Construction and Utilities (KUG). Based on the 2013 VHS curriculum, this lesson shapes students' ability to draw buildings and their components using software such as AutoCAD (Sungkar, 2023). One of the basic competencies that students must master in KUG includes the application of procedures for creating detailed drawings of door and window frames, and creating detailed drawings of door and window frames. In these competencies, students are trained to create working drawings – in particular, in the fields of Civil

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Engineering and Architecture, working drawings are produced orthographically or in multiple views (top, front, side and back views) (Syafriadi, 2023).

Accordingly, production-based learning refers to learning where schools carry out production or services as a part of the teaching and learning process (Elmunsyah & Rizza, 2018). According to Sofyan (in Rizqiyana, et al., 2023), practical learning is used to teach cognitive, affective, and psychomotor skills using laboratory or workshop facilities. It functions to train students to help them understand theory in different aspects in search for integration and application to real-life problems (Yahya, et al., 2023).

Longer time and flexibility are also needed by students who need more time to complete exercises in practical learning to reach the level of completeness. In this case, the limited time allocation stipulated in the curriculum hampers the effectiveness and student learning outcomes. There is a need for effective learning media to overcome the limitations of space, energy, and sensory power to clarify the lessons (Sapriyah, 2019). It can be said that in mastering a competency, students can add insight and complete understanding through digital literacy outside of learning in class, studio, workshop, or laboratory. Learning activities can occur even if there is no teaching activity from the teacher (Junaidi, 2019). This is in line with the statement of Bloom (Judrah, 2019) regarding the mastery learning strategy where additional time should be given to students in need or who have not mastered the lesson completely.

Based on our observations at VHS 2 Tamiang Layang, the implementation of KUG learning is carried out by the teacher by demonstrating drawing using AutoCAD, displayed through the LCD. Students further practice the material through tasks. Based on observations and experiences made by teachers, problems appear during learning to draw using AutoCAD, especially in class XI semester I. First, teachers' fatigue due to the abundant materials, in which students hardly understand quickly and remember the given instructions. The remaining lesson period is spent addressing students' difficulties individually, especially in utilising both software and hardware equipment. Second, students' learning of technical drawing in class X, which is fundamental for digital drawing, is at the bare minimum so teachers have to repeat the technical drawing material. The material includes a topic on 2-dimensional drawing. Third, teachers have never used teaching media in the form of audio-visual for conveying messages or material.

On the other hand, we regard video as a medium that can be used to channel messages and stimulate the thoughts, feelings, attention and willingness of the learner so that it can encourage a deliberate, purposeful and controlled learning process. The message presented is factual, fictional, informative, educational, and instructional (Kristanto, 2016). The use of video in learning has advantages (Febianto, 2023), in which video tutorial media can increase the active role of students in the learning process and make the learning atmosphere conducive. With visual media, students can focus and be influenced on good influence on learning outcomes. Video tutorials cannot only be seen and heard, but can also help students learn the material taught step by step (Dahliya, et al., 2022). The

availability of videos can be an alternative to learning before students embark on the workshop to practice.

The advantages of video include complete features of audio, visual and film media. It can also summarize several types of media in one program. Furthermore, video can perform various effects, present difficult and rare sources, and its use does not require a room that is too dark (Nurdiansyah, 2019). There are several characteristics that educators may not be able to do compared to video. Among the most important is the fictive feature, including its ability to store, record, preserve, and construct an event or object. This feature is important for educators because recorded events or objects can be used at any time. Second is the manipulative feature where long events can be accelerated using the time-lapse feature. There is also a slow-motion feature that can slow down a movement. Last, the distributive feature that includes media transportation through space and simultaneously the event is presented to several learners with a relative experiential stimulus regarding events that are as if involved in the event (Hasan, 2021).

Hence, this study aims at developing learning videos for KUG subjects for vocational students in class XI of the DPIB expertise program. We examine the level of feasibility of a video tutorial learning media as learning materials, especially drawing material for door and window frame details. This study sought to develop a learning media that can guide students on drawing frames, doors, and windows. The results of this study are expected to improve the teaching of KUG as a practical lesson carried out in the studio using computer equipment and the AutoCAD application.

In so doing, clear steps and stages in the video tutorial are prominent, and Bandicam is among the applications that can capture computer screens with high quality (Indra, 2022). The selection of video as a learning media is motivated by the students' low scores in KUG learning using mockups (Gunawan, 2019) and miniatures (Farhan & Kustini, 2019).

Previous studies using Bandicam-assisted videos have been carried out by Khotimah & Hasanah (2021), Cahyono (2021), Herayanti (2019), Hakim (2022), and Wijaya (2023). The difference between this research and previous studies is three-fold. First, we focus on creating teaching media in the form of videos for KUG lessons on drawing details of door and window frames. This is considered important because students of class XII DPIB in semester I should no longer learn AutoCAD material at the introduction level (Hapsari, 2022) which should have been introduced in semester I of class XI. Second, other development studies in KUG learning used SketchUp (Tarial, et al., 2022) and Microsoft PowerPoint applications (Triaghosa, et al., 2022), while this study used the Bandicam application. Third, the R&D nature of this study can enrich the treasure of information technology-based learning media in the DPIB expertise program of VHS 2 Tamiang Layang.

## **METHODS**

This study employs Research and Development (R&D) with the 4D model (Define, Design, Development and Disseminate) developed by Thiagarajan (Sugiyono, 2021). This study aims to result in a product, test its feasibility, and assess its effectiveness as a learning media. The product developed is a Bandicam-based video tutorial that will be used in the DPIB class XI VHS expertise program. The topic of making video tutorials is drawing details of door and window frames.

### **Define**

At this stage, an analysis was carried out to identify the importance of making alternative learning media that can facilitate the learning process. There are five stages of analysis at this level, explained as follows:

1. Front-end analysis  
This stage included observation, documentation, and interview techniques. Observation was conducted at the school laboratory to map out the state and condition of the tools used for practice. Documentation was to explore data related to learning objectives, learning media, time allocation, and evaluation as stated in the lesson plan and syllabus.
2. Student analysis (learner analysis)  
This analysis was carried out through direct observation including taking notes on students' learning styles, and learning conditions when KUG practice learning took place.
3. Task analysis  
This was conducted to determine the main tasks that students must master in KUG learning, especially the material for drawing details of frames, doors and windows.
4. Concept analysis  
This reflects an effort to compress the material into a tutorial comprising only necessary topics.
5. Formulation of learning objectives (specifying instructional objectives)  
This includes the expected learning objectives in the form of changes in student behaviour, determined through several indicators as learning results.

### **Design**

In this stage, we designed video tutorial products to be developed through four steps:

1. Criterion test (criterion test-construction)  
This step traced students' initial ability and ownership of computers or smartphones. A questionnaire technique was used.
2. Media selection  
This stage identified students' existing problems in learning, the number of students, their initial ability, and the time allocation to smartphone ownership. Upon completion of this level, we chose the media in the form of videos that

were arranged specifically, interactively, and in detail to resolve the problems that existed at VHS 2 Tamiang Layang.

3. The selection of media forms (format selection)

This stage was to select the type of media to use, which was video tutorials. It consists of four practical jobs for the material of drawing details of door and window frames.

4. Initial design

In this stage, we determined the flow, plot, storyboard, and material to be included in the video, both in the main and supporting applications. Materials that are considered at this stage are in the form of presentation and media accessibility by students.

Further, we created videos as basic materials. We collected hardware tools consisting of 1 unit of laptop brand Acer screen 15.5 "core i3 spec and genius brand headset. For software, we prepared the AutoCAD 2017 application as the main simulation tool, and the Bandicam 2023/v6.1.0.2044 application as the main recording application (recording and dubbing). Microsoft PowerPoint 2013 and Video Editor were also utilised as additional applications. Meanwhile, Microsoft PowerPoint was used as an intro and outro video; and the video editor functioned as an editing tool, such as connecting, cutting, and uniting all scenes to include musical illustrations in the background.

### **Development**

The development stage underwent two levels, namely: expert appraisal (to assess the feasibility of product design by experts) and development testing. At the expert appraisal, media experts and material experts were invited to evaluate the feasibility and instruments. The media expert was a practitioner and founder of PT Inspira Televisi Indonesia in Bandung, M. Tri Harmoko, S.IP., M.M. He is proficient in assessing the aspects of video effectiveness in terms of media quality, flexibility of media ease of use, presentation appearance, and media management. Meanwhile, the material expert was Mrs. Wenni Murfihenni, S.T, M.Pd., as an Associate Expert Widyaaiswara, also the head of the Civil Engineering and Planning Department at the Bandung Vocational Education Quality Assurance Development Center for Mechanical and Industrial Engineering (BBPPMPV-BMTI). The material expert was tasked to validate the video in terms of suitability of objectives, learning materials, presentation, and motivating quality.

In the development testing level, responses were obtained from teachers and students. Responses from teachers were assessed by Mr. Anyari Syaifun, S.T. who teaches KUG subjects at VHS 2 Tamiang Layang. The teacher assessed the video on aspects of learning objectives, learning material, media conciseness, motivating ability, video quality, media use, appearance, and ease & comfort of using the video. The development trial from students was carried out through a limited trial (small group) of 3 students from class XI DPIB.

The results from material experts, media experts, and limited-scale teacher and learner trial data were used to make product revisions for the perfection of the video

media produced. The broad-scale trial was carried out on XI DPIB class students through a performance test to determine the learning outcomes of students, including pretest and posttest.

### Disseminate

The dissemination stage comprised: a) validation testing; b) packaging; and c) diffusion and adaptation. The validation testing stage was carried out in the form of instrument trials. After stage I revision, the product was widely tested again on one class of 14 students to determine its efficiency. Meanwhile, the packaging and diffusion, and adaptation stages were to finalise the product prior to submission. Video products in MP4 format were stored on a computer hard disk in the DPIB drawing laboratory.

The techniques used were observation, interview, and questionnaire. Interviews and observations were performed at the analysis stage to obtain data related to the implementation, teaching media, and student responses. On the other hand, the questionnaire was distributed to configure needs analysis in the early stages of research. A different form of questionnaire was also administered for validation from media experts, material experts, and users in small ( $n=3$ ) and large ( $n=14$ ) groups at the evaluation stage. The small group filled out the questionnaire after being validated by the expert while the large group filled out the questionnaire after the second stage of product revision. The test of product effectiveness in large groups was needed in a one-group pretest-posttest design type experiment (Hikmawati, 2020).

Hence, both qualitative and quantitative data were generated. Qualitative data was in the form of suggestions, reviews, and input from material experts, media experts, and users (teachers and students). They were analysed descriptively to make product improvements. The quantitative data was analysed through the following procedure (Table 1):

1. Calculating the average score of video feasibility.

$$\text{Mean score} = \frac{\sum x}{n}$$

2. Transforming the average score into qualitative criteria

This step refers to the assessment criteria guidelines

$S_{bi}$  = ideal standard deviation

$$= \frac{1}{6} \times (\text{ideal maximum score} - \text{ideal minimum score})$$

$$= \frac{1}{6} \times (4 - 1) = 0.5$$

**Table 1. Assessment criteria for media experts and material experts**

Score range	Average score	Classification of eligibility
$X \geq X_i + 1 \cdot S_{bi}$	$X > 3$	Highly feasible
$X_i + 1 \cdot S_{bi} > X \geq X_i$	$3 > X \geq 2.5$	Eligible
$X_i > X \geq X_i - 1 \cdot S_{bi}$	$2.5 > X \geq 2$	Less feasible
$X < X_i - 1 \cdot S_{bi}$	$X < 2$	Not feasible

Description:

$$X_i = \frac{1}{2} (\text{maximum score} + \text{minimum score})$$

$$S_{bi} = \frac{1}{6} (\text{maximum score} - \text{minimum score})$$

3. Analysis of student learning outcomes by calculating the percentage of learning completeness then converted into qualitative criteria by referring to the assessment criteria guidelines. Analysis of learning outcomes is carried out with the following steps:

a) Calculating the percentage of completeness of student learning outcomes based on the Minimum Completeness Criteria (MCC) scores at school. The following is the frequency of student learning outcomes based on MCC in [Table 2](#).

**Table 2. Frequency of student learning outcomes**

No.	value	Frequency (f)
1	≥ 75	Number of students who are complete
2	< 75	Number of students who did not complete

Description:

$$\% \text{ of completeness} = \frac{\sum \text{Number of students who are complete}}{\sum \text{Number of students who did not complete}} \times 100\%$$

$$\% \text{ of non-completion} = \frac{\sum \text{Number of students who did not complete}}{\sum \text{Number of students who are complete}} \times 100\%$$

b) Changing the percentage of student learning outcomes completeness into qualitative criteria refers to the assessment criteria guidelines.

**Table 3. Student learning completeness interval**

No.	Interval	Criteria
1	0 – 39 %	Very low
2	40 – 59 %	Low
3	60 – 74 %	Moderate
4	75 – 84 %	High
5	85 – 100 %	Very high

4. The success indicators for the feasibility of video tutorial products are shown in [Table 4](#).

**Table 4. Product success indicators**

Research category	Score range	Criteria
Expert opinion	X > 65%	≥ worth
Student learning outcomes	X > 65%	≥ medium completeness
Student learning interest	X > 65%	≥ interested

The subjects in this study were material experts, media experts, and users. The video feasibility test was carried out through the feasibility test of material experts and media experts.

## RESULTS AND DISCUSSION

### Results

The products successfully developed in this study are 5 tutorial learning videos for KUG lessons assisted by the Bandicam application. The videos can improve students' practical learning outcomes in the competency of drawing details of frames, doors and windows using the AutoCAD application. The development product that has reached the implementation stage and has been revised can be accessed via the YouTube website at <https://www.YouTube.com/watch?v=iNTU0SYUVVE&list=PL2yp4PiHYTwXasyV1GzZj6VS5HTU3wX4y&pp=gAQBiAQB>.

### Define Stage

In this analysis stage, researchers conducted preliminary research using observation and interview instruments. This activity includes:

#### 1) Front-end analysis

The front-end analysis conducted was to review the lesson plans. The document used by the KUG subject teacher was prepared based on the KI/KD of the DPIB Expertise Programme. The learning objectives include core competencies and basic competencies, in which students can apply and create 2-dimensional drawings of building construction. The drawings of building components were taught and trained to students gradually and sequentially according to the learning stages. One of the basic competencies is applying procedures to create detailed drawings of door and window frames, following the nature of KUG as a practical subject.

The questionnaire result shows that out of 15 students, 46% did not understand the parts of frames, doors and windows, while 43% did not understand the width and height of standard door frames. Further, 46% did not understand the height and width of standard window frames, and 29% did not understand how to draw standard doors and windows. Interestingly, 80% could not distinguish between standard door frames and carrying types.

The observation reveals that the availability of practical tools including laptops, mouse, headsets, software applications for drawing purposes, and multimedia applications are well installed with sufficient numbers and in good condition. A total of 100% of students have smartphones but only 70% can access the internet.

#### 2) Learner Analysis

The observation results reveal that 80% of students do not have laptops or PCs that can be used for practice at home, hence learning objectives could not be achieved. The time allocation for practice only relies on the studio facilities owned by the school. This is at odds with students' high motivation to learn as seen from students' attendance in weekly lessons.

Based on discussions with the teacher, the learning material was displayed using the LCD. This method exhausted the teacher. Some students are unable to complete the task until the lesson ends because they have to queue for teachers' explanation

of who was serving other students. Personal learning media provides a solution where students can be more independent and teachers can be facilitators.

### 3) Task Analysis

The lesson aims at equipping students with the ability to draw door and window frame details. The students are also expected to show cognitive ability, such as explaining: (a) the components of the frame, (b) the dimensions of the frame, (c) the steps for drawing standard and carrying door frames, (d) the thick dimensions of wooden panel door leaves, (e) the thick dimensions of wooden window leaves, (f) redraw wooden door frames, (g) redrawing wooden window frames, (h) redrawing wooden door leaves, and (i) redrawing wooden window leaves.

### 4) Concept Analysis

At this stage, the concepts taught were narrowed down to material in the video tutorial on drawing wooden doors and window frames. The material comprises the following: (a) the process of drawing a standard-size single door frame & leaf, (b) the process of drawing a single wooden door frame & window leaf, and (c) the process of drawing a wooden door and window leaf frame.

### 5) Specifying Instructional Objectives

Students' learning behaviors were expected to change positively at this stage. The indicators of competency achievement and attained learning objectives include students' ability to: (1) draw standard size single door frames & leaves properly and efficiently, (2) draw standard size single door frames & leaves properly and efficiently, (3) draw a wooden door and window type frames properly and efficiently.

## **Design Stage**

The process of designing the initial learning media products in the form of video tutorials was explained in five stages as follows:

### 1) Criterion test

While 48.8% of students do not understand the knowledge and skills related to the material of drawing details of door frames and shutters, personalized media is needed to learn independently both in the school studio and at home.

### 2) Media selection

Because 80% of students have phones and can access the internet, the researchers decided to use video as a media and learning channel.

### 3) Selection of media presentation form

Next, video tutorials were tailored as a proper learning medium for instructions in drawing details of door and window frames. The tutorials were stored on the school PC so that students could listen to them between practices. For special considerations, videos can also be viewed by students via YouTube where students have ample opportunities to access learning materials from anywhere.

### 4) Simulate the steps in the media to be created

The learning video is summarized in Figure 1.

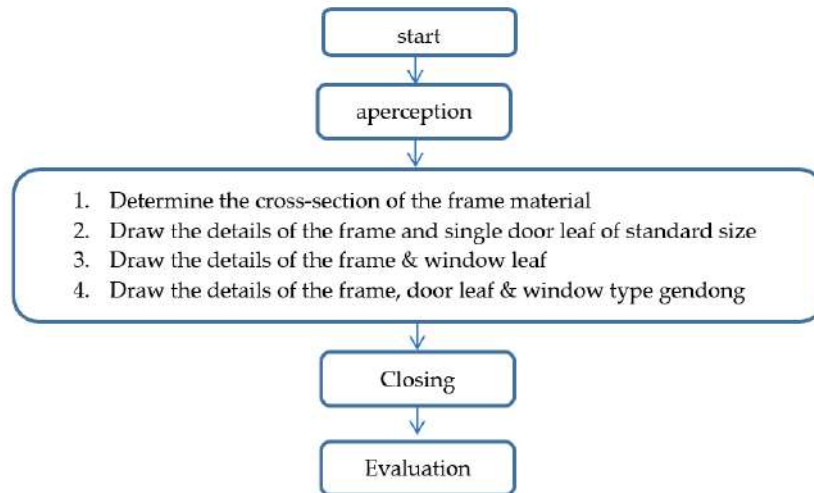


Figure 1. Steps in making media at the design stage

**Development stage**

The development stage resulted in four videos with the longest duration of 17.52 minutes and the shortest is 7.07 minutes. In the development stage, several steps were taken related to the video material presented including (Table 5):

1) The results of the assessment from media experts:

**Table 5. Media expert assessment results**

No	Aspects	Number of items (n)	Score (x)	$\bar{X}$
1.	Video Quality	3	12	$\bar{X} = \Sigma x/n$ $= 55/15$ $= 3.67$
2.	Use of media	2	7	
3.	View	6	24	
4.	Learning video	4	16	
<b>Total</b>	$\Sigma$	<b>15</b>	<b>55</b>	

The average score of video feasibility is 3.67 which is in the range of scores  $x > 3$ , categorised as highly feasible. Suggestions for improvement from media experts to eliminate the *Activate Windows* on the screen and add a video description in the description column. Furthermore, the media expert suggested that the name of the researcher as the video maker be included in the video text to avoid author obscurity, especially if the video is allowed to be downloaded. It was concluded that the media was feasible to test upon revisions.

2) Results of the material expert assessment are presented as Table 6.

**Table 6. Material expert assessment results**

No	Aspect	Number of items (n)	Score (x)	$\bar{X}$
1.	Learning Objectives	5	20	$\bar{X} = \Sigma x/n$ $= 76/20$ $= 3.8$
2.	Learning Materials	5	16	
3.	Presentation	6	24	
4.	Motivating Qualities	4	16	
<b>Total</b>	$\Sigma$	<b>20</b>	<b>76</b>	

The average score of video feasibility is 3.8 which is in the score range  $x > 3$ , categorised as highly feasible. The material expert suggested changes, including (a) the part text at the beginning of the video covering the description text, (b) the cut line for doors and windows that did not match the standard depiction of architectural standards, (c) size notation, cut text was not following the standards issued by the PUPR ministry, and (d) not yet equipped with practice questions. It was concluded that the media was feasible to test upon revisions.

3) The results of the user test from the teacher are presented as [Table 7](#).

**Table 7. Results of instrument testing by teachers**

No	Aspect	Number of items (n)	Score (x)	$\bar{X}$
1.	Learning objectives	5	15	
2.	Learning material	5	16	
3.	Media conciseness	6	24	
4.	Motivating qualities	4	16	$\bar{X} = \Sigma x/n$
5.	Video quality	3	12	$= 131/35$
6.	Use of media	2	8	$= 3.74$
7.	View	6	24	
8.	Learning Video	4	16	
<b>Total (<math>\Sigma</math>)</b>		<b>35</b>	<b>131</b>	

4) The results of the limited trial from 3 students are presented as [Table 8](#).

**Table 8. Results of a limited trial of instruments by students**

No	Aspect	Number of items (n)	Score (x)	$\bar{X}$
1.	Quality of material content	14	47	
2.	Learning Quality	11	37	$\bar{X} = \Sigma x/n$
3.	Quality of communication	14	46	$= 146/44$
4.	Use of media	5	16	$= 3.32$
<b>Total (<math>\Sigma</math>)</b>		<b>44</b>	<b>146</b>	

The average score of video feasibility is 3.32 which is in the range of scores  $x > 3$ , categorised as highly feasible. The video before revision is on the YouTube channel page which is managed independently by the researcher <https://www.YouTube.com/watch?v=EJDdEVkFN50&list=PL2yp4PiHYTtwVHI9Qhr2jiQsjeQhjB8Hxx&index=4>. The results of the assessment were utilised to improve the learning video being developed.

5) The next stage is to make revisions related to the videos on the Stage I revisions. Further improvements are made based on suggestions from media experts and material experts. The number of videos increased to 5 pieces with the shortest duration of 7.54 minutes and the longest of 19.38 minutes.

6) To obtain the results of revision I, a broad-scale trial was conducted to determine the effectiveness of the learning video through a practical test. The wide-scale trial was

conducted on a larger group using the AutoCAD application. The duration of the test was 3 x 45 minutes, and the results are presented as Table 9.

**Table 9. Results of a wide-scale trial of class XI DPIB students**

No	Test material	Average pretest	Average posttest	Learning progress
1	Drawing of door and window frames of the spindle type	68,66	95,58	26.62

The results show that before using the media, the average student learning outcome (pretest) on June 17, 2023 was 68.66%. Then, students were given an internet link to watch the revised video tutorial through the YouTube channel. On June 19, 2023, a posttest was conducted and the average learning outcome was 95.58%. When referring to the acquisition of student learning completeness, it is classified as very high. The existence of media in the form of video tutorials can improve student learning outcomes by 26.62% compared to not using media.

- 7) After the test, students were asked to rate the video tutorial and the results as Table 10.

**Table 10. Results of student assessment of video tutorials**

No	Aspect	Number of Items (n)	Score (x)	$\bar{X}$
1.	Quality of material content	14	47	$\bar{X} = \Sigma x/n$ $= 151/44$ $= 3.43$
2.	Learning Quality	11	38	
3.	Quality of communication	14	48	
4.	Use of media	5	18	
<b>Total (Σ)</b>		<b>44</b>	<b>151</b>	

The average score of video feasibility is 3.43 which is in the range of scores  $x > 3$ , categorised as highly feasible.

### Disseminate Stage

After the product has been validated and revised, it can be used as learning media in KUG lessons. At this stage of dissemination, a series of videos in MP4 format was then duplicated in the form of soft copies stored in a stand-alone PC belonging to the DPIB laboratory/studio/workshop at VHS 2 Tamiang Layang. This has made the product accessible to students and wider interests. The video tutorials can also be viewed on the YouTube channel.

### Discussion

This study at least produced several findings. First, the video tutorial developed with the help of the Bandicam application is considered suitable for use in learning the practice of drawing details of frames, door leaves and window leaves. This confirms Sumantri's statement that video tutorials have the function of guiding the audience on how to explain something, both learning materials or training presented in the form of media to make an explanation of the material easier (Rifandi, et al., 2020).

This study is also in line with the three advantages of using videos in learning as stated by Hasan (2021). First, it has a fixative characteristic which is the ability to record scenes that can be watched at any time. The research video results can be accessed both at school and at home. The second, manipulative characteristic has made the video to be accelerated or vice versa. The product meets both of these capabilities. The third, distributive characteristic is that the video can be distributed to students directly and have relative experience as if involved in the events and experiences.

Second, the effectiveness of this video in improving student learning outcomes is proven by the increase in post-test scores compared to the pre-test. This is in line with Bloom's comprehensive learning strategy, where everyone can learn anything well if they receive quality learning and sufficient time (Judrah, 2019). If students are unable to understand the learning in the classroom, then students should look for other learning resources outside the classroom or studio that have very diverse forms. As long as the learning resource is relevant to the learning objectives, it can be used as the main learning resource.

Third, the dominant use of AutoCAD software in KUG learning, one of which is drawing detailed construction of door and window frames, is used as the basis for making video tutorials as learning media. The presentation of material in the video is chosen based on the complexity of the scope and character of the KUG subject. The products developed are easily accessible to students because they can be watched online via the YouTube channel or offline via a stand-alone PC in the VHS 2 Tamiang Layang drawing laboratory. This follows Fikri's (2018) opinion that the characteristics of learning videos provide convenience and completeness of content so that users can use the media without guidance from others. Nabila's (2022) research regarding the practicality of use also denotes the same. Research on the use of videos that have elements of practicality or are easy to use as learning media was also carried out by Titania (2020) who studied the use of animated videos for productive learning in DPIB expertise program vocational schools which indirectly supports this research.

The results of this study support previous studies that utilise learning media in the form of Bandicam-based videos. Among them is a class action research conducted by (Khotimah & Hasanah, 2021) which examines the application of Bandicam media with a realistic approach to improve student learning outcomes in class XI Islamic religious education subjects at SMA Negeri Plandaan Jombang. The results of another study (Cahyono, 2021) with an experimental method entitled "The Use of Bandicam Application-Based Learning Videos in Graph Theory Courses to Improve Student Abstraction Ability". Both studies produced findings that the use of videos can improve student learning outcomes and learning using videos is better in learning than not using videos.

Another study supported by this development is an experiment by Herayanti (2019) who conducted a 4D and ADDIE model development research entitled "Learning to Design Houses Using Audio Visual Media by Utilizing Bandicam" and research from Hakim (2022) entitled "Optimising Bandicam in the Making of Video Presentations for Interactive Static Fluid Materials". The two development studies resulted in 100% classical completeness of student learning in home design learning and the results of

Physics learning using videos were able to increase student interest, attractiveness, and participation in learning Physics about static fluid material. Previous research that also utilises Bandicam is development research (Wijaya, et al. 2023) with the title "Development of Video Tutorials AutoCAD Learning in Software Applications and Building Interior Design Lessons With 4D Development Model". The results of the study state that video tutorials in AutoCAD learning can be done based on the assessment of lecturers and teachers.

From the results of this research and development, video tutorials for vocational students in Class XI of the DPIB expertise program for Building Construction and Utilities subjects, especially the material for Drawing Detailed Door and Window Frames, are suitable for use. The feasibility is shown by a series of small-scale and broad-scale trials involving media experts, material experts, teachers, and student responses. This research lends strong support to previous research that produces findings on the effectiveness of media in the form of videos in classroom learning to improve student learning outcomes.

## CONCLUSIONS

Research and development of video tutorials on KUG learning has been carried out through the stages of the 4D Thiagarajan development model. The products developed by researchers can be used to support learning and have been proven effective in improving the learning outcomes of class XI DPIB students. The video content focuses on the material of drawing details of door and window frames, considering the many difficulties experienced by teachers and students in studio learning on this competency. The assessment of media experts, material experts, teachers and students on the product is appropriate. Overall, researchers have carried out revisions suggested by experts, teachers, and students. Regarding the existing shortcomings, researchers suggest further development of this research, especially in terms of the duration which is too long.

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## Implementation of augmented reality herbarium malangensis website tour to enhance conservation literacy

Murni Sapta Sari<sup>1\*</sup>, Deny Setiawan<sup>1</sup>, Umi Fitriyati<sup>1</sup>, Zahra Firdaus<sup>1</sup>, Dinar Arsy Anggarani<sup>1</sup>, Claesia Tsany Kusmayadi<sup>1</sup>, Maisuna Kundariati<sup>1</sup>

<sup>1</sup>Department of Biology, Faculty of Natural Science and Mathematics, Universitas Universitas Negeri Malang, Jalan Semarang 5 Malang, Indonesia

[murni.sapta.fmipa@um.ac.id](mailto:murni.sapta.fmipa@um.ac.id)\*; [setiawan.fmipa@um.ac.id](mailto:setiawan.fmipa@um.ac.id); [umi.fitriyati.fmipa@um.ac.id](mailto:umi.fitriyati.fmipa@um.ac.id); [zahra.firdaus.2203418@students.um.ac.id](mailto:zahra.firdaus.2203418@students.um.ac.id); [dinararsys@gmail.com](mailto:dinararsys@gmail.com); [claesia.tsany.2203418@students.um.ac.id](mailto:claesia.tsany.2203418@students.um.ac.id); [maisunakundariati@gmail.com](mailto:maisunakundariati@gmail.com)

\*Correspondence author

### Abstract

The biodiversity of Indonesia showed by the numerous of plant species, including one of the 89,326 species of spore plants. Along with the high diversity of various threat factors that will affect the status of a plant, knowledge about plants can be enhanced through conservation literacy using modern technology-based learning media, such as 3D modeling and augmented reality (AR) websites. AR acts as an interactive window that opens the view of conservation reality. The aim of this research is to produce a rare plant learning media product in the Bromo Tengger Semeru National Park that exists on the Malangensis Herbarium with the integration of 3D modeling websites. The method used is R&D, referring to the ADDIE model. The practicality test results obtained 91.54%, while the media effectiveness test showed with n-gain scores obtaining a result of 0.66 that media can improve conservation literacy skills in biology students of the State University of Malang. This research could provide a benchmark and literature for advanced media development on plant divisions other than Pteridophyte.

**Keywords:** Website; Herbarium; Conservation Literacy.

### INTRODUCTION

Indonesia harbors an exceptional richness of plant biodiversity. KPPN/Bappenas reports around 89.326 species of spore-bearing and 19.232 species of flowering plants thriving within its borders. Among this vast array of flora, the Pteridophyta, or ferns, stand out with a remarkable 2,197 species, representing 21% of global Pteridophyta diversity (Windari et al., 2021). Over 4,000 species of Pteridophyta are distributed across Indonesia. This remarkable diversity of Pteridophyta is directly proportional to the level of conservation threat. Several factors, including exploitation, illegal logging, forest conversion, poaching, and illegal trade, pose significant threats to these plants (Leksono et al., 2021). Extinction awareness has been noted in 7,365 species of flowering plants and Pteridophyta in Indonesia, representing 34.4% of the total plant diversity.

The escalating biodiversity crisis poses a severe threat to the ecosystem stability and sustainability of human well-being (Pietro et al., 2019). Generation Z, born between 1997 and 2012, encounters a direct consequence of this crisis, presenting a lack concern of the

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conservation awareness (Djafarova & Bowes, 2021). Conservation literacy enables Generation Z to make informed decisions that promote sustainable practices and protect biodiversity (Wallis & Loy, 2021) to continue conservation strategies.

Conservation literacy, as defined by Aripin et al., (2021), encompasses an individual's ability to comprehend and communicate effectively regarding biodiversity. This aptitude extends to the application of acquired knowledge to address biodiversity-related challenges. Conservation literacy fosters a heightened awareness and sensitivity, enabling individuals to make informed decisions grounded in scientific reasoning (Agustiani & Imtihana, 2023). The significance of conservation literacy within environmental education lies in its ability to bridge the gap between scientific understanding and environmental stewardship (Yuniawan et al., 2023). The formation of conservation character is ultimately shaped by the cumulative actions of students (Fauzi et al., 2021).

The Herbarium Malangensis nestled within the Department of Biology at Universitas Negeri Malang curated under the auspices of BRIN. The herbarium consists of hundred specimens spanning the Pterydophyta, Gymnospermae, and Angiospermae from Malang Raya area and selected area across Java Island. This valuable resource serves as a wellspring of knowledge for students seeking to delve into the intricacies of plant diversity. However, the aftermath of the COVID-19 pandemic has cast a shadow over the herbarium's collection, rendering many specimens susceptible to damage. Concurrently, a pressing need has emerged to revamp pedagogical approaches, emphasizing plant diversity and conservation threats within a contextual framework. Yudiyanto et al. (2020) advocate for the integration of contextual approaches to instill conservation consciousness in students. The adoption of augmented reality presents a compelling solution to revitalize Herbarium Malangensis, ensuring the sustainability as facilities for education, research, and botanical advancement.

Technology-driven learning tools such as augmented reality have emerged as transformative gateways to the world of conservation (Setiawan et al., 2022). Augmented reality seamlessly blends the virtual and real world by immersive, interactive, and seemingly tangible experiences (Firdaus et al., 2022). Augmented reality learning media facilitates the comprehension and application of conservation principles in the real contexts (Geng et al., 2019).

The advent of augmented reality herbarium tour websites has ushered in a new paradigm within botanical education, seamlessly merging cutting-edge technology with scientific content to deliver an immersive and profound learning experience (Erbas & Demirer, 2019). These innovative platforms enrich the visual representation of plant species by incorporating interactive digital information of conventional encyclopedias and adding a new dimension to botanical exploration. Augmented reality transforms two-dimensional plants specimens into three-dimensional models, facilitating more immersive learning experience (Arslan et al., 2020a). Augmented reality promotes a deeper understanding of plant morphology, enabling students to grasp plants structural and functional contents (Khan et al., 2019).

Technology-driven media promote deeper engagement and knowledge retention in education by exploring and manipulating plants model by learning media interactions (Firdaus et al., 2022). Augmented reality encyclopedias effectively enhance conservation

literacy among students (Yuniawan et al., 2023). Integrating augmented reality into botanical education empowers students to address environmental conservation challenges, especially in the global significant reduction of biodiversity (Fauzi et al., 2019). This study aims to assess the effectiveness of Herbarium Malangensis website tours in enhancing student's conservation literacy.

Several research and development efforts in electronic media have been dedicated to creating encyclopedias (Bunga, 2017; Mulia et al., 2019), video (Kant, 2016), game (Calvi et al., 2018; Pfirman et al., 2021). The efficacy of these learning tools in fostering positive learning outcomes has been well-documented. Additionally, notable research advancements have been made in the development of AR-based learning media, as exemplified by the works of Arslan et al., (2020) in biology education, Zhou et al., (2020) in the context of microscope usage, Garcia-Bonete et al., (2019) in the living organism structure. However, a conspicuous gap exists in the development of augmented reality learning media tailored to the topic of rare plants, particularly those belonging to the Pteridophyte. This is important to refine the learning process, leading to enhanced student outcomes, particularly in augmenting conservation awareness for rare Pteridophyta species.

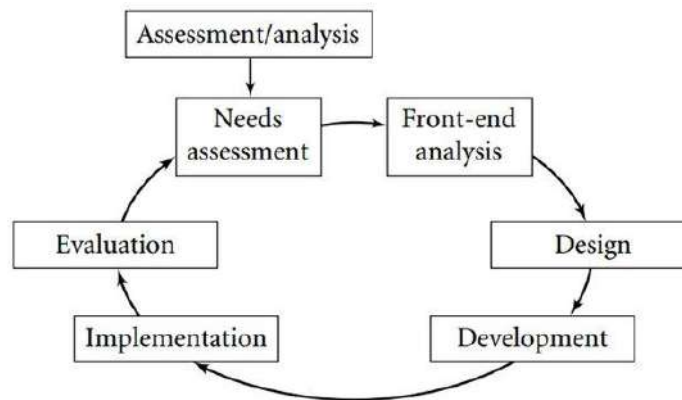
## METHODS

### Research model

This study is research and development (R&D) guided by the Lee and Owens model (Lee & Owens, 2004). The aim of the study is to produce digital learning media products for the Herbarium Malangensis Website Tour with the integration of augmented reality. Augmented reality helps visualize plants in three dimensions, which is expected to make learning more engaging, meaningful, and have positive impact on student learning outcomes. Data for this study comprised both quantitative and qualitative data. Qualitative data included Herbarium Malangensis collection profile and product improvement feedback from validators and users. Quantitative data, on the other hand, consisted of the results of pre-test and post-test assessments of students' conservation literacy.

### Research and development steps

This study consisted of five phases: analysis, design, development, implementation, and evaluation (Figure 1). The first phase is analysis, involved identifying learning need and objectives related to plant diversity, regard on Herbarium Malangensis collection. Based on this analysis, the researchers designed the curriculum and learning content. The second phase is design, aimed to develop the research and development framework and targets.



**Figure 1. Lee and Owen stages**

The third phase is development and implementation, aimed to create an Herbarium Malangensis Website Tour, incorporating animations and educational game featuring herbarium specimens based on 3D website models and augmented reality. The Herbarium Malangensis Website Tour was introduced to students to gather feedback on its use in learning. The implementation was conducted with one class of Biology Education students. The class was selected through purposive sampling with the criterion being Biology Education students enrolled in a course in the Botanical Course. The fourth phase is the evaluation phase, which consists of Level 1: Reaction and Level 2: Knowledge. The first step involves face validity, conducted by media experts, followed by content validity carried out by subject matter experts, practitioners, and instructional device validators. In the evaluation of Level 1: Reaction, concurrent validity is performed with 10 Biology Education students enrolled in a Botanical Course. This step aims to test the revised version of the media and gather user feedback. Level 2: Knowledge is assessed through construct validity using a quasi-experimental design with an experimental class and a control class to test the media's effectiveness. This stage aims to evaluate the outcome of the media revisions and its overall effectiveness. The process includes a small group trial to assess practicality and a field trial involving pre-test and post-test assessments of conservation literacy.

### **Instrument and research subject**

The research instruments employed in this study included expert validation questionnaires, Course Outlines (SAPs), and conservation literacy essay tests. The conservation literacy essay tests covered aspects of species habitat, benefits, conservation status, and conservation management. The tests were administered in the form of a pretest at the beginning of the learning session and a posttest at the end. To minimize data bias, students were encouraged to complete the tests objectively.

### **Data collection**

The first phase involved survey and profiling specimens at the Herbarium Malangensis. Second, to acquire scientific and traditional knowledge about plants, interviews were conducted with botanical experts and online material was explored. Third, validation of media and material experts was obtained from validator lecturers. Validation criteria use likert scale, the Likert scale is as follows: a score of 5 indicates "very valid," a score

of 4 indicates "valid," a score of 3 means "fairly valid," a score of 2 means "less valid," and a score of 1 means "very invalid", then compared with the criteria by (Tegeh et al., 2014) in Table 1.

**Table 1. Validation criteria**

Percentage (%)	Qualification	Explanation
90-100	Very good	No revisions
75-89	Good	Slight revision
65-79	Enough	Revised sufficiently
55-64	Less	Many things have been revised
1-54	Very Less	Repeated making the product

Fourth, feedback was collected from students regarding the Herbarium Malangensis website tour.

Data gathered from participants' activities and interactions with the application was analyzed to assess the effectiveness of the Herbarium Malangensis website tour media in assisting students in understanding plant conservation. Effectiveness was determined from pretest-posttest results analyzed using the n-gain score formula. The n-gain score formula is as follows: The equation to calculate the standard gain equation is as follows (1):

$$g = \frac{\text{Posttest Score} - \text{Pretest Score}}{100 - \text{Pretest Score}} \quad (1)$$

The results of the data analysis are interpreted and concluded based on the criteria for the effectiveness of the learning media. These criteria reflect the alignment between the theoretical framework and the development of the instructional media. The effectiveness criteria are presented in Table 2.

**Table 2. The effectivity criteria**

Percentage (%)	Qualification
$\langle g \rangle \geq 0,7$	High effectiveness
$0,3 \leq \langle g \rangle < 0,7$	Moderate effectiveness
$\langle g \rangle > 0,3$	Low effectiveness

## RESULT AND DISCUSSION

### Practicality

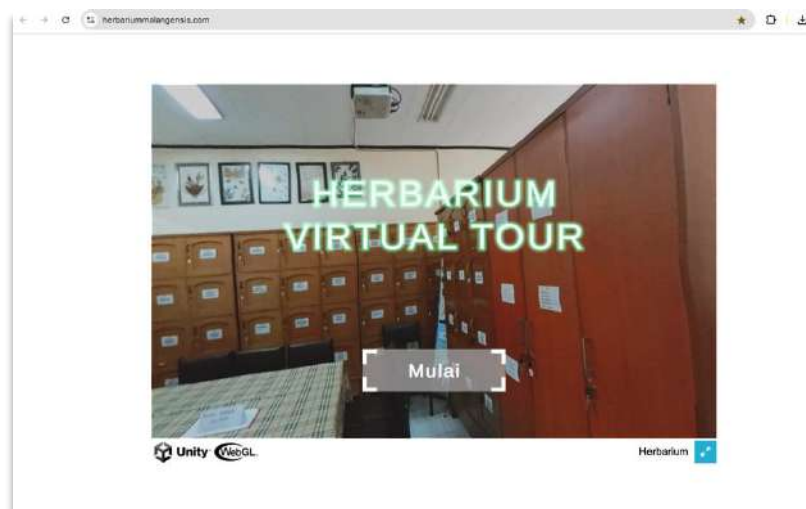
The research and development process follows the Multimedia-Based Instructional Design model (Lee & Owens, 2004) with the aim of producing a learning media product that is valid, practical, and effective. First step is analysis, The analysis phase is divided into needs analysis and front-end analysis. Interviews were conducted with the lecturer responsible for the Botany course. It was found that botany instruction faces challenges in representing 3D forms of plants that are difficult to find in the environment or are rare species. Therefore, a media solution is needed to facilitate the learning process. In the front-end analysis phase, it was determined that the target audience consists of Biology

Education students at Universitas Negeri Malang. They possess basic technology skills and have devices that are compatible with the use of website and augmented reality. The second stage is design, in this phase both media design and content design are developed. The media design involves creating a storyboard to serve as a guide for the media development process. The content design is aligned with the Biology Education Course Outlines (SAPs).

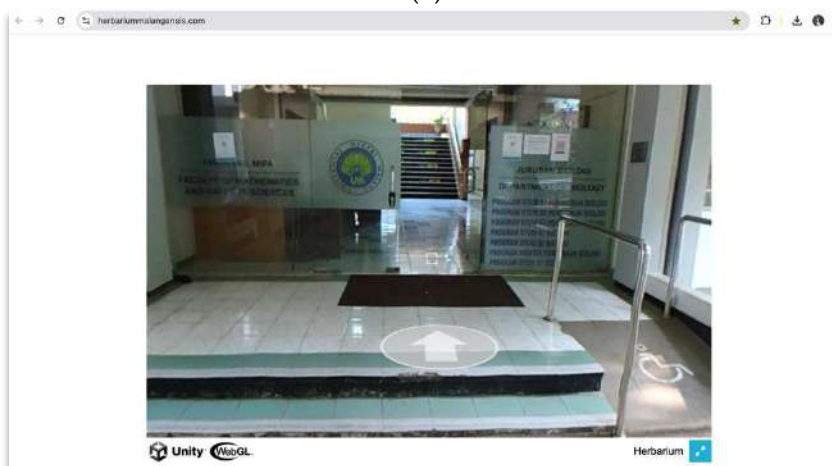
The development of virtual media based on augmented reality (AR) holds great potential in overcoming instructional limitations in representing three-dimensional plant species that are difficult to find in the real environment or are endangered. [Tegeh et al \(2014\)](#) explained that augmented reality and virtual learning provide interactive and immersive experiences that enhance students' understanding of real-world objects. This is particularly relevant in conservation education, as virtual learning can effectively communicate the preservation of rare species ([Lai et al., 2019](#); [McMillan et al., 2017](#)). The development of the Herbarium Malangensis website, the integration of augmented reality offers students the opportunity to access information about plant biodiversity more comprehensively and in greater depth. The use of augmented reality as part of the virtual tour not only enhances the learning experience but also allows for visual exploration that supports conservation literacy ([Lo & Tsai, 2022](#); [Meng et al., 2024](#)).

The third stage is development and implementation. The media development is conducted in two stages: the creation of media assets and the development of the website. The 3D assets are created using Blender, while the media is developed using Unity and uploaded to a hosting service, resulting in the website link [www.herbariummalangensis.com](http://www.herbariummalangensis.com). The implementation phase is conducted in a small class setting through a practicality test involving 10 student respondents. This is followed by an effectiveness test conducted with a single class of 22 Biology Education students from Universitas Negeri Malang.

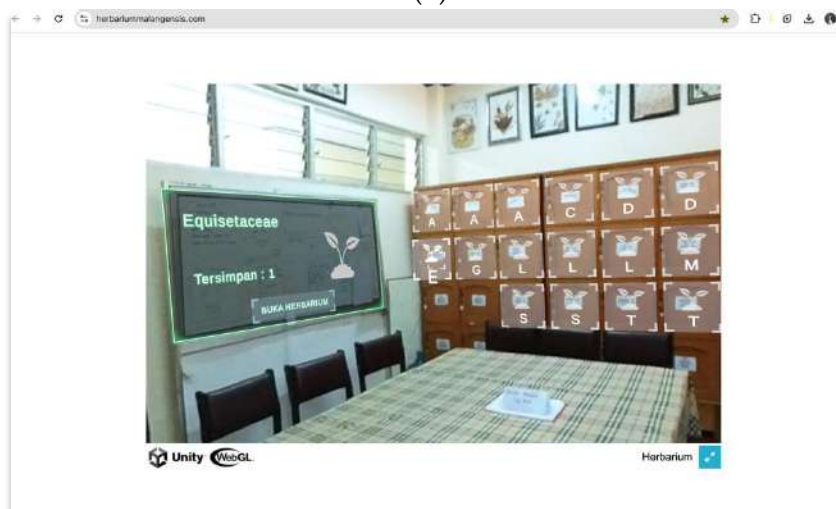
The use of AR in the Herbarium Malangensis website provides a more realistic and contextual learning experience for students, aligning with the findings of [Lai et al. \(2019\)](#) and [McMillan et al. \(2017\)](#) that AR-based media can facilitate better understanding through interaction and manipulation of digital objects relevant to the learning content. This also supports students' ability to connect theoretical concepts with real-world visual representations, which significantly enhances their learning outcomes ([Arslan et al., 2020](#); [Chien et al., 2019](#)). The product developed showed in [Figure 2](#).



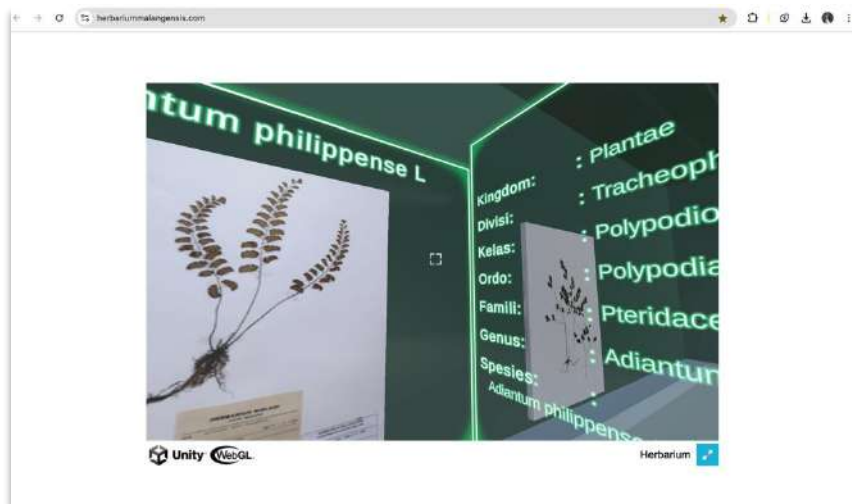
(a)



(b)



(c)



(d)

**Figure 2. Herbarium malangensis website tour media, (a) Start page, (b) Tour feature, (c) Interactive herbarium cabinet, and (d) Room of herbarium museum feature**

The fourth phase is the evaluation phase, which consists of Level 1: Reaction and Level 2: Knowledge. The first step involves face validity, conducted by media experts, followed by content validity performed by subject matter experts, practitioners, and validators of instructional materials. The media validation achieved a rate of 100%, while the material validation reached 89%.

In the evaluation of Level 1: Reaction, concurrent validity is performed with 10 Biology Education students enrolled in a Botanical Course. The practicality test aimed to assess the usability of the Herbarium Malangensis Website Tour. The practicality test encompassed two aspects: information layout and material presentation. The product practicality test scores are presented in [Table 3](#).

**Table 3. Practicality score**

Numb	Aspect	Score
1	Information layout	4.52
2	Material presentation	4.60
Average		4.57
Product practicality (%)		91.54

According to [Table 3](#), the average product practicality test score for the information layout aspect was 4.52, and for the material presentation aspect, it was 4.6. The overall product practicality percentage was 91.54%, falling within the "practical" category. We also gathered student feedback on the Herbarium Malangensis website tour. Some of the student suggestions and feedback are as follows:

*"It would be better to improve further in adjusting QR code scanning and provide it for iOS" #student1*

*"Learning is interesting and makes me gain new knowledge" #student2*

“The application used is very useful for knowing various types of Pteridophyta and can used to study the material in more depth” #student3

“It would be better to add more features to the application to prevent users form getting confused when open it. It would also be good to provide an introductory menu feature before use” #student4

### Effectivity

The effectivity test was conducted on biology education students enrolled in the plant diversity course (N=22). The effectiveness of the Herbarium Malangensis Website Tour was evaluated by assessing students' conservation literacy through pre-tests and post-tests. Conservation literacy was a crucial objective in developing this application, as biodiversity conservation in Indonesia is of paramount importance. The improvement in pre-test and post-test scores was calculated using the n-gain score formula. The average pre-test and post-test scores are presented in Figure 3.

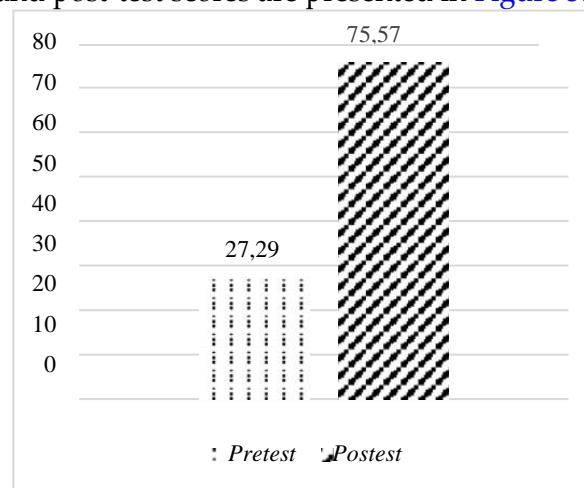


Figure 3. Pre-test and post-test score

As illustrated in Figure 3, the average post-test score (27.29) of the students was higher than their average pre-test score (75.57). Subsequently, the improvement in pre-test and post-test scores was calculated using the n-gain score formula, yielding a result of 0.66. According to Chien et al., (2019) an n-gain score of 0.66 is categorized as moderate. This finding indicates that the AR-based Herbarium Malangensis Website Tour is effective in enhancing students' conservation literacy. This is supported by studies from Arslan et al. (2020); Chien et al. (2019); Zhou et al. (2020), which found that students learning with AR demonstrated higher cognitive engagement and deeper understanding compared to traditional learning methods. Thus, the implementation of the Herbarium Malangensis AR website not only enriches students' learning experiences but also contributes to the enhancement of conservation literacy, particularly in fostering students' appreciation of the importance of plant species preservation (Beasley et al., 2023).

### Advantages of the herbarium malangensis website tour

The implementation results obtained from Biology students at Universitas Negeri Malang demonstrate the significant advantages of augmented reality for rare plant specimen collections in website, offering a multitude of crucial benefits. Augmented

reality that showed the collection served in website can enhance student experiences by providing interactive supplementary information about each plant specimen included in the herbarium collection, specifically the Pterydophyta plant collection of Herbarium Malangensis. Herbariums can serve as tool in the botanical curriculum's teaching process for plants, encompassing morphology, anatomy, and the diversity of plant species. Several studies exploring the utilization of herbariums in the context of biology education have indicated their effectiveness as teaching aids (Dahlia, 2020; Janiarli, 2021; Nabila, 2023; Retnoningsih & Rahayuningsih, 2020; Zaimatul Ulya et al., 2021). Nabila (2023) said the research and development of interactive herbarium-based learning media exhibits high enthusiasm during the learning process and enhance their motivation to learn. Thus, Pterydophyte herbarium utility in learning process indicated was effective to be used in learning process from the high validity result (Retnoningsih & Rahayuningsih, 2020). The integration of herbariums in biology instruction holds the potential to improve student understanding, particularly in the process of plant morphological identification (Dikrullah et al., 2018).

The advantages of augmented reality in digital exploration website stand in its ability to present data in a more dynamic visual format, enabling users to observe three-dimensional representations of the displayed structures (López Belmonte et al., 2019). In the context of herbarium studies, augmented reality in virtual tour can visualize plants, including their roots, stems, and leaves, which may be challenging to comprehend through conventional herbarium presentations (Akn et al., 2024; Akn et al., 2023). The use of augmented reality and 3D technologies in education increase engagement and provide a greater understanding of concepts (Sun et al., 2023; Zhang & Feng, 2022). As well as integrating augmented reality into plant education transforms the learning process into a more engaging, effective, and technologically relevant experience, preparing students for the demands of the digital age. According to Jhuang et al., (2024), the interactive experimental plant structure learning media based on AR (Augmented Reality) for plant anatomy units has effectively made experimental learning more efficient.

The novelty of augmented reality in the Herbarium Malangensis Website Tour to preserve herbarium specimens exemplifies the effectiveness of technological advancements in the current era. While conventional herbarium specimens are susceptible to damage and require meticulous care, augmented reality technology offers a numerous of solutions and enhanced information for users. Augmented reality serves as an effective medium for simulating objects and presenting more comprehensive information (Aydoğdu & Kelpšiene, 2021; Saidin et al., 2015). By leveraging augmented reality, conservators and researchers can access real-time supplementary information about each specimen without compromising or damaging the collection materials (Shweta et al., 2024). Augmented reality does not only enhance the efficiency of herbarium collection management but also plays a crucial role in safeguarding the sustainability and availability of information required for research and educational purposes (Chien et al., 2019). ICT-based learning aids can facilitate the teaching and learning process for both students and teachers. Moreover, ICT media can be utilized anywhere without access or usage constraints (Nielsen et al., 2016; Saidin et al., 2015; Savindya et al., 2020).

### **Enhancement of conservation literacy through the augmented reality herbarium malangensis website tour**

An herbarium serves as an organized collection of dried plant specimens, meticulously arranged for ease of access and retrieval. Herbarium are highly valuable data sources for researchers in various plant-related knowledge, with primary application in taxonomic studies. Herbarium function as centralized hubs for the study of plant taxa. Digital exploration website based augmented reality herbarium assist students learning in observation activity to several plants in experiential learning. Four stages that considered in observational augmented reality focus of several task consists 1) concrete experience, observe plants in the botanical garden; 2) reflective observation, observe and record designated of plants; 3) abstract conceptualization, connect prior knowledge to the results, and 4) active experimentation, develop the concepts for the exploration of real-world scenarios and obtain learning experience from several plant that refers to biodiversity (Chien et al., 2019). Herbarium represents a rich resource, offering a wealth of information on plant taxa, as well as the flora and vegetation of a particular region. The scientific value of a collection essentially linked to the quality of specimens. Thus, meticulous collection practices are paramount in preparing high-quality specimens, especially for rare or endangered plant species.

Plants hold immense significance, warranting their preservation due to their profound contributions to biodiversity and ecological balance (Davies & Cadotte, 2011; Proença et al., 2017; von et al., 2017). Several plant species are facing the threat of extinction, rendering them vulnerable and susceptible to disappearance and become extinct due to anthropogenic activities, including deforestation and land-use changes (Raven, 2021; Stroud et al., 2022). Further exacerbating this situation is the inadequate understanding and knowledge of biological principles governing plant biodiversity (Evans, 2021). In this context, plant conservation literacy refers to the scientific literacy aspect encompassing scientific context, scientific competence, and scientific knowledge. Nurturing plant conservation literacy is paramount to safeguarding our planet's rich biodiversity. Educational settings serve as fertile ground for fostering this awareness, and electronic media offers a compelling strategy to achieve this goal. Herbarium provides a valuable tool for imparting taxonomic and morphological knowledge. To effectively harness this potential, electronic herbariums, as a form of large-scale electronic learning media, should be meticulously designed to facilitate the learning process. Numerous technology-based learning initiatives have emerged to enhance botanical education, encompassing automated taxonomic identification (Ahrends et al., 2011; Kubiak et al., 2021), implementation of field trips (Mulhauser & Gaille, 2024; Pettit et al., 2014), and electronic herbariums, including augmented reality applications (Sulisetijono et al., 2023).

The advent of augmented reality has ushered in a transformative era in education and conservation, particularly in the realm of rare plant protection. By harnessing the power of augmented reality, we can foster profound understanding, appreciation, and tangible actions toward safeguarding plant biodiversity. A pivotal outcome of augmented reality implementation is the heightened public awareness of biodiversity and its crucial conservation. Augmented reality empowers individuals to engage directly with rare plant species, delving deeper into their intricacies through wealth

visual interactive experiences. This immersive engagement cultivates a heightened appreciation for the value of ecosystems and the imperative to maintain their delicate balance. Individuals become more attuned to the threats faced by rare plants, fostering a sense of responsibility for preserving our natural heritage. Furthermore, augmented reality implementation has demonstrated a remarkable surge in participation and tangible actions towards rare plant conservation. The profound knowledge and emotional connections forged through augmented reality experiences ignite a stronger motivation to actively engage in conservation efforts. This includes replanting initiatives, species monitoring, and environmental advocacy campaigns.

## CONCLUSION

The implementation of the Augmented Reality Herbarium Malangensis Website Tour significantly enhances conservation literacy among biology students in higher education, particularly in the moderate category. Augmented reality has proven to be a valuable tool for enhancing the learning experience of biology students by providing interactive information about herbarium specimens, especially the Pteridophyta collection in Herbarium Malangensis. Augmented reality can provide visual and interactive experiences that enrich understanding, appreciation, and public awareness of plants, as well as increase participation in protection and conservation efforts. This research has significant implications for the conservation value of rare plants in Indonesia, and further research can create visualizations for each plant division.

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## Developing assemblr edu to improve elementary school students' explanatory text writing

Sartika Ayu<sup>1)\*</sup>, Arum Fatayan<sup>1)</sup>

<sup>1</sup>English Education department, Faculty of Teacher Training and Education, Universitas Muhammadiyah Prof. Dr. Hamka, Jl. Warung Buncit, South Jakarta, Indonesia

[sartikaayu16022000@gmail.com](mailto:sartikaayu16022000@gmail.com)\*; [arum\\_fatayan@uhamka.ac.id](mailto:arum_fatayan@uhamka.ac.id)

\*Correspondence author

### Abstract

All Indonesians normally master Bahasa Indonesia (BI), but Indonesia's elementary school students' learning outcomes for writing explanatory texts in BI are low. This research aims to develop the feasibility of Assemblr Edu in improving students' ability to write explanatory texts in BI for fifth graders. The research and development (R&D) method with the ADDIE approach was employed. The participants were 30 fifth graders who underwent trial, and series of data collection including observation, interviews, questionnaires, and documentation. The obtained data were analysed quantitatively and qualitatively. The results show that Assemblr Edu is suitable for development at 95% per cent feasibility. The media was also proven to improve students' ability to write explanatory text.

**Keywords:** Assemblr; Explanatory Text; BI; Elementary School.

### INTRODUCTION

Bahasa Indonesia (BI) is Indonesia's official language used as a means of verbal and non-verbal communication (Siregar, 2021). BI is taught at all levels of education (Abidin et al., 2022) in the skills of listening, speaking, reading, and writing (Sukirman, 2020). BI also become the instructional language in Indonesian classrooms (Alvita & Airlanda, 2021).

This study focuses on students' writing skills in explanatory text material. Students' low writing skills are common in Indonesia due to their lack of familiarity with writing, advanced vocabulary, and habit of turning words into coherent sentences according to language rules (Nuryaningsih, 2021). Besides, teachers' inability to create a pleasant learning atmosphere for BI has made students bored during the learning process (Lawatri & Indihadi, 2021).

In this era of digital-based learning, the leverage of technology can create innovative learning media that will attract students' attention and interest in learning, including BI (Buwono & Dewantara, 2020; Suprianto, 2019). A massive introduction of digital media takes place, hence it is necessary to choose and pay attention to several things when using learning media, such as material needs, student characteristics, and ease of applying the media (Syahroni et al., 2020).

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Learning methods should also be less conventional to support Assemblr Edu (Nengsih et al., 2023). This media supports the notion that elementary school students tend to understand material more quickly in concrete than abstract form. Concurrently, the RADEC model is a learning model that consists of several stages of learning, namely reading, answering, discussing, explaining, and creating (Firdausya & Fatayan, 2024). Previous research stated that learning to write explanatory texts using the RADEC model obtained sufficient results (Setiawan et al., 2019). Meanwhile, previous research using Assemblr Edu experienced an increase in learning outcomes on ASEAN material due to students' enthusiasm for learning in using 3-dimensional digital media, which is still rarely used in the learning process (Iskandar et al., 2023). Assemblr Edu is a digital-based interactive media that can create a learning atmosphere that is fun, interesting, and enthusiastic (Hasanah, 2023; Jayanti & Yuniawan, 2021). Moreover, Assemblr Edu can provide more detailed explanations of the material with 3-dimensional illustrations, text, and audio (Ginting & Tambunan, 2023). It can be designed according to student and material needs.

Based on observations and assessments made at a primary school in Indonesia, the authors denote students' lack of interest in reading and studying. This calls for teacher creativity and innovation to shape students' interest in their BI learning (Setiawan & Herlambang, 2022). The authors regard that the presentation of explanatory text material could be more enjoyable even though students tend to be passive and have infrequent questions during discussion sessions. Therefore, this study employs Assemblr Edu to improve the ability to write explanatory tests for the fifth graders, particularly on Reduce, Reuse, and Recycle.

In the first stage, the teacher asks students to read a problem about garbage. Second, the teacher asks questions about a problem with waste. Third, students and their groups discuss to complete the answers to the questions given. Fourth, the teacher explains the exploration text about garbage. Fifth, ideas can be created by writing exploration texts about waste. The radio model supports the use of Assemblr Edu in the application of exploration texts (Pratama et al., 2019).

Hence, Assembler Edu was developed in this study to design innovation in learning media to improve students' BI writing skills through explanatory text material. Due to its regular use in daily life and as an instructional language, it will be useful to improve students' competency in BI, especially in writing as a productive skill. The results of this research are innovative learning media products that are open to continuous feedback and improvement based on user experience.

## **METHODS**

This study uses R&D research with the ADDIE model, namely analysis, design, development, implementation, and evaluation (Ranuharja et al., 2021). It was conducted with a significant sample of 30 fifth-grader students of SDI Al Kindy. The data collection stages involved observation, interviews, questionnaires, and documentation (Dwitiyanti et al., 2020). The technique used to select the participant

sample was purposive sampling, ensuring a focused and relevant study (Octaviani et al., 2022).

Then, data analysis techniques using mixed methods include qualitative and quantitative. Before implementing the Assemblr Edu, the researcher first tested the feasibility of the product using a trial of the Assemblr Edu with a small group of five students.

## RESULTS AND DISCUSSION

Our research, which involved the development of Assemblr Edu to enhance the ability of fifth-grade elementary school students to write explanatory texts, has led to a practical solution. The media can be easily accessed by downloading the Assemblr Edu application on student gadgets and scanning the Assemblr Edu barcode card. The following are the ADDIE stages used to collect data for our research.

### Analysis

This analysis is needed to determine the existing problems and provide solutions according to needs. Based on observations, we found that many teachers still use the lecture method using PowerPoint media packed with text. Students' low reading exacerbated this condition in that they could not improve their writing skill, especially in explanatory text material related to the environment. Students also need clarification about writing down ideas to compose explanatory texts (Hanim et al., 2023). When the teacher asked questions, students were quiet. In detail, when the teacher asked students to present the explanatory text they composed, the students were silent and avoided presenting it.

In the needs analysis through interviews, teachers stated that they preferred to use the lecture method, PowerPoint media, and BI textbooks as a guide. There were also discussion activities and student presentations because they were easier to implement. Apart from that, teachers had limited time to make proper preparations and material adaptation.

Therefore, there is a need for learning media based on Augmented Reality (Czerkawski & Berti, 2021), to help teachers improve their ability to write explanatory texts for BI, such as Assemblr Edu. This is because students will understand the material presented visually. Students can also relate it to the environment around them. Learning will become more fun, thereby increasing students' interest in learning.

### Design

Design was carried out through several steps, namely, determining the topic of explanatory text material; creating an attractive design tailored to the chosen topic; designing barcode cards to present and display the Assemblr Edu. This method follows Aryasahab & Suryadi (2024) in teaching media development.

The preparation began with creating teaching modules for BI learning activities, creating Assemblr Edu, and preparing product feasibility research instruments. Assemblr Edu contains 3-dimensional illustrations, explanatory text, and audio (Ramadani et al., 2024), which we tailored specifically for the topic of Environmental Learning. The following is an illustration of Assemblr Edu.



Figure 1. Material display

This illustration (Figure1) design depicts the problem of waste in the surrounding environment and the lack of concern and awareness of the dangers of waste. This material displays an explanation in text and audio on the topic of Waste. It presents the structure of the explanatory text. Through such illustrations, students can understand the danger of rubbish thrown away carelessly into the environment.

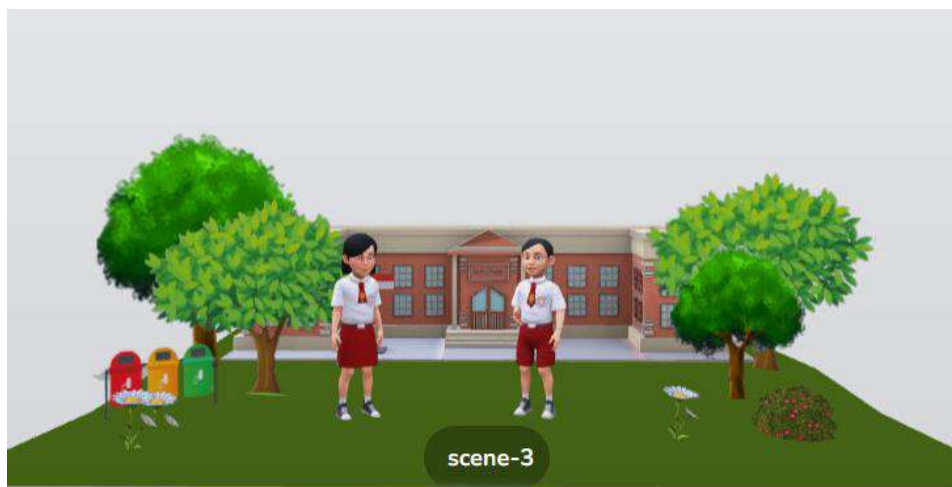


Figure 2. Final view

This final display (Figure 2) explains that the explanatory text interprets the Waste phenomenon when accompanied by an awareness of the surrounding environment. The given illustration depicts the beauty and neatness of the environment when people are aware of and concerned about the waste problem. Besides, the environment becomes healthy and comfortable.



Figure 3. Barcode card

This barcode can be scanned by students during explanatory text learning. In detail, illustrations of an explanatory text illustration will appear when students scan the barcode using their device (Figure 3).

#### Development

This development tests the feasibility (Fitriyani et al., 2023) of Assemblr Edu through trials carried out in small groups with five elementary school students. In this test, the aspects assessed for product suitability are material, language, and media. The following is the feasibility results (Figure 4).

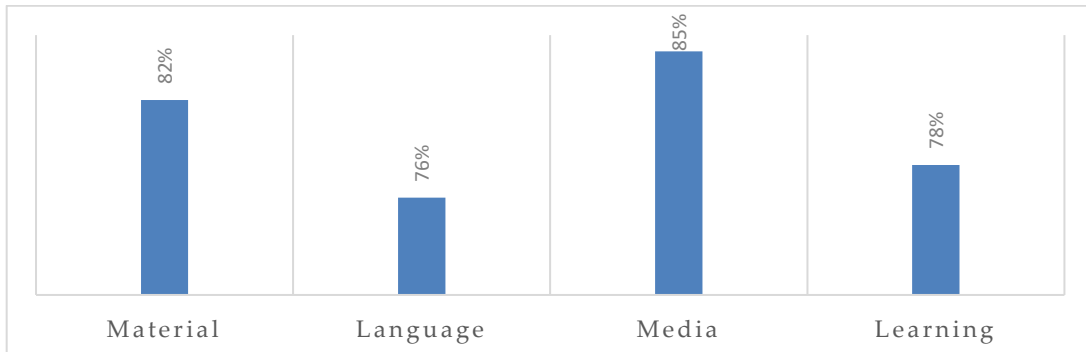


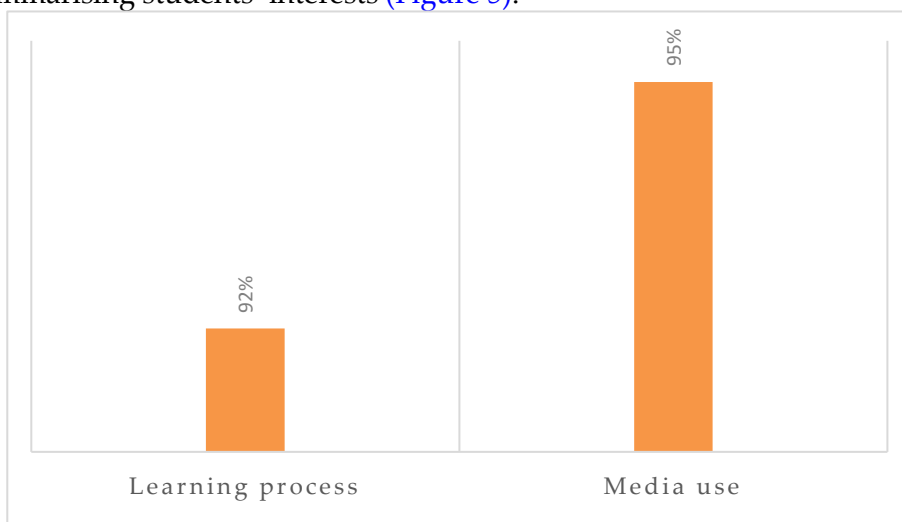
Figure 4. Assemblr edu feasibility graph

The graphic image states that the material aspect received a presentation of 82% in the very decent category. The language aspect, with a percentage of 76%, is in the appropriate category. Then, the media aspect gets 85% in the very decent category. Meanwhile, the percentage was 78% in the appropriate category of learning. So, from the results of this trial, the learning media obtained 80.25% feasibility so that the Assemblr Edu could be implemented in the learning process.

Then, using small groups, the Assembly Edu feasibility testing stage obtained 95% of the feasible category. This research is based on what is expected for students to experience an increase in explanatory text learning outcomes by obtaining an average of 82.27.

### Implementation

Thirty fifth-graders were involved during implementation, divided into small groups of five. The barcode was distributed to each group where students took turns scanning the coded cards. The adaptation of Assemblr Edu took place in this stage where the teacher explained the learning material, and let the students discuss using Assembler Edu. Following are the learning results using Assemblr Edu summarising students' interests (Figure 5).



**Figure 5. Learning outcomes using Assemblr Edu**

The bar diagram reveals the feasibility of using Assemblr Edu for fifth-graders. It is also shown that students' understanding of the ability to write explanatory texts has increased due to high learning interest. It is known that the learning process obtained a percentage of 92% in the outstanding category. Meanwhile, the use of Assemblr Edu obtained a percentage of 95% in the outstanding category in its implementation.

### Evaluation

The evaluation was conducted to improve the learning process, and the Assemblr Edu was used to collect research data. From the evaluation, it is evident that Assemblr Edu is highly effective in improving students' ability to write explanatory texts in BI. This is proven by the measurement of learning outcomes of explanatory texts before and after using Assemblr Edu as summarised in the following table 1.

**Table 1. Learning outcomes before and after using Assemblr Edu**

Information	N	Mean
Before	30	65.77
After	30	82.27

Before using Assemblr Edu, students' learning outcomes were an average of 65.77. Meanwhile, their learning outcomes improved to an average of 82.27 after the implementation of Assemblr Edu. So, there has been an increase in the margin of 16.5.

This finding shows that innovative digital-based learning media such as Assemblr Edu can improve the ability to write explanatory texts. This is because media can

attract students' attention during the learning process so that students become focused when studying.

Assemblr Edu, as interactive media based on augmented reality, can give students a high sense of curiosity, which concurs with the notion that learning is always associated with digital technology built from students' curiosity (Purnomo et al., 2023). Teachers must be able to face change by continuing to learn about the latest innovations. So, students feel energised and motivated to learn.

### **Discussion**

The development of three-dimensional technology as a learning medium is increasing. One of the three-dimensional technologies is the Assemblr Edu application. In the study results, learning Indonesian about the exploration text with the theme of garbage positively impacts learning outcomes. The results obtained in the pre-test were 65.77. Meanwhile, in the post-test, it obtained 82.27 with an N-gain of 0.48, an effective category for improving the exploration text of fifth-grade students. Students can think critically and are motivated when learning using the Assemblr Edu media.

It uses the Assembler Edu application to improve students' understanding of exploration texts. This is the opinion of [Hamidah et al. \(2024\)](#) that Assemblr Edu is an interactive media that can help students develop experience, creativity, skills and problem-solving. Then, create meaningful learning so that it can be related to students' daily lives. Meanwhile, research conducted by [Tuta et al. \(2022\)](#) regarding Assemblr Edu can improve students' understanding of learning materials very well and practically.

The increase in exploration text learning outcomes can be seen from the percentage of 16.5 after using Assemblr Edu media. This increase is influenced by constructivist theory. The opinion of [Amalina et al. \(2024\)](#) explains that constructivism theory is learning that emphasizes student experience so that learning becomes meaningful. This theory is based on learning in the 21st century. Learning uses technology and project-based media to improve student understanding and learning outcomes.

Assemblr Edu media about exploration text presents advantages and disadvantages in learning. The advantages are easy access through the practical Assemblr Edu application, three-dimensional displays combined with text and audio, making it easier for students to understand the content, combining case-based approaches, and making the learning experience more enjoyable. The disadvantages of Assemblr Edu media are that it requires a stable internet network and a cellphone (gadget) is needed for smooth use of Assemblr Edu media ([Damayanti & Putra, 2022](#)). Therefore, when learning, students are allowed to bring gadgets from home.

### **CONCLUSION**

The results of this research from developing Assemblr Edu in improving the ability to write explanatory texts are very feasible, with 95% of presentations using the waste phenomenon. Using Assembler Edu as Augmented Reality media, students can see moving illustrations in 3 dimensions: explanatory text and audio. Apart from that, there was an increase in learning outcomes for explanatory texts by 16.5 from before using Assemblr Edu, an average of 65.77, and after using an average of

82.27. The weakness of Assemblr Edu is that it requires a high internet connection because the content is extensive. A device is also absolutely needed to carry out the learning process using Assemblr Edu. The limitation of this research lies in the small number of participants and lacking resolutions for internet connection in operating Assemblr Edu. Both teachers and students sometimes waited too long to display explanatory text illustrations.

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## Augmented reality based android application for introduction of pneumatic hydraulic components

Yuwono Indro Hatmojo<sup>1)</sup>, Christin Elisabet Panjaitan<sup>2)</sup>, Satria Muhammad Azis<sup>3)</sup>  
Vando Gusti Al Hakim<sup>4)</sup>, Dwi Ratnawati<sup>5)</sup>

<sup>1,2,3</sup>Departement of Electrical Engineering Education, Faculty of Engineering, Universitas Negeri Yogyakarta, Jl. Colombo No.1, Karang Malang, Caturtunggal, Depok, Sleman, Daerah Istimewa Yogyakarta, Indonesia.

<sup>4</sup>Department of Computer Science and Information Engineering, National Central University, No. 300, Jhongda Rd., Jhongli City, Taoyuan County 32001, Taiwan.

<sup>5</sup>Departement of Information Technology Education, Faculty of Business and Humaniora, Universitas Teknologi Yogyakarta, Jl. Siliwangi, Mlati Krajan, Sendangadi, Kec. Mlati, Kabupaten Sleman, Daerah Istimewa Yogyakarta, Indonesia

[yuwono\\_indro76@uny.ac.id](mailto:yuwono_indro76@uny.ac.id)\*; [christinelisabet.2017@student.uny.ac.id](mailto:christinelisabet.2017@student.uny.ac.id);

[satriamuhammad.2017@student.uny.ac.id](mailto:satriamuhammad.2017@student.uny.ac.id); [110582605@cc.ncu.edu.tw](mailto:110582605@cc.ncu.edu.tw);

[dwiratnawati@uty.ac.id](mailto:dwiratnawati@uty.ac.id)

\*Correspondence author

### Abstract

This study focuses on the utilization of augmented reality (AR) to enable comprehensive visualization of objects. Its primary objective is to develop and evaluate an AR application as a medium for introducing pneumatic hydraulic components. The research method employs a development research approach, following the assessment, design, development, implementation, and evaluation steps proposed by Lee and Owens. The feasibility of the product is determined through various assessments, including black box testing, validation by media experts, validation by content experts, and evaluation of initial user response. The outcome of this study is application software incorporating AR technology for the purpose of introducing pneumatic hydraulic components, along with a corresponding workbook. Whereas the application is compatible with the Android operating system and utilizes QR codes as markers for augmented reality objects, which are conveniently included within the workbook. Performance testing reveals that all application functions perform exceptionally well according to black box testing. Furthermore, the content expert feasibility assessment yields results categorized as "Good," while both the media expert feasibility and initial user response tests indicate "Very Good" outcomes.

**Keywords:** Augmented Reality; Pneumatic Hydraulic; QR Code; Marker; Feasibility.

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## **INTRODUCTION**

Technology was developed to assist human activities (Mensah, 2019; Toupas et al., 2023). The rapid development of technology in this era has provided many benefits and changes of progress in various social aspects (Hamidi & Chavoshi, 2018; Agarwal & Alam, 2023). Technology is developing thoroughly in various fields, such as in manufacturing industry, tourism, economy, hospitality, and education. Technology that was only a complement now turned into a necessity (Law et al., 2018; Iqbal & Campbell, 2021). Technology is used to achieve certain goals and one of advanced technology that important to develop is augmented reality (Iatsyshyn et al., 2020).

Augmented reality (AR) technology is growing rapidly at this time, it is supported by almost every human being in this world who has a smartphone (Youm et al., 2019). Augmented Reality technology contains a combination of two-dimensional (2D) or three-dimensional (3D) virtual objects that can be displayed in real time (Maryadi et al., 2019). Augmented Reality can provide the user with a virtual experiment space freely and safely (El Kabtane et al., 2018; Wildan et al., 2022). The user can directly engage with touch and manipulation of 3D objects in mobile application which has augmented reality features (Faith, 2019). AR technology can help present information about the real world to be more interactive (Ulas, 2019). In additional, AR technology has positively influenced in any fields, such as industry, education, tourism, and other (Garzón, 2021; Wildan et al., 2022; Hallmann et al., 2023). So, the AR technology can show 2D or 3D object that the user can directly engage with a virtual experiment in any fields.

Augmented reality is recognized to support a learning process, which can be implemented in learning scenarios that can increase motivation to study (Guth et al., 2021). This research used AR to show the text and symbol in a machine which uses a marker for AR technology, and the result succeeded to grow a student's motivation. But unfortunately, this research did not use a 3D object to further enhance interactive learning media. As for research from (Arief et al., 2018), which implements AR technology in the field of vocational education. Unfortunately, in this research only tests were carried out on the usefulness of users. Augmented reality also can be implemented in curriculum framework such as a social technical curriculum (Widiaty et al., 2021). This research developed AR media to support the curriculum, but the product did not have a feasibility test to know the quality of product before implementing it to student. So, augmented reality can be used in education to support the learning process (Taran, 2019), such as to develop a learning media.

Everything is given or disseminated by someone in the form of information which raises the engagement of others to learn that can be called learning media (Puspitarini & Hanif, 2019; Hasanah Lubis et al., 2023; (Monika et al., 2023). Learning media contains information about the symbols or pictures of the subject matter in it (Arsyad.A, 2019). Learning media are created to

achieve educational goals both visually and non-visually (Sanjaya, 2015). So, learning media greatly affects the learning process and without learning media the learning process will be hampered and even not delivered optimally. Learning media must be developed for all levels of education, and one of which is vocational high school.

Vocational high school has the purpose to develop skills which follow advanced technology such as in science, digital technology, and art, also preparing students for work (Hatmojo & Azis, 2021). One of which a compulsory subject at the vocational high school level in the mechatronic engineering department is pneumatic hydraulics (Kustija et al., 2021). Students in vocational who study pneumatic hydraulics must understand how each component works, so learning media are needed to facilitate the delivery of material. According to my observational data in one of vocational education school in Indonesia (SMK SMTI Yogyakarta), learning media in that school is less interactive, so the student feels bored when studying in class. According to the reasons and gap in research before, this research developed a learning media with augmented reality technology which used a three-dimensional object that is important to support the learning process. This article aims to develop augmented reality as a medium for introducing hydraulic pneumatic components, and determine feasibility products based on black box testing, media expert assessment, content expert assessment, and first user response assessment.

## METHODS

### Development Method

This article uses a type of development research. Development research is a scientific method that has stages of manufacture and testing before being published to the public (Soenarto et al., 2013). The development model used is the ADDIE model by Lee and Owens (W. Lee & L. Owens, 2004). The steps of this research are needs assessment, design, development, implementation, and evaluation, described as shown in Figure 1. Respondents who participated in this study consisted of 2 material experts, 2 media experts, and prospective users from Vocational High School students in class XI of the Mechatronics study program totaling 30 respondents.

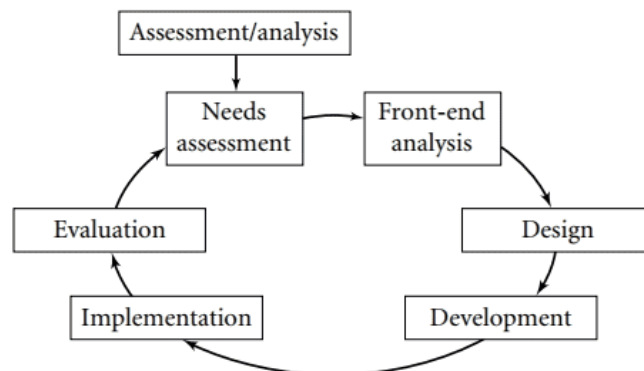


Figure 1. Concept ADDIE

The first stage in this development method is analysis/assessment, which is divided into two parts, need assessment and front-end analysis. Need assessment is to identify the difference between the actual situation and the expected situation. While the front-end analysis is divided into three parts, namely subject analysis, problem analysis and technology and media analysis. Subject analysis activities were carried out by observing teachers and students, analyzing existing problems related to the learning process by observing the implementation of learning activities, then analyzing technology and media used as materials to be developed using development research. During process learning, students have difficulty understanding pneumatic hydraulic components because there are still limited practical tools used. In addition, the technology applied in the learning media is less interactive, and the delivery of the material is not optimal. So, in the stage analysis explains what needs are to develop augmented reality-based learning media.

The design stage aims to facilitate researchers in product development according to the results of the analysis. Interface design, flow chart, workbook design, and software requirements are activities carried out at this stage. Interface design in this research was made using Utility software. Interfaces design include main menu, target menu, instruction menu, suggestion menu and profile menu. In additional, design for 3D object also was prepared using Solid work software. Flowchart as a guide to the learning media process developed (see [Figure 2](#)). The development stage aims to realize the planning and analysis that has been made in the form of application software. Application software with augmented technology will be intended for the Android operating system. In addition, at this development stage, a hydraulic pneumatic workbook was also made as a software application support book. In the workbook there is a QR code as a marker of AR technology. QR codes can allow users to access information instantly, hence the name Quick Response ([Soon, 2008](#)). This quick response technique can efficiently encode and decode the data content of a QR tag ([Lin et al., 2021](#)). In this article, the implementation stage is only carried out for potential users who have the potential to use this AR application product, namely students who are in vocational high school majoring in mechatronic engineering. The evaluation stage determines feasibility product based on black box testing ([Wang et al., 2019](#)), media expert validation and content expert validation ([Köhler & Hariyanto, 2020](#)), and also first user response assessment. The purpose of the feasibility test is to find out whether the product is feasible or not to be applied to users.

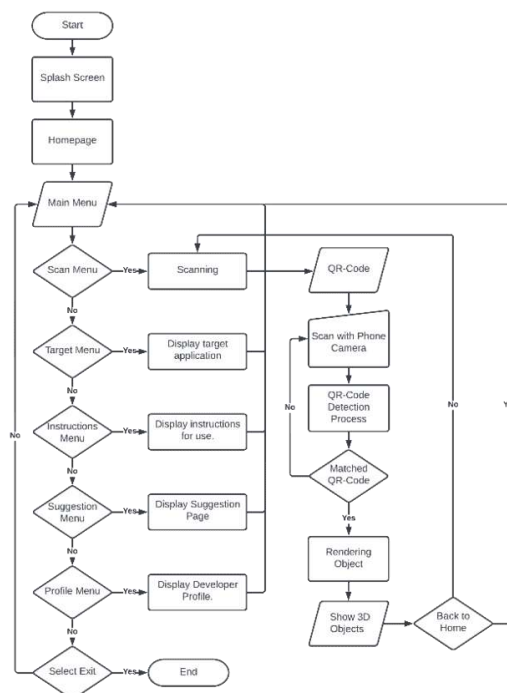


Figure 2. Flowchart of the developed learning media process guide

### Developing instrument of feasibility test

Product feasibility in this article is divided into four tests, including black box testing, media expert assessment, content expert assessment, and first user response assessment. Black box testing is carried out to determine the performance of the application (Maxim & Pressman, 2014), starting from the installation process and operating of the application (see Table 1). There are 18 questions in the black box test, 4 questions about aspects of application installation and 14 questions about the operating aspects of the application.

Table 1. The black box questionnaire items

No	Aspect	Indicator	Item Number
1.	Installing application	Installing application in smartphone	1, 2
		Showing application icon	3, 4
2.	Operating the application	Initial view the application	5, 6,
		Function of QR code	7, 8, 9
		Function of button in application	10, 11, 12, 13, 14, 15
		Showing 3D object from marker of augmented reality	16, 17, 18

The learning content expert questionnaire was adopted from the criteria for assessing the quality of learning media made by Walker & Hess according to (Arsyad.A, 2019). This questionnaire is divided into two aspects, content quality and instructional. The content quality aspect has three indicators

with eleven questions. Meanwhile, the instructional aspect has three indicators with six questions. The questionnaire items can be seen in [Table 2](#).

**Table 2. The learning content expert questionnaire items**

No	Aspect	Indicator	Item Number
1.	Content quality	Standard and basic competence	1, 2, 3
		Grammatik	4, 5
		Correlation application AR and workbook	6, 7, 8, 9, 10, 11
2.	Instructional	Introduction content	12, 13
		Benefit for the learner	14, 15
		Benefit for the teacher	16, 17

The media expert questionnaire adopted from Walker & Hess in ([Arsyad.A, 2019](#)) but combined with the decision of evaluate the learning media made by the Ministry of National Education of Indonesia ([Direktorat Pembinaan SMA, 2010](#)) which has been analyzed. This questionnaire is divided into three aspects, design of media, software utilization, and technical quality (see [Table 3](#)). The design of media aspect has four indicators with twelve questions. Meanwhile, the software utilization aspect has three indicators with four questions and technical quality aspect has two indicators with five questions.

**Table 3. The media expert questionnaire items**

No	Aspect	Indicator	Item Number
1.	Design of media	Interface design	1, 2, 3, 4
		Text	5, 6
		Picture quality	7, 8, 9, 10, 11
		Instruction for use	12
2.	Software utilization	Ease of operation	13, 14
		Communicative	15
		Interactive	16
3.	Technical quality	Legibility	17, 18
		Feedback quality	19, 20, 21

The media expert questionnaire was also adopted from Walker & Hess in ([Arsyad.A, 2019](#)) and combined with the decision from Ministry of National Education of Indonesia ([Direktorat Pembinaan SMA, 2010](#)) which has been analyzed. This questionnaire is divided into three aspects, design of media, technical quality, and usability (see [Table 4](#)). The design of media aspect has three indicators with five questions. The technical quality aspect has two indicators with six questions and usability aspect has three indicators with five questions.

**Table 4. The first user response questionnaire items**

No	Aspect	Indicator	Item Number
1.	Design of media	Layout	1, 2
		Text	3, 4
		Attractiveness	5
2.	Technical quality	Legibility	6
		Feedback quality	7, 8, 9, 10, 11
3.	Media usability	Motivation to learn	12
		Interest	13
		User understanding	14, 15, 16

### Data collection

Data were obtained from direct school observations and interviews with subject teachers, and then questionnaires were distributed. The instruments used are observation data and questionnaires with a Likert scale (Mumu et al., 2022). The Likert scale in this study uses a modified model with four answer choices (Asún et al., 2016). The Likert scale is used for content expert and media expert questionnaires, and the nominal scale is used for black box questionnaires. The feasibility category is explained based on the item questionnaire's nominal average and standard deviation (Yin et al., 2016). Respondents to the expert questionnaire consisted of 2 material experts. Respondents for the media expert questionnaire consisted of 2 media experts. Six respondents conducted the functional test of the black box. Table 5 shows the calculation of the feasibility category for the developed augmented reality learning media.

The functional test data was carried out on six users with different types of smartphones. The assessment used a questionnaire with two statements, 'functional' or 'not functional', with a total of 34 questions consisting of 2 aspects, namely the aspect of installing the application with four questions and operating the application with 30 questions. The specifications of the smartphone used include the screen size and type of Android Operating System (OS). The results of the data analysis are then analyzed qualitatively and produce data on all functions of the application.

Material experts and media experts assess materials and media in the development of learning media, the implementation of augmented reality in the introduction of basic components of android-based pneumatic hydraulics, to find out their feasibility. The total score of the material experts and media experts, then the average is sought. The average results are then analyzed using Table 5 to find out the eligibility category from materials and media. Users provide assessments in the form of a questionnaire consisting of 17 questions with four answer choices and three aspects. The three aspects are the aspect of media design with six questions, the aspect of technical quality with six questions and the aspect of media usefulness with five questions. The data from the results of these users is then searched for

average. The average results are then analyzed using Table 5 to find out the eligibility category from the user's side.

**Table 5. The feasibility of media and category (Istanto, 2018)**

Score Interval	Category
$(Mn + 1.5 SDn) - (Mn + 3.0 SDn)$	Very Good
$(Mn) - (Mn + 1.5 SDn)$	Good
$(Mn - 1.5 SDn) - (Mn)$	Good Enough
$(Mn - 3.0 SDn) - (Mn - 1.5 SDn)$	Not Good

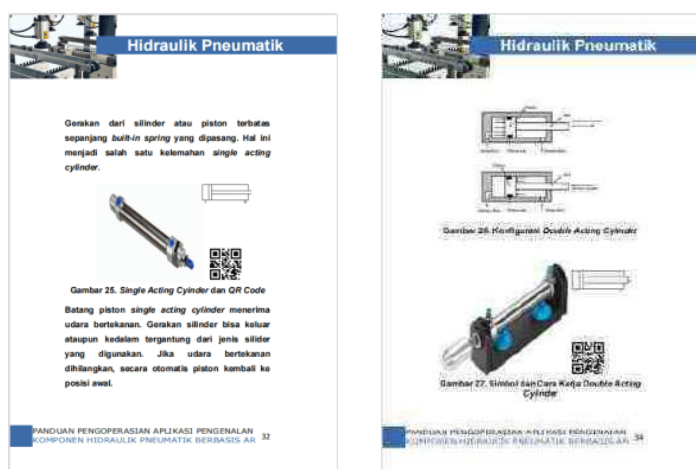
\*Mn: nominal mean value [ $1/2 \cdot (\text{highest ideal score} + \text{lowest ideal score})$ ]

## RESULT AND DISCUSSION

### Hydraulic Pneumatic Workbook

Pneumatic systems convert air into mechanical motion through an actuator (Jamian et al., 2020). The pneumatic control component used in this research is divided into several parts. The first device that provides air energy sources consists of a compressor, an air filter system, an air-drying system, and an air pressure regulating system. The second part is the input to control the system, in the form of push button valves and sensor valves. The third part is the various types of directing valves and air pressure regulators, and the last part is the actuator as a power converter. The material for the introduction of all these components is contained in the workbook that has been developed by the researcher. The workbook displays a picture pneumatic component and a description function of the component, as shown in Figure 3.

Augmented reality technology can visualize objects that initially only looked two-dimensional into a three-dimensional that can be seen from various points of view. AR uses a marker to display three-dimensional objects. The marker in this study uses a QR code, where the QR code is entered in the workbook which is placed next to the two-dimensional component image as shown in Figure 3.



**Figure 3. Figure of hydraulic pneumatic workbook**

### **HP-AR Application**

The development of this application uses the Unity 3D desktop software that runs on the Windows 10 operating system. Unity 3D is often used by developers to develop three-dimensional games, in this study Unity 3D is used to process application interfaces, placement of component objects and text. Making three-dimensional image assets using Solidwork 2018, this software was chosen by researchers because the objects drawn are components that often exist in the industry. AR technology requires objects that are used as markers to display three-dimensional objects, AR markers can be images or text. The marker in this AR development uses a QR code, because it is considered unique so that it is different from other markers. The QR code is uploaded as a target into the Vuforia SDK database. Then when you run the Unity 3D software for the first time, the Vuforia SDK must be installed first to run the Augmented Reality feature. Vuforia SDK is also useful for exporting Unity 3D software results into android application extension files (\*.apk). An android application requires an icon image as an identifier of the application. The icon will appear on the main screen of the smartphone when the application is installed, the icon of the developed application is as shown in Figure 4. The augmented reality application of the introduction of pneumatic hydraulic components was named HP-AR by the author.



**Figure 4. Icon application HP-AR**



**Figure 5. Homepage display HP-AR**

Augmented reality application for introduction of pneumatic hydraulic components developed by the researcher has several menus as depicted in the flowchart (Figure 2). Figure 5 is a homepage interface display on the application. On the homepage display there are five main menus, namely the scan menu, target, instructions, suggestions, and profiles. In the upper right corner of the homepage there is an exit button which is used to end the application. To display AR technology in the HP-AR application, users need to prepare a workbook first, then enter the Scan menu and point the camera at the QR code. The display when scanning an AR marker is shown in Figure 6. A three-dimensional image will appear on the phone screen, at the bottom of which there is a brief description of the component. Three-dimensional objects can be rotated as desired to be viewed from different angles by pressing the rotate icon button.



Figure 6. Display camera-AR when scanning QR code

### Product Feasibility Test

The black box test questionnaire has two answer choices, namely “Yes” and “No”. Application performance testing was carried out on 6 people with different smartphone specifications. The results of this black box test are that all respondents answered “Yes” to all questions. So, it can be concluded that the performance of the HP-AR application (Table 6) for the identification of pneumatic hydraulic components is running very well.

**Table 6. Black box testing results**

Specification Smartphone		Aspect	
Screen size	Android Version	Installing App	Operating the App
6.53"	10	Yes	Yes
5.5"	6	Yes	Yes
5.6"	8	Yes	Yes
6.52"	10	Yes	Yes
6.67"	10	Yes	Yes
6.47"	11	Yes	Yes

Feasibility tests of content experts and media experts were carried out on two different experts for each test. The content expert's feasibility assessment is based on two aspects, namely the quality of the content and its usability. Based on the results of the analysis (Table 7), the content quality aspect is included in the "Good" category with an average score of 38 out of a maximum score of 48 and the usefulness aspect gets an average score of 19 out of a maximum score of 24 which is included in the "Good" category. The feasibility of all content expert assessments is in the "Good" category with an average score of 57 out of a maximum score of 82.

**Table 7. Content expert assessment results**

Aspect	1st Expert Score	2nd Expert Score	Mean	Score Max	Category
Content quality	40	36	38	48	Good
Usability	18	20	19	24	Good
Total Score			57	82	Good

The feasibility of media experts is divided into three aspects, namely aspects of media design, software, and usability. Based on the results of the analysis in Table 8, it is known that the media design aspect is in the "Very Good" category with an average score of 46 out of a maximum score of 52. The software aspect is declared "Very Good" with an average score of 14.5 out of a maximum score of 16. The usability aspect is included in the "Very Good" category with an average score of 22 out of a maximum score of 24. The overall feasibility level is in the "Very Good" category with an average score of 82.5 out of a maximum score of 92.

**Table 8. Media expert assessment results**

Aspect	1st Expert Score	2nd Expert Score	Mean	Score Max	Category
Media design	48	44	46	52	Very Good
Software	15	14	14,5	16	Very Good
Usability	22	22	22	24	Very Good
Total Score			82,5	92	Very Good

The results of the responses of the first 30 users are shown in [Table 9](#). The first user test questionnaire is divided into three aspects, namely media design aspects, technical quality aspects and media usability aspects. The media design aspect is included in the "Very Good" category with an average score of 20.33 from a maximum score of 24. The technical quality aspect is included in the "Very Good" category with an average score of 19.93 from a maximum score of 24. Media usability is included in the "Very Good" category with an average score of 17.53 from a maximum score of 20. The overall assessment was declared "Very Good" with an average score of 57.80 from a maximum score of 68.

**Table 9.** The result of the first user responses

Aspect	Score (30 Users)	Mean	Score Max	Category
Media design	610	20,33	24	Very Good
Technical quality	598	19,93	24	Very Good
Media Usability	526	17,53	20	Very Good
Total Score		57,80	68	Very Good

The aspect of media design shows a very good category, it shows that augmented reality learning media can attract students' interest and motivation to learn. Visual learning media significantly increases student motivation by making learning more engaging ([Herawati et al, 2014](#); [Katona et al., 2023](#)). The technical quality aspect shows a very good category, this shows that the media fosters students' creativity in learning. Digital learning media significantly increases students' creativity in solving problems ([Lubis, 2023](#)). The aspect of usability media is included in the category of very good, students in using this learning media have an increased learning experience and ease of learning. Augmented Reality (AR) has shown significant potential to improve the learning experience and convenience for students by making educational content more engaging and interactive ([Raharja & Pramudya, 2022](#)). The use of computer-human interaction technologies, such as virtual simulation learning, can significantly improve memory engagement and retention. This technology allows for personalized learning experiences, adapting to individual student needs and preferences ([Xia, 2023](#)).

## CONCLUSION

This study develops learning media for the development of augmented reality on the introduction of pneumatic hydraulic components based on Android in the form of application software and workbooks accompanied by a QR code as a marker of augmented reality. This learning media supports Pneumatic Hydraulics Practicum learning by projecting two-dimensional components into three dimensions. The product has passed the functional test with a black box test that is reviewed from 6 types of smartphones to

determine their performance. The black box test results show that all application performance can run very well. This learning media has also passed the feasibility level test regarding the assessment of content and media experts. The material content produced shows good categories, and media content also shows very good results. Operation by users shows excellent results. This research is important to support the education field, in which AR technology has proven to be suitable for use as a learning media. This research is limited to recognizing the components that exist in hydraulic pneumatic devices. Further development can be done to implement the introduction of these components to be assembled in an AR-based hydraulic pneumatic control system and developed again into a system that is implemented using Virtual Reality.

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## The development of electronic worksheets for students using Live worksheets and GeoGebra to enhance students' digital literacy

Lioni Anka Monalisa <sup>1)\*</sup>, Arika Indah Kristiana <sup>2)</sup>, Arif Fatahillah <sup>3)</sup>, Saddam Hussien <sup>4)</sup>, Laila Nurul Fatimah <sup>5)</sup>

<sup>1,2,3,4,5</sup> Mathematics Education, Faculty of Teacher Training and Education, University of Jember, Jl. Kalimantan 37, Jember, Indonesia.

[lioni.fkip@unej.ac.id](mailto:lioni.fkip@unej.ac.id); [arika.fkip@unej.ac.id](mailto:arika.fkip@unej.ac.id); [arif.fkip@unej.ac.id](mailto:arif.fkip@unej.ac.id);  
[saddamhussen.fkip@unej.ac.id](mailto:saddamhussen.fkip@unej.ac.id); [lailanrlftmh28@gmail.com](mailto:lailanrlftmh28@gmail.com)

\*Correspondence author

### Abstract

Educational digitalization is characterized by technology-assisted media, leading to improved students' digital literacy. One of these media is the electronic worksheet for students. An initial observation revealed that learning activities at Public Islamic Senior High School (MAN) in Bondowoso still operationalized conventional books as the sole media. This study aimed to develop electronic worksheets for students using valid, effective, and practical Geogebra-assisted live worksheets, guided by the 4-D model designed by Thiagarajan. This model consisted of four stages, i.e., define, design, develop, and disseminate. Data were collected through observation, tests, and questionnaires. Test questions were used to determine the level of effectiveness, and questionnaires were used for validity and practicality tests. The results revealed very high validity. The effectiveness analysis exhibited an N-Gain percentage of 76%, signifying a satisfactory effectiveness rate. The practicality analysis marked 86.20%, which is classified into a good category. The analysis results corroborated that electronic worksheets for students have proven valid, effective, and practical, demonstrating the potential to improve students' digital literacy.

**Keywords:** Digital Literacy; Electronic Worksheet; GeoGebra; Liveworksheets; Research and Development.

### INTRODUCTION

Technological advances have sparked various digitalization initiatives, including education (Yuliyanti et al., 2021). Educational digitalization transforms the way lessons are delivered to students. It creates a dynamic and interesting teaching that facilitates the learning process, understanding complex concepts, and fostering learning motivation (Cirneanu & Moldoveanu, 2024). Digitalization is

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characterized by learning resources and media that utilize technological advances to facilitate learning (Yuliyanti et al., 2021).

Likewise, technology can be implemented in Mathematics learning. Some examples of technology integration include online tutorials, interactive simulations, graphing calculators, and so on (Cirneanu & Moldoveanu, 2024). Koskenoja & Törmä (2023) argue that GeoGebra is one of the most widely used technologies in Mathematics learning. GeoGebra is software that supports the effective delivery of mathematics. It allows easy access for free at any time and anywhere and visualizes abstract mathematical concepts using a smartphone (Khasanah & Nugraheni, 2022).

One of the Mathematics topics that can be delivered with the aid of GeoGebra is quadratic function. GeoGebra can be used as a graphing calculator to visualize the graph of a quadratic function (Doc et al., 2023). Hudu et al., (2024) mention that using GeoGebra to teach quadratic functions can improve students' understanding and digital skills. One implementation of GeoGebra involves the development of electronic worksheets for students.

Student worksheets are a learning media used to help achieve learning objectives (Lathifah et al., 2021). Student worksheets are available in paper-based format and electronic form, known as electronic worksheets for students. Electronic worksheets make it easier for students to understand learning material, save time and costs, and are more environmentally friendly (Subandi et al., 2023). One way to convert student worksheets into electronic worksheets for students is by using the "Liveworksheets" platform. These are website-based interactive learning media that can convert printed student worksheets into electronic worksheets for students (Amalia et al., 2022). Electronic worksheet for students is known to enable (1) free access on Google, (2) effortless file conversion, (3) automated documentation of student scores or answers, (4) motivating learning, and (5) practical implementation (Nirmayani, 2022).

The application of electronic worksheets for students can improve students' digital literacy (Sari et al., 2021). Digital literacy allows students to critically and creatively select and sort information (Wicaksono & Kuswanti, 2022). Notwithstanding, the importance of digital literacy is not fully actuated in the existing instructional initiatives. This is because Indonesia has a relatively low level of digital literacy (Syarifah et al., 2021). Considering these problems, learning innovations are necessary to improve students' digital literacy.

Initial observations at MAN (Islamic Senior High School) of Bondowoso revealed several issues. First, the learning activities at the school were conventional and only based on books and teacher explanations. Also, the delivery of Mathematics learning never engaged digital media, such as electronic worksheets for students. The GeoGebra website was hardly explored to promote Mathematics learning. Most importantly, students' digital skills at the school were relatively lacking. The present study was geared toward addressing these issues.

Previous studies found several learning strategies to help improve students' digital literacy. For example, research by Nabilla et al., (2022) aims to improve students' digital literacy by developing interactive electronic worksheets for mathematics.

The results documented valid, practical, and effective electronic worksheets that could improve students' digital literacy skills. This study, however, only developed electronic worksheets without audio and geogebra. [Handayani et al., \(2023\)](#) aimed to cultivate digital skills by utilizing liveworksheets, and the results indicated that liveworksheets in online learning improve students' digital literacy. Notwithstanding, the LMS powered by liveworksheets is still less interactive. Meanwhile, [Elfandi et al., \(2023\)](#) explored ways to improve students' digital literacy using Geogebra. They report an enhancement of students' digital literacy. In this study, GeoGebra was used in learning without electronic worksheets for students. These studies indicate no investigation has been made to combine e-LKPD, liveworksheets, and Geogebra. In response, the present study aims to fill that gap.

Against this background, the present study was designed to develop a learning innovation by combining electronic worksheets for students, liveworksheets, and Geogebra to improve students' digital literacy. Previous researchers have never done the combination. This study aims to develop an electronic worksheet for quadratic function material adjusted to digital literacy indicators. The activities associated with electronic worksheets for students focused on internet searching, hypertextual navigation, content evaluation, and knowledge assembly. The electronic worksheet for students with liveworksheets involved students collaborating to analyse quadratic functions using GeoGebra. Finally, it analysed the feasibility and effectiveness of using electronic worksheets for students with liveworksheets assisted by GeoGebra to enhance students' digital literacy. The present study has validated and tested the effectiveness of the e-LKPD in an actual classroom setting, enabling direct scrutiny of its impacts on students' digital literacy.

## **METHODS**

This study employed a research and development approach based on the 4-D model developed by Thiagarajan, which consists of four phases: defining, designing, development, and dissemination ([Pramono, 2022](#)). Conducted in February 2024, it involved 2 Mathematics Education lecturers, 1 teacher, and students in class X-I (first grade) at MAN Bondowoso. This class included 30 female students. In both qualitative and quantitative formats, research data were gathered through observation, test questions, and questionnaires. The observation aimed to capture learning methods, learning media, and students' digital literacy at MAN Bondowoso.

Test items were used to determine the product's effectiveness. Validation sheets with a Likert scale of 1-4 were used for validity tests performed by lecturers and teachers. The sheet grid contained indicators to measure the material content of digital literacy indicators, the accuracy of language use, and the display format, instructions, and steps of the activities. Student responses to questionnaires were used for practicality tests. The responses also employed a Likert scale of 1-4 with 16 statements. The grid for the response questionnaire included statements related to the ease of students in using electronic worksheets, the ease in understanding

quadratic function material using electronic worksheets, students' interest in reusing electronic worksheets, and the responses to digital literacy skills after using electronic worksheets. Quantitative data were obtained from the questionnaire, the practicality tests, and the results of the tests. The tests involved a pretest and posttest, each comprising 4 essay questions that students must address individually. Meanwhile, qualitative was obtained through observation and suggestions from Mathematics Education lecturers and teachers during the validation stage.

The first stage of the development was defining, aimed to analyze the needs, context, and existing problems (Sari et al., 2020). The results were used as a reference in determining the objectives of the electronic worksheet for students' development. This stage included initial-final analysis, student analysis, concept analysis, task analysis and specification of learning objectives (Wahyuningtyas & Yahya, 2021). The second stage was designing an initial prototype (prototype I). The included media selection, format selection, initial media design, and test preparation (Nengsih et al., 2023). The third stage was development, in which expert validation and trials were performed (Mufida et al., 2022). The validation helped determine the validity of electronic worksheets for students, test questions, and student response questionnaires (Ayuni et al., 2022). The validation aspects included content suitability, language, and format, leading to data analysis. The analysis comprised validity, effectiveness, and practicality analysis. The product validity is affirmed when the validity coefficient is higher than 0.60. The validity coefficient ( $\alpha$ ) was calculated using the following formula (1).

$$\alpha = \frac{V_a}{4} \tag{1}$$

The validity coefficient was determined by recapitulating the validity assessment on aspects, indicators, and values. The validity assessment employed a 4-scale rubric for each indicator. The validity coefficient ( $\alpha$ ) was obtained by calculating the total average value ( $V_a$ ), which was divided by the maximum assessment criteria for each indicator (Rohman et al., 2021). The resultant  $\alpha$  was then interpreted according to Table 1 below.

**Table 1. Category of validity coefficient**

$\alpha$	Validity Level
$0,80 <  \alpha  \leq 1,00$	Very high
$0,60 <  \alpha  \leq 0,80$	High
$0,40 <  \alpha  \leq 0,60$	Moderate
$0,20 <  \alpha  \leq 0,40$	Low
$ \alpha  \leq 0,20$	Very low

Source: (Hussen et al., 2021)

Valid instruments were tried out to determine their effectiveness and practicality. Based on the test results, electronic worksheets for students have proven effective.

The test consisted of 4 descriptive questions adjusted to the digital literacy indicators. The question grid is presented in [Table 2](#).

**Table 2. Indicators of digital literacy**

Indicators	Sub-indicators
Internet Searching	The ability to perform activities and meet the need for information concerning quadrat functions by using the internet
Hypertextual Navigation	The knowledge of hypertext and hyperlinks to a website, along with the procedures to discover the solution to a quadrat function
Content Evaluation	The ability to analyse information on the website retrieved to identify the solution to a quadrat function
Knowledge Assembly	The ability to optimize the exploration of a website as media to determine information accuracy
	The ability to construct knowledge by drawing upon an aggregate of information

The qualitative analysis in this study was grounded in teachers' and lecturers' comments during the validation stage. The comments were considered to guide the revision of e-LKPD, so it can better cater to students' needs. Paired Sample Tests using SPSS and N-Gain analysis were performed to measure the product effectiveness ([Kartikaningsih et al., 2021](#)). This test was referred to differences in average pretest and posttest. Practicality was quantified by calculating the average scores of the students' responses ([Susanti & Damayanti, 2022](#)). The average score was converted into a percentage to determine the practicality, displayed in [Table 3](#).

**Table 3. Category of practicality**

Percentage (%)	Practicality Level
$P > 95\%$	Very high
$80\% < P \leq 95\%$	High
$65\% < P \leq 80\%$	Fair
$50\% < P \leq 65\%$	Low
$P < 50\%$	Very low

Source: ([Fatahillah et al., 2020](#))

The fourth stage was dissemination. It aimed to disseminate electronic worksheets for students after their validity, effectiveness, and practicality had been confirmed ([Belanisa et al., 2022](#)). Dissemination was carried out online via YouTube.

## RESULT AND DISCUSSION

This study produced the electronic worksheet for students with liveworksheets assisted by GeoGebra, which was amassed through pretest, posttest, and questionnaires. The development was accomplished through defining, designing, developing, and disseminating.

## Defining

The analyses found that Mathematics learning was still carried out conventionally with teaching media, books, PowerPoints, or student worksheets. The school already has a computer laboratory where Mathematics learning is organized with digital technology. In addition, student analysis, concept analysis, and task analysis demonstrated that many students struggled to understand Mathematics material. One of these materials is the quadratic function, in which students struggled.

GeoGebra is a digital-based media that can promote students' understanding of learning material, such as quadratic function material. GeoGebra can be integrated with electronic worksheets for students to optimize student learning of GeoGebra while escalating their digital literacy. This integration is achieved by designing lessons aligning with key digital literacy indicators, ensuring a comprehensive approach to content learning and technological proficiency.

## Designing

Media was developed as electronic worksheets for students with the assistance of liveworksheets. The electronic worksheets integrated activities that directed students to use GeoGebra. The activities were selected and organized aligned with digital literacy indicators, as shown in Table 2.

An electronic worksheet for students is developed as a web page accessible to the public via a link. GeoGebra is an online platform accessed via browsers such as Google Chrome, Mozilla Firefox, and the like. Electronic worksheets for students contained activities that directed students to use GeoGebra. A learning video was developed to guide students upon engaging in GeoGebra, describing the steps for using GeoGebra in learning Mathematics. This video was uploaded to YouTube, and the URL was attached to the worksheet. Electronic worksheet for students was edited using the liveworksheets. Open Answer, Drag and Drop, Single Choice, Select Element, and YouTube Player were some of the facilities used to edit electronic worksheets for students. The initial electronic worksheet for students is in Figure 1.



Figure 1. The initial design of electronic worksheet for students

The initial electronic worksheet for students informed the title of the electronic worksheet for students. After the cover or title page, the first page describes learning achievements, objectives, and instructions for using and filling out electronic worksheets for students. The next pages on the electronic worksheet for students are observable in Figure 2.



Figure 2. The display of electronic worksheets for students

On the second page, the activities are developed in alignment with digital literacy indicators, namely internet searching. This section contains activities to meet the need for information related to quadratic functions via the Internet. Students are directed to identify a quadratic function's definition and general form using online resources. The third page elaborated on the activities developed coherently with another digital literacy indicator, namely content evaluation. The content was presented as a video containing steps for using GeoGebra. Students were directed to observe the video and analyze the steps to use GeoGebra on quadratic functions. These details are presented in Figure 3.

On the fourth page, the activities were arranged to cater to hypertextual navigation. This section contained activities to fulfill the completion of quadratic functions with the aid of websites. Students were directed to visit the link from the GeoGebra website to investigate the graphic form of a quadratic function. As for the fifth page, the activities were focused on knowledge assembly. In this section, students were directed to use the GeoGebra as a medium to discover the truth and co-construct knowledge by exploring the quadratic function material.

The final step of this stage involved test preparation, where pretest and posttest questions were created, accompanied by scoring guidelines, validation sheets, and student questionnaires. The test questions consisted of 4 questions arranged based on digital literacy indicators. The test questions were distributed using the liveworksheets. In addition to the test questions, a validation sheet was also

prepared to validate electronic worksheets for students, test questions, and student response questionnaires before being used for testing.

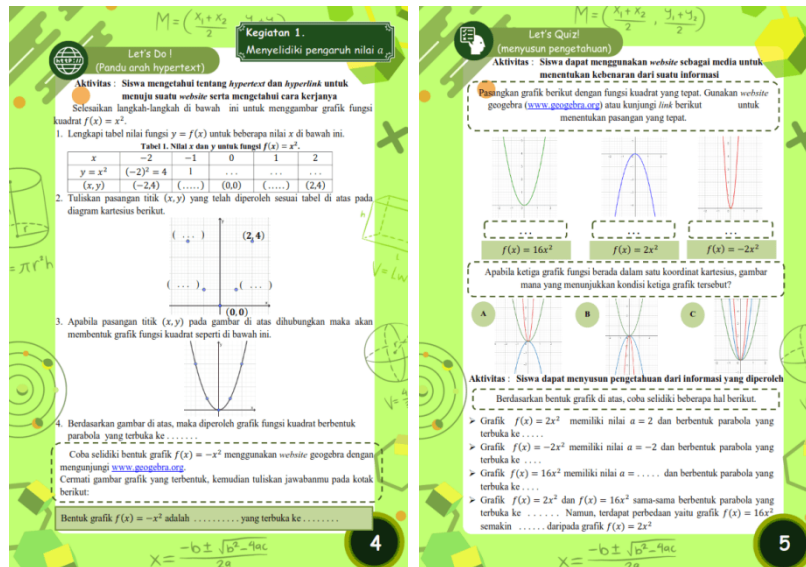


Figure 3. The display of electronic worksheets for students

### Development

The development stage aimed to refine the electronic worksheet for students based on the validity, effectiveness, and practicality analysis. The prototype I was validated. The next stage was to revise prototype I and validate it to achieve a better version, prototype II. Prototype II was tested on research subjects. The trial was carried out for 2 days. On the first day, the activity required students to work on pretest questions consisting of 4 questions. On the second day, students worked on an electronic worksheet for students, and they were subsequently given posttest questions consisting of 4 questions. The tryout ended with a questionnaire being filled out. The tryout results were analyzed for effectiveness and practicality. The first analysis dealt with media validity, examining content, language, and format using a 4-level rubric for each indicator. As the basis for evaluation, validators underlined several comments for improving e-LKPD. First, the display had to be modified by reducing the pictorial elements and making the content more prominent. In addition, the sentences had to be rewritten in compliance with standardized Bahasa Indonesia. Finally, the content in e-LKPD had to be adjusted to meet the indicators of digital literacy. The validation score was interpreted according to Table 1. The content, language, and format analysis revealed a total average of 3.94, with a correlation coefficient ( $\alpha$ ) of 0.99, right in the  $0.80 < |a| \leq 1.00$  range. Thus, electronic worksheets for students demonstrated a high level of validity.

The second analysis was the analysis of test questions. The validated questions consisted of a pretest and a posttest. The validator mentioned several comments. First, the question statement had to be put in the center. Also, the misspelling of several words had to be addressed. Finally, the sentences were rewritten to ensure their accuracy according to the standards of the Indonesian language. The total average value was 3.89, with a correlation coefficient ( $\alpha$ ) 0.97. The correlation

coefficient, following Table 1, was very high. Thus, the test questions were declared valid, ensuring their suitability to test the effectiveness of electronic worksheets for students.

The third validation was the analysis of student responses. The validated aspects consisted of content, language, and response. The validator raised the need to add more questions relevant to the indicators of digital literacy. A total average validation score of 3.89 was obtained with  $\alpha$  0.97. When interpreted according to Table 1, this signifies a very high validity. As such, the student response to the questionnaire was declared valid for actual use to test the practicality of electronic worksheets for students.

Effectiveness analysis was used to measure the increase in students' digital literacy by comparing the pretest and posttest. The results are presented in Figure 4.

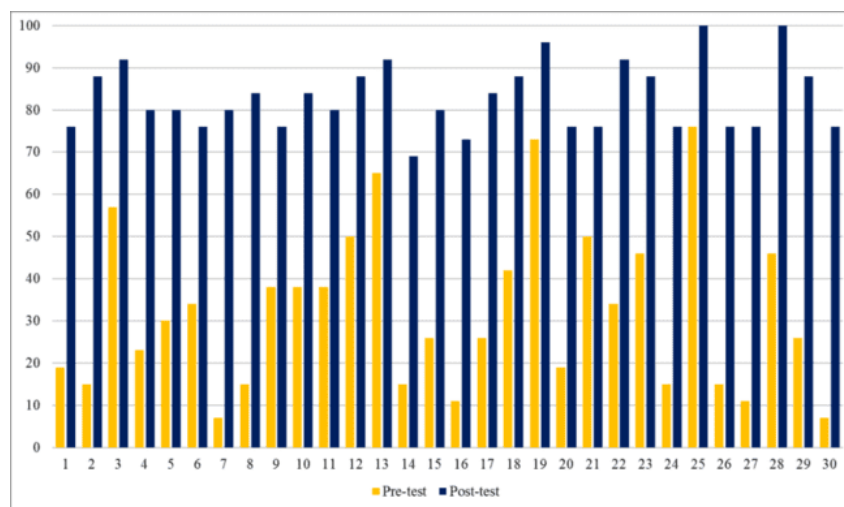


Figure 4. The results of pre-test and post-test

The data from the students' pretest and posttest were tested using the Paired Sample T-test and N-Gain to determine the effect of implementing electronic worksheets for students to improve students' digital literacy. The following are Paired Sample T-tests in Table 4.

Table 4. Paired samples statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	32,2333	30	19,20252	3,50588
	Posttest	83,0000	30	8,09427	1,47781

Based on Table 4, the average pretest was 32.23, and the average posttest was 83.00. This demonstrates a significant difference in the average test results before and after using electronic worksheets for students because the average score is  $32.23 < 83$ . The next activity was the N-Gain analysis, presented in Table 5 below.

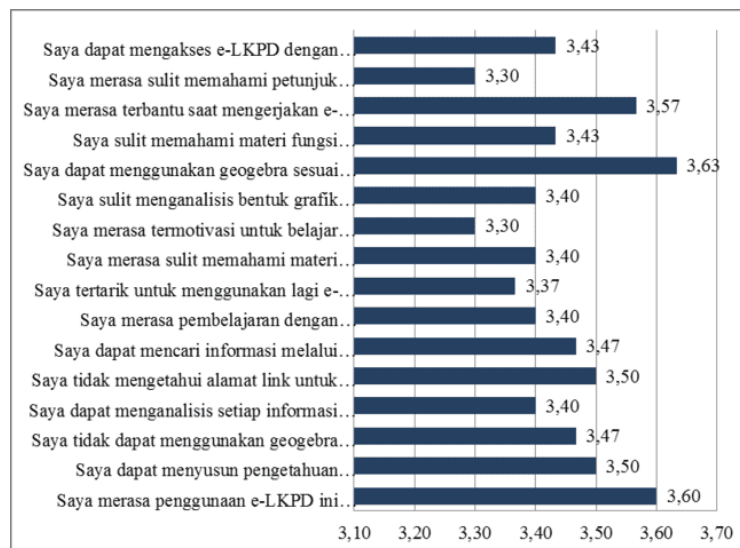
**Table 5. The criteria of  $N - Gain$**

Score of $g$	Effectiveness criteria
$g > 0,70$	High
$0,30 \leq g \leq 0,70$	Medium
$g < 0,30$	Low

Source: Hake (Fatahillah et al., 2020)

The N-Gain analysis revealed that 22 students significantly improved digital literacy skills, as indicated by a high N-Gain score ( $g$ ). Meanwhile, 8 students showed moderate improvement in digital literacy, reflected by moderate  $g$  criteria. The overall analysis yielded an N-Gain percentage of 76%, confirming that the electronic worksheet for students effectively enhances digital literacy, particularly in the context of learning quadratic functions.

Practicality analysis was based on the scores derived from the students through the questionnaire. The average score for each indicator is in [Figure 5](#).



**Figure 5. Average scores of student response**

[Figure 5](#) highlights the total average of 3.45, with a percentage of 86.20%. According to Table 3, the percentage lies in the 80%  $<P \leq 95\%$  range. Thus, electronic worksheets for students with liveworksheets assisted by GeoGebra were declared practical at a decent rate.

The fourth stage is dissemination. This stage aimed to disseminate electronic worksheets for students after testing its validity, effectiveness, and practicality. Dissemination was done online by sharing the electronic worksheet for students link via YouTube at the following link: <https://youtu.be/1PIG6RRRCfM?si=s-NIXhkj7uuatiq7>.

The researcher successfully developed an electronic worksheet for students through the Thiagarajan in this study. At the define stage, student analysis, concept analysis, task analysis, and specification of learning objectives were performed. At the design stage, the researchers designed an electronic worksheet using liveworksheets and Geogebra. In addition, a set of test instruments adjusted

to the student's digital literacy indicators was developed. At the development stage, validation, revision, trial, and analysis of effectiveness and practicality were accomplished. At the dissemination stage, the product was published by sharing the electronic worksheet via YouTube.

In this study, an electronic worksheet was tested for validity, effectiveness, and practicality. The validity was highly satisfactory, confirming its suitability for actual learning. The electronic worksheet was also found effective and practical. This situation aligns with the finding of [Nabilla et al., \(2022\)](#), who argue that an interactive mathematics electronic worksheet could improve students' digital literacy. This finding also supports [Simamora et al., \(2022\)](#), who state that the use of electronic worksheets for students adjusted to digital literacy indicators is effective in supporting students' digital literacy.

The present study employed liveworksheets as the media in developing e-LKPD for the students. This instrument has been proven effective in promoting students' digital literacy. This is indicated by their ability to address tasks involving digital elements. The measurement result of digital skill indicates that the theory by [Handayani et al., \(2023\)](#), utilized liveworksheets to cultivate students' digital skills. The research shows that LMS liveworksheets can also support students' digital literacy. Furthermore, the improvement of students' digital literacy has been affirmed by the increase from pre-test to post-test, 32,23 and 83,00, respectively. This situation aligns with the finding of [Elfandi et al., \(2023\)](#) showed that technology-assisted mathematics learning using Geogebra can also help improve students' digital literacy. This is based on the acquisition of students' digital literacy scores, showing a positive difference. The score shows increased digital literacy before and after using mediated by Geogebra. Likewise, [Septia & Wahyu \(2023\)](#) contend that Geogebra can improve students' digital literacy. The theoretical study by [Wahyuni et al., \(2022\)](#), Geogebra can increase creativity in digital literacy. Therefore, the electronic worksheet added a Geogebra link to support students' digital skills.

These findings acknowledge that learning innovation through the combination of technology can improve students' digital literacy. Electronic worksheets and live worksheets assisted by Geogebra on quadratic function material can help improve students' digital literacy.

## **CONCLUSION**

An electronic worksheet integrated with Liveworksheets and supported by GeoGebra for quadratic function material meets the criteria of validity, effectiveness, and practicality. Consequently, this electronic worksheet can effectively enhance students' digital literacy skills and is suitable for implementation in Mathematics instruction, particularly for quadratic functions.

Notwithstanding, the findings demonstrate that electronic worksheets for students with live worksheets can only provide automatic scores on short answers without descriptive elaboration on student performance or achievement. In addition, electronic worksheets for students on liveworksheets cannot yet visualize the GeoGebra website directly on the liveworksheets website page because it only

attaches a link. Therefore, the researcher recommends further inquiry into developing an electronic worksheet for students that integrates a website with more complete and interactive menus, such as an automatic correction menu for descriptive answers and a menu to display visualizations from GeoGebra directly.

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## The development of learning media "UNGGAS NANNO" on subjects of intranatal care and newborn care

Lellyawaty<sup>1)\*</sup>, Rizky Vaira<sup>2)</sup>

<sup>1</sup> Diploma III Midwifery Study Program, Sekolah Tinggi Ilmu Kesehatan Abdi Persada, Jl. Soetoyo S No. 365, Banjarmasin, Kalimantan Selatan, Indonesia.

<sup>2</sup> Diploma III Midwifery Study Program, Universitas Borneo Tarakan, Jl. Amal Lama No. 1 Kota Tarakan, Kalimantan Utara, Indonesia

[lellyawaty30@gmail.com](mailto:lellyawaty30@gmail.com), [vairarizky@gmail.com](mailto:vairarizky@gmail.com)

\*Correspondence author

### Abstract

Quality learning is the goal of learning. The mismatch of media in the delivery of lessons will result in the goal of learning not being achieved. In addition to teacher talks, videos, and practices in the laboratory to achieve learning objectives, it turns out that midwifery students have not mastered the related scientific foundations in subjects of intranatal care, especially providing care during labor and newborn care that has been studied. To attract students' interest and motivation in mastery, "Ular TaNGGAs ASuhan PersaliNAN Normal (UNGGAS NANNO) or Intranatal Care and Newborn Care Snakes and Ladders Game" is needed in learning. The ADDIE model was used in research with validation subjects from expert teams and midwifery students as users. UNGGAS NANNO media is considered very worthy and very interesting in terms of the suitability of learning materials, images, and sizes, with an average score (of 92.5% and 96.8%). In addition to being feasible, UNGGAS NANNO can be used as an additional medium for learning and alternative assessments as a substitute for the final semester exam by teaching lecturers.

**Keywords:** Intranatal; Learning Media; Newborn Care; Snakes; Ladders.

### INTRODUCTION

Maternal and child health problems are international problems whose handling is included in the Sustainable Development Goals (SDGs), with a target by 2030 for the Maternal Mortality Rate to reach 70/100,000 live births while the Neonatal Mortality Rate reaches 12/1,000 live births (Perpres, 2017). One way to achieve this is by producing midwives who can provide quality intranatal care. Midwifery students have received learning materials about intranatal care in the third semester, which aims to provide midwifery care to mothers giving birth (Yulizawati & Fitria, 2022).

When researchers conducted observations on fourth-semester midwifery students at the Abdi Persada College of Health Sciences (STIKES) Banjarmasin, Indonesia, it

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was found that the majority of students did not remember the lesson intranatal care which had been taught in the previous semester. Even though many learning media are used, including video learning, laboratory practicum, and community practice, students still do not master the scientific basis of the course. Seeing this fact, lecturers need to create interesting and not boring learning media other than usual, hoping that students can remember and re-understand the learning that has been taught before.

Determining what media lecturers will use during learning is important in producing quality learning. Media inconsistencies can result in goals not being achieved, wasted time and high costs, and an unpleasant learning process (Sari, 2019). Media use in the learning process can arouse new interests, stimulate and motivate learning, and influence psychological conditions for the better (Heavyndah & Puspasari, 2021). Lecturers can use technology to make games as a learning media (Latifah et al., 2023).

Some of the research results to increase the learning motivation of midwifery students include a phantom product from simple fabrics equipped with an umbilical cord and placenta, as well as a vulva (Amalia et al., 2022). There is a virtual development of active management in the third period (Hasyim et al., 2021). Web-based learning with video and animation displays to improve practicum skills in the laboratory (Wiriyanti et al., 2020). The development of games is also one of the innovations that has made the learning atmosphere not monotonous. One of them is the *Eclipse Crossword Educational Game* in the Complex Case Midwifery Care Course, which was a significant influence on the use of games to improve student learning outcomes (Zulisa, 2021). Several studies have presented that snake and ladder games have not been found to be learning media for midwifery courses, especially intranatal care and newborn care, so this learning media is considered to be able to overcome the factual problems that have been explained in this study as a novelty of learning media.

Snakes and ladders can increase student activity and learning enthusiasm and allow students to dare to express their opinions. It impacts improving student learning outcomes, and teachers can easily convey material (Dewi et al., 2017). According to Salombe (2021) snake and ladder is a game for elementary school that can increase motivation, understanding, and learning outcomes. In line with several research results with these media, among others, it can increase knowledge in pregnant women about stunting by 26%, where snakes and ladders games are fun games (Mulianingsih et al., 2021), there was an increase in adolescent knowledge of stunting by 9.04% (Lellyawaty et al., 2022), mothers' knowledge about toddlers's health is increasing, mothers understand stunting, its causes, impacts, characteristics, and how to prevent and overcome stunting (Zulfita et al., 2020).

Research that uses snakes and ladders as a learning media for obstetrics, including increasing knowledge of preventing complications in pregnant women (Rosada et al., 2019), knowledge about reproductive health (Sari et al., 2024; Waliyanti et al., 2021) and increasing activity in pregnant women's classes (Wulandari et al., 2022). The literature search results have not found snakes and ladders games used in intranatal care, especially providing care during labor and newborn care for

midwifery students. Based on the gap, an innovation in learning media development is called "Ular TaNGGAsuHan PersaliNAN Normal (UNGGAS NANNO) or Intranatal Care Snakes and Ladders Game." The development of UNGGAS NANNO displays pictures of snakes and ladders boards in modified banners with colours and images displayed according to intranatal care learning material for midwifery students.

UNGGAS NANNO learning media attracts students' attention and curiosity so that they play and learn happily. It also aims to describe the material subjects of intranatal care and newborn care. This research contributes to previously existing learning media, such as learning videos and practice using phantoms. It can be used as an alternative assessment to replace semester exams, especially providing care during labor and newborn care.

## METHODS

Research conducted is a type of Research and Development (R&D) with the ADDIE model (Sugiyono, 2021) with the procedure as shown in Figure 1.

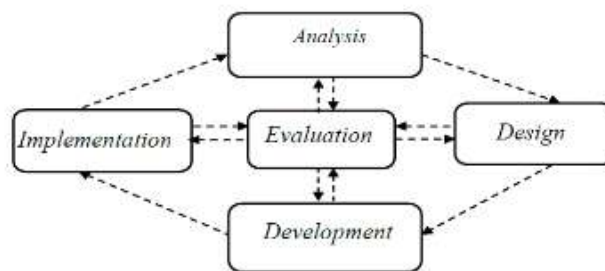


Figure 1. ADDIE Model

Figure 1 shows this development research using a procedural approach. In the first stage, an analysis was carried out on the causes of problems in learning, where most midwifery students forgot the theories previously studied in the intranatal care course, especially providing care during labor, which is one of the competencies of midwifery students. Learning media in videos and phantoms/childbirth models have also been used but have not reached the final goal of learning optimally. So, it is necessary to add development to learning media. The second stage is design; after conducting an analysis, the next step is to design and determine a method or strategy for media development. At this stage, the design is prepared according to the material on the syllabus or semester learning plan in the course by determining the expected goal, which is to be able to carry out intranatal care. The expert team carries out the results of this stage of media validation. The third stage is the stage of producing, developing, and validating learning resources. At the development stage, validation by professional experts, material experts, and users, namely midwifery students. The fourth stage is implementation. The learning media that has been validated is then tested for the use of UNGGAS NANNO for Midwifery students in the classroom. The last stage is an evaluation to assess the quality of UNGGAS NANNO, which was developed using a questionnaire.

The feasibility aspects assessed by the expert team consist of the suitability of learning objectives and materials, simplicity of the media, not outdated, clean, attractive media, practicality, and the size of media that large and small groups can use. The assessment questionnaire of the expert team contains input and suggestions for improvement in the game guidebook and questions and answers on each UNGGAS NANNO box. Meanwhile, the aspects assessed by students to see the practicality of the media that have been developed are the appearance of the media, the presentation of the material, and the usefulness of the media to increase learning motivation and interaction with fellow midwifery students.

The questionnaire assessment uses a Likert scale, as shown in Table 1. The questionnaire results were analyzed using modified steps from Riduwan (2018).

**Table 1. Likert scale**

Criteria	Score
Very Worth It	5
Worthy	4
Quite Decent	3
Not feasible	2
Unworthy	1

Next, to calculate the percentage of ideality of the data obtained, use the following formula (1):

$$P = \frac{\text{score obtained}}{\text{maximum score}} \times 100\% \quad (1)$$

The scores are then converted into qualitative data by comparing them to qualitative data on the assessment criteria table as in Table 2.

**Table 2. Assessment criteria**

No	Evaluation	Interpretation criteria	
		Expert team	Student respondent
1	81% ≤ P ≤ 100%	Very Worthy	Very interesting
2	61% ≤ P < 81%	Worthy	Interesting
3	41% ≤ P < 61%	Quite Decent	Quite interesting
4	21% ≤ P < 41%	Not Eligible	Not attractive
5	21% ≤ P < 0%	Unworthy	Very Uninteresting

Table 2 shows the criteria for assessing the suitability of learning media assessed by team experts (material experts and professional experts) and the requirements for assessing the attractiveness of learning media as assessed by users, namely students. The subjects in this study are a professional expert appointed by a midwifery professional organization, 2 lecturers who are lecturers of intranatal care courses, and 14 midwifery students in the fourth semester of the D-III midwifery study program at STIKES Abdi Persada Banjarmasin, Indonesia as users. The instrument used a questionnaire validated by a team of experts and a student response questionnaire.

## **RESULT AND DISCUSSION**

The stages of this research start from examining the problem, collecting data, making a design, conducting a product assessment, making revisions, conducting trials, and ending with product revision.

This development research produces learning media through snakes and ladders games as a feasible and attractive media for students in the third semester of the D-III midwifery study program using the ADDIE model as follows:

### **Analysis**

This research started from the lack of learning evaluation results, students have not been able to master intranatal care and newborn care in terms of case response, mastery of intranatal cases, lack of motivation to read other references, and lack of application of the theory obtained to the practice of intranatal care in the practice area. Through the development of UNGGAS NANNO, midwifery students are more enthusiastic about learning and practicing the skills they have gained and are not bored when attending lectures. Based on the analysis of student characteristics, curriculum analysis, and analysis student needs, the researcher developed learning media in the form of UNGGAS NANNO by adopting the snakes and ladders image, each box contains photos according to the learning materials in the Semester Learning Plan (RPS) for intranatal care and newborn care that have been obtained previously.

### **Design**

The learning media developed is called UNGGAS NANNO. The activities at the design stage identify competencies and indicators of competency achievement based on the curriculum used. Conducting documentation in the form of photos according to the study materials determined to be included in each snake and ladder box using tools/materials in the midwifery laboratory, searching for related references to be used, making designs, and compiling research instruments. This learning media is prepared based on the study materials determined in the Semester Learning Plan. The design of "UNGGAS NANNO" was made using Adobe Photoshop software. The design of the snake and ladder game "UNGGAS NANNO" has been revised 3 (three) times based on input from material experts and professional experts available at the link <https://s.id/meUkV>.

### **Development**

This stage includes development, validation of research instruments, and product development and validation. In the initial step of the development and validation stage of research instruments, the instruments prepared in advance are consulted with a team of experts to ensure that the material presented has met the aspects. The instruments used are the material expert validation questionnaire, the professional expert validation questionnaire, and the student response questionnaire. The next step is to carry out the development stage of UNGGAS NANNO product instruments and be validated by professional experts, material experts, and users. The results of the questionnaire were then analyzed quantitatively and qualitatively. The expert team's assessment results are at <https://s.id/qfcgl>. The expert team's conclusion of the feasibility results is referred to in [Table 3](#).

**Table 3. Conclusion of validator assessment results**

No	Validators	Validation values	Category
1	Professional Expert	95%	Very Worthy
2	Subject Matter Expert	90%	Very Worthy
	Average	92.5%	Very Worthy

Table 3 shows the assessment by professional experts from the midwifery profession (95%) and material experts from midwifery lecturers (90%), meaning that UNGGAS NANNO is very worthy of being used as a learning media with an average score of 92.5% from the expert team with a value of  $P = 81\% \leq P \leq 100\%$  (very worthy). The assessment is categorized as very worthy regarding the suitability of the objectives, materials, and images in UNGGAS NANNO with the course learning plan. The expert team also assessed that UNGGAS NANNO could convey the intention and message of the images that are shown; practical, the size of UNGGAS NANNO is suitable for large and small groups with a size of 3 x 3 meters, which means that 1 box has a size of 60 x 60 centimetres.

### Implementation

After the design was revised according to the expert team's input and suggestions, the researcher published the UNGGAS NANNO design in the form of a banner of 3x3 meters for testing. Before the implementation of the trial, students are asked to re-literate the teaching materials to prepare thoroughly. The students who took part in the trial were 14 students in the third semester of the D-III midwifery study program who had taken the intranatal care and newborns course. Students are divided into 5 groups, each comprising 2-3 students as in Figure 2.



**Figure 2. Trial preparation group representative**

The group's representative advances to represent his group, as shown in Figure 2. After being drawn, the group that advances first (the group representative) rolls the dice and steps according to the number that appears. The lecturer reads the questions according to the numbers; if students can answer them correctly according to the assessment criteria, they can play again. The game is limited to 3 throws if the group can answer the question correctly, as presented in Figure 3.



**Figure 3. The group answers questions and works on cases according to the question box**

The next group continues the game with the same pattern until all groups play. The game is repeated in the first group to play again. The game rules, question templates, and assessment criteria are in the UNGGAS NANNO game guidebook ([https://s.id/UNGGAS\\_NANNO](https://s.id/UNGGAS_NANNO)). After that, students conducted evaluation as presented in Figure 4.



**Figure 4. Evaluation after the game**

After testing the product on students, representatives of student groups expressed their opinions through a questionnaire, as in Table 4.

**Table 4. Student assessment results**

No	Validator	Validation value	Category
1	Student Group 1	97 %	Very interesting
2	Student Group 2	95 %	Very interesting
3	Student Group 3	100 %	Very interesting
4	Student Group 4	97 %	Very interesting
5	Student Group 5	95 %	Very interesting
<b>Average</b>		<b>96.8 %</b>	<b>Very interesting</b>

Based on Table 4, according to students, learning using UNGGAS NANNO is very interesting (96.8%), as shown in Figure 4, and the attractiveness assessment is in the link <https://s.id/3UZbF>. UNGGAS NANNO is easier for learning media than providing learning evaluation using the Final Exam because of the variety of

colours and images on the snakes and ladders media. In addition to being interesting, UNGGAS NANNO can also improve memory of the material with the images available in each snake and ladder box, increasing cohesiveness and cooperation between groups.

### Evaluation

In this evaluation stage, the product is reviewed again to identify errors that need to be corrected in the previous stage. Experts offer suggestions to accomplish the product developed at the development stage. The product is fixed based on expert input as shown in Table 5.

**Table 5. Evaluation results**

No	Before revision	After revision
1		
2		
3		

Based on Table 5, the explanation of product improvement suggestions in the follow-up review of experts to add course learning outcomes (point 1), in question number 6, the answer choices were added from 6 answer choices to 7 answer choices (point 2) and in question number 16 the answer choices were added from 3 answer choices to 4 answer choices.

The increasingly advanced midwifery science requires midwives to work professionally with the competencies they must possess, work with responsibilities, and have a professional code of ethics starting from education. The strategy of producing professional midwife graduates is through innovation in learning.

Learning media is everything that can convey a message to students, which can ideally attract interest and attention and improve thinking skills and comprehension can be improved (Hanifa, 2023). The optimal use of technology as a learning media can shape the generation to be creative, innovative, and competitive (Alfin et al., 2018). The role of media in the learning process is important because it can help students understand a concept in learning (Nikmah et al., 2020). In addition, with the existence of media, students will be more interested and motivated in the learning process (Irvan & Marwan, 2023), shorter delivery time, and can improve the quality of learning (Nurfadillah et al., 2021). According to Dinar et al., (2022), motivation in learning is important for students to increase their enthusiasm for learning, impacting their learning outcomes.

This research aims to develop learning media through games. Game-based media development is quite popular and in great demand by students today. Previous research has shown that gamification is effective in increasing student motivation compared to a control group without gamification (Sotos-Martinez et al., 2024), and can increase self-confidence to participate and work in a team (García-López et al., 2023). Snakes and Ladders is a simple game with, an attractive design with color and picture games, but still paying attention to the learning objectives. Through the game, students become more active in the learning process. Learning that was originally only centred on lecturers, by using snake and ladder games, has become student-centred learning.

Results of the student response to UNGGAS NANNNO media in the "very interesting" category (96.5%) were seen from the appearance and presentation of the material and in terms of its benefits. In line with the results of the study (Mulyawati & Windiyani, 2020) show that the learning outcomes of elementary school students influence learning using snakes and ladders. This is also in line with Montenegro-Rueda et al., (2023) the application of learning strategies through gamification can improve student academic performance, motivation levels, and involvement in the learning process. Through snakes and ladders games, students can find new and interesting things; students are more active during the learning process both individually and in groups.

The result of the observation is that students feel bored when the courses taught only use PowerPoint and learning videos. Hence, the author adds another media, namely the snake and ladder game. UNGGAS NANNNO contains learning materials adapted to the lesson plan and designed to be interesting in games. In line with the research Kasanah et al., (2022), in addition to aiming to describe material contained

in the textbook, display on the Snake and Ladder media can attract attention and increase curiosity so that they can learn and play happily.

Research (Fadilla et al., 2023) shows that learning using snake and ladder games can attract attention, and students are more focused on the subject matter, easy to understand, and quickly remember lessons. For the smooth teaching and learning process, high interest and motivation from students are needed. Students think the material presented will be interesting and fun if the teaching strategy and media are used correctly. Even so, each teacher has different strategies according to conditions in increasing student interest, motivation in learning, and achievement of learning outcomes (Chan et al., 2019; Fitri et al., 2019; Kristiyani & Budiningsih, 2019).

UNGGAS NANNO learning media is designed using attractive colours and images of learning materials obtained by students. Making media must be based on several considerations, one of which is colour. According to Julianto et al., (2019), understanding colour interactivity is an element in helping the transition process of the 'state of mind audience' and fostering motivation or interest in learning. The visual strategy seeks to influence visual stimuli or stimulation to increase students' interest in interacting.

## CONCLUSION

Development of learning media "Ular TaNGGa ASuhan PersaliNAN Normal (UNGGAS NANNO) or Intranatal Care Snakes and Ladders Game" used as one of the learning media in the D-III Midwifery Study Program, Abdi Persada Health Sciences College, Banjarmasin. The UNGGAS NANNO learning media has been validated by material experts and professional experts, with results included in the very worth it criteria (92.5 %) used for learning media. UNGGAS NANNO learning media was tested on 14 third-semester D-III Midwifery Study Program students, and the results, according to students, were included in the very interesting criteria (96.8%) used for learning media. Besides being a learning media, UNGGAS NANNO can be used as an alternative assessment to replace the final semester exam. It has received a creation registration letter with the number EC00202410395. The limitation of this research is that the material on normal intranatal care and newborn care is not represented, so suggestions for further research are to add more snakes and ladders boxes so that the learning material on intranatal care and newborn care is complete.

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

Penulis 1<sup>1)\*</sup>, Penulis 2<sup>2)</sup> dst. [TNR 12, tanpa gelar dan tidak boleh disingkat]

<sup>1</sup>Nama Institusi, Alamat, Nama Kota, Negara. [penulis 1, TNR 10]

<sup>2</sup>Nama Institusi, Alamat, Nama Kota, Negara. [penulis 2, TNR 10]

penulis [\\_1@abc.ac.id](mailto:_1@abc.ac.id)\*; penulis [\\_2@abc.ac.id](mailto:_2@abc.ac.id); penulis [\\_3@abc.ac.id](mailto:_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:

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*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 menyebutkan kebaruan/ 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]**

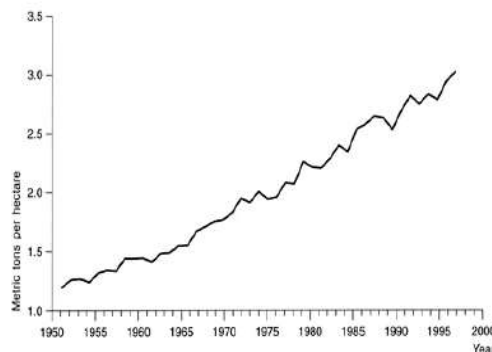
Hasil penelitian berisi paparan hasil analisis yang berkaitan dengan pertanyaan penelitian, sedangkan pembahasan berisi pemaknaan hasil dan perbandingan dengan teori dan/atau hasil penelitian sejenis, dengan persentase 40-60% dari keseluruhan artikel.

Dalam pembahasan diulas tentang temuan penting sesuai tujuan penelitian. Hasil penelitian dan kejelasan data digambarkan dengan gambar yang harus 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]**

Condition	M(SD)	95%CI	
		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.

#### **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 Eventual Attainment in Second Language Acquisition. *TESOL Quarterly*, 13: 543-567 (CD-ROM: *TESOL Quarterly-Digital*, 2007).

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**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](http://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.

## **Petunjuk Penulisan Artikel JINoP (Jurnal Inovasi Pembelajaran)**

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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 unggah dan register lebih dulu melalui laman website : <http://ejournal.umm.ac.id/index.php/jinop/user/register>

### **Ketentuan Penulisan Naskah**

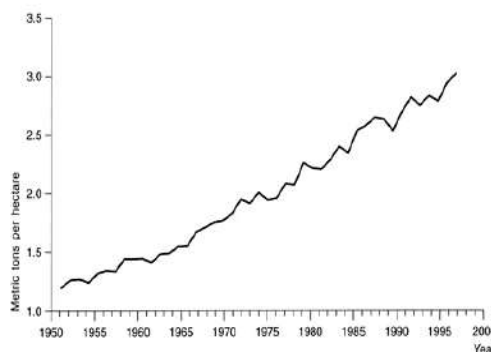
1. Bahasa yang digunakan dalam penulisan naskah adalah Bahasa Indonesia atau Bahasa Inggris.
2. Naskah diketik di atas kertas A4 dengan margin kiri 4 cm, margin atas, bawah dan kanan 3 cm, menggunakan tipe huruf Times New Roman, ukuran huruf 12, dan spasi 1.
3. Jumlah halaman naskah adalah 10 sampai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

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[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.

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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.

**FORMULIR BERLANGGANAN  
JINoP (JURNAL INOVASI PEMBELAJARAN)**

Mohon dicatat sebagai pelanggan JINoP ( Jurnal Inovasi Pembelajaran)

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Alamat : .....  
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