

Innovation of Web-Based Learning Modules: Improving Biology Understanding and Computational Thinking of High School SJ

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ABSTRACT

This research aims to develop a web-based biology learning module on virus material with the aim of improving the computational thinking ability and concept understanding of high school students. The research was conducted using the Research and Development (R&D) method with the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model. Research data was collected through expert validation, readability questionnaires, and student pre-test and post-test. The results of the study show that the developed one has a high level of validity with an average score of 84%. The practicality test obtained a student readability result of 83.3%, which is classified as very practical. The effectiveness test showed an increase in learning outcomes with an average N-gain score of 0.65 which belongs to the medium category. This web-based module is able to increase students' motivation to learn, computational thinking, and understanding of biology concepts. Based on this study, the web-based virus learning module is valid, practical, and effective enough to be used in biology learning in high school. This module is expected to be an alternative teaching material that supports interactive and innovative learning.

INTRODUCTION

The development of science and technology has brought the world into the digital era, where the use of technology is one of the key factors in increasing the effectiveness of learning (Tanjung *et al.*, 2024). In the context of education, digital technology, such as web-based media, provides flexibility for students to access learning resources anytime and anywhere (Hsb, 2024). This also encourages independent learning that is not limited to the school environment. Biology learning requires students to not only understand the material textually, but also develop scientific thinking skills regarding biological concepts, principles, and processes (Latifah *et al.*, 2023). One of the materials that is quite abstract and difficult to understand is viruses, because they cannot be observed directly in everyday life. Therefore, the delivery of this material requires interesting visualization to help students understand (Darmawan *et al.*, 2020). Unfortunately, the limitation of visual resources is often an obstacle in the learning process of virus material, so visualization in the form of images or animations is needed so that students can understand the concepts better (Ahdad *et al.*, 2023).

Initial observations conducted in several high schools in Jember the study revealed that students struggled to grasp the concept of viruses due to the ineffectiveness of traditional teaching methods. A technology-based approach can be a solution, especially in the face in the era of Industrial Revolution 4.0, students are required to possess computational thinking skills, such as problem-solving, logical thinking, and understanding the relationships between concepts (Aristiawan *et al.*, 2023). One of the innovations that can be applied in biology learning is the development of web-based e-modules. E-modules are digital learning media that are systematically designed to help students learn independently (Prihatiningtyas *et al.*, 2021). The use of memorization methods in learning often makes students' interest in learning decrease, coupled with the limitation of learning resources that only rely on school package books (Prayogii & Rohiat, 2022). Package books tend not to provide additional resources such as learning videos or links to online resources, which should increase student engagement in learning (Risna, 2023).

The development of web-based learning modules can provide a solution to these problems. Web-based modules allow for wider accessibility through a variety of devices with an internet connection (Yuliastrin *et al.*, 2024). One of the platforms that can be used for the development of this learning module is Google Sites. This platform offers ease in the integration of various functional menus, such as storage instructional materials, educational videos, and student activity sheets (Gumilar *et al.*, 2022). Another advantage of Google Sites is its simple and free interface, as well as an online storage capacity of 100 MB which makes it easy for users to access (Nuraini *et al.*, 2023). Research by Cantika and Suryanti (2025) shows that the development of Google Sites-based biology learning media has a validity level of 93.88% and a practicality level of 88.55%, so it is suitable and efficient for use in education. Based on this background, this study aims to develop a web-based virus learning module to improve computational thinking skills and understanding of biology concepts of high school students in Jember.

RESEARCH METHODS

This study uses the Research and Development (R&D) method with the ADDIE (Analyze, Design, Development, Implementation, Evaluation) model approach. This method aims to develop and evaluate the effectiveness of web-based learning modules in improving students' understanding of biology concepts (Deniarti *et al.*, 2020). This study was carried out at SMA Negeri 3 Jember, the research will be carried out in the odd semester of the 2024/2025 school year. The population in this study is students of class X MIPA SMA Negeri 3 Jember. The test subjects in this study are students of class X MIPA for the 2024/2025 school year consisting of 2 classes. The research collected 2 types of data, namely quantitative and qualitative data. Qualitative data includes the results of the validation of the web-based module products that have been developed as well as the responses of students after using the web-based module. Quantitative data includes scores of students' computational thinking skills and conceptual understanding. The detailed data taken in the study includes: Questionnaire: To assess the practicality and validity of web-based modules. Tests: Includes (Pre-test and Post-test) to measure the improvement of students' computational thinking skills and understanding of biology concepts before and after using the module.

Stages the development of the ADDIE model in this study is as follows:

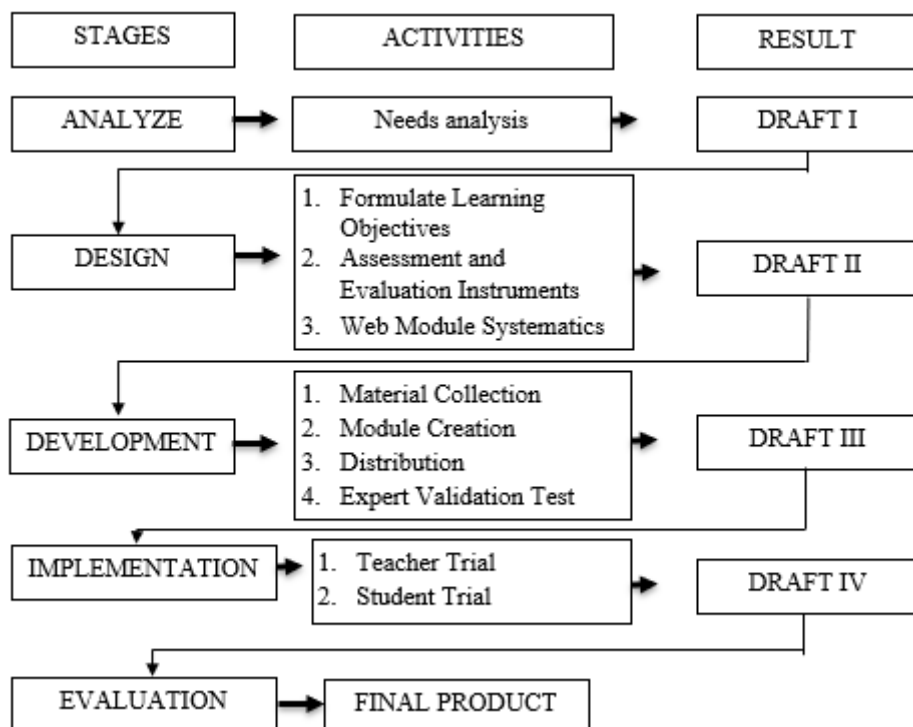


Figure 1. Research and development stage of the ADDIE model

The ADDIE model is designed in detail with the stages of activities that are systematically arranged, suitable for developing learning media (Putri & Desyandri, 2024) aims to improve student computational thinking skills and understanding of biology concepts. The data of the research results include data on the practicality, validity and the efficiency of the online virus learning module.

The validation of the development product is carried out by 3 validators, namely 3 Biology Education Lecturers by analyzing and testing in accordance with relevant theories. The assessment is carried out by the validator by calculating the average of each aspect of validity using the validity formula. The validity formula put is as follows:

$$Va = Tse / (Tsh) \times 100\%$$

Questionnaire: To determine the effectiveness and validity of web-based module:

Description:

Va : percentage of validity

Tse: total score achieved

Tsh : total maximum score

Table 1. Validity Criteria

Criteria	Validity Level	Information
86-100	Very Valid	Excellent to use
71-85	Valid	Can be used with minor revisions
56-70	Valid Enough	Enough Can be used with major revisions
41-55	Lack of Validity	Not to be used
25-40	Invalid	Not to be used

(Deniarti *et al.*, 2020)

a. Practicality test

The practicality of product development is carried out by students who aim to find out the level of ease of media used. The practicality of the development product can use the following formula:

$$\text{Practicality Level} = \frac{\text{Number of points obtained}}{\text{total number of scores}} \times 100\%$$

Table 2. Practicality Criteria

Average interval score	Category
81-100	Very Practical
61-80	Practical
41-60	Quite Practical
21-40	Less Practical
0-20	Impractical

(Lestari *et al.*, 2020)

b. Test effectiveness

The results of the effectiveness test were obtained from the students' science literacy tests. The analysis of the student literacy test includes the pre-test and post-test given to grade X students.

$$N - \text{Gain} = \frac{\text{Skor posttest} - \text{Skor pretest}}{\text{Ideal score} - \text{Pretest score}}$$

Table 3. N-gain criteria

N-gain value	Category
$g > 0,7$	High
$0,3 < g < 0,70$	Medium

$g < 0,3$

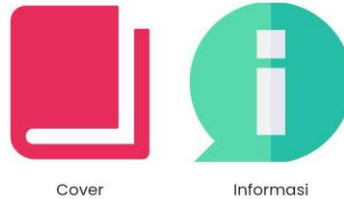
Low

(Rismayanti *et al.*, 2020)

RESULTS AND DISCUSSION

The ADDIE model is designed in detail with the stages of activities that are systematically arranged, suitable for developing learning media aimed at improving students' computational thinking skills and understanding of biology concepts. The data of the research results include data on the practicality, validity and effectiveness of the web-based virus learning module. Analyze the needs of students and teachers by observation and interview methods. The analysis was carried out with the aim of identifying problems that students experienced during the learning process as well as the ability of students and as well as identifying what learning media were used by educators during the instructional and learning process. The use of learning media that lacks variety causes students to lose motivation and enthusiasm in the learning process (Hidayati *et al.*, 2022). According to Al Hadiq (2023), another thing that is a problem is because student books are incomplete and uninteresting, so students need new additional resources to learn.

The design of web-based learning modules needs to be adjusted to ISO standards. The web module product developed by the researcher has a systematics that includes a cover page, a compiler page, a concept map, a table of contents, an introduction (web module identity, learning objectives and learning outcomes, learning materials). The selection of learning media must consider the suitability and needs of teachers and students as well as the suitability of the material being taught so that it can affect the level of student understanding of the subject matter (Titin *et al.*, 2023). The use of web-based modules can make students in control and have free access to use modules (Indarto *et al.*, 2024). The process of creating a web-based module by utilizing the Canva application for module creation design on Virus material in order to get a valid web-based module. After being designed in the form of canva, it will then be uploaded to the google site and will be copied the link so that it becomes a web-based module. That is the product design in figure 2.



<https://sites.google.com/view/modul-virus-web/home>

Figure 2. Web module cover

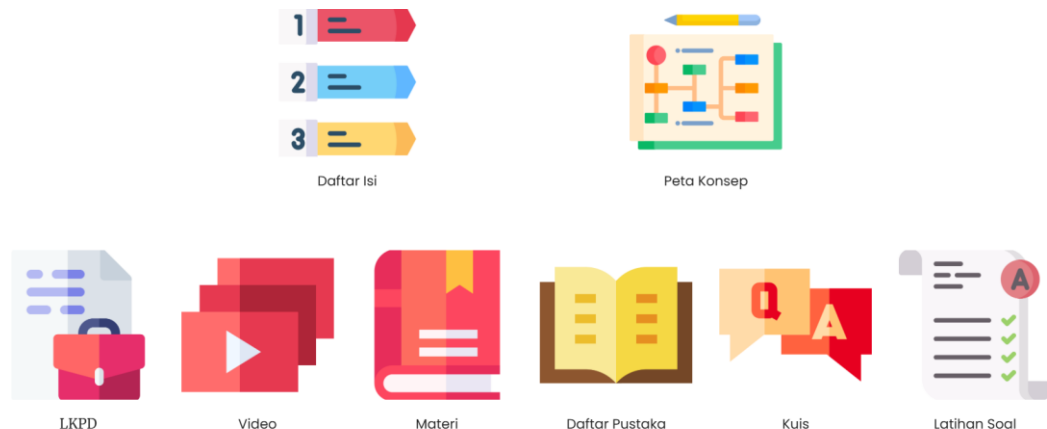


Figure 3. Menu view

Instruction delivery activities in the classroom and Web-based module media trials. The learning model used is PBL (Problem Based Learning), which is a learning concept that prioritizes solving common problems that occur in daily life and can increase understanding of biology concepts because students are more involved in a deep and reflective learning process (Sukarso *et al.*, 2024). There are several obstacles experienced by researchers during the research process, including: there are limitations of projectors from schools, limited quotas for each student to open web-based modules so that students join other students.

The evaluation stage aims to evaluate the influence of the product regarding students' learning outcomes and the overall quality of learning and conclude whether the product developed is successful in accordance with the researcher's expectations according to Ardiansyah & Miftakhi (2020). The results of this stage are in the form of analysis of students' readability scores against Web-based

modules, analysis of pre-test and post-test results conducted by students before and after learning. According to (Insani *et al.*, 2023), collaborative learning with students and a fun environment can help students be more motivated and interested in what they are learning, thus helping students absorb lessons so that they can improve students' computational thinking skills and understanding of biology concepts. The message and suggestions for web-based module media are that the average student states that web-based module media is a media that is exciting and improves student learning and is more practical and easy to use anywhere and anytime.

The validation of the biology module was carried out before the module was used as a trial for class X students at SMA Negeri 3 Jember. Expert validation consists of 3 validators of media experts, material experts and development experts who are FKIP lecturers at the University of Jember who have been recommended and selected by the supervisor in accordance with their field of expertise. The results of the expert assessment of the module are shown in Table 4.

Table 4. Results of Module Expert Validation Analysis

Aspects assessed	Percentage (%)	Percentage (%)
Material	83	Valid
Media	85	Valid
Development	83	Valid
<i>Average</i>	84%	Valid

The validation of the web-based module uses validation sheets assessed by three expert validators. The purpose of the validation (Abidin *et al.*, 2021) is to get responses in the form of assessments and also suggestions related to the media, both in terms of content, appearance, and language contained in the developed product. In line with the opinion of Febrianti (2023) which states that the validation sheet is used to evaluate the feasibility of the website-based e-module developed along with the learning tools. Therefore, validation is very necessary before the web-based module is tested so that the product developed is appropriate and appropriate to the needs of students. The analysis results from table 4.1 show that the overall web-based module products developed fall into the valid category with an average percentage of 84%. (Mita *et al.*, 2023) indicates that a product is considered suitable for use if it meets valid criteria in every assessed aspect, based on the overall evaluation results from all validators, and is deemed appropriate for field testing.

The large-scale trial stage is carried out by involving all students in 1 class that has been selected. Students as respondents, read the modules that have been developed and fill out questionnaires to give responses to the modules.

Table 5. Wide-Scale Trial Readability Questionnaire Data

Average %	Interpretation
83,3%	Very Practical

Practicality assessment is measured using observations assessed by observers with the aim of conducting a practicality test because it is appropriate to use it in assessing the practicality of the product developed against the learning design that has been made during the learning (Cahyani *et al.*, 2024). The average calculation results from web-based module learning obtained a percentage of 83.3% with the category of very practical. In accordance with the level of practicality stated by (Lestari *et al.*, 2020). The product developed is said to be practical if each category of activities is at a score of 81% - 100% with very practical criteria. This statement is also reinforced by research (Putri *et al.*, 2024) that the average result of the percentage of practicality using web-based modules is very practical to use with a score of 83%.

The module's effectiveness is determined through pre-test and post-test score data collected from students. The pre-test is conducted before they study the modules, while the post-test takes place after they have read the developed modules. This process aims to assess students' level of understanding and the extent of information they have acquired.

Table 6. Pre-test and Post-test results

Subject	Average Pre-test	Average Post-test	Average Difference	Normalized gain	Criterion
35 Students	53,9	85,1	31,2	0,65	Moderate

The effectiveness of web-based modules on virus materials to improve students' computational thinking skills and understanding of biological concepts was evaluated by providing tests to students. The test consists of a pre-test and a post-test designed to measure and improve students' computational thinking skills and understanding of biology concepts. The pre-test is given at the beginning of learning at the first meeting before explaining the material to be taught. The N-Gain method provides teachers with a deep understanding of the effectiveness of certain media or pursuits (Rudianto *et al.*, 2024). According to (Muyassayaro *et al.*, 2022) product research and development can be said to be effective if it can achieve the desired goals and the average ability of students to achieve KKM and students can solve problems and achieve learning completeness. The acquisition of the results of the effectiveness test from the pre-test and post-test scores showed an N-gain score of 0.65 with a moderate category in accordance with the opinion (Hindrasti *et al.*, 2022) This is because students have studied virus material in junior high school, but on average students forget about the material, so that at the beginning of learning before the delivery of the material, many students cannot answer the pre-test questions properly.

After the delivery of virus material using a web-based module, the insights provided and able to remember the material well so that the students' learning outcomes in the form of post-test questions showed good scores. These results

are reinforced by research (Fadieny *et al.*, 2023) students who take part in learning using web-based electronic modules combined with PBL (*Problem Based Learning*) can significantly increase learning motivation.

CONCLUSION

Based on the research conducted, the following conclusions were obtained: The results of the expert validation test, the web-based virus learning module to improve computational thinking skills and understanding of biology concepts of high school students in Jember were considered valid with a percentage of 84%. Meanwhile, the results of user validation stated that this module was very valid, so that the module was ready to be used in field trials. The results of the practicality test of the web-based virus learning module to improve computational thinking skills and understanding of biology concepts of high school students in Jember were classified as practical with a percentage of 83.3% so that the module was ready to be used and further disseminated. The results of the effectiveness test of the web-based virus learning module to improve computational thinking skills and understanding of biology concepts of high school students in Jember are classified as moderate with the calculation of the Normalized gain formula of 0.65 with the medium category and show that the module can increase student motivation and contribute to improving student learning outcomes.

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