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Development of Basic Physics Experimental Props 1 on Fluid Viscosity Material

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Abstract

This research objectives were to Describe students' perception of the readability test of arduino-based basic physics experiment props on fluid viscosity material. The method used in this research is the Research and Development (R&D) method with ADDIE development model. Products are made using Arduino Uno and Arduino IDE software with C++ programming language. The data samples used in this study were 42 students of JPMIPA FKIP Unib (Physics Education, Chemical Education, Biology Education and Science Education). The instruments used in this student perception questionnaires. The student perception was interpreted by Likert Scale. Student perception was reviewed from 7 aspects, namely the efficiency aspects of the tool, the association with the lecture material, containing the value of education, tool durability, aesthetics, technical components and tool safety. The results obtained from this study showed that the props developed fall into the category of is the best with an average score of 87%

Keywords: *Arduino, Experimentation Basic Physics, Fluid Viscosity, Props, Research and Development*.

A. Introduction

Learning media becomes one of the support in the learning process in addition to explaining theory. Learning media also includes tools and materials in the laboratory, so that tools and materials become a set of important things. The selection of the right tools and materials and techniques will be the basic construction in finding precise data, particularly practicums or experiments. In the process of learning through physics experiments in college, it takes tools that support so that the purpose of the concept of the material to be conveyed can be achieved.. One of the learning media that can be applied in the physics learning process is props. Props are used as aids to visualize physical concepts as well as measuring instruments in practicums or experiments..

Physics Education Study Program of Bengkulu University in the first year or in semester 1, students are required to take 20 credits with 8 courses. Among the compulsory courses, one of them is the Basic Physics Experiments 1 course. As the name implies, an experiment or practicum is a course that directly practices in the laboratory to prove some existing theories. One of the materials studied in the Basic Physics Experiments 1 course is the viscosity experiment. The purpose of the experiment is to understand the relationship between the frictional forces experienced by objects moving in the fluid and to determine the coefficient of liquids. The content developed on this experiment in addition to practicing skills using physical measuring instruments, as well as to understand the concepts put forward by Sir George Stokes (13 August 1819 – 1 February 1903), an Irish physicist and mathematician, best known for his Stokes Law. [1]

To support the implementation of practicum viscosity so that results are obtained in accordance with the purpose of the practicum, it takes a measuring tool. The measuring instrument used to determine the viscosity of a liquid is a viscometer. This viscosity measurement tool can measure the viscosity level of a liquid accurately and specifically in accordance with predetermined standards. In its manufacture viskometer is intended to obtain time so that it can be calculated the viscosity value of a fluid.. Viscometers are of different types. Commonlyused viscometer models include falling balls, rolling balls, capillary pipes,co-centriccylinderrotation, and plate cone rotation. [2]

Based on observations at Laboratorium Fisika FKIP University of Bengkulu there are KIT and media that support the course Of Experiment Fisika Basis 1, especially viscosity experiments. Although using such devices is able to attract the attention and interest of studentsin physics experiments, there are some shortcomings that make the learning atmosphere less conducive, both in terms of practicing errors

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during practicums or tool errors. For this reason, as a support for the research, researchers carried out initial observations on 100 respondents of Physics Education students of the University of Bengkulu who had taken the Basic Physics Experiments 1 course which consisted of the class of 2017, 2018, and 2019.

Of the 100 respondents of Physics Education students, the urgency of this study was still found to be a flurry of practices when taking data in carrying out viscosity practicum. This is due to the error of the measuring instrument that is usually used in the practicum viscosity in the Physics Laboratory of FKIP University of Bengkulu and is worthy of renewal, taking into account several reasons that the tool is less accurate to calculate the viscosity value of liquid substances. In addition, the reason for this study there are problems or errors that often occur such as errors in calculating the travel time of the ball falls, this is because the practicum viscosity tool still uses a manual *stopwatch.* In addition to errors in the calculation of time, practical errors are also caused because the tubes that are often used have decreased the value of their function. So that the reconstruction of fluid viscosity experiments is needed more sophisticated, *simple* and accurate.

The lack of props can be manually reduced by developing microcontroller or arduino-based automatic props. Oto matisprops can reduce the influence of human error innature taking measurements thereby improving the accuracy and precision of measurements. In addition, arduino-based props have *digital output* and are easy to operate*(user friendly)*so as to attract students (students) in learning. [3]

Based on some of these problems, in accordance with research by Karsumi at SMA Negeri 2 Pati with the title "Development of Liquid Viscosimeter Practicum Tool" this study measured the viscosity value of water, oil and cooking oil. However, in this study has some disadvantages, namely alat practicum viscosity made in this study applying a pulley system, where the weakness of the friction value affects and is not known exactly.. This resulted in the base value of the measurement being very large (0.2507 Pass) and affecting the accuracy of its viscosity value. [4]

Likewise, the Tissos & Kamus study entitled "Digital Creation Of Fluid Viscosity Measurement System Using Arduino UNO 328-Based Hall Effect Sensor UGN 3503" This research was conducted at the Laboratory of Electronics and Instrumentation department of Physics FMIPA Universitas Negeri Padang. The disadvantage of this tool is, the unstable temperature of the fluid that can interfere with the measurement process, because basically indirectly the temperature also affects the viscosity value of the fluid. The higher the temperature, the smaller the viscosity value. The other weaknesses are; The diameter of the tube is too small, making it difficult to vary the ball with a larger diameter, in addition to the Hall effect sensor's ability to edit iron balls is still limited, because hall effect sensors detect less or even not detect smaller iron balls at all. In addition to the above, another disadvantage is the absence of filtration that can be used to hold an iron ball at the base of the tube so that it cannot lift the iron ball that has been dropped into the fluid sample, so in this case the researchers use a rope attached to a ballast to lift the iron ball. [5]

Another relevant research was conducted by Boimau & Mellu under the title Design of Arduino-Based Viskometer Practicum Tool which in this study applies the principle of free fall ball method and *atwood* aircraft concept with pulley method, consequently the effect of pulley friction affects some measurement errors. This study uses IR*(Infrared)*sensors, which is the disadvantage of using these IR sensors is that they cannot directly read the motion of the ball in a concentrated fluid. In addition, the weakness in this study measurements are only consistent at a maximum track length of 20 cm. [3]

Further research was conducted by Romadhan, The subject of this study was a Student of Physics Education, University of Muhammadiyah Purworejo Semester VI. The title of the study is "Effectiveness of Viscosity Props With Arduino-Based *Magnetic Mini Reed Switch* Sensor To Improve *Learners' Analyze* Capabilities". There are some drawbacks to this study so researchers suggest making longer tubes so that ball movement is more observable and the movement time is measured to the maximum. Then the researchers suggested replacing the sensor with higher sensitivity to reduce subsequent practicum errors. In addition, previous researchers also suggested to make a tool that can be used to pick up objects after being dropped into the tube, because previously researchers used ropes to pick up objects as a result there was an effect of friction. [6]

Another study on viscosity tools was conducted by Wulandari with judul "Development ofPhysical Props On Viscosity Materials as a Learning Medium" This tool is used to measure the time the ball slides on each tube. The time gauge used is a *digital stopwatch* modified with *microswitch.* In the design of this tool has an automatic deficiency can not function with the patent because the fluid will expand at a hot temperature so it must be reset automatically.[7]

Based on some shortcomings from previous research, it is necessary to develop tools that are in accordance with current needs, especially the problem during basic physics experiment 1 on fluid viscosity material by students of JPMIPA FKIP University of Bengkulu. Therefore, the author is

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interested in conducting a study entitled "Development ofBasic Physics Experiment Props 1 On Fluid Viscosity Material" This research aims to: (1). Produce a product in the form of basic physics experiment prop 1 based arduino on fluid viscosity material. (2). Tested the feasibility of basic physics experiment prop 1 based on arduino on fluid viscosity material. (3) Looking at students' perception of basic physics experiment prop 1 based on arduino on fluid viscosity material.

B. Research Metods

This research uses research and development *methods research and development* (R&D). The study used the ADDIE development model by Robert Maribe Branch. In his book,RobertMaribe Branch developed *Intructional Design* with the ADDIE Approach, which is an extension of *Analysis, Design, Development, Implementation, and Evaluation* [8]. Thedevelopment of the ADDIE model is as follows:

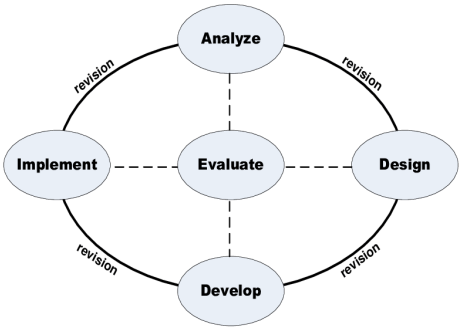

Figure 1. The ADDIE Model Development Chart. [9]

The development carried out is the development of arduino-based props on fluid viscosity materials, The data collection technique used in this study is in the form of analysis of student perception questionnaire sheets. The data analysis technique used is descriptive statistical analysis. The analysis of perception questionnaires is carried out on the data obtained percentages. Percentages are obtained based on the calculation of the modified likert scale. With the likert scale, the variable to be measured is spelled into a variable indicator. Furthermore, the indicator is used as a guideline in compiling items in the form of questions or statements, for the sentence of each instrument item is given a quantitative value as in table 1 below:

Table 1. Calculation of Likert Scale

Interpretation	Score
Excellent	4
Good	3
Bad	2
Very Bad	1

Then calculate the percentage of each statement using the following equation.

$$\text{Percentage score (P)} = \frac{total\ score}{skor\ max} \times 100\% \quad (1)$$

$$P = \frac{f}{N} \times 100\% \quad (2)$$

After getting a percentage of the score using the formula, then measure the achievement of the score. The intertasi score can be seen on table 2.

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Tabel 2. Kriteria interpretasi skala likert

No.	Interval	Criterion
1	75% ≤ score ≤ 100%	Excellent
2	50% ≤ score ≤ 74%	Good
3	25% ≤ score ≤ 49%	Bad
4	0%≤ score ≤ 24%	Very Bad

[10]

The research was conducted at the Physics Laboratory of FKIP Bengkulu University. This development research was conducted in readability tests to students of JPMIPA FKIP UNIB (Physics, Chemistry, Biology and IPA) class 2017, 2018, and 2019 who have taken basic physics experiment courses 1 specialty of fluid viscosity material. This readability test uses a limited-scale test, so the student response taken is 42 students. The instrument in this study in the form of student perception sheets was obtained using the likert scale.

C. Result and Discussion

The product perception test is conducted using *probability sampling* techniques where this sampling technique provides the same opportunity for each element. In this perception test using *Probability Sampling* which is *simple random sampling* because sampling is done randomly without regard to strata, this method is taken when members of the population are considered homogeneous[.

The product perception test was conducted on 42 students of JPMIPA FKIP, namely students of the Physics Education Study Program, Chemical Education, Biological Education and IPA Education. With each study program taken samples with different numbers, with details of 27 physics education students, namely the class of 2017 as many as 13 people, the class of 2018 as many as 8 people and the class of 2019 as many as 6 people. Then the Chemical Education Study Program as many as 5 students in the class of 2017, Biological Education as many as 5 students in the class of 2017 and IPA Education as many as 5 students in the class of 2018. The test is carried out by providing an explanation in advance about the concept of fluid viscosity, the constituent components of props and how to use arduino-based viscosity experiment props.

This product perception test is done to see the comparison or assessment of props that have been used with props developed today. This assessment is taken from each student who has mastered basic physics experiments 1, especially in fluid viscosity material. Because the JPMIPA study program must take the course at the beginning of the semester, therefore why this product perception test is conducted in the study program, except for mathematics study programs that have nothing to do with physical experiment activities.

Before the readability test to students, the perception test instrument is validated first by an expert lecturer, on this instrument that gives an assessment is one examiner lecturer. After assessing the instrument and getting some revisions to the question point, finally this perception questionnaire can be used in the field. For more details the results of the assessment of student perception instruments can be seen in Appendix 10.

Product perception tests to students result in high scores that are in the good and excellent categories. Students are very interested in learning to use developed props and are very enthusiastic to learn. These results are derived from the perception of students. Because the student perception questionnaire is given to 4 samples of the study program, it is generated 4 student perception data. Data on student perception of arduino-based viscosity experiment props obtained from students of the Physics Education Study Program is in the category of very good with a percentage of 88%. For more details, you can see it in the following table.

Table 3. Results of product perception tests to Physics Education students

Aspects	Total score(f)	Maximum Score (N)	Percentage P=(f/N)*100%	Category
A. Efficiency of tools	15	16	92%	Excellent
B. Relationship with lectures	11	12	93%	Excellent
C. Tool durability	7	8	81%	Excellent

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Aspects	Total score(f)	Maximum Score (N)	Percentage P=(f/N)*100%	Category
D. Aesthetics	4	4	95%	Excellent
E. Technical components	11	16	67%	good
F. Security	4	4	97%	Excellent
	Average		88%	Excellent

Data on student perception of arduino-based viscosity experiment props obtained from students of the Chemical Education Study Program is in the category of very good with a percentage of 87%. For more details, you can see in Table 4 below.

Table 4. Results of product perception tests to Chemistry Education students

Aspects	Total score(f)	Maximum Score (N)	Percentage P=(f/N)*100%	Category
A. Efficiency of tools	13	16	83%	Excellent
B. Relationship with lectures	11	12	93%	Excellent
C. Tool durability	7	8	85%	Excellent
D. Aesthetics	4	4	100%	Excellent
E. Technical components	11	16	69%	good
F. Security	4	4	95%	Excellent
	Average		87%	Excellent

Data on student perception of arduino-based viscosity experiment props obtained from students of the Biological Education Study Program is in the category of very good with a percentage of 88%. For more details, you can see in table 5 below.

Table 5. Results of product perception tests to Biology Education students

Aspects	Total score(f)	Maximum Score (N)	Percentage P=(f/N)*100%	Category
A. Efficiency of tools	15	16	91%	Excellent
B. Relationship with lectures	11	12	93%	Excellent
C. Tool durability	7	8	88%	Excellent
D. Aesthetics	4	4	100%	Excellent
E. Technical components	10	16	64%	good
F. Security	4	4	95%	Excellent
	Average		88%	Excellent

Data on student perception of arduino-based viscosity experiment props obtained from students of the IPA Education Study Program is in the category of very good with a percentage of 85%. For more details, you can see table 6 below.

Table 6. Results of product perception tests to IPA Education students

Aspects	Total score(f)	Maximum Score (N)	Percentage P=(f/N)*100%	Category

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A. Efficiency of tools	14	16	85%	Excellent
B. Relationship with lectures	10	12	85%	Excellent
C. Tool durability	7	8	88%	Excellent
D. Aesthetics	4	4	95%	Excellent
E. Technical components	10	16	64%	good
F. Security	4	4	95%	Excellent
Average			85%	Excellent

From the data of student perception results by 4 JPMIPA Study Programs (Physics Education, Chemical Education, Biological Education and IPA Education) FKIP UNIB that has been described above, it is seen that each study program student has a different perception of the readability of arduino-based fluid viscosity props. Based on this, student perception is represented in a conclusion table and graph of student perception results that can be seen below.

Table 7. Accumulated student perception data on products developed

Aspek	**Assessment of the Study Program**			
	Physics	**Chemistry**	**Biology**	**IPA**
A. Efficiency of tools	92%	83%	91%	85%
B. Relationship with lectures	93%	93%	93%	85%
C. Tool durability	81%	85%	88%	88%
D. Aesthetics	95%	100%	100%	95%
E. Technical components	67%	69%	64%	64%
F. Security	97%	95%	95%	95%
Average	88%	87%	88%	85%

Then here is the graph data from the results of the JPMIPA student perception test on the product of basic physics experiment prop 1 on fluid viscosity material.

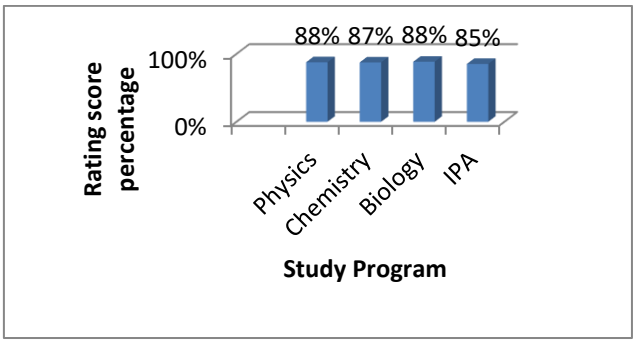

Figure 2. Graph of student perception results

D. Conclusion

Based on data analysis and discussion in the development of basic physics experiment props 1 on the viscosity material of arduino-based fluid obtained the conclusion of props conducted a readability test or perception test to 42 JPMIPA students where this test was conducted to see the extent of the readability of the use of this tool according to the perception of JPMIPA students. On this perception test, an average student assessment of 87% stated that this tool is very good for use in basic physics experiments 1 especially in fluid viscosity material. The results in detail can be seen from the answers of Physics

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Education students as many as 88% stated that this tool is very good, 87% of Chemistry Education students stated that the props developed are very good, 88% of Biology Education students stated that the props developed are very good to use, and lastly according to IPA Education students got 85% stated that the props developed are very good to use in basic physics experiments 1 on fluid viscosity material. Based on the author's experience in research and development, the author suggested that the tools that have been developed can be used and utilized as appropriate as a means of practicum viscosity.

E. Acknowledgement

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