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# Developing Proteus video tutorials as interactive mathematics learning media based on a realistic approach

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**Abstract**
The advantages of video tutorials as an alternative learning media in mathematics are significant. Video tutorials are easily used because they are not limited by space and time constraints. For teachers who lack competency in using technology, such learning media greatly assist the teaching process in achieving the desired outcomes. Proteus video tutorials specifically explain the application of Proteus software. These videos are designed based on a realistic approach, where learning begins with real-world contextual problems. The purpose of this study is to develop interactive mathematics learning media through realistic approach-based Proteus video tutorials that are valid and practical. The research method employed is Research and Development (R&D), adapting the ADDIE development model. This model comprises five stages: Analysis, Design, Development, Implementation, and Evaluation. The research results indicate that the video is considered valid, obtaining a validation score of 93%, which falls into the very valid category, and practical, with a score of 94%, indicating a very practical category. Furthermore, the video is developed with the characteristics of a realistic approach.

**Keywords:** Proteus software, Realistic approach, Video tutorial

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## Introduction

Learning is a process involving interaction between teachers and learners. Even in higher education, pleasant interactions should be fostered in teaching and learning activities to achieve optimal learning objectives. Creating a learning environment that facilitates the transfer of knowledge and information interactively and engagingly is crucial in the field of education. As Nurhayati et al. (2023) assert, interactive elements must be present in learning media to elicit responses and achieve effective and desired learning outcomes. Supporting this view, Prior et al. (2016) argue that interactive learning media can mutually influence and share actions and emotions, thereby effectively facilitating users in the delivery of learning content.

Interactive learning media is a method that integrates electronic devices or computer technology to present learning content (Ramadhani et al., 2023). Through the use of media, students can actively participate in the learning process by directly accessing digital simulations, and facilitating interactions between teachers and students, among students, and between students and digital media. Interactive learning media, which can manipulate natural behavior and control commands, include a combination of audio, text, images, animation, and video (Pramitasari et al., 2020). According to Handayani & Rahayu (2022) interactive learning media has great potential to encourage students to react actively to the content presented. Essentially, interactive learning media refers to computer-based learning that integrates audio, video, animation, simulation, graphics, and other elements (Hamada & Hassan, 2017).

Interactive learning media is essential in mathematics education. Mathematics, as a science of logical thinking, is integral to modern technology and daily life (Kemendikbud, 2022). Interactive mathematics learning media can serve as a valuable tool for delivering information effectively, supporting the success of the teaching and learning process anytime and anywhere (Yanti et al., 2019). Yanti et al., (2019) further explain that interactive mathematics learning media are necessary because mathematics is inherently abstract, consisting of numbers and symbols. Therefore, it must be presented in a tangible form by integrating images, sound, and everyday life contexts. One effective solution for interactive mathematics learning media is the Proteus video tutorial based on a realistic approach.

A video tutorial consists of a series of moving images that provide information delivered by a tutor, intended to impart new knowledge to the viewer (Utomo & Ratnawati, 2018). Video tutorials offer several advantages as interactive mathematics learning media, including the ability to demonstrate phenomena and procedures, illustrate abstract material through animation, and serve as an alternative to face-to-face classroom meetings (Adisasongko, 2019). Additionally, video tutorials can be paused, replayed, and viewed according to the learner's needs. Therefore, video tutorials are an effective choice for interactive mathematics learning media, particularly for demonstrating the use of the Proteus application in learning.

Proteus is a suite of electronic software used to design and simulate electronic circuits (Asmara & Ali, 2016). The Proteus work screen display, which closely resembles the actual state, is suitable for studying the actual form of electronic components and understanding how to assemble these components correctly (Putri & Mukhaiyar, 2022). According to Matsun et al. (2021) the Proteus application can demonstrate phenomena that are difficult to observe through ordinary means. However, it is unfortunate that not all teachers can operate technology optimally. Therefore, Proteus video tutorials can be used to enhance the teaching and learning process.

Furthermore, integrating the correct learning approach is essential in addition to using appropriate media. The realistic approach is one such method that connects mathematical concepts with real-life situations. Asma et al. (2019) mentioned, the characteristics of the realistic approach actively involve learners, enabling them to construct their own knowledge. Aspriyani & Suzana (2020) stated that the starting point of the realistic approach is to present problems that are closely related to real life. The realistic approach is an innovative learning method that emphasizes mathematics as a human activity connected to real life, using real-world contexts as the starting point for learning (Nguyen et all., 2021). As highlighted, the fundamental principle of the realistic approach is that learning must begin with the context of real problems (Angraini & Muhammad, 2023).

Moreover, the research conducted by Sukmaningthias et al. (2023) demonstrates that learning media based on a realistic approach, supported by digital applications, significantly influences problem-solving abilities. Additionally, Agustin et al. (2023) Systematic Literature Review on the realistic mathematics approach to mathematical creative thinking skills for the period 2016-2023 indicates that realistic learning using technology can encourage learners to acquire information, deeply understand the material, conduct investigations, interpret various procedures, and build representations based on their existing knowledge. Therefore, the Proteus video tutorial, based on a realistic approach, enables students to directly simulate applied mathematics problems, such as logic gates, resulting in improved learning outcomes.

The reality in the field is that some teachers do not use the Proteus application due to a lack of competency. This underscores the urgency of this research. Innovation is needed in the form of interactive mathematics learning media capable of implementing abstract logic gate material in practical terms. The purpose of this study is to develop a Proteus video tutorial based on a realistic approach that is deemed valid and practical by experts. Validity refers to the alignment of the product's substance, developed or constructed by the researcher, with the learning objectives. Practicality pertains to the ease of use of the developed product by practitioners for teaching purposes (Zaputra et al., 2021).

## Methods

This research is a development study, also known as Research and Development (R&D), which utilizes the ADDIE development model. According to Waruwu (2024), the application of the ADDIE model in development research is an appropriate alternative for producing educational products. This is because each stage involves a thorough, systematic, and structured process, ensuring that the resulting product is valid. The model consists of five stages: Analysis, Design, Development, Implementation, and Evaluation (Sugiyono, 2019). These stages serve as the research method to produce a valid and practical product. The product developed is a Proteus video tutorial based on a realistic approach. The realistic approach in this video starts with presenting everyday problems related to logic gate material. It then explains how to construct logic gate problems using Proteus until the end of the video, which displays the truth table to be achieved. The stages of the ADDIE development model are depicted in the form of a flow diagram in Figure 1.

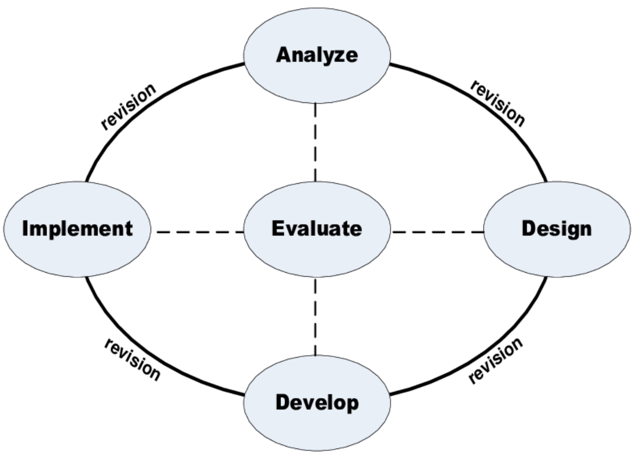


**Figure 1.** ADDIE Development Model

The initial stage involves conducting an analysis, which includes field observations and a literature review. Field observations were carried out during the teaching of digital systems courses for Informatics Study Program students at the Faculty of Computer and Multimedia at the Islamic University of Indonesia. Digital systems are a key learning topic in Informatics and are closely related to mathematics. They encompass various mathematical materials, with one of the prerequisites being mathematical logic, known in digital systems as logic gates. Observations during the teaching of digital systems courses reveal that students struggle with understanding and determining the inputs and outputs of logic gates, leading to errors in constructing logic tables. Simultaneously, the researcher conducts a literature review of several relevant previous studies.

The second stage is design. In this phase, researchers begin creating a video script to facilitate the shooting of this tutorial video. The video script includes initial problems related to logic gate materials in real life and introduces electronic tools designed to integrate logic gates. This is followed by an introduction to Proteus as an application that can help solve the logic gate problems. The tutorial covers downloading, installing, and using the application. In addition to designing the video script, researchers also prepared assessment instruments in the form of validation sheets to measure validity and response questionnaires to measure the practicality of the developed video tutorial.

The third stage is development. In this phase, the researcher develops the Proteus video tutorial based on a realistic approach according to the previously designed script. The characteristics of the realistic approach used in this video are demonstrated by the researcher creating a simple light circuit along with its simulation during the tutorial. This indicates that the learning process begins with real-life problems relevant to the students. It then proceeds to introduce the logic gates studied in digital systems, which can be used to design an electronic circuit. This introduction is accompanied by simulations to obtain the output values of the illustrated logic gates. The final part of the video presents the established concepts of logic gates, specifically the truth tables of each logic gate. At this stage, the video undergoes validation. The validators in this research consist of media experts, material experts, and learning method experts.

The fourth stage is implementation, where the learning media that have been designed and validated by experts are tested on students. In this phase, the researcher requests the participation of a practitioner, specifically a lecturer responsible for the Digital Systems course, to teach the logic gate material using the Proteus video tutorial learning media that has been designed. At the end of the lesson, the practitioner is asked to fill out a response questionnaire to measure the practicality of the research product.

The fifth stage is evaluation. At this stage, data is processed from the practitioner response questionnaires, and conclusions are drawn to determine whether the developed video tutorial is practical and suitable for use as a learning medium. The data analysis techniques used include both qualitative and quantitative analysis. Qualitative data is obtained based on feedback and suggestions from the validation instruments completed by each validator, as well as feedback and suggestions from the response questionnaires filled out by practitioners. Meanwhile, quantitative data is obtained from the scores of the evaluations by the validators and practitioners.

## Validity analysis

The first step in validity analysis is to tabulate the validation data scores from media experts, material experts, and learning experts, using a Likert scale for scoring. Next, the average score for each indicator is calculated using the formula for finding the mean value. The obtained results are then classified according to the learning media evaluation guidelines developed by Widoyoko (2017), as shown in Table 1.

**Table 1.** Guidelines for Classification of Learning Media

| Mean | Criteria |
|---|---|
| $\bar{x} > 4{,}2$ | Very Good |
| $3{,}4 < \bar{x} \leq 4{,}2$ | Good |
| $2{,}6 < \bar{x} \leq 3{,}4$ | Fair |
| $1{,}8 < \bar{x} \leq 2{,}6$ | Poor |
| $\bar{x} \leq 1{,}8$ | Very Poor |

The next step is to analyze the overall validity data to obtain the percentage value from the total score of the three validators using Formula 1.

$$Validity\ Score = \frac{The\ total\ validity\ score\ of\ 3\ validator}{maximum\ total\ score} \times 100\% \qquad (1)$$

The obtained results are then grouped according to the validity criteria for learning media adapted from Akbar (2017), as presented in Table 2.

**Table 2.** Criteria for Validity of Learning Media

| The Percentage of Validity | Criteria |
|---|---|
| $85\% < V \leq 100\%$ | Very Valid |
| $70\% < V \leq 85\%$ | Fairly Valid |
| $50\% < V \leq 70\%$ | Less Valid |
| $1\% < V \leq 50\%$ | Invalid |

The learning media in the form of Proteus video tutorials based on a realistic approach developed in this research is considered valid if it achieves a validity percentage >85%. However, if the percentage is <85%, it needs to be revised and re-validated by the validator.

## Practicality analysis

The data obtained from the practitioner response questionnaires are analyzed in the same manner as the validity analysis, by calculating the average score for each indicator using the mean value formula. The results are then classified according to the evaluation guidelines presented in Table 1 above. Subsequently, the overall data is analyzed using Formula 2 (Lestari et al., 2018).

$$Practicality\ Score = \frac{Total\ score\ of\ every\ practitioner}{The\ maximum\ total\ score} \times 100\% \qquad (2)$$

The obtained results are then grouped according to the criteria in Table 3 (Akbar, 2017).

**Table 3.** Practicality Criteria for Learning Media

| Practicality Percentage | Criteria |
|---|---|
| $85\% < Pm \leq 100\%$ | Very Practical |
| $70\% < Pm \leq 85\%$ | Quite Practical |
| $50\% < Pm \leq 70\%$ | Less Practical |
| $1\% < Pm \leq 50\%$ | Not Practical |

The product developed in this research is considered practical if the practicality percentage is >85%. However, if the percentage is <85%, it is deemed impractical and needs to be revised and re-tested for its practicality.

## Result

The analysis phase, as previously described in the research methodology section, revealed that students struggle to determine the truth tables for logic gates with more than three inputs. The media analysis indicated that several students were unable to independently install the Proteus software when required to do enrichment assignments. The final step in this initial phase is a literature review. The literature review results showed that there has been no development of Proteus video tutorials based on a realistic approach.

The results obtained in the design stage include a video script that facilitates the shooting of the Proteus tutorial video. The video script produced serves as a guide for the researcher to deliver the lesson during the video recording process. The video script is designed to ensure that the narration is more structured and systematic. After the video script is completed, the researcher begins the video development process.

The next stage is development. In this phase, the researcher develops the video through a shooting process conducted at Kalanaraa Studio. During the shooting, the researcher provides a tutorial on using Proteus while simultaneously demonstrating its working process, which is recorded via screen recording software on a laptop. The atmosphere during the shooting and editing process can be seen in Figure 2.

**Figure 2.** The Process of Shooting and Editing Video Tutorial Proteus in Kalanaraa Studio

The results obtained from the development stage include a Proteus tutorial video based on a realistic approach, named Prototype 1. Prototype 1 is ready to be validated by three expert validators: media experts, material experts, and learning method experts. The validation process in the ADDIE development model is conducted during the implementation stage. The results obtained show a score of 77%, which falls under the "sufficient" criteria. Meanwhile, the average score for each indicator is 3.84, which falls under the "good" criteria. This means that Prototype 1 still needs revision.

The media expert commented that the video appears rigid and boring due to its focus on narration. The media expert suggested adding suitable background music to accompany the narration to make it less monotonous. The material expert commented that the Proteus tutorial displayed on the work screen is limited to creating a simple light circuit example. The material expert suggested also adding a tutorial for creating basic logic gates. The learning method expert commented that there are no characteristics of realistic learning appearing at the end of the video, making the video seem to lack a conclusion. The learning method expert suggested displaying the truth table for each established logic gate at the end of the video as the final goal of concept discovery.

Prototype 1 was subsequently revised according to the suggestions from the three experts. The result obtained is referred to as Prototype 2. Prototype 2 is re-validated by the validators before proceeding to the second implementation stage, which is the trial phase. The validation results obtained for Prototype 2 are presented in Table 4.

**Table 4.** The results of Product Validity

| **Aspect** | **Expert Validator for Media** | | | | | **Expert Validator for Content** | | | | | **Experts Validator for Learning** | | | | | **Mean** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Delivery | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 4 | 5 | 4 | 5 | 5 | 5 | 5 | 4 | 4,7 |
| Presentation | 4 | 4 | 5 | 5 | 5 | 4 | 4 | 5 | 5 | 5 | 5 | 4 | 5 | 5 | 4 | 4,58 |
| Compatibility | 5 | 5 | 4 | 5 | 5 | 5 | 5 | 4 | 5 | 5 | 5 | 4 | 4 | 4 | 5 | 4,64 |
| **Mean** | | | | | | | | | | | | | | | | 4,64 |
| The percentage of the three validators | | | 96 | | | | | 92 | | | | | 92 | | | |
| **Mean** | | | | | | | | 93% | | | | | | | | |

Based on Table 4, it can be seen that the total average score for the indicators obtained is 4.64, which falls under the "very good" criteria. Meanwhile, the total average percentage is 93%, which means that the developed product falls under the "very valid" criteria. This means that the Proteus tutorial video based on a realistic approach has been declared valid by the three validators. Subsequently, this research product is tested on students. The trial is conducted by observing a selected lecturer who carries out the teaching process for the digital systems course on logic gate material using the Proteus tutorial video based on a realistic approach. The documentation results can be seen in Figures 3 and 4.

**Figure 3.** Students Watching a Video with Their Lecturer

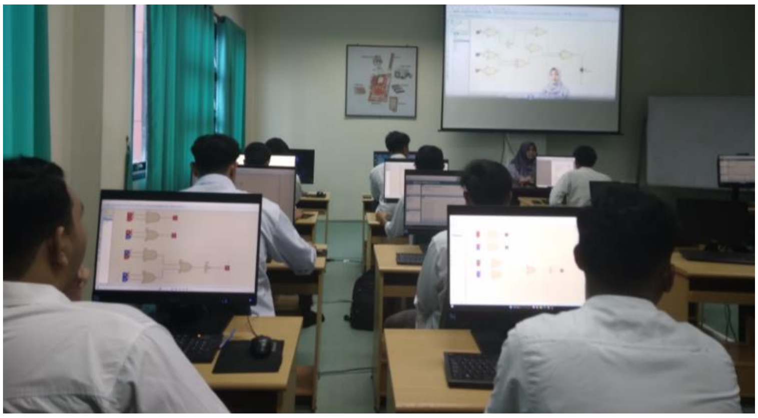

**Figure 4.** Students Working on the Exercise through Proteus

Next, the practitioner lecturer is asked to fill out a response questionnaire to measure the practicality of the developed product. The results obtained are presented in Table 5.

**Table 5**. The product practicality based on practitioners' questionnaire responses

| | Effectivity | | Interactivity | | | | Efficiency | | Creativity | |
|---|---|---|---|---|---|---|---|---|---|---|
| Score in every aspect | 5 | 4 | 4 | 5 | 5 | 4 | 5 | 5 | 5 | 5 |
| The total mean score | | | | | | 4,7 | | | | |
| The total percentage | | | | | | 47 | | | | |
| **Mean** | | | | | | **94%** | | | | |

Based on the trial results, an average score of 4.7 was obtained, indicating that the practicality based on the practitioner response questionnaire falls under the "very good" criteria. Meanwhile, the average percentage obtained is 94%, which means that the practicality of the developed product falls under the "very practical" criteria.

The final stage of the ADDIE model is evaluation. This stage is important because it aims to assess the developed product and provide conclusions regarding the achievement of the goals of the learning media produced (Rizkitania & Arisetyawan, 2021). The results of the evaluation are: the Proteus tutorial video based on a realistic approach is useful for helping lecturers teach logic gate material effectively; the material taught through the video can attract students' attention, making them realize the importance of learning logic gates because of their close application to real life; even without the guidance of a lecturer, students can independently learn and understand the logic gate material by watching the video.

## Discussion

Learning media in the teaching and learning process can be considered an important instrument that functions to transfer information, thereby achieving specific learning objectives (Simamora & Winardi, 2024). The advantages of interactive video learning media, in general, have been highlighted in several previous studies. One of them (Arbain et al., 2024) mentions that videos in learning are used to facilitate students' independent learning, enable students to construct their understanding as much as needed, and can be repeated several times for materials that are less understood, thereby achieving the desired learning skills.

The research conducted by Syahminan & Hidayat (2021) focused solely on the development of learning devices using the Proteus application as the learning media.

Meanwhile, Kholis et al. (2018) conducted research that produced a teaching module through the Hybrid Learning method, integrating the Proteus application. Furthermore, research producing Proteus tutorial videos has also been conducted by Firmandha (2019) demonstrating that the Proteus 8 Professional tutorial video is suitable for use as a learning media for computer science, although the video was not designed based on a realistic approach. Additionally, Asma & Khairunnisak (2023) revealed that students find it very convenient with the availability of many interactive mathematics learning media, especially in the form of tutorial videos, as they no longer need to wait for teaching materials from lecturers and can easily obtain the material they want to learn from any digital source.

Good learning should begin with activities that relate real-life situations to the material to be studied, also known as a realistic approach. Zubainur et al. (2020) explains that there are five characteristics of a realistic approach, one of which is using real-life problems at the start of learning. According to Ramadhani et al. (2021), learning associated with real-life activities is easily accepted by students, making the learning material easier to understand and comprehend.

The Proteus tutorial video based on a realistic approach produced in this research is a valid and practical learning medium based on validity and practicality tests. This learning medium is flexible, meaning that students can easily access the video on the YouTube channel or through the link https://youtu.be/3nxbhxZNZu0 and can watch it anytime and anywhere.

## Conclusion

Based on the series of research processes conducted, it can be concluded that the development of interactive mathematics learning media in the form of Proteus tutorial videos based on a realistic approach is valid and practical. The video is considered valid because it achieved a validation score of 93%, which falls under the "very valid" category, and it is deemed practical because it received a score of 94%, categorized as "very practical". This tutorial video is suitable for use as a learning medium for digital systems, specifically in the logic gates material, as it was developed according to the characteristics of a realistic approach. The author suggests that future researchers should conduct more development research that produces digital-based learning media products beneficial to support the teaching and learning process, especially in the field of mathematics.

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## Declarations

| | | |
|---|---|---|
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