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Magnetic Measuring Instrument Based on Arduino Uno Microcontroller and Its Implementation As A Learning Medium

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Abstract: This study aims to develop a magnetic measuring instrument based on Arduino Uno microcontroller and apply the results as a learning medium to measure student achievement. This tool is designed to provide precise magnetic measurements using sensors integrated into the Arduino Uno. The measurement method implemented in this tool allows users to obtain magnetic data accurately and efficiently. This research is a Research and Development research using a five-stage ADDIE model. In preparation for the study, the analysis stage has been carried out. The Design, Development, and Implementation stages are carried out at the stage of research implementation. Evaluation is carried out at every stage starting from preparation, implementation to research reporting. The results of the research obtained based on the validation of material and media experts obtained an average value of 81 with a very feasible category so that the Arduino Uno microcontroller-based magnetic measuring instrument can be used in classroom learning. The results of the post test and pritest revealed that the Arduino Uno microcontroller-based magnetic measuring instrument proved effective in improving student learning outcomes with an N-Gain value of 0.76 in the high category. The implementation of this magnetic measuring instrument not only focuses on technical aspects, but also on its use as a learning medium. With a simple interface design and clear user guidance, the tool is expected to provide an interactive and effective learning experience. Users can understand the concept of magnetism and apply it in a practical context with the help of this tool. This research contributed to the development of magnetic measuring instruments that are affordable, easy to use, and can be applied in various learning contexts. Thus, the results of this research can be a reference for the development of similar technologies and provide benefits in the field of science and technology education.

Keywords: Magnetic Measuring Instrument, Arduino Uno Microcontroller, Learning Media, Learning Outcomes.

Introduction

Understanding the concept of magnetism has a crucial role in the development of knowledge in the field of physical sciences. Magnetic measurement is one of the important aspects in natural science experiments and learning (Ghoni, Dharmawan, and Santosa 2015). Today, the use of microcontroller technology is increasingly common in the development of measuring instruments for physics experiments. One of the popular and easy-to-use microcontrollers is the

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Arduino Uno (Matsun et al. 2021). In this context, the development of magnetic measuring instruments based on Arduino Uno microcontrollers is important to improve efficiency and accuracy in measurement. This tool can not only provide more precise measurements, but can also be integrated as a learning medium that supports direct interaction with physics concepts (Fajrin, Ruhiyat, and Darman 2021).

The application of microcontroller technology in learning not only facilitates measurement, but also provides practical experience to students in using the latest technology. The use of Arduino Uno-based magnetic measuring instruments can stimulate students' interest in understanding magnetic properties, provide a deeper understanding, and improve memory of physics concepts(Waruwu, Rahmi, and Anaperta 2021). Through this research, it is hoped that magnetic measuring instruments can be produced that can be an innovative solution in supporting physics learning. The implementation of this tool as a learning medium is expected to provide an interesting learning experience, bring theoretical concepts to life, and increase students' understanding of magnetic phenomena. Thus, this research can make a positive contribution to the development of learning technology and understanding of physics concepts among students (Dwicahyaning et al. 2018).

The study of magnetic electricity in Higher Education has the main objective of developing students' understanding of scientific concepts, including understanding of physical properties such as magnetism. One of the challenges in science learning is to create an engaging learning environment and motivate students to actively participate in scientific experiments (Kholis, Syariffuddien Zuhrie, and Rahmadian 2018). In this context, the use of technology in the development of Arduino Uno microcontroller-based magnetic measuring instruments is expected to be a solution to improve student learning outcomes.

Today, innovative and interactive teaching methods are considered more effective in improving the understanding of science concepts. The use of magnetic measuring instruments based on the Arduino Uno microcontroller not only allows for more accurate measurements, but also creates a more interesting and applicable learning experience. Students can directly engage in the use of technology, understand physics concepts, and see the relationship between theory and its practical application (Fenanlampir, Leasa, and Batlolona 2021).

With the Arduino Uno-based magnetic measuring instrument, it is hoped that students can more easily understand the basic principles of magnetism and develop experimental skills. The tool can also facilitate independent learning, allowing students to conduct experiments individually or in groups. In addition, the implementation of this technology can help teachers in presenting learning materials in a more dynamic and motivating way.

This study aims to explore the potential of Arduino Uno-based magnetic measuring instruments as effective learning aids and improve student learning outcomes. By integrating technology into science education, it is expected to create an inspiring learning atmosphere, spark students' interest in science, and increase their understanding of physics concepts.

Method

The subjects of this study were students of the physics education study program IKIP PGRI Pontianak totaling 57 students. The form of research is research and development with the ADDIE model. Type. Steps for the Development of Magnetic Measuring Instruments Using Arduino Uno to Improve the Ability of Student Learning Outcomes consist of define contains material analysis, programming language analysis, and sonsor analysis. The design stage contains activities for making product designs, validation, and revision. The development step contains the initial test, and the main test. Disseminate Step In this step, the tools and materials that have been developed will be disseminated to tool users, namely students and students.

Persentase validitas instrumen diperoleh dari nilai rata-rata angket menggunakan angket validasi skala likert. Skala yang digunakan berupa angka 4, 3, 2, 1. Score 4 If the rating strongly agrees, score 3 if the rating agrees, score 2 if the assessment does not agre, score 1 if the rating strongly disagrees (Imamora et al. 2021). For analysis of the results can be seen in equation 1.

$$P = \frac{\sum X}{\sum Xi} \; X \; 100\% \qquad (1)$$

Where:

$P =$ Percent value sought/expected

$\sum X =$ total score

$\sum Xi =$ Maximum score

A magnetic measuring instrument using Arduino Uno to improve the ability of student learning outcomes developed is said to be feasible if the interpretation is 61% and above. The criteria for eligibility score interpretation are 81-100% with Very worthy interpretation, 61-80% with Worthy interpretation, 41-60% with Decent enough

interpretation, and 21-40% with Less worthy interpretation, and 0%-20% with Not worthy interpretation (Khairati et al. 2021).

Student learning outcomes are analyzed using N-gain with equation 2 below.

$$N - Gain = \frac{Posttest\ Score - Pritest\ Score}{Ideal\ score - Pritest\ Score} \quad (2)$$

The results of this calculation are then converted into criteria for improving critical thinking skills based on the provisions, namely with a g value of > 0.7 with a high category, a value of 0.3 ≤ g ≤ 0.7 with a medium category, and a g value of < 0.3 with a low category.

Result and Discussion

1. Result

Achievement indicators in the research preparation stage are analyzed the needs of magnetic field measuring devices. The stages of analysis are: 1) analysis of student problems. Students have difficulty understanding the concept of magnetic fields, because there is no paractic device that determines magnetic fields, 2) sensor selection analysis. The sensors used in the construction of magnetic field measuring instruments are the holl effect, 3) analysis of program language selection. A programming language that is easy to understand is C ++ programming language.

The next stage is design. Design is very important in the development stage of magnetic field measuring instruments. The design stage is made so that the magnetic field device developed is in accordance with expectations. The design of the magnetic field tool is made based on needs, easy to use, and easy to carry. At this stage, the manufacture of magnetic field devices is carried out in accordance with the content framework of the results of curriculum and material analysis(Rahman, Doyan, and Sutrio 2021). The design of the magnetic field device development using Arduino Uno can be seen in figure 1.

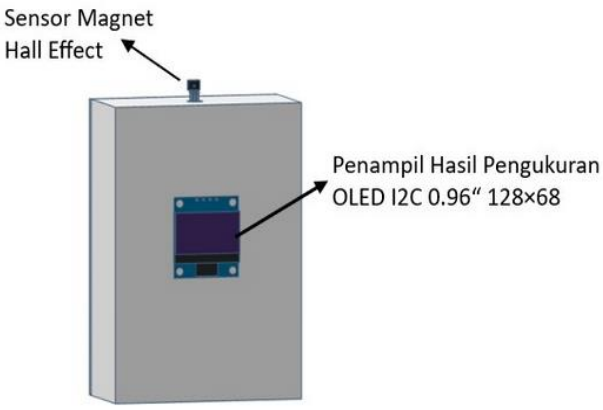

Figure 1. Design magnetic field tool using arduino uno

The next stage after the design stage is the development stage. The development stage requires experts to assess the product being developed. Material and media experts are used to assess whether the product is feasible or not (Fitriani et al. 2022). The results of product development can be seen in the image 2.

Figure 2. Display of magnetic field tools after development.

Tahapan pengembangan berikutnya yaitu melakukan validasi melalui validator ahli materi dan media menggunakan angket yang diberikan kepada para ahli expert (Neswary and Prahani 2022). Material expert assessment with indicators of linkage with aspects of clarity of instruction, linkage with subject matter, suitability of difficulty levels, and its impact on students' critical thinking skills. Assessment of media experts with indicators of tool durability, speed of the tool system in reading measurement results, tool efficiency, aesthetics, safety, and ease of use. Obtaining an average score of material and media expert validation with a score of 81.00% with a very decent category. The expert validation range line can be seen in figure 3 below.

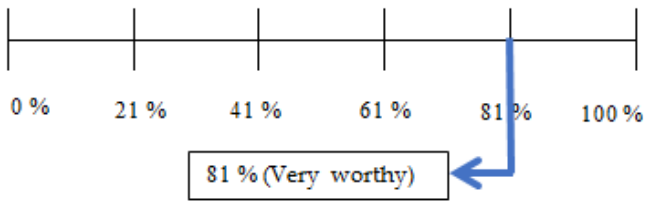

Figure 3. Expert validation range lines

The next stage after the magnetic field device is declared suitable for use in class, then the tools developed are used in the learning process to improve student learning outcomes (Rahman et al. 2021). The calculation results can be seen in Table 1. Based on the table of statistical test results, student learning

outcomes were obtained, namely the average pritest score of 45, the average value of the postest 87, and the N-gain value of 0.76 with the high category.

Table 1. Statistical results of student learning outcomes

Pritest Score	Posttest Score	N-gain
45	87	0,76

2. Discussion

The magnetic field tool has gone through the development stage and has been validated with the ability to be very feasible to be applied in classroom learning. Magnetic field measuring instruments that have been developed can improve student learning outcomes. This reason is in accordance with the research that has been carried out by(Liana, Linuwih, and Sulhadi 2020). Magnetic field measuring instruments using ardouno uno can improve student learning outcomes, students can understand the concept of magnetic fields in magnetic electric learning. Students can conclude and draw conclusions from the results of experiments. Research conducted by(Purnamawati, Akil, and Nuridayanti 2021), Magnetic field measuring devices using Ardouno Uno can improve student learning outcomes in designing and conducting experiments. Students are asked to observe the tools and materials used in the experiment. With this activity, students have a meaningful experience in the learning process. Magnetic field measuring instruments help students understand the concept and experience of conducting experiments by providing experiments in measuring magnetic fields to function distances.

As the results of research conducted (Ghoni et al. 2015) found that 59.8% of students stated that the material learned with Arduino-based media was interesting and 39% stated that the learning was very interesting. That is, Arduino-based learning can increase student learning motivation in addition to improving student learning outcomes. According to Putri et al, (Putri, Radiyono, and Setiawan 2022), There is a positive correlation between student motivation and learning outcomes. In addition, the results of this study are also consistent with the results of the study (Pramuda, Hadiati, and Pratama 2023). (Fenanlampir et al. 2021) Explain that learning motivation is proven to improve student learning outcomes.

Conclusion

The development of magnetic field measuring devices can be used because it has a feasibility value from material and media experts with an average score of 81.00% with very decent knowledge. The N-gain value is 0.76 with a high category so that it can be concluded that magnetic field measuring devices can improve the learning outcomes of students with high categories.

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