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Student Response to the Arduino Uno-Based Uniformly Accelerated Motion Experiment Equipment in Basic Physics I Course

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Abstract: This research is based on technological advancements. As time progresses, numerous components have evolved in terms of functional efficiency, benefits, and physical aspects. In this context, a study was conducted to examine students' responses to the experimental equipment. The research was carried out in the physics laboratory of the Faculty of Teacher Training and Education at Jambi University. The aim of this study was to determine students' responses to technology-based experimental equipment. The subjects of this study were regular 2022 physics education students. The instrument used was a student response questionnaire. The data collection technique in this study was quantitative and analyzed using descriptive statistics with a Likert scale. The results of this study showed an average interest level of 80.1% towards the experimental equipment, categorized as very good. The conclusion of this study is that the Arduino Uno-based experimental equipment received positive responses from the respondents.

Keywords: Arduino Uno; Experimental Equipment; Technology

Introduction

Technological advancements are rapidly progressing, driving numerous changes. Technology helps and facilitates human life, including in the field of education. Students and educators are expected to adapt to the fast pace of technological development, which ultimately supports the learning process in the classroom (Saenab, Yunus, and Virninda 2017).

The education sector, particularly the use of technology in the learning process, serves as a tool for educators to enhance and simplify education. Additionally, various types of technology are now utilized to support the learning process. Technology, especially multimedia, plays a crucial role in education. Many believe that multimedia fosters an enjoyable, creative, and engaging learning experience. In the learning process, besides educators and students, two essential elements are teaching methods and learning media. One way to integrate educational technology into learning is through instructional media, such as using experimental equipment. Modern learning requires students to develop a deeper understanding of the subject matter. Therefore, experimental equipment is necessary to enhance the learning process. Lecturers must innovate and motivate students to learn. These efforts may include conducting experiments related to basic physics courses.

One technology that can be utilized in the development of experimental equipment is Arduino Uno. Arduino Uno is a highly popular microcontroller platform widely used in various electronic projects. One of its key features is its ability to easily connect multiple sensors, actuators, and other electronic components through its available input and output pins. Technology-based instructional media, such as microcontroller-based learning tools, are increasingly being used today. These tools not only offer digital capabilities but also provide higher precision compared to conventional media kira(Wijaya, Handhika, and Kartikawati 2017) A

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microcontroller is a small-scale computer system commonly used as a control system that is programmed according to the specific needs and objectives of the designed tool (Qomariyah and Wirawan 2018). The microcontroller used in this study is Arduino, an open-source electronic platform that consists of both hardware and software, making it user-friendly. Arduino can interact with its environment by integrating various types of sensors and controlling components such as lights, motors, and other actuators. There are several types of Arduino, including Arduino Uno, Arduino Mega 2560, Arduino Fio, and others (Tunggali, Kadir, and Asma 2023).

The basic physics topic examined in this research is uniformly accelerated linear motion. This topic is one of the fundamental concepts in physics. The concept of uniformly accelerated linear motion can be applied in everyday life and is highly relevant in various fields such as engineering, industry, and transportation. However, during the learning process, students often face difficulties in visualizing this concept concretely. This challenge may arise due to the lack of adequate experimental equipment to facilitate students' understanding. Therefore, the objective of this study is to analyze students' responses in learning the use of an Arduino Uno-based experimental tool for uniformly accelerated linear motion in Basic Physics I.

Method

This research was conducted in August 2023 at the Physics Education Laboratory of Jambi University. The study utilized both qualitative and quantitative data. Qualitative data consisted of product validation in the form of students' critiques, comments, and suggestions regarding the Arduino Uno-based experimental tool. Quantitative data included students' responses, which were analyzed using statistical methods.

The population of this study comprised 22 students from the 2022 cohort of the Physics Education program at Jambi University. The instrument used in this research was a learning interest questionnaire, based on Safari (2003). The questionnaire was in the form of multiple-choice questions, with responses categorized into four options and a predetermined scoring system.

Instruments for data collection serve as tools to obtain research data. According to Mamik (2015), research instruments are tools used in research to systematically collect, process, and organize various types of information. This study employed a quantitative research method, with student response questionnaires and an assessment sheet for the Arduino Uno-based experimental tool as the primary instruments.

Table 1. Indicators of Student Response Questionnaire

Indicators	f
Clarity of numerical data	1
Attractiveness of the tool	2
Material presentation	2
Ease of learning	1

The data analysis technique employed inferential statistics to test the validity of the proposed hypothesis. The data analysis in this study involved prerequisite tests, including a normality test using the F-variance test formula, and a hypothesis test using the t-test.

The hypothesis test was conducted to determine the effect of the treatment or to verify the proposed hypothesis. The hypothesis test was calculated using post-test data from all respondents or the data obtained from the completed questionnaires. Based on the normality and homogeneity tests, if the data met the assumption tests (i.e., the data were normally distributed and homogeneous), the hypothesis was tested using t-test statistics. To examine the differences between two sample groups, student learning outcome scores were processed using a two-tailed t-test formula with a 5% significance level. The t-test formula applied in this study was Pooled Variance, as $n_1 = n_2$ and the homogeneous variance formula follows $dk = n_1 + n_2 - 2$ (Sugiyono 2017).

Result and Discussion

This study aimed to examine the effect of experimental tools on students' learning interest. Learning interest is associated with students' curiosity and enthusiasm for participating in the teaching and learning process.

The term learning interest consists of two words: interest and learning, which have different meanings. Therefore, the author will define each term separately. According to Gie (2004), interest plays a role in: "Generating spontaneous attention, facilitating the creation of focused concentration, and preventing external distractions." Furthermore, Hilgard, as cited in Slameto (2010:), states: "Interest is a persisting tendency to pay attention to and enjoy certain activities and/or content." This means that students will continuously pay attention to and engage in learning activities that they find interesting, accompanied by a sense of enjoyment. According to Slameto, cited in Asmani (2009): "Interest is a preference and attraction towards a particular thing or activity without being forced." Thus, when someone begins to focus on something, they initially develop an interest in it. Interest is closely related to an individual's personality; it involves three psychological functions—cognition, emotion, and conation. Interest can arise naturally, but sometimes, it needs to be cultivated.

This research was conducted at the Physics Education Laboratory of Jambi University. Although the laboratory is equipped with numerous experimental tools, only a few incorporate modern technologies, especially for experiments related to uniformly accelerated linear motion. Therefore, the researcher developed a technology-based experimental tool to address this gap. The integration of technology in education serves as a valuable resource for educators, facilitating and enhancing the learning process. Additionally, various types of technology, particularly multimedia, play a crucial role in education. Many believe that multimedia fosters an engaging, creative, and stimulating learning environment. In the learning process, besides educators and students, two essential elements are teaching methods and learning media.

One way to integrate technology in education is through instructional media, such as experimental tools. Modern learning approaches require students to actively engage in understanding the subject matter. Therefore, practical tools are necessary to enhance learning. Educators must innovate and motivate students to be more actively involved in the teaching and learning process.

One of the technologies that can be utilized in developing experimental equipment is Arduino Uno. Arduino Uno is a widely used microcontroller platform in various electronic projects. One of its key features is its ability to easily connect multiple sensors, actuators, and other electronic components through its input and output pins. The basic physics topic examined in this research is uniformly accelerated linear motion, which is a fundamental concept in physics. This concept has practical applications in daily life and is highly relevant in engineering, industry, and transportation. However, during the learning process, students often struggle to visualize the concept in a concrete way. This difficulty may arise due to a lack of adequate experimental tools to facilitate their understanding.

Studying physics using experimental tools not only helps achieve learning objectives but also allows students to acquire knowledge independently. Moreover, it enhances students' experiential learning, enabling them to actively participate in hands-on activities. According to (Hudha, Aji, and Rismawati 2017), the use of experimental tools not only improves cognitive and affective skills but also enhances students' psychomotor abilities. Engaging students in problem-solving activities stimulates critical thinking and behavioral development based on problem-solving methodologies.

Based on this premise, the researcher developed a technology-based experimental tool by modifying the existing equipment in the Physics Education Laboratory at Jambi University using Arduino Uno. As a result, a uniformly accelerated linear motion experimental tool based on Arduino Uno was successfully developed.

After the Arduino Uno-based experimental tool for uniformly accelerated linear motion was developed and underwent validation by subject matter and media experts, the next step was the trial phase. This phase aimed to analyze students' responses to the developed experimental tool. The trial was conducted at the Physics Education Laboratory of Jambi University, involving 22 students from the 2022 cohort as respondents.

The trial process began with a demonstration of the experimental tool in front of the class, explaining the purpose of developing the tool and providing instructions for its use in studying uniformly accelerated linear motion. Following this, the researcher allowed students to operate the tool independently. To assess their responses, the researcher distributed student response questionnaires to gather feedback on the developed experimental tool. The complete student response data is presented in Table 2.

Table 2. Rsult of Student Response Questionnaires

Indicators	Average Score	Percentage	Criteria
Material	3.8	77.25	Good
Learning Design	4.0	82.50	Very Good
Implementation	4.1	82.25	Very Good
Average	4.0	80.60	Very Good

In this stage, the researcher conducted a small-group trial involving 22 students from the 2022 Physics Education program at Jambi University to collect their feedback on the developed experimental tool. The researcher first demonstrated the operation of the tool, showing how to conduct the experiment. After several students performed the experiment, they were asked to fill out the student response questionnaire provided by the researcher. The analysis of student responses showed an average indicator percentage of 78.25%, which falls into the "Good" category. Based on these responses, the Arduino Uno-based experimental tool for uniformly accelerated linear motion was deemed suitable for use in physics experiments. The tool simplifies measurement and operation, making it easier for students to use. Measurements are conducted automatically, significantly reducing students' workload and saving time during experiments. The tool relies on an infrared sensor system, which is highly sensitive to light. If the light intensity varies, the sensor requires adjustments to align with the surrounding light conditions.

Conclusion

Based on the research conducted on the development of GLB-GLBB (Uniform Linear Motion -

Uniformly Accelerated Motion) learning media using a speed sensor to enhance students' problem-solving abilities, the following conclusions can be drawn: The analysis of student responses showed an average indicator percentage of 78.25%, which falls into the "Good" category. Based on student feedback, the Arduino Uno-based experimental tool for uniformly accelerated linear motion was rated effective and suitable for practical use in physics experiments. The development of GLB-GLBB learning media using a speed sensor produced a valid tool for enhancing students' problem-solving skills. The GLB-GLBB learning media using a speed sensor proved to be effective in improving students' problem-solving skills from their initial abilities. This indicates that students were assisted in analyzing graphs and concepts of motion, particularly in understanding distance-time and velocity-time relationships in GLB-GLBB.

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