

The Development of an Android-Based Interactive Learning Media to Enhance Understanding of OP-AMP Application as a Temperature Sensor Controller

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Abstract

The utilization of OP-AMP as controllers for temperature sensors plays a crucial role in both the manufacturing and automation sectors. Nevertheless, traditional learning approaches often fail to engage students, leading to diminished interest and lower academic performance. To address this issue, an interactive learning media based on Android technology is being developed, aimed at enhancing current teaching methods and improving students' understanding of OP-AMP applications in temperature sensor control. The objectives of this study are threefold: (1) to analyze the viability of the developed learning media, (2) to evaluate the impact on learning outcomes, and (3) to compare the learning improvements between this new media and traditional teaching methods. The research follows the ADDIE model, with data collection carried out via pre-tests and post-tests. Media feasibility was evaluated using CVR and CVI tests, while the cognitive test's validity was measured through Aiken's V and ICC. Data analysis employed a two-tailed t-test and N-Gain calculation. The study involved 72 eleventh-grade students from the Industrial Electronics Engineering program at SMK NU Ungaran. Results indicated that the Android-based interactive learning tool was highly effective, with a CVR above 0.75, an Aiken's V score of 0.90, and an ICC value of 0.797. Moreover, this learning media significantly enhanced students' academic performance, with a t-value of 30.234 and a p-value of 0.000. The experimental group saw a 74.4% improvement in learning outcomes, compared to 67.4% in the control group, demonstrating the media's effectiveness in teaching OP-AMP applications.

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INTRODUCTION

Education is the process in which adults guide children, with the goal of fostering their physical development and nurturing their spiritual growth. This guidance not only benefits the individual child but also contributes positively to the well-being of society (Indriyani, 2022: 7). This process is seen as a journey of maturation that allows students to explore and develop their talents, potential and skills. As such, educational planning must be done carefully to improve students' understanding and learning achievements (Satria et al., 2023:1). According to the Ministry of National Education Law No. 20 of 2003, the purpose of education is to establish a learning environment that allows individuals to fully develop their potential. This includes fostering spiritual resilience, self-discipline, a strong moral character, intelligence, admirable traits, and essential skills (Kiritin & Darsono, 2019:13)..

Vocational education plays a critical role in addressing these challenges by developing programs that are tailored to equip learners with specialized knowledge, skills, and competencies across various disciplines. The primary goal of vocational education is to offer in-depth expertise in specific industries, technologies, or professions, ensuring that students are adequately prepared to enter the workforce with relevant skills (Suharno et al., 2020:1). In Indonesia, Vocational High School (SMK) is one form of vocational education that aims to produce graduates who are ready to work.

Vocational High Schools (SMK) are a key priority for the government in producing graduates with strong academic achievements. To accomplish this, schools must implement effective learning tools that enhance the educational experience. Developing innovative, engaging, and interactive learning media is crucial to boosting student performance and equipping them with the skills needed for success in the workforce.

SMK NU Ungaran, located in Semarang Regency, offers five areas of expertise, one of which is Industrial Electronics Engineering (TEI). In the 11th grade TEI, comprising 72 students

across two classes, the learning process encounters several challenges that negatively affect student performance. Observations conducted from April 2-12, 2024, revealed that students' average scores on daily assessments related to OP-AMP applications as temperature sensor controllers were 55.5% in class XI TEI 1 and 52.8% in class XI TEI 2. These scores fell below the minimum competency standards (KKM).

The results of interviews with students revealed that 70% of them felt that learning OP-AMP application material using PowerPoint media that only contained text and images was boring and monotonous. On the other hand, teachers also face challenges in finding learning methods that are more interesting, interactive, and able to improve student understanding, especially with the limited media available.

According to Daryanes (2023: 2) the utilization of technology, especially Android-based smartphones, can be a solution to create learning methods that are more interactive, interesting, and improve student understanding. Technological advances are expected to contribute to the development of effective learning media. In addition, Android-based learning media offers ease of access and allows for more efficient learning without reducing class hours. Arsana (2020:72-79) states that interesting learning media makes it easier for students to understand the material.

Research on the utilization of android-based learning media has been conducted by other researchers. Bao et al (2023: 21) stated that 90% of the use of interactive learning media based on android helps students in understanding the material and makes it easy for students to learn anywhere and anytime. Anthony et al (2021: 43) stated that 62% of students using android-based interactive learning media have a better level of understanding than students who do not use android-based interactive learning media.

Based on the above problems, researchers developed an android-based interactive learning media to improve student learning outcomes on OP-AMP application material as a temperature sensor controller at SMK NU Ungaran. The development of interactive learning media based

on android is expected to improve student learning outcomes on OP-AMP application material as a temperature sensor controller.

METHODS

The method used in this research is research and development (R&D). The development research is an approach that aims to produce a product and test its effectiveness (Sugiyono, 2016). This research and development model is designed to facilitate the creation of new products. In this study, the product being developed is an educational tool intended to simplify and guide students in learning about OP-AMP applications as temperature sensor controllers.

This research design is adapted from the ADDIE model which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. (Branch, 2015:16). Educational development research encompasses several key processes, including product creation, validation, pilot testing, and evaluation. The ADDIE model, which emphasizes classroom learning, is a widely used framework for this purpose. The steps involved in media development following the ADDIE approach are illustrated in Figure 1.

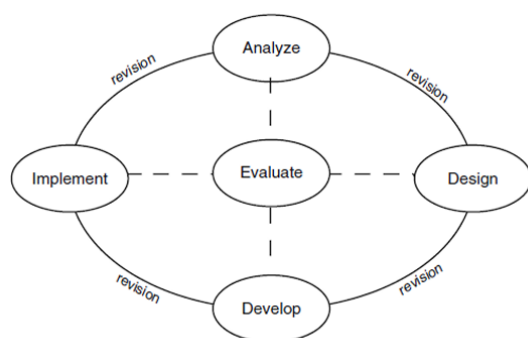


Figure 1: ADDIE Model Media Development Procedure

RESULTS AND DISCUSSION

Research Results

1. Analysis Result

The initial phase of this research is the analysis stage, where the need for learning media is assessed through observation. These

observations aimed to determine the requirements for learning tools related to OP-AMP applications as temperature sensor controllers. Several issues emerged during the observations, including: (1) the learning media used by teachers lacks engagement, making it difficult to capture students' attention, (2) the media is ineffective in helping students grasp the material and lacks communication clarity, (3) students require learning tools with features that promote independent study, (4) there is a demand for more practical and accessible media, and (5) learning media is needed to enhance student performance. Therefore, for the OP-AMP material on temperature sensor controllers, digital learning media is necessary to improve students' learning outcomes.

Seeing the characteristics of students, learning media is needed that can overcome these problems and help increase student confidence in learning OP-AMP applications as temperature sensor controllers. For this reason, the use of android applications was chosen as a learning medium to improve student learning outcomes in this material. Therefore, this topic was raised to solve the existing problems.

2. Design

The second stage in the ADDIE model is design, which aims to help researchers design media in a structured manner. At this stage, product manufacturing is carried out, designing the initial product design, preparing product assessment instruments.

a) Product Designing

The design of the interactive learning media application follows the media development guidelines set by the BPMK under the Ministry of Education and Culture. This media is structured into systematically organized learning activities. At the beginning, students are introduced to the material along with Learning Objectives, Achievement Criteria, simulations, and instructional videos. The core of the application features Android-based interactive learning tools, while the final section offers practice exercises and learning evaluations to assess comprehension.

b) Product Design Drafting

The product design is organized in three parts: beginning, content, and end. The following

is the appearance of the initial and final design of the designed Android-based interactive learning media.



Figure 2. Designing the Media

3. Development

This stage aims to evaluate the feasibility of the designed Android-based interactive learning

media. Several follow-up steps are then taken to ensure the media is ready for use. The following follow-up steps were taken:

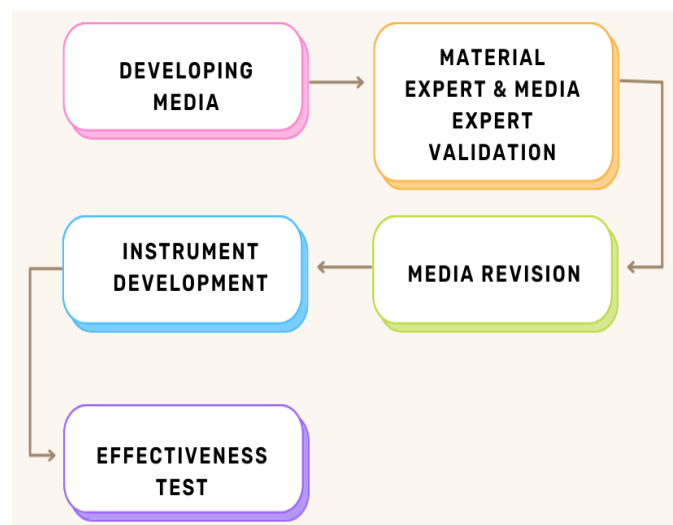


Figure 3. Media Development

4. Implementation

The fourth stage of the ADDIE model is implementation, carried out after the android-based interactive learning media is declared feasible by media and material experts. This implementation was carried out at SMK NU Ungaran in class XI TEI 1 (36 students) as the control group and XI TEI 2 as the experimental group (36 students). The research design used Two Group Pre-Test Post-Test to avoid bias. (1) The first stage involved administering a pre-test to both classes to assess students' initial understanding of electronic control systems and operational amplifiers (op-amps) as temperature controllers. The control class then received conventional learning using lecture and PowerPoint methods. (2) The second stage involved giving treatment in the form of Android-based interactive learning media to class XI TEI 2 as the experimental class, and afterward a post-test was given to evaluate their understanding. (3) In the third stage, a post-test was conducted on the experimental class to measure the change in students' understanding after using the interactive media, especially regarding op-amps as temperature controllers and temperature control circuits.

a) Media and Material Feasibility Test

The media feasibility test refers to the research of McAlpine & Weston (1994) in Chaeruman (2019: 6-7). The research instrument was filled in by media expert validation from Semarang State University. Based on the results of the data obtained using the Content Validity Ratio (CVR) and Content Validity Index (CVI) analysis with a CVR value of 0.75 and CVI 0.88, the android-based interactive learning media on OP-AMP application material as a temperature sensor controller is declared valid because the value is more than 0.62. In addition, based on the percentage value of inter-rater agreement of 88% greater than 80%, the indicators of the feasibility instrument for interactive learning media based on android are declared reliable.

Based on the material expert feasibility test using the same analysis as the media feasibility test. Then the data results obtained CVR 0.75 and CVI 0.90. These results are declared valid because the value is greater than 0.62. In addition, based

on the results of the percentage of agreement between raters, a value of 90% was obtained, so the indicators of the feasibility instrument for interactive learning media based on android were declared reliable. From the results of the media and material feasibility test, it shows that the android-based interactive learning media is relevant and feasible as an OP-AMP application media as a temperature sensor controller for Industrial Electronics Engineering SMK students.

b) Student Learning Outcomes

Two tailed t-test using independent sample t-test to get a significant difference value in the post-test. Based on the calculation results, the significant value (sig) of 0.00 is smaller than 0.05, indicating a difference in student learning outcomes between the initial test and after treatment. The t-count value of 30.234 compared to the t-table of 1.669 (df=35; $\alpha=5\%$), shows that the t-count is greater than the t-table. Thus, it can be concluded that the use of Android-based interactive learning media is effective in improving student learning outcomes.

The n-Gain score showed an average of 74.4%, with a minimum score of 84% and a maximum score of 93%. From this data it can be concluded that the average n-Gain score is 74.4%, which indicates that the learning media developed is able to improve student learning outcomes.

5. Evaluation

The next step in R&D research is the evaluation stage, which aims to improve the quality of the results by analyzing the data obtained. The evaluation stage is divided into two types, namely formative evaluation and summative evaluation. The formative evaluation in this study is related to the media feasibility test, while the summative evaluation focuses on testing the effectiveness of the media. (Elpalina et al., 2024:1). Formative evaluation is associated with testing the effectiveness and feasibility of the media, while summative evaluation is related to the overall assessment. (Rizky et al., 2020: 117). At this stage, data analysis is carried out to identify the weaknesses of the learning media.

The evaluation results are based on feedback in the form of questionnaires and

suggestions from respondents after going through the four stages of the ADDIE model. This evaluation aims to test the effectiveness of Android-based interactive learning media in OP-AMP application material as a temperature sensor controller. If no revision is needed, then the media is declared very feasible to use. The effectiveness analysis was carried out with a right-side independent sample t-test, which showed t-count $30.234 > t\text{-table } 1.669$, with an N-Gain value of 74.4%.

Discussion

This research aims to design Android-based interactive learning media to improve student learning outcomes on OP-AMP application material as a temperature sensor controller. This research is a type of research and development (R&D) using the ADDIE approach developed by Dick and Carry (2009). The ADDIE model includes five stages, namely Analysis, Design, Development, Implementation, and Evaluation. The advantage of this approach is that there is an evaluation at each stage, which aims to reduce errors or product deficiencies at the end of the process (Fayrus & Slamet, 2009).

The first stage in this research is to conduct media analysis through observation. After the data is analyzed, the second stage is design, which involves preparing the media framework, collecting and selecting references, and designing media to facilitate the creation of learning media. The third stage is development, which aims to test the feasibility of Android-based media. At this stage, several compilation processes are carried out to produce optimal media, accompanied by validation from media experts, material experts. Validation from experts to revise and perfect the product in the form of Android-based interactive learning media.

The fourth stage is implementation, which is the application of the media that has been developed on the OP-AMP application material as a temperature sensor controller. A total of 36 students participated and were given treatment using Android-based interactive learning media. Media feasibility testing was carried out based on feedback assessments from media experts and

material experts in the field of Industrial Electronics Engineering. The results of media validity include coherence between content, clarity of concepts conveyed, accuracy of the theory used, as well as construct validity, namely the ability to translate theoretical concepts into operational form. (Drost & Ellen, 2011: 105-123).

The next step is the validity test. Researchers found that android-based interactive learning media is very feasible to be used by students to improve learning outcomes. This is based on research (William et al., 2020: 1) with an average media validation score of 90%, which is categorized as very feasible. These results confirm that the developed media are relevant and feasible to use as learning media on OP-AMP application material as a temperature sensor controller in Industrial Electronics Engineering competency vocational schools.

Android-based interactive learning media is an interesting innovation in the field of education, which utilizes various multimedia elements such as text, images, videos, and animations that can be accessed through Android devices to support more interesting and effective learning. (Dzil Ikram et al., 2021:1). The interactive learning media approach, by bringing together elements such as text, images, videos, and animations, takes learning to a more interesting and effective level. This approach aims to increase student understanding and engagement, making the learning process more interesting and efficient. (Lathifaturrohman AJ & Yunikawati, 2022: 90). Increasing the effectiveness of learning in schools is the main goal of using learning media, including in terms of time efficiency, costs, facilities, and efforts to maximize the achievement of learning objectives. (Fathurrahman et al., 2019: 843).

The media developed is in accordance with the objectives of this study, namely to improve learning outcomes on OP-AMP application material as a temperature sensor controller for industrial electronics engineering students. The results of the pre-test and post-test can be seen as follows.

Table 1. Experimental Class Pre-test and Post-test Results

Experiment	Pre-test	Post-test	N-Gain	Note
	53%	88%	0,74	HIGH

Based on the research results, the N-Gain score shows an average of 74.4%, with a minimum score of 84% and a maximum score of 93%. This shows that the application of Android-based interactive learning media in Vocational High Schools (SMK) is able to improve student learning outcomes. In other words, the use of this media has a positive impact on student learning achievement.

This finding is consistent with research (Dzil Ikram et al., 2021:3) which emphasizes the positive impact of using android-based interactive learning media on student motivation and achievement and increases the effectiveness of learning in schools.

This study demonstrates a notable improvement in learning outcomes related to the understanding of OP-AMP applications as temperature sensor controllers in the experimental group compared to the control group. The findings suggest that the teaching methods or interventions used in the experimental class were effective in enhancing students' comprehension of OP-AMP applications in temperature sensor control.

CONCLUSION

In conclusion, this media has proven to be effective in supporting both students and teachers throughout the learning process, leading to improved student performance. The analysis further indicates that the media fosters independent learning, as it provides clear instructional steps and a well-structured evaluation process. Additionally, the use of Adobe Flash on the Android platform has been demonstrated to be an effective learning tool, contributing to enhanced student creativity. The findings revealed that students' average scores increased significantly, from 49.86% before using the media to 88.12% after its implementation.

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