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# A Digital-Based Practical Guide to Encourage Students' Critical Thinking Skills

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**Abstract:** This research aims to develop a digital-based practicum guide to stimulate the critical thinking skills of high school students on cell structure materials. This research uses the 4D model development method (Define, Design, Develop, Disseminate), which consists of the stages of defining needs, product design, development, and dissemination. The product is developed in the form of an interactive flipbook that contains videos, images, critical thinking simulation questions, and answer links. The validation results showed that the digital-based practicum guide was declared very valid by media experts with a score of 97 and by material experts with a score of 95. The practicality test involving 74 students showed an average score of 90 in the "very practical" category. This guide is considered effective because it facilitates self-paced learning, is easily accessible, and increases student engagement through interactive features. The discussion of the results shows that this guide can support the student learning process, increase motivation, and provide an interesting and meaningful learning experience. This study concludes that the digital-based practicum guide that was developed is valid, practical, and feasible to be used to support biology learning that trains critical thinking skills.

**Keywords:** Biology learning; Critical thinking skills; Digital-based practical guide; Flipbook

## Introduction

The digitalization era is developing rapidly and affecting various aspects of life, including education. The shift from conventional learning to the use of digital technology has major consequences and opportunities in transforming the global education system. One of the main indicators of this transformation is changes in access to information and the delivery of knowledge (Hasnida et al., 2023). Technology plays an important role in increasing the efficiency and accessibility of learning, as a result of advances in science in the field of education (Haleem et al., 2022; Mahdianto, 2022; Serrano et al., 2019; Szymkowiak et al., 2021).

The education system has a strategic role in determining the progress of a nation. The ability to provide education that prepares the younger generation to face globalization is the key to competitiveness in the modern era (Asbarin et al., 2018). 21st-century education requires mastery of critical thinking skills, communication, collaboration, and creativity. In this context, the use of digital technology as a flexible and adaptive learning medium is very crucial (Syahfitri et al., 2023; Yusuf, 2012).

One important aspect of science education is laboratory practicums. Practicums provide students with hands-on experience in applying scientific concepts, developing critical thinking skills, and problem-solving skills through a scientific approach (Dewi, 2021; Mu'minah, 2022). In addition, laboratories help students understand the process of observation, measurement, and evaluation of scientific ideas or

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theories (Darmaji et al., 2019; Hamed et al., 2020; Husnaini et al., 2019; Suryana et al., 2024).

However, the reality in the field shows that the practicum guides used are still conventional and lack interactivity. Guides such as Student Worksheets are often limited to presenting practicum steps without providing space for students to explore, design, or evaluate independently. As a result, students' critical thinking skills are less developed because they tend to rely on textual and one-way answers (Fajari, 2021; Mahanal et al., 2019; Ningsi et al., 2021).

On the other hand, digital media such as interactive flipbooks offer great potential in increasing student engagement. This media can be tailored to individual needs, provide real-time feedback, and present a more engaging and contextual learning experience (Apriliyani et al., 2021). Digital-based practicum guides have been proven effective in improving students' critical thinking skills and conceptual understanding through features such as simulations, quizzes, and demonstration videos (Çakır et al., 2021). Previous research also stated that the learning resources most widely used in biology learning in high school are textbooks, printed worksheets, e-books, the environment, videos, and internet media (Syahfitri et al., 2024).

The results of observations at the MGMP IPA workshop in Bengkulu City on October 1, 2024, showed that 85% of junior high school/Islamic junior high school science teachers still used conventional worksheets, and 90% of participants expressed interest in implementing electronic-based practicum guides. The constraints of using laboratories simultaneously and interference from students' digital devices are challenges that can be overcome through the integration of flexible and attractive digital practicum guides.

Based on this description, the importance of this research lies in the effort to create a digital-based practicum guide that is not only an alternative to conventional guides, but also as a means to stimulate students' critical thinking skills. This research is relevant as an answer to the challenges of 21st century learning and supports the strengthening of science literacy through media that is in accordance with the characteristics of the digital generation.

Thus, the research entitled "Development of Digital-Based Practical Guidelines to Stimulate Students' Critical Thinking Skills" is very important to be carried out in order to improve the quality of biology learning in secondary schools.

## Method

This study uses a Research and Development (R&D) approach with a 4-D development model consisting of four stages: Define, Design, Develop, and Disseminate. This method is designed to produce a digital-based practicum guide that aims to train students' critical thinking skills. The stages of this research are explained in detail in the flow diagram (Figure 1).

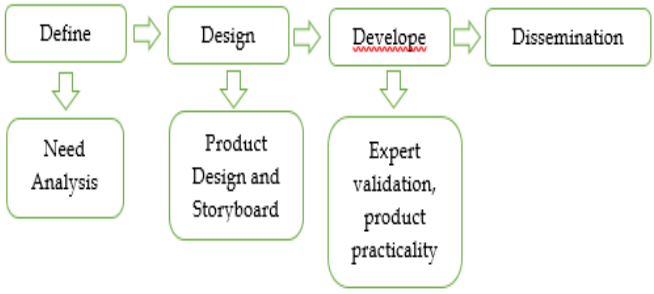


**Figure 1.** Research flow chart

In the first stage, namely the definition stage, a needs analysis was carried out, which involved collecting data from various sources to determine existing problems related to the use of conventional practicum guides (LKS) in the laboratory.

The steps taken included observations in class XI of SMA Negeri 2 and SMA Negeri 7 Bengkulu City to identify problems in the use of LKS, followed by interviews with science teachers and students to explore problems faced during the implementation of the practicum. In addition, a literature review was conducted to explore the theory and best practices regarding digital-based practicum guides that can support critical thinking skills-based learning.

In the design stage, the researcher designed a digital-based practicum guide that will be used in laboratory activities. The steps include determining the features that will be included in the digital guide, such as visual simulations, interactive quizzes, and evaluation of practicum results that aim to improve students' critical thinking skills. In addition, an intuitive user interface (UI) was designed so that it is easily accessible to students. This guide is presented in the form of a digital flipbook equipped with multimedia elements such as images, animations, and text. The design of the practicum material is adjusted to the curriculum and learning objectives to be achieved, namely, understanding cell structure.

The development stage is carried out by creating a prototype of a digital practicum guide that has been designed and then tested to obtain feedback. The steps in this stage include developing a digital guide that includes practicum material content, user interface design, and interactive features that can actively involve students. Furthermore, validation is carried out by material experts and media experts to ensure the suitability of the material and the quality of the media used. The beta trial was conducted in class XI of SMA

Negeri 2 by involving one class to test the usefulness, feasibility, and effectiveness of the guide in supporting practicum activities and improving students' critical thinking skills.

In the dissemination stage, the validated digital practicum guide is distributed for wider use in schools. This stage includes further trials in class XI of SMA Negeri 7 and one other class in SMA Negeri 2 to test the implementation of the guide in a broader context. Data obtained from limited and further trials are analyzed to assess the effectiveness of the guide in improving students' critical thinking skills. The results of this study are disseminated in the form of a report that is shared with related schools and can be adapted for wider use.

## Results and Discussion

This study produced a digital-based practicum guide designed to train students' critical thinking skills. Research data were collected through a questionnaire consisting of a media expert validation sheet, a material expert validation sheet, and a student response questionnaire. In the process of developing a digital-based practicum guide, it refers to the 4D development model consisting of four stages, namely define, design, development, and disseminate. This development research has been carried out following the stages in the 4D development model. The following is a description of the stages carried out by the researcher:

At the definition stage, an initial analysis was conducted, which showed that learning at SMA N 2 Kota Bengkulu still uses conventional practical guidebooks (LKS) without the support of images or videos, and has not implemented digital-based practical guidebooks. Another obstacle faced is the clash of laboratory usage schedules, which often causes delays in practical work. Therefore, a digital-based practical guidebook is needed that is more attractive, flexible, and can be accessed at any time without relying on the laboratory, so that practical work can run more effectively according to schedule. Based on the results of the analysis of practical activities at SMAN 2 Kota Bengkulu, it is known that the implementation of practical work still uses conventional guidelines in the form of LKS, whose design is less attractive to students. At the beginning of the practical guide, it only displays the title of the activity, followed by a list of tools and materials, implementation steps, and questions without illustrations or material guides that can help students understand. Seeing the existing facts, the researcher wants to develop a digital-based practical guide. In the task analysis, a study was carried out on learning achievements and ATP related to the material that will be developed through a digital-based practical guide. This analysis is adjusted to the Teaching Module, then further described in the form of learning indicators. At this stage, details are also made to determine the basis for the need to develop the learning media to be created, which must be in line with the learning achievements and objectives that students want to achieve.

At the design stage, the material used to design this digital practical guide is material on Cell Structure. At each stage, some indicators must be understood by students, namely being able to dissect animal cells and plant cells. The material on cells was chosen as the basis for making a digital-based practical guide because cells are the smallest units of living things. Students are expected to have an understanding of the differences between animal cells and plant cells because both are key to understanding the organization of life, from the molecular level to the organism. The components in the practical guide are video simulations of practical activities, video materials, pictures of the differences between animal and plant cells, questions that can stimulate critical thinking skills, and answer links. The main application used by researchers in product development is the Canva application. Researchers use the premium-based Canva application by using a learning account that provides icons or templates that can be used without paying. After all product designs are completed through the Canva application, the next step is to export them into a digital-based book. Export is done using a flipbook that produces links that can then be directly accessed via the internet, so that the teaching media for this practical guide is more lively and interesting, and easy to access. In the initial product design stage, the development of teaching media in the form of a digital-based practice guide begins with the creation of a framework that is compiled based on the storyboard design and product prototype.

At the development stage, the purpose of product validity testing is to measure whether the learning media used are valid or not. After receiving suggestions, input, and revising the developed product, the media expert validator assesses the product's feasibility using a teaching media validation instrument sheet in the form of a digital-based practice guide. The following are the results of the teaching media assessment analysis:

**Table 1**. Results of Validation of Digital-Based Practical Guidelines by Media Expert Validators

| Average value | Range | Category |
|---|---|---|
| 97 | 81-100 | Very Valid |

The results of the validation sheet analysis carried out by the media expert validator on the teaching media in the form of a digital-based practical guidebook to stimulate students' critical thinking skills, which was developed, obtained an average score of 97 in the

interval 81-100, with a very valid category. The assessment from the media expert validator showed that the digital-based practical guidebook to stimulate students' critical thinking skills, which was developed, was valid and feasible to be used in the next stage. After receiving suggestions, input, and making revisions to the developed product, the material expert validator assessed the feasibility of the product using the digital-based practical guide validation instrument sheet. The results of the validation sheet analysis carried out by the material expert validator on the teaching media in the form of a digital-based practical guidebook to stimulate students' critical thinking skills, which was developed, can be seen in the table below.

**Table 2.** Validation Results of Digital-Based Practical Guidelines

| Average value | Hose | Category |
|---|---|---|
| 95 | 81-100 | Very Valid |

The assessment from the material expert validator shows that the digital-based practical guidebook to stimulate students' critical thinking skills, which was developed, is valid and suitable for use in the next stage.

At the dissemination stage, the trial was conducted after the developed digital-based practical guide received approval from both validators and was declared suitable for use in learning activities. This trial aims to determine the results of the digital-based practical test developed. The results of the practical test are shown in the table below:

**Table 3.** Results of Practical Tests

| Number of students | Total score | ∑x Student achievement | | Practicality category |
|---|---|---|---|---|
| | | | Student | |
| 74 | 6688 | | 90 | Very practical |

The results of the questionnaire responses from 74 students showed that the developed digital-based practicum guide obtained an average score of 90. This score is in the interval of 81–100, which is included in the category of "very practical". Students also commented that this digital-based practicum guide is more interesting than the practicum guide contained in the LKS that is usually used. In addition, its use is more practical because it can be accessed anywhere simply by clicking on the practicum guide link that has been shared by the teacher so that the practicum can still run well even though it is not carried out in the laboratory. Thus, it can be concluded that the developed digital-based practicum guide received a response of "very practical" and is suitable for use in the learning process.

In the discussion of the research results, the validity of the digital-based practice guidelines shows that the media components in the developed practice guide can be seen from the ease of access to the menu containing interactive videos and images that improve student understanding and encourage their involvement in the learning process. Digital-based practice guides are audiovisual media equipped with images and videos, so they can increase students' interest in learning. Digital-based practice guides have proven to be effective, efficient, and creative in supporting students' learning processes. In terms of effectiveness, digital-based practice guides facilitate the implementation of practice, motivate students to learn independently because they are equipped with practice steps, and help train critical thinking skills through the questions presented. This digital-based practice guide in the form of a Flipbook is expected to help students learn independently and provide a more interesting learning experience through images, videos, and various other interactive digital features.

The results of the validation of material experts on digital-based practicum guides to stimulate critical thinking skills show that the material components in the developed practicum guides align with the Learning Outcomes (CP), indicators, and Learning Targets. The writing of material in the digital-based practicum guide is also directed to be more by its appearance. The material in the practicum guide is arranged systematically so that students can understand the flow of the guide more clearly, making it easier for them to understand the material. Cell structure is included in the phase F learning material for grade XI. The learning targets in this phase require students to be able to dissect animal and plant cells. In this study, students made miniature cells from food ingredients and analyzed the structure and function of each organelle. They discussed, chose appropriate materials, and arranged miniatures with the right size, colour, and proportions. After finishing, they reflected on the results by comparing the cell images that had been shared in the practicum guide, then identified deficiencies, and developed improvement strategies. Through this activity, students can practice critical thinking skills actively and deeply.

Based on the results of the practicality of small trials and extensive trials, this digital-based practicum guide has been declared practical to use, with the results of the assessment with a practicality level of small trials of 89 and extensive trials obtaining a practicality level of 90. This shows that this guide is very practical in supporting the student learning process. This digital-based practicum guide can be accessed anytime and anywhere using devices such as laptops, tablets, or smartphones, thus providing practicality for students in conducting practicums. The practicum guide is presented in the form of a Flipbook, so that students do not need to carry

physical books so that it lighter and more practical to use. This Flipbook has been equipped with various instructions, materials, questions, and other supporting information, which makes it easier for students to conduct practicum experiments. Flipbook presents material more neatly and structured, equipped with hyperlinks that lead to learning videos or practice questions. This feature makes it easier for students to access materials, watch videos, and directly answer the available questions, so that learning becomes more practical and interactive.

## Conclusion

The conclusions drawn show that the developed digital-based lab guide has proven to be valid and practical. This study provides evidence that this guide is able to improve students' critical thinking skills. This lab guide offers greater flexibility compared to conventional methods, allowing students to access materials at any time without relying on laboratory schedules. Another advantage of this guide is its ability to present materials more interestingly and interactively, such as using videos and images. Based on the trial results, the majority of students considered this guide very practical and useful in the learning process. However, some limitations need to be noted, such as the lack of in-depth qualitative data analysis, as well as limitations in understanding student responses to the guide. This study also did not further discuss how expert validation results and student responses correlate with each other, which is important for evaluating the overall effectiveness of the product. Furthermore, further research is needed to test the use of this guide on a broader scale and in different learning contexts.

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There is no conflict of interest in the final assignment.

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