BIO-EDU: JURNAL PENDIDIKAN BIOLOGI
Available in https://jurnal.unimor.ac.id/JBE/index
2026, Vol. 11, Issue 2, pp 154-165, e-ISSN: 2527-6999
https://doi.org/10.32938/jbe.v11i2.11213

Development of Interactive Multimedia Using Articulate Storyline 3 as a Learning Tool for Photosynthesis in High School

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Article Information
Received: 2026-07-17
Revised: 2026-08-15
Accepted: 2026-08-15
Published: 2026-08-30

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Abstract

This study was prompted by the significant difficulties students face in understanding photosynthesis, due to limited learning resources and a lack of educational media capable of comprehensively illustrating the concept of photosynthesis. Based on a problem analysis and a needs assessment, the goal of this study is to develop an interactive multimedia application on the topic of photosynthesis using Articulate Storyline 3 and to analyze the results of the suitability test conducted by experts and users. This study employs the research and development (R&D) method based on the 4D model, which is limited to three phases: definition, design, and development. The research instruments include validation forms for subject matter experts, validation forms for media experts, and user feedback questionnaires. The results show that the interactive multimedia application developed received an acceptability score of 90.41% from subject matter experts and 95.65% from media experts, with both values falling into the "very acceptable" category. Feedback from teachers yielded a rating of 99.52%, while feedback from students in the limited trial was 86.65%, which also falls into the "very acceptable" category. Based on these results, the interactive multimedia program developed with Articulate Storyline 3 is rated as very well suited for use as a learning medium on the topic of photosynthesis.

Keywords: *Articulate storyline 3; Interactive multimedia; Photosynthesis; Research and development*

Abstrak

Penelitian ini dilatarbelakangi oleh kesulitan yang signifikan yang dihadapi siswa dalam memahami fotosintesis, akibat keterbatasan sumber belajar dan kurangnya media pendidikan yang mampu mengilustrasikan konsep fotosintesis secara komprehensif. Berdasarkan analisis masalah dan penilaian kebutuhan, tujuan penelitian ini adalah mengembangkan aplikasi multimedia interaktif tentang topik fotosintesis menggunakan Articulate Storyline 3 serta menganalisis hasil uji kesesuaian yang dilakukan oleh para ahli dan pengguna. Penelitian ini menggunakan metode penelitian dan pengembangan (R&D) berdasarkan model 4D, yang dibatasi pada tiga fase: definisi, desain, dan pengembangan. Instrumen penelitian meliputi formulir validasi untuk ahli materi pelajaran, formulir validasi untuk ahli media, dan kuesioner umpan balik pengguna. Hasil menunjukkan bahwa aplikasi multimedia interaktif yang dikembangkan memperoleh nilai kesesuaian sebesar 90.41% dari ahli materi pelajaran dan 95.65% dari ahli media, dengan kedua nilai tersebut masuk ke dalam kategori "sangat layak". Umpan balik dari guru menghasilkan penilaian sebesar 99.52%, sedangkan umpan balik dari siswa dalam uji coba terbatas adalah 86.65%, yang juga termasuk dalam kategori "sangat layak". Berdasarkan hasil ini, program multimedia interaktif yang dikembangkan dengan Articulate Storyline 3 dinilai sangat sesuai untuk digunakan sebagai media pembelajaran mengenai topik fotosintesis.

Kata Kunci: *Articulate storyline 3; Multimedia interaktif; Fotosintesis; Penelitian dan pengembangan*

1. INTRODUCTION

Biology instruction in high school plays a crucial role in shaping students' understanding of various biological phenomena through mastery of concepts, scientific processes, and their application in everyday life. One of the most complex topics is photosynthesis, as it involves

biochemical processes that occur at the cellular level and cannot be observed directly (Eriksson *et al.*, 2025). The nature of this subject matter often causes students to struggle with understanding the relationship between the structure, process, and products of photosynthesis when instruction relies solely on verbal explanations or static media. This is supported by the results of a preliminary analysis of a study conducted among students at SMAN 1 Maja, SMAN 1 Pandeglang, and SMAN 6 Kota Serang, which revealed that 63.3% of 12th-grade students had difficulty understanding photosynthesis. These difficulties stem from limited learning resources that do not present the material comprehensively, as well as the use of learning media that is still dominated by PowerPoint presentations, which fail to fully visualize the photosynthesis process. Furthermore, the needs analysis revealed that 60% of students desire learning media that integrates text, images, audio, video, animations, learning assessments, and laboratory simulations into a single interactive platform. These findings indicate a need for more innovative learning media capable of increasing student engagement during the learning process. The use of media that is appropriate and easily understood by students can promote their success in the learning process (Lestari & Sari, 2024).

Interactive multimedia is one type of learning medium that integrates various multimedia elements, enabling students to actively engage with the material they are studying (Suryanda *et al.*, 2020). By combining text, images, audio, video, animations, and interactive activities, interactive multimedia content can convey learning material in a more engaging way and help illustrate abstract concepts, making them more concrete and easier for students to understand (Septiana *et al.*, 2022). Engaging and interactive learning content can increase students' attention and motivation to learn (Aroyandini *et al.*, 2021), thereby supporting a better understanding of concepts. One software program that can be used to develop interactive multimedia is Articulate Storyline 3. This software allows developers to create learning materials that combine various multimedia components, provide interactive navigation, quizzes, and learning simulations that can be accessed via computer or mobile phone (Nurkhalimah & Andriani, 2025). Based on these characteristics, Articulate Storyline 3 has the potential to serve as an alternative for developing instructional media tailored to students' needs regarding photosynthesis.

Various previous studies have shown that interactive multimedia created using Articulate Storyline 3 is a highly effective and practical solution for a wide range of grade levels and subject areas. At the elementary school level, this medium has been successfully used to visualize plant anatomy and physiology (Septiana *et al.*, 2022), makes it easier to understand Indonesia's abstract geographic characteristics (Rachmawati *et al.*, 2023), including the integration of the PhET virtual lab to explain the concept of force (Nurkhalimah & Andriani, 2025). Although there have been many developments at the high school level, previous research has been limited to specific biology topics. For example, the study by Wijayanti and Prayitno (2021) aimed to produce an interactive multimedia learning resource based on Articulate Storyline on the topic of viruses, while the study conducted by Priyadewi *et al.* (2024) focused on the development of an interactive learning resource on the excretory system. However, the development of interactive multimedia that specifically visualizes the process of photosynthesis in a comprehensive manner and integrates various learning components into a single medium remains limited. Therefore, there is a need to develop educational media capable of presenting photosynthesis material in a more comprehensive and interactive way, tailored to the characteristics of high school students.

Based on the issues and previous research described above, this study aims to develop an interactive multimedia program using Articulate Storyline 3 as a learning medium for the topic of photosynthesis in high school and to analyze the medium's suitability based on evaluations by subject matter experts, media experts, and feedback from teachers and students. The results of this study are expected to provide an alternative learning medium that supports the biology learning process, particularly regarding the topic of photosynthesis.

2. METHOD

2.1. Research Design

In this study, a research and development (R&D) approach was used, adopting the 4D development model created by Thiagarajan *et al.* (1974). The 4D model comprises four phases: Define, Design, Development, and Dissemination. However, in this development study, the process was carried out only up to the third phase, namely the development phase.

2.2. Population and Sample

During the define phase, a needs analysis was conducted at Serang City State High School 6, Pandeglang State High School 1, and Maja State High School 1 through interviews with biology teachers and the distribution of student questionnaires. During the design phase, test standards were developed, media and formats were selected, and a preliminary design for the interactive multimedia was created using Articulate Storyline 3. During the development phase, the product was validated by three media experts and three subject matter experts. In addition, user feedback was collected from three 12th-grade biology teachers and 28 12th-grade students at Pandeglang State High School 1 during a limited pilot test.

2.3. Research Procedure

This research process consists of three main steps: define, design, and develop. During the define step, a preliminary study, student analysis, task analysis, and idea analysis are conducted, and learning objectives are established to determine instructional needs. The design stage included test development, media selection, format selection, storyboard preparation, and the design of a preliminary product. During the development stage, this multimedia content has been verified by professionals in the relevant fields and media experts, and has been updated based on their recommendations, and then evaluated through teacher feedback and limited trial involving students. The research procedure is illustrated in Figure 1.

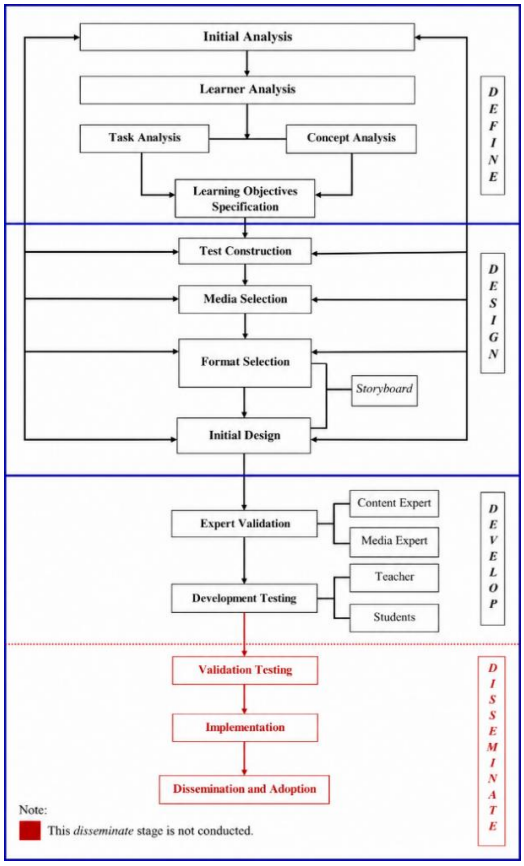


Figure 1. The 4D research procedure (source: Zamsiswaya *et al.*, 2024: with modifications)

2.4. Instrument Research

The instruments used in this study consisted of a student needs analysis questionnaire, a teacher interview guide, expert validation forms, and user response questionnaires. The student needs analysis questionnaire and teacher interview guide were developed by the researchers based on the objectives of the needs analysis and were reviewed by experts in the relevant field. The student needs analysis questionnaire was administered during the define phase to identify students' needs and difficulties regarding learning media for photosynthesis, while the teacher interview guide was used to obtain teachers' perspectives on learning needs and the use of learning media. Meanwhile, the assessment aspects of the expert validation forms and user response questionnaires were adapted from Rahma and Wardhani (2024), while the indicators were modified to align with the objectives, characteristics, and context of the present study. The adapted instruments were reviewed and judged by three experts with experience in instrument development before administration. The expert validation forms were used by subject matter and media experts to assess the suitability of the developed interactive multimedia in terms of content, presentation, language, visual appearance, and media functionality. The user response questionnaires were administered to biology teachers and Grade 12 students during the development phase to obtain feedback on the practicality, ease of use, attractiveness, and overall acceptability of the developed multimedia. The aspects and indicators of the instruments are presented in Table 1.

Tabel 1. Assessment Aspects and Indicators of the Research Instruments

Instrument	Aspect	Indicator
Subject matter expert validation	Content accuracy	Assessing the alignment of the material with accurate and up-to-date scientific concepts.
	Scope and depth of content	Evaluate the comprehensiveness and depth of the material on the topic of photosynthesis.
	Presentation techniques	Analyze the clarity, organization, and interactivity of the presentation of the material.
	Curriculum	Assessing the alignment of the material with the Competency Standards (CP) in the current curriculum.
	STEM components	Evaluating the integration of Science, Technology, Engineering, and Mathematics in the media.
	Language use	Evaluate the accuracy, clarity, and readability of the language used.
Media expert validation	Visual presentation	Evaluating the quality of the interface design and the visual aesthetics of the media.
	Use of fonts	Evaluate the clarity, consistency, and legibility of the characters.
	Visual appeal	Analyzing the appropriateness of graphic design, color, animation, and visual appeal.
	Ease of use	Evaluating ease of navigation, accessibility, and practicality of use.
	STEM components	Evaluating the integration of Science, Technology, Engineering, and Mathematics in the media.
Teacher's response	Media presentation	Evaluating the quality of the interface design and the visual appeal of interactive multimedia.
	Content quality and learning assessment	Evaluating the alignment of the material with scientific concepts and the alignment of assessment features with learning objectives.
	Scope & depth of content	Evaluate the comprehensiveness and depth of the material on photosynthesis.
	Alignment of content with learning outcomes language	Analyze the relationship between the material and the learning outcomes.
		Assessing the clarity and appropriateness of the language in relation to the students' characteristics.

	Use of fonts	Evaluate the readability and consistency of font usage.
	Visual appeal	Analyzing the compatibility of visual elements, colors, and animations.
	Ease of use	Assessing ease of navigation and efficiency of use in learning.
	STEM components	Evaluating the integration of Science, Technology, Engineering, and Mathematics in the media.
Student responses	Interest and enthusiasm	Identifying students' level of interest and attention toward media.
	Product Presentation	Assessing the clarity of the presentation and the ease of access to content in the media.
	Content	To assess the appropriateness and ease of understanding of the material on photosynthesis.
	Language	Identify the clarity and simplicity of the language used.
	Benefits	Assessing the benefits of media in promoting conceptual understanding and skill development.

(Rahma & Wardhani, 2024 : with modifications)

2.5. Data Analysis

The data obtained in this study can be categorized into two types: numerical data and descriptive data. Numerical data includes evaluations of learning materials that use interactive multimedia applications, conducted by subject matter experts, media experts, teachers, and students. The numerical data obtained was analyzed using Microsoft Excel. Meanwhile, descriptive data relates to the stages of developing learning materials using Articulate Storyline 3 and consists of input from subject matter experts, media experts, teachers, and students. This evaluation was conducted using an assessment technique based on predefined indicators in accordance with the Likert scale shown in Table 2.

Tabel 2. Assessment of Validator Tests, Teacher and Student Response Tests Using the Likert Scale

Score	Criteria
4	Strongly Agree (SA)
3	Agree (A)
2	Disagree (DS)
1	Strongly Disagree (STS)

(Pambudi & Yunus, 2023 : with modifications)

The percentage score for each aspect of the indicator is calculated using the following formula:

$$P = \frac{\sum}{N} \times 100\% \qquad (1)$$

(Khovivah, Gultom, & Lubis, 2022)

Notes:

P : Percentage Score
∑ : Total Score for the Category Obtained
N : Maximum Total Score
100% : Fixed number

The percentage score obtained is then interpreted as a qualitative value according to the following assessment categories:

Table 3. Validity Indicators for Score Analysis

Value Range (%)	Category Level
86-100	Very Acceptable
76-85	Acceptable
60-75	Fairly Acceptable
55-59	Not Acceptable
≤54	Very Unacceptable

(Rahmatullah *et al.*, 2020)

3. RESULT AND DISCUSSION

3.1 Define Phase

The definition phase began with an initial analysis of learning activities. This analysis was conducted as part of the initial phase of the study by interviewing biology teachers and distributing questionnaires to assess the needs of 12th-grade students at SMAN 1 Maja, SMAN 1 Pandeglang, and SMAN 6 Kota Serang. The results of the analysis revealed a gap between the current state of learning and the students' needs. Students need interactive learning media capable of visualizing abstract concepts and providing hands-on learning experiences, such as laboratory experiments; however, the media currently in use are limited to PowerPoint, and there are no specialized teaching materials available to meet these needs. Therefore, there is a need for learning media that not only presents material visually but also enables exploration, simulation, and self-directed learning. This is consistent with a study conducted by Pane *et al.*, (2024) which found that interactive media can provide autonomous laboratory simulations at any time and in any location, and help overcome the limitations of in-school lab sessions.

The next step is to conduct a task analysis to determine the selection of content to be used with the developed media. The core content developed in this Articulate Storyline 3-based interactive multimedia is material on photosynthesis for 12th-grade high school students. The task analysis was conducted by reviewing the Phase F learning outcomes for Biology in the Merdeka Curriculum, as outlined in BSKAP Director's Decision No. 046 of 2025. In the "Understanding Biology" element, students are expected to be able to understand and analyze various biological processes that occur in living organisms, including metabolic processes such as photosynthesis. Meanwhile, in the "Process Skills" element, students are expected to be able to conduct scientific investigations, collect and analyze data, draw conclusions, and communicate their findings. These learning outcomes serve as the basis for determining the learning tasks that will be facilitated through the developed multimedia.

The next stage involved a conceptual analysis. This analysis was conducted to examine and identify key concepts in the photosynthesis curriculum, the relationships between these concepts, and concepts that students found difficult to understand. Based on the evaluation conducted, the content designed for the educational section of this interactive multimedia resource covers fundamental aspects of photosynthesis, the components of chloroplasts, the steps involved in photosynthesis—including light-driven reactions and reactions that occur in the dark (the Calvin cycle)—the various types of photosynthesis in C3, C4, and CAM plants, as well as the factors that influence the photosynthetic process.

In the next stage, an analysis of the learning objectives was conducted to formulate the competencies that students are expected to achieve after using interactive multimedia based on Articulate Storyline 3 for the photosynthesis unit. The learning objectives served as a guideline for determining the content, learning activities, and features to be developed in the multimedia.

3.2 Design Phase

The design of the learning media developed serves as a solution to the problems identified during the definition phase. This phase consists of three steps: selecting the learning media, developing research instruments, and determining the application model and design. Based on the results of the analysis conducted during the definition phase, the researcher conducted a needs analysis that served as a reference and consideration in selecting the media to be developed, namely interactive multimedia used to support the learning process in the classroom.

In the next stage, research instruments were developed to serve as a bridge between the definition and design stages. The instruments developed include several types, namely a product feasibility test instrument for subject matter experts covering aspects of accuracy, scope and depth of content, presentation techniques, curriculum alignment, STEM (science,

technology, engineering, mathematics) components, and language use, with 20 assessment items. Additionally, the instrument for media experts covers aspects of visual presentation, typography, appeal, ease of use, and integration of STEM components (science, technology, engineering, mathematics), with a total of 23 evaluation items. In addition, a teacher response instrument was developed to assess aspects of media presentation, content and evaluation quality, content scope, alignment with learning outcomes, language, and STEM components, with a total of 35 evaluation items. The student response instrument covers aspects of engagement, media presentation, content, language, and usefulness, with 20 evaluation items.

The final stage of the design process is determining the product model and design. The interactive multimedia was developed using hyperlinks (HTML) so that it can be accessed via various devices connected to the internet. Several software tools were used to develop this media, namely Articulate Storyline 3, Canva, GitHub Desktop, and Google AI Studio. The illustrations used come from Canva, while the voice-over narration is generated using Google AI Studio. All components—such as text, images, audio, video, and animations—are then organized in a structured manner using Articulate Storyline 3. Once the design process is complete, the multimedia is published in HTML format and uploaded via GitHub Desktop so it can be accessed online via a link on various devices, such as smartphones, tablets, and laptops. Additionally, updates to the media can be made without changing the access link, as the system will automatically display the latest version. The interactive multimedia created can be accessed via the following link: https://a26327936-beep.github.io/MultimediaInteraktifBioPhotoEdu/

3.3 Development Phase

Once the product has been completed, the next step is an evaluation by professionals in the relevant fields and media experts to ensure its suitability before it moves on to the testing phase. This validation process involves three content experts and three media experts. The evaluation results from each validator are presented in Figure 2.

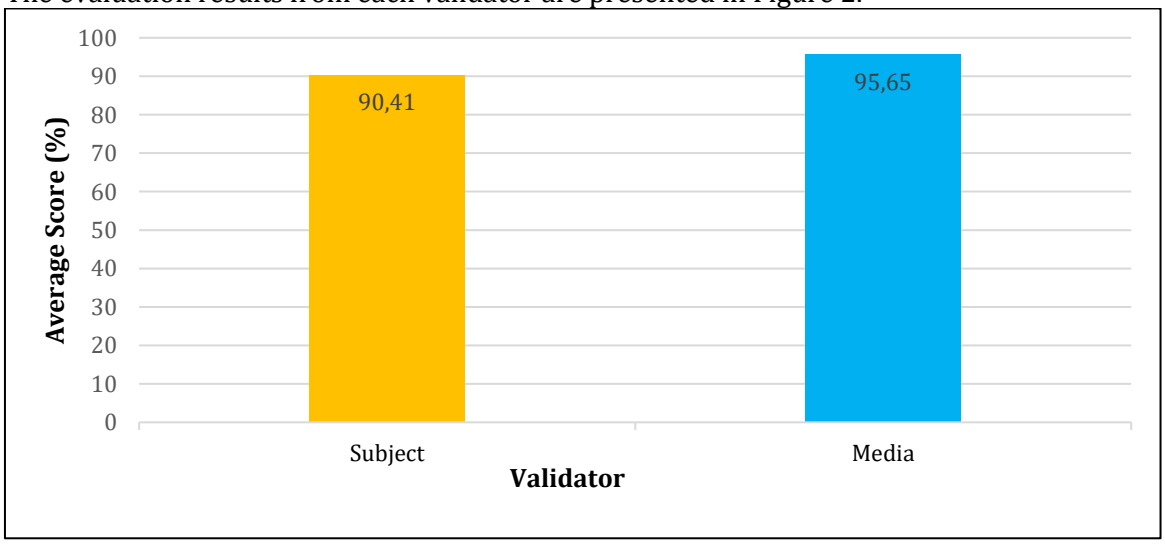


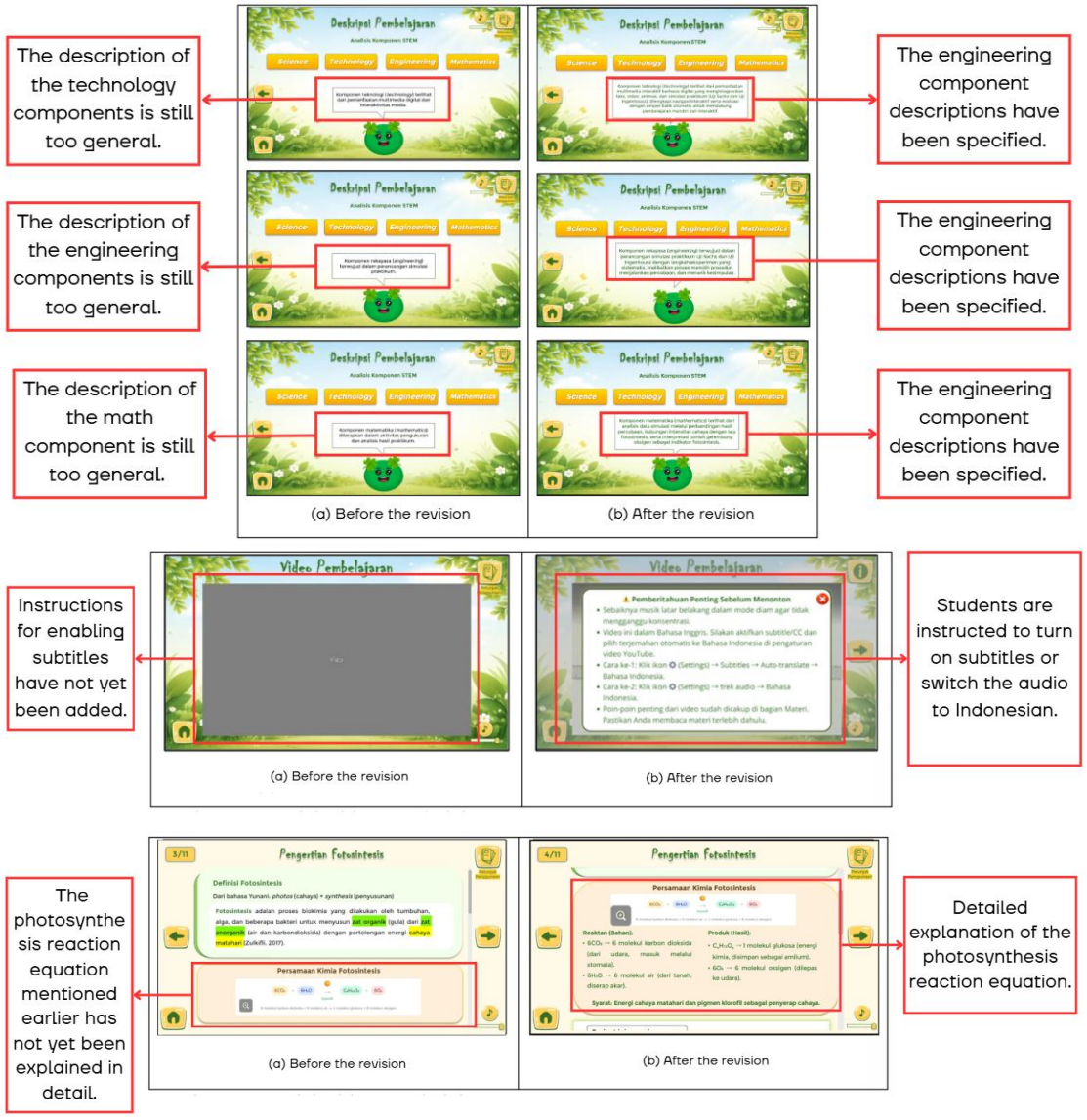
Figure 2. Diagram of Assessment Results from Content and Media Validators

Based on the data in Figure 1, the validation results from the content experts showed an average of 90.41%, categorized as "very acceptable," while the validation results from the media experts showed an average of 95.65%, also categorized as "very acceptable." These results indicate that the product was considered very acceptable in terms of content and media design. The product was subsequently revised based on the validators' feedback before being tested with teachers and students.

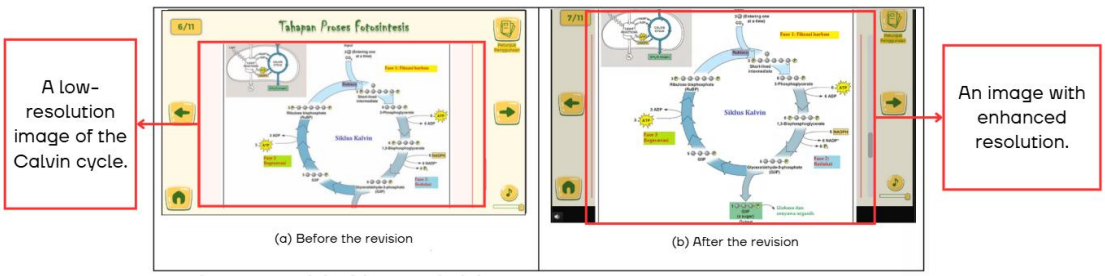
The instructional materials that had undergone the validation process were subsequently revised based on feedback from the validators. The suggestions provided were used as the basis for refining the content, presentation, and technical aspects of the materials so that the final product delivered to students was a revised version aligned with the validators' recommendations. A summary of the validators' feedback and the resulting revisions is presented in Table 4.

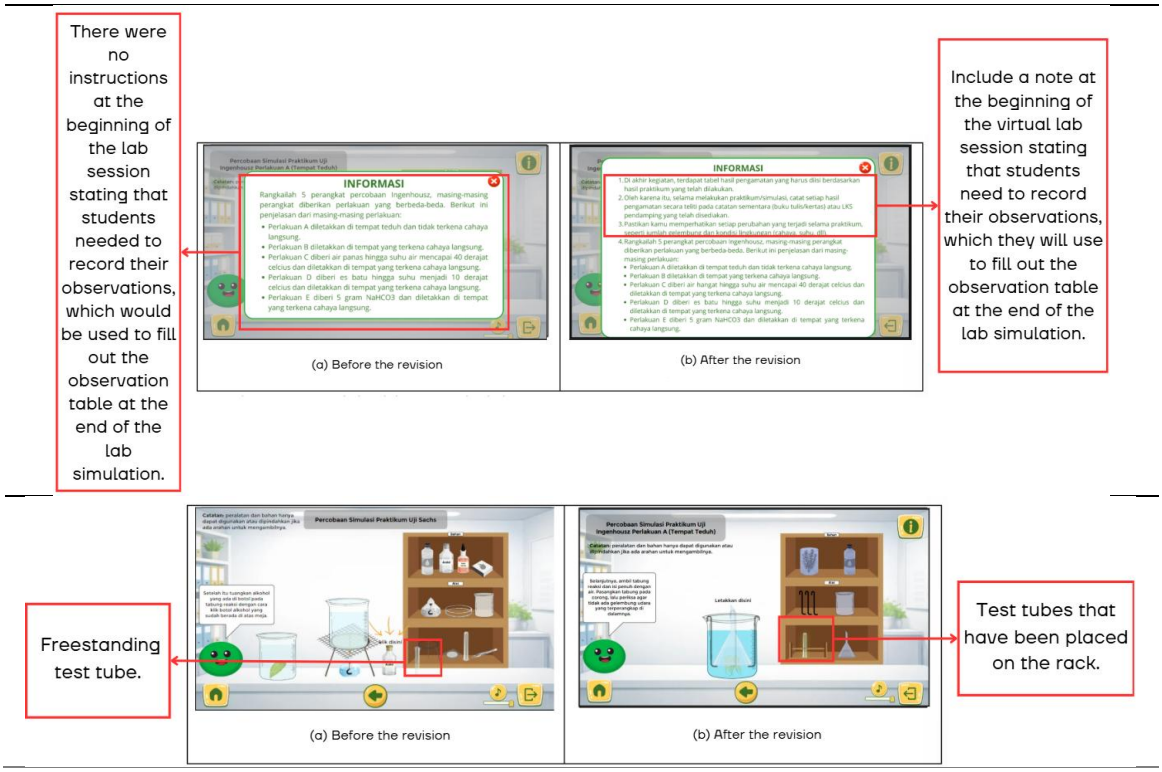
Table 4. Revised Validation Results Based on Expert Recommendations

Expert Review of the Material



Media Expert Review





The acceptability of the interactive multimedia was assessed through teacher and student responses. The teacher response survey was administered to one 12th-grade biology teacher each from SMAN 1 Maja, SMAN 1 Pandeglang, and SMAN 6 Kota Serang. The results of the evaluations by these three teachers are presented in Table 5.

Table 5. Teacher Assessment Results

No.	Aspect	Percentage (%)	Category
1.	Media Presentation	100	Very Acceptable
2.	Quality of Materials and Learning Assessment	100	Very Acceptable
3.	Scope and Depth of Course Content	100	Very Acceptable
4.	Alignment of Content with Learning Outcomes	100	Very Acceptable
5.	Language Used	97.91	Very Acceptable
6.	Typography	97.91	Very Acceptable
7.	Visual Appeal	100	Very Acceptable
8.	Ease of Use	100	Very Acceptable
9.	Science Components	100	Very Acceptable
10.	Technology Component	100	Very Acceptable
11.	Engineering Component	100	Very Acceptable
12.	Mathematics Component	100	Very Acceptable
	Total	**99.52**	**Very Acceptable**

Based on Table 5, the results of the response test for 12th-grade biology teachers yielded an average score of 99.52%, falling into the “very acceptable” category. This result indicates that the developed interactive multimedia was very acceptable to the participating teachers based on the assessed aspects. The high ratings, particularly regarding ease of use, indicate that this medium features an intuitive interface and can be used independently by both teachers and students. This aligns with the characteristics of effective learning media—namely, being practical, engaging, and aiding the understanding of concepts (Zahwa & Syafi’i, 2022).

After the teacher response assessment was completed, the multimedia was pilot-tested with a limited number of students. The pilot test involved 28 twelfth-grade students at SMAN 1 Pandeglang. According to Fauzizah *et al.*, (2023), a limited pilot test to gauge student responses was conducted to gather feedback and evaluations from students after they had used the instructional materials.

Table 6. Results of the Limited Student Response Test

No.	Aspect	Percentage (%)	Category
1.	Interest and Curiosity	88.39	Very Acceptable
2.	Product Presentation	83.70	Acceptable
3.	Content	86.60	Very Acceptable
4.	Language	86.38	Very Acceptable
5.	Usefulness	88.16	Very Acceptable
	Total	**86.65**	Very Acceptable

The results of the limited student response test, as shown in Table 6, yielded a percentage of 86.65%, which falls into the "Very Acceptable" category. This result indicates that the developed interactive multimedia was positively received by the students based on the assessed aspects, including interest, product presentation, content, language, and usefulness. The findings suggest that BioPhotoEdu is acceptable for use as a learning medium for photosynthesis based on students' responses. This finding is consistent with Ali *et al.* (2025), who reported that interactive media can support diverse student learning styles through audio-visual elements, animations, and videos, providing a more engaging learning experience. However, this study did not measure learning improvement, conceptual retention, scientific reasoning, problem-solving, or laboratory skills. Therefore, the effectiveness of BioPhotoEdu in improving these learning outcomes cannot be concluded from the present findings.

This study has several limitations. Although the student response results indicate that BioPhotoEdu was very acceptable for use as a learning medium, the study did not examine its effectiveness in improving students' learning outcomes. Specifically, conceptual understanding, learning gain, concept retention, scientific reasoning, problem-solving skills, and laboratory skills were not measured. Therefore, the findings should be interpreted as evidence of the acceptability of the developed multimedia rather than its effectiveness in improving learning outcomes. Future studies should employ an experimental or quasi-experimental design involving an experimental group using BioPhotoEdu and a control group using conventional learning media. Such studies could measure conceptual understanding, learning gain, retention, scientific reasoning, and student engagement to provide stronger evidence regarding the effectiveness of BioPhotoEdu in biology learning.

4. CONCLUSION

This study produced an interactive multimedia presentation developed using Articulate Storyline 3 for teaching photosynthesis. The developed multimedia obtained a percentage of 90.41% from subject matter experts and 95.65% from media experts, both of which were categorized as "Very Acceptable." User responses also showed very acceptable results, with a percentage of 99.52% from teachers and 86.65% from students. These findings indicate that the developed interactive multimedia meets the criteria for an acceptable alternative learning medium for teaching photosynthesis in high school based on expert and user assessments.

5. ACKNOWLEDGMENT

The author would like to thank the principals of SMAN 1 Maja, SMAN I Pandeglang, and SMAN 6 Kota Serang for their permission and support during the course of this research. Appreciation is also extended to the biology teachers at these three schools for their assistance

during the research process, as well as to all parties who actively participated. The support, cooperation, and contributions of all these parties played a crucial role in ensuring the smooth implementation of the research, allowing the entire series of activities to be successfully completed.

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