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# Development student book virus on problem-based learning assisted augmented reality to improve critical thinking skills

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| Article Info: | Abstract |
|---|---|
| | Empowering critical thinking skills in learning requires the innovation of teaching materials related to and supporting the learning process. In addition to innovations in teaching materials, integrating technology in teaching materials is also needed to support 21st century learning. This research aims to develop a problem-based learning virus-based learning student's book with the help of augmented reality media to empower students' critical thinking skills. The implementation of this research is in the Odd Semester of the 2024/2025 Academic Year. This research uses the Reseach and Development (R&D) method with the ADDIE development model which consists of five stages, namely analysis, design, development, implementation and evaluation. The instruments used to measure the validity, practicality, and effectiveness of student books include validation sheets, student response questionnaires, and critical thinking skills test questions. The results of the research at SMAN 1 Manokwari show that the student book of problem-based virus material assisted by augmented reality class X at SMAN 1 Manokwari is very valid, very practical and quite effective as a teaching material to empower students' critical thinking skills. This can be seen from the average validity score of the validator of 99.37%, the average practicality score of 88.03%, and the average effective score of 52.72%. |

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# 1. INTRODUCTION

In modern learning, teachers are no longer the only source of learning, but rather act as facilitators who help students develop skills that are in line with the needs of the times. Critical

thinking is one of the main skills needed including the ability to understand concepts, analyze information, and evaluate solutions to solve real problems (Syamsi & Fitrihidajati, 2021). Critical thinking is a thinking process that involves trying to find, analyze and evaluate information obtained from observation or experience (Wayudi et al., 2020). According to Hidayah, Salimi, and Susiani (2017), the ability to think critically is the ability to think logically, reflectively and productively which is applied in making good decisions through consideration. In line with Jiwandono (2019), critical thinking is thinking by considering common sense or logic before deciding or judging something. In line with Nuraida (2019), critical thinking is thinking logically in assessing something as a basis for decision-making or action. Critical thinking is a thinking process that involves trying to find,analyze and evaluate information obtained from observation or experience (Wayudi et al., 2020). Critical thinking skills are very important in all aspects of life, both in the world of work and other aspects of life. This is because according to Hidayah, Salimi, and Susiani (2017), critical thinking skills are useful in improving analytical skills, creativity, the ability to utilize ideas or information, and the ability to seek information and self-reflection. Thus, critical thinking skills are the ability to think logically and reflectively that focuses on assessing and evaluating information as the basis for decision-makingalready studied by other researchers, very specific statement giving the purpose/objectives of studies, and optional statements that give a value or justification for carrying out the study.

Empowering critical thinking skills in learning requires the innovation of teaching materials related to and supporting the learning process. Innovative teaching materials not only help teachers deliver material, but also encourage students to become active learners who are able to analyze and solve problems independently (Ilfiana et al., 2021). One of the important teaching materials in learning is student books. Student books present structured learning materials arranged based on basic competencies in the curriculum and used by students in the learning process (Sutrisna & Gusnidar, 2022).

The importance of critical thinking is also emphasized in the independent curriculum, which prioritizes problem-based learning or Problem Based Learning (PBL) (Nauw et al., 2018). Problem Based Learning (PBL) is an instructional method in which student learning occurs in the context of authentic problem-solving (Marra et al., 2014). In the problem-solving process, students learn to gather information, analyze problems, consider alternative solutions, and make appropriate and logical decisions (Ningsih et al., 2023). In accordance with Slamet ete al (2023) stated that PBL trains students to be able to think critically in a more varied way. Thus, it can be concluded that the PBL learning model is a learning process that focuses on students, where students are given a problem in the real world as a stimulus that triggers students to think critically to solve a problem and connect it with the material learned.

However, the challenge faced in the implementation of PBL is to provide an interesting and contextual learning experience so that students are motivated. Moreover, viral material is one of the topics that requires a special approach in learning because of its abstract and microscopic nature. Viruses are closely related to real problems in life, such as the covid-19 pandemic, so understanding the concept is very important for students (Juniarti and Suyitno 2022). With technological advancements, now there is augmented reality media. The use of augmented reality encourages interest in student involvement in learning (Vari, 2022). This innovation provides in-

depth visualization of the learning content so as to increase students' interest (Iwan et al. 2023). Using AR, learners can see three- dimensional images of objects or processes related to the problem they are facing, thus supporting a deeper understanding. Mustaqim (2016) stated that AR learning media can visualize abstract concepts for the understanding and structure of an object model so that AR as a more effective media is in accordance with the purpose of the learning media. Previous research has shown that AR is able to increase interest in learning (Iwan et al. 2023), student involvement in learning (Vari, 2022), students' critical thinking skills (Anapia et al., 2024; Caesario & Ardiansyah, 2023), as well as training students' critical thinking (Iqliya & Kustijono, 2019).

This encourages researchers to combine student books and AR in the learning process, especially to empower students' critical thinking skills. In addition, previous research on PBL has shown that the application of PBL is effective in improving students' critical thinking (Fariroh & Anggraito, 2015; Saputri, 2020; Aini et al., 2020; Annisatun et al., 2023) and PBL are effectively used in learning viral material because they are able to actively involve students in group discussions to solve real problems (Sari et al., 2024).

The combination of PBL and AR is a great step forward in improving the quality of learning. This combination can help learners develop critical thinking skills through more engaging, interactive, and relevant learning experiences. Thus, the combination of PBL and AR offers a continuous learning approach in developing students' critical thinking skills. Based on the problems and facts found with this background, it is considered very important to develop a problem-based learning student book assisted by augmented reality on virus material. This research aims to develop a textbook of virus material based on augmented reality-assistedlearning to empower students' critical thinkingskills.

## 2. METHODS

This type of research is development (R&D) using the ADDIE model procedure. The ADDIE model consists of five stages, namely Analysis, Design, Development, Implementation, and Evaluation. The following is a schema of the stages of the ADDIE model in Figure 1.
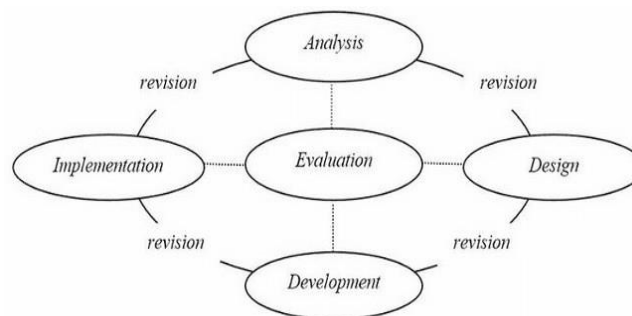


***Figure 1***. ADDIE development model (Branch, 2009)

Data source from 22 students of class X at SMAN 1 Manokwari. Data collection was carried out in the Odd Semester of the 2024/2025 Academic Year. The data taken included validity data from the validation sheet, practicality data from the response questionnaire, and effectiveness data from the critical thinking skills test questions. Data was obtained by providing validation sheets to validators of media and material experts as well as for response questionnaires and critical thinking skills questions given to students. The data that has been obtained is then analyzed descriptively to obtain an overview of the feasibilityof thedeveloped product and the critical thinking skills of students.

## A. Validity Analysis

To calculate the validity of the teaching materials of the student book on virus material, the following formula is used (Akbar 2013). Based on the calculations obtained, the percentage value can be equalized through the validation criteria can be seen in Table 1.

$$V = \frac{Tse}{Tsh} \times 100\%$$

Information:

V = Validitas
Tse = Total empirical score
Tsh = Total expected score

*Table 1*. Validity criteria

| Score | Frequency |
|---|---|
| 85,01–100 | Very valid, or can be used without revision |
| 70,01– 85,00 | Quite Valid, or usable but needs a bit of improvement |
| 50,0 – 70,00 | Invalid, recommended not to be used |
| 01,00 – 50,00 | Invalid, or may not be used |

(Source: Arikunto 2014)

## B. Practicality Analysis

To determine the practicality of the student book, it was obtained from a student response questionnaire which was guided by the calculation of the linker scale. The following table of *Likert scale* indicators 1-5 can be observed in Table 2.

*Table 2*. Likert scale indicator

| Score | Criterion |
|---|---|
| 5 | Excellent |
| 4 | Good |

| 3 | Enough |
|---|--------|
| 2 | Less |
| 1 | Very less |

(Source: Arikunto 2014)

After that, the data that has been summarizwd, each criterion statement is calculated as follows (Kartini & Putra, 2020):

Student responses = $\frac{Total\ score\ obtained}{Maximum\ score}$ x 100%

Based on the calculations that have been made, the criteria for students' response to student books can be seen in Table 3.

*Table 3*. Score interpretation criteria

| Score | Criterion |
|-------|-----------|
| 81 – 100 | Very practical |
| 61 – 80 | Practical quite |
| 41 – 60 | Practical less |
| 21 – 40 | Practical |
| 0 – 20 | Impractical |

(Source: Riduwan, 2019)

## C. Effectiveness Analysis

To determine the effectiveness of the book, students were obtained from the pretest and posttest questions of the critical thinking skills test. The data that has been obtained is then analyzed by performing the following calculations:

Critical thinking skill = $\frac{Total\ score\ obtained}{Maximum\ score}$ x 100%

*Table 4*. Score interpretation criteria

| Score | Criterion |
|-------|-----------|
| 81 – 100 | Excellent |
| 61 – 80 | Good |
| 41 – 60 | Good enough |
| 21 – 40 | Less |
| 0 – 20 | Very Less |

(Source: Rahmawati et al., 2019)

# 3. RESULTS AND DISCUSSIONS

At the analysis stage, it is known that the needs of students are met by obtaining results that there is still a lack of innovation in teaching materials used in schools. Most of the books used are descriptive textbooks, the information presented is also less relevant to the lives faced by students. Then the presentation of colors and pictures in the book used does not attract students' interest in learning because of the monotony. Therefore, the empowerment of students' critical thinking skills is still lacking both in terms of teaching materials and teachers who still lack to practice HOTS (Higher Order Thinking Skills) questions for students.

After the analysis stage, the product is designed using Canva and then for augmented reality media is designed using the edu assembler (Suparman et al., 2025). Furthermore, the products that have been developed are given to validators of media and material experts to assess the feasibility of the developed product.

The results of the validation analysis of the student textbook based on the assessed aspects obtained an average score of 99.16%, categorized as highly valid. Based on data from Arikunto (2014), with a validity score of 81.01-100%, the validation results from the validator can be used without revision. This aligns with research by Uki and Bire (2021), which showed that the student textbook is highly valid and suitable for use, with an average score from material and media experts of 93.48%. Score interpretation criteria, augmented reality bakteriofage and barcode AR, Student response questionnaire, and students' critical thinking skills score shown in Table 5, Figure 2, 3 and 4.

*Table 5*. Score interpretation criteria

| Componen | Validator | | Validity value | Criterion |
|---|---|---|---|---|
| | V1 | V2 | | |
| **Design t** | 100 | 100 | 100 | Highly Valid |
| **User Convenience** | 100 | 91.6 | 95.8 | Highly Valid |
| **Quality of Information** | 100 | 100 | 100 | Highly Valid |
| **Language** | 100 | 100 | 100 | Highly Valid |
| **According to the Student's Development** | 100 | 100 | 100 | Highly Valid |
| **Average Percentage (%)** | | | **99,16%** | **Highly Valid** |

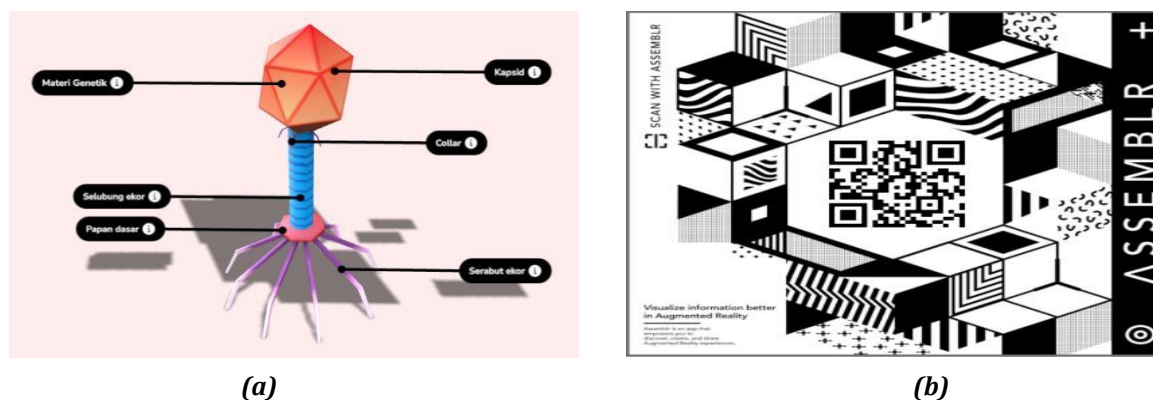*(a)*                                   *(b)*

***Figure 2***. Augmented reality: (a) Bakteriofage (b) Barcode AR
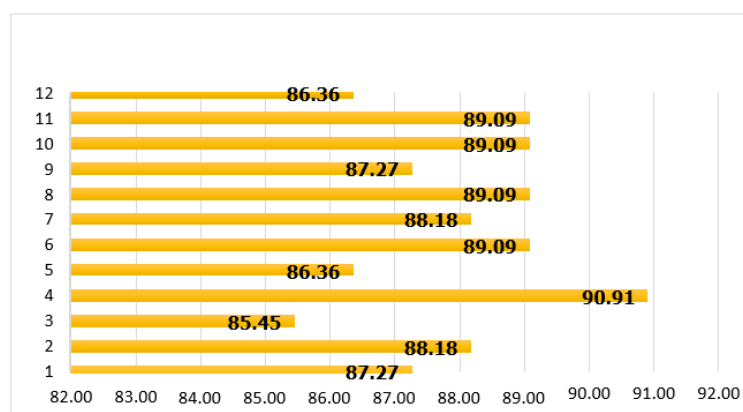


***Figure 3***. Student response questionnaire

Based on Figure 3, the students' response showed an average score of 88.03%. In accordance with the data of Riduwan (2009) in table 3, it is classified as very practical. This shows that students are interested in the appearance of the student book developed and the ease of using it. In line with Noveridha and Zulyusri (2022), it is classified as a practical category because it can attract students' interest in the learning process.
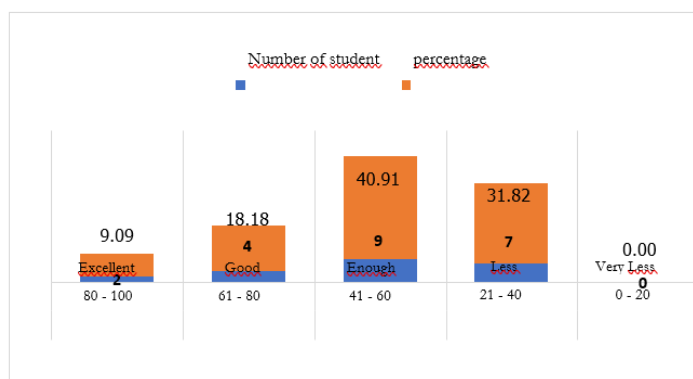


***Figure 4***. Students' critical thinking skills score

Based on Figure 4, out of 22 students, 2 students were included in the very good category with a percentage of 9.09%, 4 students were included in the good category with a percentage of 18.18%, 9 students were included in the fair category with a percentage of 40.90% and 7 students were included in the poor category with a percentage of 31.81%. The largest percentage of the category is sufficient. This can also be seen from the results of the calculation of the average pretest and posttest scores of 52.72% which are classified as quite visible in Table 6.

*Table 6*. Results of analysis of students' critical thinking skills

| Pretest | Posttest | Average | Category |
|---------|----------|---------|----------|
| 48,4% | 57,04% | 52,72% | Enough |

This is in line with research (Rahmawati et al., 2023) stating that most students have critical thinking skills in the sufficient category. In line with research (Rahmawati et al., 2019), it shows that the critical thinking skills of State Junior High School students in Magetan Regency in school A are quite sufficient. In line with the results of research conducted by Iwan et al. (2023), the critical thinking skills of prospective biology teachers at the University of Papua are in the less critical category. If viewed from the questions, most students answered questions 7 and 16 incorrectly, these questions are included in the blood analysis taxonomy indicator (C4). Of the 22 students, only 7 students answered correctly.

From the results of this analysis, it is known that there is a need to improve the quality of students by providing practice questions that refer to High order Thingking Skills (HOTS) questions (Rahmawati et al., 2019). In addition, according to Rahmawati, Masykuri, and Sarwanto (2019), teachers can also direct students to carry out discussion activities because exchanging information or ideas can trigger the mental thinking process.

# 4. CONCLUSIONS

The development of a problem-based learning based learning student book assisted by augmented reality to empower the critical thinking skills of class X students using the ADDIE model is very valid with an average score of 99.16%, very practical with an average score of 88.03%, and quite effective with an average score of 52.72%. It is hoped that the next researcher can further develop student books with other materials to help the Biology learning process in schools and develop research that focuses on the indicators of High order Thingking Skills (HOTS) questions so that students are familiar with these questions so that students are empowered with students' critical thinking skills.

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