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Development of Basic Physics Practicum Based on Virtual Android Observatory to Facilitate Students' ICT Literacy Abilities

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ABSTRACT This research will be carried out at the basic physics laboratory of the physics education study program, Muhammadiyah University of Makassar. The long-term goal of this research is to produce a prototype model of basic physics practicum based on the virtual android observatory to facilitate the ICT literacy skills of prospective physics teachers. Based on the results of basic physics practical trials, experiments on determining Earth's gravity, free fall motion and the doppler effect based on a virtual android observatory, among others, based on the results of observations from the implementation of basic physics practicals when viewed from the aspect of design ability. Experimental tools and materials for determining gravitational acceleration, free fall motion and the Doppler effect. Overall, students have very good skills in designing tools, especially in the aspect of using cellphone sensors that are integrated in the virtual android observatory application. The conclusion is that the effectiveness of the results of basic physics practicum trials for determining earth's gravity, free fall motion and the virtual android observatory-based Doppler effect is in the very good category, namely 75.41%, and the results of the ICT literacy skills of prospective physics teacher students are in the good category, namely overall. students were able to use the virtual android observatory application as a whole with a proficient percentage level of 56.60%.

Keywords Basic physics practicum, Virtual android observatory, ICT literacy.

1. INTRODUCTION

One of the technologies that is currently developing and widely used is Android technology. This technology has also begun to be used in learning, better known as android learning (Liliarti & Kuswanto, 2018; Mardiana & Kuswanto, 2017; Ma'ruf, Marisda, & Handayani, 2019). Android technology really supports learning with the various features it provides. All the features available are very useful for helping students understand learning material, so lecturers don't need to explain repeatedly, students can more easily understand learning material through this media (Ma'ruf, Marisda, & Handayani, 2019; Nursuhud et al., 2019; Ratnaningtyas, Jumadi, Wilujeng & Kuswanto, 2019; Sulistyo & Kurniawan, 2020).

Apart from that, students tend to prefer learning with media rather than just listening to explanations from lecturers, students will find it more difficult to understand what is being conveyed (Astra, Nasbey & Nugraha, 2015; Safitri, Pasaribu, Simamora & Lubis, 2019; Tania & Jumadi, 2021). Apart from that, lecturers must be able to choose the type of media or features that will be used in learning so that the teaching and learning process can be maximized. Android is a Linux-based operating system, which is an open source operating system designed for touch screen android devices such as smartphones and tablets (Darmaji, Kurniawan, Astalini, Lumbantoruan & Samosir, 2019; Sugiyanto, Setiawan, Hamidah & Ana, 2020; Sumbawati, Wibawa, Munoto & Wibawa, 2018).

To be able to use Android applications as a learning medium, lecturers must know that the use of Android as a learning medium can be maximized and can really support the learning process (Ismail, Harun, Zakaria & Salleh, 2018; Montrieux, Vanderlinde, Schellens, & De Marez, 2015; Suliswforo, 2017). Apart from that, lecturers must also be able to overcome the negative impacts of using Android as a learning medium, for example by monitoring the use of applications on Android so that the goal does not deviate in an undesirable direction. In this way, learning objectives can be achieved and the learning process will not be

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disrupted. A lecturer should also combine his teaching models so that they are more creative (Ma'ruf, Setiawan, & Suhandi, 2019).

Other research on the role of information and communication technology conducted by (Chaeruman, Wibawa & Syahrial, 2018a; Barak, 2020; Kim, Kang, Rho, Sezer & Im, 2019; Oke & Fernandes, 2020) shows that the use of interactive media based on learning styles is more effective than conventional learning in increasing mastery of basic physics practical concepts, with the highest increase occurring in the visual learning style at 83.0 (high category) and the lowest was kinesthetic learning style at 66.3 (medium category). Increased mastery of concepts in the experimental class 74.0 (high category) and control class 47.0 (medium category). Research results from Chaeruman, Wibawa, & Syahrial (2019) show that mastery of basic physics practical concepts in students taught with ICT-based learning is higher than students taught conventionally (Chaeruman, Wibawa, & Syahrial, 2019; Astra, Wahyuni & Nasbey, 2015; Martinez, Woodley, Lucero & Parra, 2019; Permatasari, Gunarhadi & Riyadi. 2019; Santyasa, Rapi & Sara, 2020).

Research conducted by (Chaeruman, Wibawa, & Syahrial, 2018b; Dasilva et al., 2019; Foley, 2020; Malmia et al., 2019; Ma'ruf, Handayani, Marisda & Riskawati, 2020, 2020b; Velly, 2021) shows that the increase in critical thinking in the basic physics practicum course for students who receive problem-based learning assisted by computer simulations is significantly higher compared to students who receive learning conventional. Based on the results of other research by (Bakri, Rodhiyah, Nurindrasari, Pratiwi & Muliyati, 2020; Halim et al., 2021; Kim et al., 2019; Nurtanto, Fawaid & Sofyan, 2020; Sugiyanto, Setiawan, Hamidah & Ana, 2020), it was found that the use of Adobe Flash-based learning media can help students understand material regarding basic physics practicum. This can be seen in the results of students' material understanding tests where the percentage of students who have a level of understanding that is in the very good and good categories is 81.4%. The remaining 18.6% were in the sufficient level of understanding category, and there were no students at all who had a level of understanding in the poor or very poor category. This shows that ICT learning media products can motivate students to study basic physics practicum material (Jalinus et al., 2021; Marisda & Ma'ruf, 2021; Yuliarni, Marzal & Kuntarto, 2019).

Initial observations to determine the use of information and communication technology carried out by Physics Education students and lecturers at Muhammadiyah University of Makassar. Of the 39 students observed, 84.6% chose to use mobile internet with Android for social media applications. while the remaining 15.4% chose to browse or look for references for teaching materials via mobile, from these results it can be concluded that the use of information and communication technology, especially Android learning, has not been maximized by both students and lecturers. One of the influencing factors is a lack of ability to utilize technology and a lack of high awareness about the importance of this technology (Ma'ruf, Setiawan, & Suhandi, 2019; Ma'ruf, Handayani, Marisda & Riskawati, 2020; Ma'ruf, Setiawan, Suhandi & Siahaan, 2020)

The results of the observation aimed at 39 students in the Physics Education Study Program, Muhammadiyah University of Makassar for the 2019/2020 academic year, especially during the Covid-19 pandemic, showed that 71.8% of students stated that the basic physics practicum course was not interesting, and only 28.2% of students who said the basic physics practicum course was interesting. Based on the results of observations in the initial observation activities, it was shown that physics practical learning requires a better form of practical work that can be integrated with current technology.

2. METHOD

2.1 Research design

The type of research used is development research, with a Research and Development (R&D) research design. This research design is used to produce a product and test the effectiveness of a product. The development procedures according to are (1) needs analysis; (2) product development (design, manufacture and product validation); (3) product testing; and (4) product revision (Creswell, 2008).

2.2 Participants

The product trial participants were all first semester physics education students of Muhammadiyah University of Makassar consisting of two classes, namely class IA consisting of 25 people and class IB consisting of 20 people. The population was all physics education students of Muhammadiyah University of Makassar.

2.3 Data Collection

The data in this research is grouped into three groups of data, namely virtual android observatory-based basic physics practicum model validation data, questionnaire data, and ICT literacy skills. The data collection techniques are 1) Validation data for the virtual android observatory-based basic physics practicum model, which is validated qualitatively and quantitatively. Qualitative validation was carried out by practical equipment experts and basic physics material experts, in order to review and test the feasibility of the courseware. Quantitative validation is carried out to test the suitability of the product for users, or that the resulting courseware functions according to its purpose. 2) Questionnaire data, namely to obtain data on student responses to the basic physics practicum model based on the virtual android observatory. 3) ICT literacy data, namely to obtain data on students' ICT literacy level through ICT literacy tests.

2.4 Data Analysis

Data from limited trials and extensive trials were analyzed using quantitative descriptive analysis using criteria as in Table 1.

Table 1 Criteria for the feasibility level of the basic physics practicum KIT based on the virtual android observatory being developed.

Category	Percentage (%)	Qualification	Equivalent
4	86-100	Not revised	Very worthy
3	76-85	Not revised	Worthy
2	56-75	Needs revision	Decent
1	≤ 55	Must be revised	enough
			Not feasible

Questionnaire data, analyzed qualitatively. For positive statements, the strongly agree category was given the highest score of 4, 3 for agree, 2 for disagree, and 1 for strongly disagree. On the other hand, for negative statements, the strongly disagree category is given the highest score of 4, 3 for disagree, 2 for agree, and 1 for strongly agree. ICT literacy skills data in the form of initial test scores and final test scores. The initial test and closing test score data are calculated to determine the increase in students' abilities regarding ICT literacy.

3. RESULT AND DISCUSSION

3.1 Results of The Needs Analysis

This study was conducted to obtain an overview of the feasibility and supporting capacity for developing a virtual android observatory-based basic physics practicum. Preliminary studies that have been carried out in this research include: (1) Study of physics laboratory facilities and infrastructure, implementation of basic physics practicum; (2) Study of student perceptions of practicum activities and provision of ICT literacy through practicum activities. (3) Analysis of basic physics practicum manuals to find out the topics and number of practicums that have been carried out and the practicum stages used.

Through this study, an overview of the carrying capacity of basic physics practicum activities held in the physics education study program at Universitas Muhammadiyah Makassar was obtained. The results of this study are used as a rational consideration for the importance of developing basic physics practicum based on a virtual android observatory to improve the ICT skills of prospective physics teacher students. Physics laboratory facilities and infrastructure standards are explored using physics laboratory facilities and infrastructure observation sheets. Aspects explored include the availability of lab furniture, basic measuring materials and tools, experimental equipment sets, and physics practical equipment (Ma'ruf, Handayani, Marisda & Riskawati 2020a; Rizal, Rusdiana, Setiawan & Siahaan, 2020; Wheeler, Wick & Lee, 2020).

Based on the results of observatory lab data analysis, it was found that the physics laboratory facilities and infrastructure owned were in the adequate category. When reviewed based on each aspect, it is found that the physics learning laboratory has furniture in the good category, the availability of basic measuring instruments in the good category, the availability of basic physics experiment equipment sets in the sufficient category, and the availability of physics practicum equipment in the poor category. Basic physics practicum is explored using student perception sheets. Aspects explored include practicum support capacity, practicum implementation, practicum obstacles, practicum models, and the use of ICT in practicum (Bao & Koenig, 2019; Firmansyah & Suhandi, 2021; Mardiana & Kuswanto, 2017; Nijdam, Teunissen & Ebert, 2020; Suastra, Ristiati, Adnyana & Kanca, 2019). Students are asked to answer "Yes" or "No" to each statement item given. The percentage of respondents' answers to each statement item is determined based on the number of answers given. The categorization of practical support capacity aspects and the use of ICT in practicum activities is determined based on the average percentage of the number of answers given, namely good/high categories (the average number of answers "Yes" is more than 66.6%), sufficient/medium (the average number of answers " Yes" was 33.3 – 66.6%), and less/low (the average number of "Yes" answers was less than 33.3%).

Table 2 Results of data analysis of the basic physics observatory of Muhammadiyah University of Makassar.

Practical aspect	Description	Number of answers (Yes)	Category
Practical carrying capacity	Practical activities are guided by a practical guidebook	100	Enough
	Basic physics practical equipment is available according to required standards	50	
	Lecturers provide regular guidance on practical activities	87	
	Practicum implementation is guided by a practicum assistant	100	
Barriers to practical activities	Basic physics practical equipment is inadequate	92	Enough
	Limited practicum time	81	
Utilization of ICT in practicum	ICT-based practical data processing system	43	Not enough
	Online-based practical assignments	86	
	ICT-based data interpretation system	26	
	ICT-based data recording system	15	

Table 3 Observation results of the virtual android observatory-based basic physics practicum

No	Observed aspects	Percentage of Observation Results (%)			Results description
		determine Earth's gravity	free fall motion	Doppler effect	
1	Designing experimental tools and materials	15,38	23,08	61,53	Overall very good design skills
2	Using a virtual android observatory measuring instrument	7,69	15,76	76,89	Overall there are no problems when using measuring instruments, especially those using mobile phone sensors
3	Take measurements with a virtual android observatory	0,00	30,79	69,58	Overall, students were able to take measurements and there were no sensor errors
4	Reading data from virtual android observatory sensors	7,69	15,85	76,91	Overall the ability to read data from the application is very good
5	Prepare conclusions from practicum results	0,00	7,68	92,12	Overall, there are no problems in the ability to draw conclusions from the practicum results
Average		6,15	18,63	75,41	

Table 4 Data on ICT literacy skills test results for physics education students

No	ICT Literacy Capability Indicators	Percentage of ICT Literacy Ability Results (%)			
		Very less	Not enough	Good	Very good
1	Accessing and evaluating information and communication technology	1.07	12.05	76.66	10.22
2	Use and manage information	0.00	39.12	22.42	38.46
3	Apply technology effectively	0.00	11.15	88.85	23,08
4	Implement and use technology with honesty and integrity	0.00	37.49	38.46	24.05

Based on the data in the table 2, it is clear that the physics education study program at Universitas Muhammadiyah Makassar has a practicum support capacity in the sufficient category, physics learning is supported by practicum activities but with a level of implementation in the sufficient category, and the obstacles or challenges experienced by students in taking part in the practicum are in the medium category, the dominant practicum design model applied is the verification practicum model (conventional), the use of ICT technology in practicum activities is still in the low category.

Based on the results of laboratory observation data analysis, it was found that the physics laboratory facilities and infrastructure owned were in the adequate category. When reviewed based on each aspect, it is found that the basic physics learning laboratory has furniture in the good category, the availability of basic measuring instruments in the good category, the availability of basic physics experiment equipment sets in the sufficient category, the availability of physics KITs in the low category.

3.2 Results of The Product Testing

Basic physics practical testing activities on experiments to determine Earth's gravity, free fall motion, and the Doppler effect based on a virtual android observatory are carried out in the basic physics laboratory using a small group pattern consisting of 3-5 people in each group. This activity begins with designing experiments to the stage of reporting the results of practicum activities. This activity is equipped with an android sensor using the Phyphox application. Implementation practicum observation activities were carried out during the practicum process, the data obtained can be seen in Table 3.

Apart from that, this research also measured the ICT literacy skills of prospective physics teacher students after carrying out basic physics practicum activities based on a virtual android observatory. The results of the ICT literacy skills test can be seen in Table 4.

Based on the results of basic physics practical trials, experiments on determining earth's gravity, free fall motion and the doppler effect based on a virtual android observatory, among others, based on the results of observations from the implementation of basic physics practicals when viewed from the aspect of design ability. experimental tools and materials for determining gravitational acceleration, free fall motion and the doppler effect. Overall, students have very good skills in designing tools, especially in the aspect of using cellphone sensors that are integrated in the virtual android observatory application.

Another aspect is the ability to use virtual measuring tools, including for measuring the motion of objects, so overall there are no problems and all virtual tools can be used well. during the practicum process, students are better able to carry out measurements with the virtual android observatory and do not experience errors in the sensors or virtual measuring instruments used.

A very important aspect of the practicum process is the student's ability to read data recorded on sensors and visualized digitally through a virtual android observatory application, where students are able to read data from the application very well. The results of reading the data are

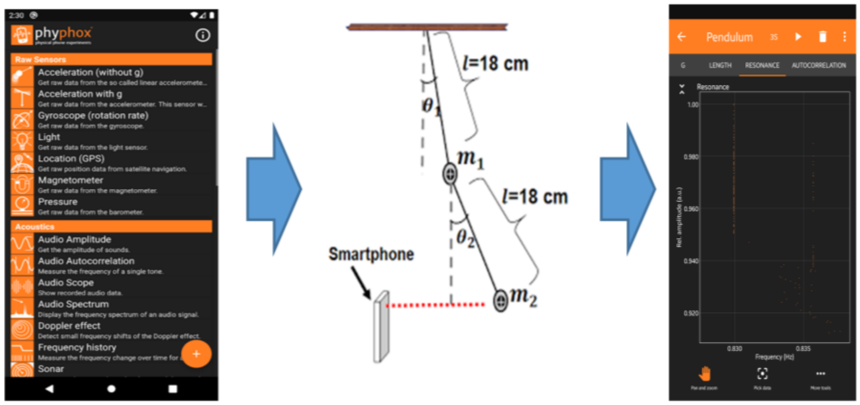

Figure 1 Basic physics practicum scheme gravitational acceleration basic physics practicum based on virtual android observatory

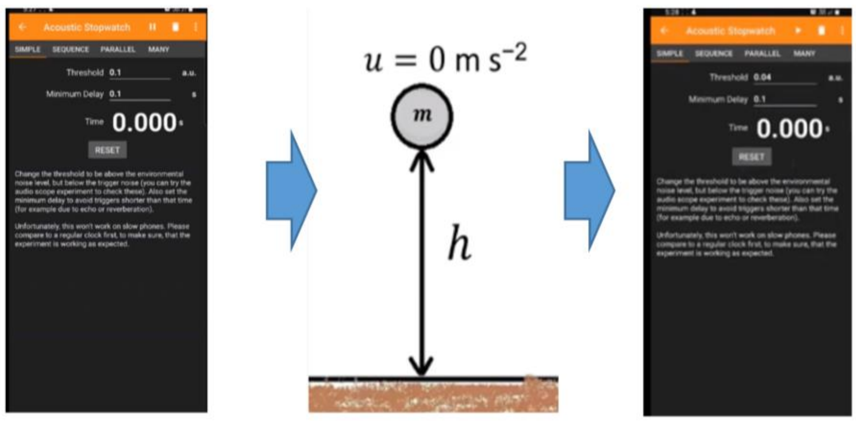

Figure 2 Basic physics practicum scheme for free fall motion basic physics practicum based on virtual android observatory

Figure 3 Scheme of basic physics practicum doppler effect basic physics practicum based on virtual android observatory

followed by data processing and analysis that is integrated with a computer. This data processing ability is very important for students, especially when reading graphs and tables produced on a computer screen. The final aspect is the preparation of practicum results reports, where students as a whole are able to prepare these reports very well and can be accounted for.

Based on data from students' ICT literacy test results after using the virtual android observatory application, the percentage of the very low ICT literacy category was 0.27%, for the poor category it was 24.95%, and for the good category it was 56.60%, and the very good at 24.24%. Therefore, it can be concluded that students' ICT literacy skills in using the virtual android observatory application during the basic physics practicum process for experiments in determining the acceleration of earth's gravity, free fall motion and the doppler effect are in the good category.

Students responded very well to the practical learning of basic physics based on the virtual android observatory, this can be seen from their enthusiasm for participating in the practicum. Learning activities can be carried out online or offline, and is one solution for carrying out basic physics practical activities, especially at this time.

3.3 Results of The Product Revision

For product revision or product finalization activities, by paying attention to and analyzing the test results. The final product of this research is a practicum design assisted by Student Worksheets in Basic Physics Practicum based on Virtual android Observatory. After conducting trials in the basic physics laboratory of the physics education study program, Muhammadiyah University of Makassar, especially in the aspect of testing sensors for each type of student cellphone, testing the use of the application, and testing the design of the practicum model, so that it can be described in the form of product revision or product finalization as a stage At the end of this research activity, the results are as follows: 1) basic physics practicum design profile gravitational acceleration basic physics practicum based on virtual android android observatory (figure 1), 2) Basic physics practicum profile free fall motion basic physics practicum based on virtual android observatory (figure 2), 3) Basic physics practicum profile doppler effect basic physics practicum based on virtual android observatory (figure 3).

4. CONCLUSION

The conclusion is that the effectiveness of the results of basic physics practicum trials for determining earth's gravity, free fall motion and the virtual android observatory-based doppler effect is in the very good category, namely 75.41%, and the results of the ICT literacy skills of prospective physics teacher are in the good category, namely overall. students were able to use the virtual android observatory application as a whole with a proficient percentage level of 56.60%.

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