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Development of Cell Biology Lab Guidelines in Video Form for Biology Education Students

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Abstract

Cell biology practicums face challenges in student readiness and procedural understanding. This study aims to develop a video-based guide for a cell biology practicum on the topic of the plasma membrane as a gateway for cellular transport and to determine its validity and practicality. This study uses a research and development approach based on the ADDIE model, which is limited to the analysis, design, and development stages. The research subjects involved 1 cell biology lecturer for the initial needs interview and practicality testing, expert validation across 3 aspects (media, material, and language), and biology education students divided into a small-group trial of 10 students and a large-group trial of 20 students. The research instruments included a needs analysis questionnaire, validation sheets from media, material, and language experts, and a practicality questionnaire. The results indicated that the developed video-based practicum guide was considered valid, with a validity score of 77.5% from the media expert, 90% from the material expert, and 95% from the language expert. The results of the practicality test indicated that the product was categorized as very practical based on responses from lecturers and students. Therefore, the video-based Cell Biology practicum guide is suitable for use as a supporting learning medium to help students understand practicum procedures more clearly and systematically.

Keywords: ADDIE, cell biology, learning video, plasma membrane, practicum guide

INTRODUCTION

Video-based learning media play an important role in biology education because they help students visualize complex biological processes and improve conceptual understanding by integrating visual and auditory information (Brame, 2016; Yanti, 2024). In modern learning, educational videos can enhance student engagement and support the understanding of scientific concepts by integrating visual demonstrations with verbal explanations, particularly in laboratory-based learning environments (Croker et al., 2010; Brame, 2016). In biology learning, instructional videos can bridge theoretical concepts and practical activities by providing visual demonstrations that help students understand laboratory procedures and biological phenomena more effectively. (Croker et al., 2010; Hofifah & Sumiati, 2023).

One effective medium for supporting the learning process is visual media, particularly instructional videos. Videos can present concrete information through a combination of images, text, and audio, helping students visualize the material more clearly (Prabowo et al., 2025). Furthermore, video media is also effective in transforming abstract concepts into easier-to-understand ones (Syafi'e et al., 2025). The use of visual media is relevant in science learning, including biology, which often involves complex concepts and microscopic processes that are difficult to observe directly (Indah & Fadilah, 2024).

Cell Biology is a compulsory course integrated with practical activities. Cell biology practicums play a crucial role in helping students understand abstract concepts such as cell structure, the plasma

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membrane, and cellular transport processes more concretely. The success of a practicum is determined not only by the material but also by the availability of supporting resources, one of which is a practicum guide (Mustika & Hamidah, 2025). The practicum guide serves as a reference for practicum implementation so that activities run smoothly and can train students' process skills (Fajarianingtyas & Hidayat, 2020).

However, the current lab guidelines primarily consist of printed text and two-dimensional images. This format is considered inadequate to fully explain complex work procedures, such as workflows, tool usage techniques, and proper hand movements (Sastria et al., 2020). This limited visualization impacts student readiness and confidence during lab work, potentially reducing learning effectiveness (Cahaya et al., 2025). This situation demonstrates the need to develop lab guidelines that are more visual, communicative, and easy to understand.

The field study, conducted through a needs assessment questionnaire, revealed that 63.4% of biology education students experienced difficulties understanding cell biology practicum procedures, with 64.8% specifically struggling to identify cell structures and organelles. Furthermore, the structured interview with the Cell Biology lecturer highlighted that students often lack preparation and face difficulties operating microscopes, which hinders optimal laboratory time management. These findings reinforce the high demand for video-based lab guidelines. While existing articles predominantly focus on general biology videos for secondary schools, the novelty of this research lies in the development of a website-integrated video guide via Canva, specifically tailored to address microscopic processes like plasma membrane transport for higher education students. To comprehensively present the development process, this research systematically presents the empirical results obtained at each ADDIE stage, including the analysis, design, and development phases.

Based on the highlighted challenges in laboratory activities, this study addresses the primary problem regarding how to systematically design and develop video guidelines for cell biology labs as an interactive learning medium for biology education students. Consequently, the research questions guiding this study focus on determining the systematic development process of these video-based laboratory guidelines and assessing the extent to which the developed product meets the standards of technical validity and operational practicality. Driven by these questions, the definitive objectives of this research are to develop cell biology lab guidelines in video format, analyze their validity through comprehensive expert appraisal, and evaluate their practicality based on lecturer and student user responses. Ultimately, this digital medium is expected to serve as an optimized alternative to support independent student learning and efficiency during laboratory execution.

Several previous studies have shown that video as a practical medium for lab work is valid, practical, and effective in aiding understanding of work procedures (Safitri et al., 2022; Siwiyanto et al., 2022). Other studies have also developed biology learning videos using the ADDIE model and demonstrated acceptable results (Purba et al., 2023). However, most of these studies have focused on secondary school levels and subjects other than cell biology and have not specifically developed video-based lab guidelines for biology education students.

This indicates a gap between the learning needs of higher education institutions and the availability of appropriate laboratory media. Based on this description, it is necessary to develop Cell Biology laboratory guidelines in a video format tailored to the needs of Biology Education students. Video media was chosen because it can present work procedures in a realistic, systematic manner and can be flexibly accessed before the laboratory begins (Mamin & Arif, 2019).

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RESEARCH METHODS

This is a Research and Development (R&D) study using the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) development model. The ADDIE model was selected because it provides a systematic framework for developing educational products through the stages of analysis, design, development, implementation, and evaluation (Branch, 2009). However, this research was only conducted up to the development stage, in accordance with the research objectives, which focus on product development and testing for validity and practicality. The ADDIE model is a systematic approach that emphasizes analysis of how each component in the model interacts and coordinates according to predetermined stages (Rayanto, 2020). The stages of the ADDIE model are presented in Figure 1.

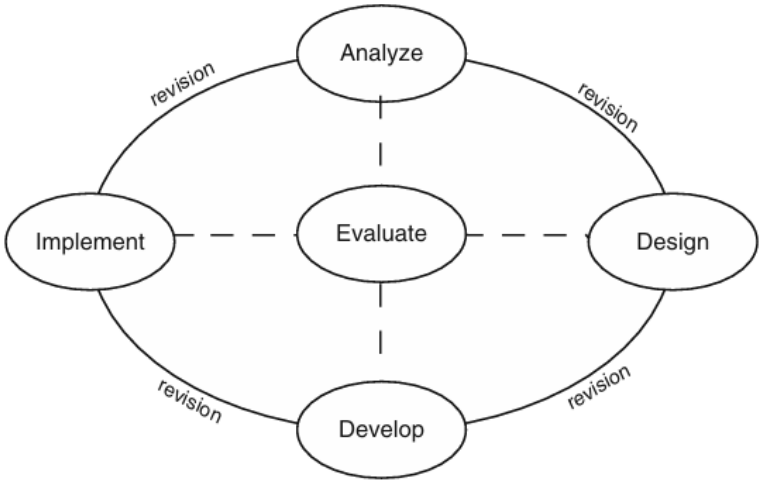

Figure 1. ADDIE Model Stages of Design and Development Procedures (Branch, R. M., 2009:2).

The development procedures presented in Figure 1 are concretized in this study through three main stages. The Analyze stage was empirically realized by distributing a needs assessment questionnaire to active biology education students from the 2022 and 2023 cohorts who had passed the Cell Biology course, alongside a structured interview with the course lecturer to map operational laboratory constraints. The Design stage involved drafting the video content flow, visual layouts, and assessment instruments. Subsequently, the Develop stage was executed through direct laboratory video recording, editing via CapCut, and packaging the media into a structured website using Canva. The revision lines shown in Figure 1 were operationally manifested through iterative evaluation and refinement cycles with media, material, and language experts to ensure product validity before conducting a small-group practicality trial (10 students) and a large-group trial (20 students). The users in this study were biology education students taking the cell biology course and the lecturers teaching it. The research object was a video guide for a cell biology practicum, specifically on the plasma membrane and intermembrane transport. The development of a cell biology practicum video on the plasma membrane as a gateway for cell traffic consisted of the following steps:

A. Analysis

At this stage, the main activity is to analyze the need to develop video format guidelines for the cell biology practicum and the requirements for such development. The analysis includes student needs, lecturers' needs, and the existing curriculum or practicum guidelines. The steps involved are (1) distributing a questionnaire using Google Forms online via WhatsApp to students in the Biology

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Education study program who have completed the Cell Biology course; (2) interviewing the lecturer teaching the Cell Biology course in the Biology Education study program; and (3) reviewing the alignment of the Course Learning Outcomes (CLOs) and the learning indicators listed in the Semester Learning Plan (SLP) for the Cell Biology course. By carrying out these steps, we define the research problem and establish effective solutions. The analysis phase will then produce learning objectives that will serve as useful information for the design phase.

B. Design

At this stage, the product concept is designed, including determining the material, developing the video flow, designing the display, and planning the media used. The lab guidelines are designed to reflect student characteristics and the learning objectives of the Cell Biology lab. Additionally, research instruments are developed, including validation sheets and practicality questionnaires.

C. Development

The development stage is the process of turning the design into a tangible product. Practical videos are recorded in the laboratory and then edited using a video processing application, adding subtitles, procedure numbering, and supporting animations for ease of understanding. The completed videos are then integrated into the website using the Canva application. The developed product is then validated by subject matter experts, media experts, and linguists. The validation results are used as the basis for product revisions until a suitable practical guideline is obtained.

Data Collection Techniques and Instruments

Research data was collected through expert validation sheets and a practicality questionnaire. The validation sheets were used to assess the material, media, and language aspects, while the practicality questionnaire was used to determine the level of ease of use of the product by lecturers and students. To provide a clear global overview of the research execution, the specific participants, research instruments, and data analysis methods mapped across each utilized ADDIE stage are systematically summarized in Table 1.

Table 1. Matrix of Research Methodology Across ADDIE Stages

ADDIE Stage	Participants	Research Instruments	Data Analysis Methods
Analyze	Active biology education students (cohorts 2022 and 2023). 1 Cell Biology course lecturer.	Online needs assessment questionnaire via Google Forms. Structured interview guide.	Quantitative descriptive analysis (percentage of frequency metrics). Qualitative descriptive analysis (thematic synthesis of interview responses)
Design	Researcher	Semester Learning Plan (SLP) analysis grid. Video content flow and storyboard planning.	Qualitative logical analysis of curriculum alignment and media sequencing.
Development	3 Expert validators (1 media expert, 1 material expert, and 1 linguist). 1 Cell Biology course lecturer. 10 Students (Small-group trial). 20 Students (Large-group trial).	Expert validation sheets (Likert scale). Lecturer and student practicality questionnaires (Likert scale).	Quantitative descriptive analysis using validation percentage formula: $p = \frac{f}{N} \times 100\%$ Practicality mean score calculation:

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$$Mx = \frac{\sum X}{N}$$

Qualification mapping based on interval criteria.

In this study, the ADDIE model was applied up to the Development stage. The evaluation conducted was strictly formative, aiming to assess the validity and practicality of the developed medium. The user trials involving 10 small-group students and 20 large-group students served as formative product try-outs to ensure usability and readability within the development phase, rather than evaluating summative learning outcomes through a full implementation phase.

Data Analysis Techniques

The data analysis used in this study consisted of two types: validity analysis and practicality analysis. Validity and practicality data were analyzed descriptively and quantitatively by converting assessment scores into percentages. Validity refers to the appropriateness, meaningfulness, accuracy, and usefulness of the inferences made by the researcher (Fraenkel, J., Wallen, N., & Hyun, H., 2023). The process for assessing the quality of the learning media developed by the researchers was then converted into quantitative data using a Likert scale. The Likert scale used to analyze the assessment criteria is shown in Table 2.

Table 2. Likert Scale Categories (Fraenkel, J., Wallen, N., & Hyun, H., 2023:125)

No	Category	Value
1.	Strongly agree	5
2.	Agree	4
3.	Undecided	3
4.	Disagree	2
5.	Strongly disagree	1

Furthermore, quantitative data, which is in the form of numbers resulting from calculations or measurements, can be processed by calculating the achieved value (percentage). The percentage calculation uses the following formula:

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

Description:
p = percentage number
f = frequency whose percentage is being sought
N = Number of Cases (sum of frequencies/number of individuals).
(Sudijono, 2010: 43).

The percentage results were then categorized based on feasibility criteria to determine the level of validity and practicality of the developed product. Table 3 displays the categories for achieving validity values (percentages).

Table 3. Validity categories (Riduwan & Akdon, 2015, modified)

No	Achievement Score (Percentage)	Criteria
1.	81% - 100%	Very valid
2.	61% - 80%	Valid
3.	41% - 60%	Fairly Valid

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No	Achievement Score (Percentage)	Criteria
4.	21% - 40%	Less Valid
5.	0% - 20%	Invalid

Table 4 displays the division of the practicality category range based on value achievement (percentage).

Table 4. Practicality Category (Riduwan & Akdon, 2015, modified)

No	Achievement Score (Percentage)	Criteria
1.	81% - 100%	Very Practical
2.	61% - 80%	Practical
3.	41% - 60%	Quite Practical
4.	21% - 40%	Weak
5.	0% - 20%	Not Practical

RESULTS AND DISCUSSION

Results of Developing a Video Guide for Cell Biology Labs

This research resulted in a video guide for cell biology labs developed using the ADDIE model, encompassing the stages of analysis, design, development, limited implementation, and evaluation. The video product was designed to help biology education students understand lab procedures in a more visual, systematic, and accessible way before conducting lab work in the laboratory.

During the analysis phase, the needs questionnaire results indicated that students experienced difficulty understanding practicum procedures solely through printed guidelines. This finding aligns with the findings of Cahaya et al. (2025), who stated that limited visualization in conventional guidelines was a factor hindering students' practicum readiness. Consequently, creating a video practicum guideline was considered a pertinent solution to this issue. During the design phase, the focus was on ensuring the video flowed smoothly, developing a clear work procedure, and adjusting the language so students could understand it better. The video was supplemented with supporting text and step numbering to clarify each stage of the practicum. This approach supports the statement by Sastria et al. (2020) that visual media that display a complete workflow can help students develop a procedural picture before the practicum begins.

Validity of the Video-Based Cell Biology Practical Guidelines

Product validity was determined through assessment by three validators: a media expert, a content expert, and a language expert. The validation process was conducted in two stages: the first stage aimed to obtain feedback for improvements, and the second stage was used to assess the product's feasibility after revisions. Validation results indicated that the video-based cell biology practical guidelines were valid to very valid in every assessment aspect. The comprehensive results of the expert appraisal, covering media, material, and language aspects, are systematically summarized in Table 5.

Table 5. Summary of Expert Validation Results

No	Validation Aspect	Score (%)	Qualitative Category
1.	Media	77.5%	Valid
2.	Material	90.0%	Very Valid
3.	Language	95.0%	Very Valid
Total	**Overall Average Score**	**87.5%**	**Very Valid**

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Media experts' validation revealed an average percentage of 77.5%, placing it within the valid category. According to Riduwan & Akdon's criteria (2015), the percentage is 61%-80% (valid). The results of this expert opinion indicate that, in general, the appearance and presentation of the media are valid for use in learning, such as video design, text arrangement, images, and animations that have been presented proportionally and in accordance with student characteristics. This finding is consistent with previous studies showing that video-assisted practicum learning media achieve high validity and are suitable for supporting science learning activities (Haslipa et al., 2022; Kandriasari et al., 2023). The validity of the developed media indicates that the visual design, sequence of activities, and instructional components are appropriate for guiding students during laboratory activities (Ahmad et al., 2020; Kandriasari et al., 2023). These results indicate that the video appearance, presentation flow, and visual clarity have met the eligibility criteria, although they still require minor improvements according to the validator's suggestions. Improvements to the visual display are based on the Cognitive Theory of Multimedia Learning, which explains that presenting information through a balance of visual and verbal channels helps students process information, making learning more effective and meaningful. This theory emphasizes the principle that the arrangement of multimedia elements must take into account the limited capacity of cognitive channels so that information can be optimally processed in working memory (Staneviciene & Zekiene, 2025). Additionally, Dual Coding Theory suggests that using both text and images at the same time can help students remember and understand learning materials better, especially when the visuals back up the written explanations, making it easier to recall concepts.

Following up on these suggestions, researchers revised the video by adding explanatory text and numbering to each work procedure. These additions aimed to clarify the sequence of practical activities, help students visually understand the work stages, and reduce the potential for errors during laboratory practice. The improvements from media validation can be seen in Figures 2 and 3.

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Figure 2. Before revision

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Figure 3. After revision

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Figures 2 and 3 illustrate the visual and structural transformation of the Cell Biology lab guide interface before and after the formative evaluation cycle. In the pre-revision stage Figure 2, the platform interface suffered from high extraneous cognitive load due to the absence of clear layout dividers, a lack of procedural tracking landmarks, and the presentation of abstract workflows without graphical guidance.

Following the implementation of expert feedback, the post-revision stage Figure 3 exhibits a highly structured layout. The difference is visually prominent through the addition of bold headings (e.g., 'Prosedur Kerja to Difusi'), sequential step-by-step numbering, and distinct text boxes outlining specific sub-objectives. Furthermore, the language was optimized into direct imperative instructions, significantly lowering student confusion and maximizing independent navigation on the Canva-hosted website. To ensure scientific transparency regarding the product's development, the specific qualitative critiques raised by the validation team across media, material, and language aspects, along with the subsequent revision actions executed, are systematically structured in Table 6.

Table 6. Expert Critique and Revision Matrix for the Video Guide

Expert Type	Initial Critique/ Feedback	Revision Action Taken
Media Expert	The video presentation lacks step-by-step markers, making it difficult for students to follow the procedural workflow systematically.	Integrated clear on-screen text and chronological numbering for each laboratory procedure.
Material Expert	Laboratory instructions are too general, unmeasured, lack specific treatment durations, and omit specific experimental sub-objectives.	Restructured the guidelines to include precise treatment times (e.g., 30 and 45 minutes) and added a dedicated "Specific Objectives" section for each treatment.
Language Expert	Instructional sentences are ambiguous for beginners and lack active, directive tone.	Simplified sentence structures and replaced passive verbs with direct imperative verbs such as "lakukan", "ukur", and "catat".

The revisions to the use of language also take into account Cognitive Load Theory, which states that cognitive load must be managed in such a way as to minimize unnecessary elements (extraneous cognitive load), so that students can focus more on understanding the core material without being distracted by excessive language complexity or design (Nurhatmi, 2025). Meanwhile, validation by material experts obtained a percentage of 90% with a very valid category. This value indicates that the content of the material, the accuracy of the practicum work procedures, and its suitability with the learning outcomes of the Cell Biology course have been well met. The quality of the material presented improved after the first stage of validation, which included confirming the goals of each procedure and clarifying the treatment time. Meanwhile, the validation by the subject matter expert achieved a score of 90.0%, falling into the very valid category, as detailed in Table 5.

In terms of language, validation by linguists showed a percentage of 95%, categorized as highly valid. This indicates that the language used in the video conforms to good and correct Indonesian language standards, ensuring it is communicative and easily understood by students. The consistent use of scientific terms and clear instructional sentences supports the effective delivery of practicum procedures. Clear and concise instructions are essential in laboratory learning because they help students follow experimental procedures accurately and reduce misconceptions during practicum activities (Croker et al., 2010; Tauhidah et al., 2026). The use of clear, concise, and well-structured language in video-based practicum guides is essential to ensure that students can accurately follow laboratory procedures and minimize errors during practical activities. The combination of verbal

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explanations and visual demonstrations also enhances students' understanding of experimental techniques (Croker et al., 2010). In terms of linguistics, the language expert's validation yielded a score of 95.0%, categorized as very valid (see Table 5).
Overall, the validity graph indicates that the developed product fulfills the eligibility criteria as an effective supporting medium for cell biology practicums. This aligns with the assertion of Donna et al. (2021), who noted that a developed product is considered valid if it has been verified by material experts, language specialists, and media professionals.

Practicality of Video-Based Cell Biology Lab Guidelines
The practicality of the developed video lab guideline was assessed through a questionnaire distributed to lecturers teaching cell biology courses and to students who had completed the course. The practicality assessment was conducted by the lecturers teaching cell biology courses, who assessed the extent to which the video lab guideline was easy to use, aligned with learning needs, and supported the achievement of learning objectives. Table 7 displays the results of the lecturers' practicality assessment.

Table 7. Results of Practicality Assessment by Lecturers Teaching Cell Biology Courses

No	Lecturer Name	Total Score	Maximum Score	Percentage	Category
1	HF	28	30	93,3%	Very Practical

Based on Table 7, it can be concluded that the practicality of the product developed, in the form of a video guide for cell biology labs, was 93.3%, according to the lecturer in charge of the course. Based on the interpretation criteria, this score falls into the very practical category. The lecturer stated that overall, the video guide for cell biology labs was good and could aid students' understanding of cell biology material.

The practicality assessment by students was conducted in two distinct formative stages: a small-group trial involving 10 students and a large-group trial consisting of 20 students. This evaluation aimed to determine the overall ease of use, visual clarity, and user response toward the website-integrated video guide. A general summary of the empirical scores collected from both student try-out phases is systematically presented in Table 8.

Table 8. General Summary of Student Practicality Trials

No	Trial Phase	Number of students	Total Score	Average Percentage	Qualitative Category
1.	Small Group Trial	10 Students	301	86.00%	Very Practical
2.	Large Group Trial	20 Students	638	95.86%	Very Practical
	Total	**30 Students**	**939**	**90.93%**	**Very Practical**

Based on Table 8, data from the small group trial with 10 students show that the average practicality score for the practicum guidelines reached 86%, categorized as very practical. Most respondents gave a rating in the very practical range, while one respondent gave a rating in the practical category. Several suggestions were provided for improvement so that this product can more optimally support the student learning process. The practicality assessment by students in the large group trial can be seen in Table 8.

Based on Table 8, the results of the large-group trial involving 20 students yielded a total score of 638, with a practicality percentage of 95.86%, which falls into the very practical category. The

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average practicality percentage of the learning resources was calculated based on the results from all trial stages, including trials by the lecturer teaching the cell biology course, small-group trials, and large-group trials. This score was then obtained by dividing the total number of trials conducted. Further detailed calculation results will be explained in the following section.

$$Mx = \frac{\sum X}{N}$$

Description:
Mx = The mean we are looking for.
∑X = The sum of the scores (values).
N = Number of Cases (the number of scores themselves).
(Sudijono, 2010: 81).

$$Mx = \frac{93{,}3\% + 86\% + 95{,}86\%}{3}$$
$$Mx = 91{,}72\%$$

The average practicality percentage from lecturer assessments and student trials shows that clear video displays, step-by-step presentations, and the use of text and numbered procedures helped students easily understand the lab process. Furthermore, media accessibility prior to the lab session also supported student readiness for laboratory work. This result is reflected in the high percentage of positive responses from students and lecturers regarding ease of use and clarity of instructions, as shown in the practicality graph.

These findings align with the opinion of Prasetyo and Fatmawati (2020), who stated that learning media is considered practical if it is simple to use without requiring complicated adjustments and can help users achieve learning objectives efficiently. Susanti (2021) also highlighted that the clarity of navigation, visual appearance, and the understandability of presented instructions influence the practicality of media. Therefore, based on the practicality percentage obtained from the trial results, the Cell Biology lab guide in video format can be declared feasible and practical for use as a supporting medium for lab activities. This media not only make it easier for students to understand work procedures but also supports independent learning and efficiency in carrying out practical work in the laboratory.

However, this study acknowledges certain research limitations. The evaluation was strictly formative and conducted within a limited scope of 30 biology education students, without statistically measuring the summative learning outcomes or post-test performance. Additionally, the ADDIE framework applied was intentionally bounded to the development stage. Consequently, for further research, it is highly recommended to advance this product into a full-scale implementation stage in actual classrooms and employ quasi-experimental designs to empirically evaluate the video guide's direct impact on student academic achievement and retention.

CONCLUSION

This research successfully produced a digital cell biology practicum guideline in the form of instructional videos integrated into a website platform using the Canva application. Developed systematically through the analysis, design, and development stages of the ADDIE model, the final product comprehensively features structural practicum videos, supporting instructional texts, and an interactive post-test evaluation link to facilitate independent student access. Based on the formative evaluation results, the video-based guideline achieved high validity across media, material, and

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linguistic aspects, confirming its readiness as a feasible learning tool. Furthermore, the formative product try-outs demonstrated that the guideline is highly practical, receiving outstanding usability responses from both course lecturers and students in small-group and large-group trials. Although this study is deliberately bounded to the development stage, the high level of readability during the trials indicates that the guide effectively addresses field implementation needs, while the embedded post-test provides a functional mechanism for independent student self-evaluation.

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