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IDENTIFY ACHIEVEMENT AND LEARNING ACTIVITY OF PHYSICS PROSPECTIVE TEACHER THROUGH UTILIZATION OF WAVE-PARTICLE DUALITY TECHNOLOGY ENABLED ACTIVE LEARNING SIMULATIONS

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ABSTRAK

Kajian tentang pemanfaatan simulasi interaktif sebagai media pada pembelajaran fisika sangatlah penting. Saat ini penggunaan simulasi interaktif dengan berbagai metode pembelajaran telah banyak digunakan. Penelitian ini bertujuan untuk mengetahui hasil belajar dan aktivitas belajar calon guru fisika dengan memanfaatkan Technology Enabled Active Learning Simulation (TEALSim) pada konsep fisika. Jenis penelitian ini adalah Pra Eksperimen dengan One Group Pretest-Posttest Design. Subjek penelitian ini adalah 41 mahasiswa jurusan pendidikan fisika Universitas Negeri Makassar. Analisis data penelitian ini menggunakan analisis deskriptif dan kuantitatif. Hasil penelitian menunjukkan bahwa terdapat peningkatan yang signifikan sebelum dan sesudah diberikan perlakuan dimana nilai N-Gain mayoritas berada pada kategori "cukup" sebesar 73,09%. Hal ini menunjukkan bahwa penerapan TEALSim dapat meningkatkan prestasi belajar mahasiswa di Jurusan Pendidikan Fisika. Selain itu berdasarkan hasil analisis aktivitas mahasiswa rata-rata berada di atas 80% yaitu pada kategori "sangat baik" yang artinya siswa sangat aktif dalam melakukan pembelajaran fisika dengan pemanfaatan TEALsim.

Kata kunci: Achievement, Learning Activity, Technology Enabled Active Learning Simulations (TEALSim)

ABSTRACT

Study about utilization of interactive multimedia simulation as a learning media on physics learning is very crucial. Currently, the use of interactive simulations with various learning methods has been widely used.This study aims to identify achievement and learning activity of physics teacher candidate by harnessing Technology Enabled Active Learning Simulation (TEALSim) on physics concept. The research type is Pre-Experimental with One Group Pretest-Posttest Design. The subject of the study was 41 student of physics education department at Universitas Negeri Makassar. Data analysis of this study using descriptive and quantitative analysis for research result. The results of the study revealed that there is a significant improvement on *before and after giving treatment where the value of N-Gain is mayority on "enough" category by 73,09%. This indicate that the implementation of TEALSim can enhance of student's achievement in Physics Education Department. Beside of that, according to result of student's activity analysis, the average is above 80% that is on "very good" category which means that students are very active on doing learning of physics by the utilization of TEALSim.*

Keywords: Achievement, Learning Activity, Technology Enabled Active Learning Simulations (TEALSim)

INTRODUCTION

Some universities in physics learning are still conventional or commonly referred to as traditional science learning methods where lecturers are more active than students. The characteristics of this method are that most of the concepts used by lecturers display power point presentation media or through blackboards (Ilassan et al, 2015). In addition, students are required to memorize the facts or laws of physics without helping students conceptualize the phenomenon and process scientifically (Swandi et al, 2020). Students by training in introductory physics courses have many problems in understanding concepts that enable them to remember the equations taught. Learning that is watchful and unattractive and does not lead students to become problem solvers results in students being unable to properly remember the concepts that have been learned. Learning science and physics is difficult to realize active learning because learning only focuses on one direction, the lecturer is not a good facilitator. Lecturers do not direct students to be more active (Swandi, 2019; Agung et al 2019). The role of a lecturer is needed, they not only master the concept but also have the skills to transfer knowledge properly, attract and be liked by students.

Development and technological advances are very broad. At present, learning-based technology has been widely applied in teaching and learning in higher education (Hassan et al, 2015). With technology, various facilities in learning can be very helpful in accessing relevant sources. One example of the use of technology in physics learning is the use of interactive multimedia simulations. Compared to traditional learning methods, the use of interactive interactive multimedia has several advantages. The first, can save individuals, groups or students who use the internet using laboratory tools and also do not need many lecturer to use (Swandi et al, 2018; Amin et al, 2018). Secondly, applications that use more accurate information and help students to see visualizations of phenomena that cannot be seen, as is commonly called abstract concept. (Swandi et al. 2014; Amin et, 2016). In addition, multimedia simulation has also been developed to be used as an effective solution while still incorporating the concepts included in, development and solutions for experimental design students (Arundel et al, 1994). Dengan pemanfaatan instructional media yang menarik dan interaktif, dosen dan guru dapat menyajikan pembelajaran yang berkesan, tidak monoton, menarik dan mampu meningkatkan keterampilan pemecahan masalah mahasiswa (Swandi et al, 2015; By using interactive physics simulation, an approach is expected to improve students' understanding and concepts in physics problems.

The approach used in implementing interactive learning with multimedia simulations aims to create an effective learning system to improve learning outcomes through increased creativity and innovation from the use of technological innovations so as to produce active learning (Swandi et al, 2015. Interactive simulations are considered appropriate because students are passive and do not have the ability to think creatively and innovatively during the learning process (Hassan et al, 2015). Active learning in higher education is one solution in improving the quality of learning outcomes (Pariabti & Swandi, 2019). So, lecturers need to determine the right media and can be used by students to support this. Moreover, the current situation forces lecturers and universities to change the face-to-face learning format into distance learning. Distance learning for a variety of subjects certainly has different methods and approaches, especially in the science and social fields. As a part of science, physics learning has been done a lot both through observing natural phenomena around us and by direct learning in the classroom. The use of experimental methods has been shown to improve students' understanding of physics concepts such as the results of research by Subekti and Ariswan which stated that the use of experimental methods in learning physics was able to improve cognitive learning outcomes and science process skills (Subekti & Ariswan, 2016). There is also research by Handika which states that learning physics through guided inquiry with experimental and demonstration methods is viewed as increasing student activity and attention (Handika, 2010). The use of the experimental method with the guided inquiry model can also increase student creativity in science learning (Wahyuni & Husein, 2019).

Physical phenomena that can be understood with mastery of mathematical concepts first become quite difficult. Physics students must be able to understand and observe directly existing physical phenomena. Learning like this will be more interesting, less boring and able to increase student activity, therefore physics learning should involve direct experimentation (Swandi et al, 2019). However, not all physical phenomena can be observed by conducting experiments because some abstract material is impossible and invisible (Swandi et al, 2020; Amin & Swandi, 2016). The implementation of the experimental method is currently not possible due to several factors such as (1) during the pandemic, which requires learning to be carried out in their respective homes; (2) the availability of equipment in the laboratory that can be used by students in their homes is very limited (Swandi et al, 2014) (Amin et al, 2019); (3) absence of remote-based practicum guidelines that can direct students to make observations independently.

To overcome this, there needs to be a learning technology that is able to direct students to explore abstract concepts even though learning is done online (Swandi et al, 2017; Amin et al, 2017). This technology is able to replace the use of physics practicum tools and is also easy to use by students. With this technology, learning will be focused on students (studen center). In addition, with the right technology-based teaching materials, students' learning independence and conceptual mastery can be much better even though learning is done online. Therefore, Technology Enabled Active Learning Simulations is the right choice.

According to Hasan et al, TEAL emphasizes the use of active learning and small groupings during the learning process. Interaction and discussion is carried out through the Interactive Response System (IRS) which allows instructors or lecturers to ask questions, track and assess student responses to questions (Hasan et al, 2015). The use of the IRS makes it easy for lecturers and students to evaluate the feasibility of initial learning to final evaluation. The main objective of TEAL is to create a learning format that involves students in studying physics and matters related to technology more deeply so that they can gain a more comprehensive understanding of the content being studied both conceptually and analytically (Shie, 2012). The use of TEALSim which is rich in instructional videos and instructional videos as well as interactive simulations integrating remote lectures, problem solving, and direct observation (Swandi et al. 2020). So it is hoped that students will be more active in participating in physics learning.

Therefore, the researchers intend to implement instructional materials based on TEALSim to identify the level of learning outcomes of students in the physics education program of Universitas Negeri Makassar. In addition, this study aims to find out how much student activity in learning physics through this approach. According to Han and Chin, students are also often reluctant to share their ideas during lesson discussions. This is because they lack in planning, construction, and use of unattractive tools. During the teaching and learning process, lecturers do not use teaching aids that can attract students to start engaging in activities carried out during teaching, especially in higher education institutions (Khali, 2011).

METHOD

This research includes Pre-Experiment research which aims to improve student learning outcomes. The research design at the time of the trial was One Group Pretest-Posttest Design. In this design only consists of one class. The class was given an initial test and then treated in the form of the application of Interactive multimedia simulation-based learning devices. Then given the final test. The multimedia interactive simulation used was developed using the Lectora application which was adapted from several open sources, one of them from www.kcvs.ca. This software contains teaching material that is equipped with interactive simulations and is able to demonstrate physical phenomena virtually. The subjects of this study were students of the Department of Physics Education, Universitas Negeri Makassar in 2019, totaling 41 people. The instruments used in this study were, student activity instruments, as well as learning outcomes test instruments.

Observations are made to collect data about students during the process of teaching and learning activities take place. Data collection through observation was carried out by two observers with the same instrument sheet. Instrument test are used to determine the improvement of student learning outcomes. Learning outcomes test is used twice, before learning (pretest) and after learning (posttest).

The collected data were analyzed quantitatively and qualitatively. Student activities observed consisted of 8 criteria. Quantitative data analysis by calculating the percentage of students who do the appropriate activities using the following formula:

$$P = \frac{F}{N} \times 100\%$$

Information:

P : total value in percent
F : The number of students doing the recommended activities
N : The number of all students

Pretest-posttest data were analyzed quantitatively to determine the increase in student learning outcomes. the formula used to determine the increase in N-Gain learning outcomes as follows:

$$\langle g \rangle = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}}$$

Information:

$\langle g \rangle$: Gain Value
S_{post} : Posttest Value
S_{pre} : Pretest Value
S_{max} : Maximum Value

The results of the N-Gain calculation are then described quantitatively according to the criteria in table 1 (R,P Saputro, et al 2015).

Table 1 Criteria of Gain Value.

Gain Value	**Kriteria Normalized Gain**
0,70<Gain Value	High
0,30< Gain Value<0,70	Moderate
Gain Value<0,30	Low

FINDINGS A ND DISCUSSION

Student activities in learning are a series or stages of structured student activities carried out during the learning process. Data about student activities will indicate the level of student activity during the learning process. The types and stages of student activities will vary according to the learning method used. For learning with the experimental method, an instrument of student activity was developed which included eight forms of activity as below:

Table 2. Forms of Student Activity

No	**Form of Activity**	**Criteria**
1	Pay attention to the demonstration	Students are expected to listen and record lecturer explanations
2	Look for concepts	Students are expected to read concepts related to the observation process that will be carried out
3	Perform calculations	Students are expected to do the calculations correctly, using the appropriate equation
4	Doing exercises (making observations)	Students are expected to conduct virtual observations by following the virtual observation procedures correctly
5	Categorize (enter observational data correctly into the table)	Students are expected to categorize data from virtual observations correctly and write in the observation table

6	Explain the concept	Students are able to explain the results of virtual observations correctly to the observer
7	Presenting (answering validator questions)	Students are expected to be able to present / respond to the results of virtual observations responsively, coherently, easily understood, and accompanied by examples
8	Creating Process (answering questions outside of observations)	Students are then expected to be able to study issues that can foster creativity so that many new ideas emerge at the end of learning

The activity instrument developed was then validated by 2 experts to find out whether this instrument could be used in physics learning. After being declared valid and qualifying as an instrument of activity in learning physics of the virtual experiment method, this instrument is then used by 2 observers whose task is to observe student activities during the learning process by giving an assessment as guidelines for scoring as above.

The observations were then analyzed for each student activity at each meeting. In this study there were 5 meetings according to the number of subjects. The percentage of each form of student activity can then be obtained as in the table below:

Table 3. Students Activity Percentage.

Lectures	**Percentage of each Form of Activity (%)**								**Average**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
1	84	87	84	86	87	80	80	71	82.375
2	76	84	91	87	86	85	77	70	82
3	89	87	88	88	90	90	88	80	87.5
4	90	86	84	90	86	87	86	72	85.125
5	91	86	84	90	87	89	85	74	85.75
Average	86	86	86.2	88.2	87.2	86.2	83.2	73.4	84.55

From the table above, it can be seen that the average student activity for each meeting above 80% is in the very good category. When compared with other meetings, student activity was lowest at the 2nd meeting with an average percentage of 82% while at the 3rd meeting, the highest student activity with an average percentage of 87.5%.

Whereas in terms of the form of activity, the form of the 4th activity is categorizing the highest average percentage of 88.2%. Which is in the very good category. Whereas in the 8th activity, the process of obtaining the lowest percentage compared to the others with a value of 73.4% is in the good category. In general, the average of all meetings was 84.55% which was in the very good category. This shows that students are very active in learning physics by using hypermedia-based learning tools.

Based on the observer's assessment of each meeting, it was found that student activities above 80% showed that learning using Interactive multimedia simulation-based learning tools provided opportunities for students to move. Interactive multimedia simulation-based learning provides opportunities for students to explore, so it is very possible for them to always move, not just listen and record as expressed by Cengiz (2010) that media accompanied by the right learning tools can actively engage students in learning. The same result was also obtained in other studies that by using TEALSim which is rich in interactive simulations directing students to explore concepts through experiments, students are trained to observe phenomena, analyze, interpret into graphics, communicate and work together. These results make students more active and improve science process skills (Yusuf, 2018, Swandi et al 2015; Pariabti 2018).

From the results of student activity analysis shows that in general, the application of interactive multimedia simulation-based learning tools can make students more active in learning physics. Students were enthusiastic in paying attention to the initial demonstrations carried out by the lecturers who were shown using the LCD. This demonstration aims to explain briefly about the experiments that will be carried out. Student worksheets distributed contain material, experimental steps, observation tables, analysis and questions. With a complete student's worksheet structure, students are expected to be able to explore the concept first, then experiment according to the steps described in the worksheet. Most students are able to experiment independently, although there are still some students who need to be guided when making observations. In general, almost all students have been able to write the results of their experiments on the prepared observation sheet. There are still many students who have not been able to do calculations properly. This is because the understanding of students in analyzing the questions given in the worksheet is still lacking. Many students are still confused in mapping problems, using formulas and mastering numbers. This makes the researcher must explain in the class how to analyze and do calculations based on observations. As for the activity of explaining concepts, most students have been able to explain the concepts they have learned with Interactive multimedia simulation. The use of computer simulations allows students to see the physical phenomena that exist even if only through a laptop or computer. But when observers gave questions to students individually, there were still some students who were not optimal in answering questions. This is because the ability of students to communicate verbally is not optimal even though they are actually able to explain the concept in writing. While in creating the understanding they get, many students cannot explain or relate the concepts they have learned with problems that are quite complicated even though there are actually links.

The implementation of research by lecturers (researchers) in addition to describing the magnitude of learning outcomes with learning through the application of Interactive multimedia simulation-based learning devices encourages students to channel their curiosity. As a result of their observations, they were encouraged to collaborate with their group friends and be responsible for the results obtained and then report the results honestly. Through the results of the demonstration students are more active in asking questions and more responsive to expressing their opinions. By conducting experiments through Interactive multimedia simulation students are skilled in working on and analyzing the results of observations in the MFI. Observations and informal discussions revealed that students felt a combination of multimedia and lectures. Participation and motivation were increased from the previous year and students were asked more profound questions about concepts rather than simply seeking instructions on specific mathematical problems.

Facts that support that the use of Interactive multimedia simulation is supported by the research of B.D Amin et al (2018) which shows that student activities as outlined in the indicators of science process skills taught using Interactive multimedia simulation are above 80% in the high category. This is supported by the research of Yusuf et al (2015) which shows that the application of media such as virtual laboratories turns out to make students much more active than conventional physics learning.

Although the results of this study indicate that student activities in the category are very good, include activities to pay attention to demonstrations, seek concepts, calculate, categorize, explain, present, and create processes. It is not claimed that and also Multimedia programs represent an opportunity for students to learn about the physics involved, while momentarily removed from the inevitable complications of obtaining. Multimedia does not help students develop the practical laboratory skills that are the basis of scientific research and along with the vast majority of multimedia proposals, that there is no substitute for hands-on experience. (Susan et al, 1996)

Score of learning outcomes of students majoring in physics at Muhammadiyah University of Makassar before and after being given treatment if categorized according to categorization in accordance with the Minister of Education and Culture, the frequency distribution chart can be made as follows.

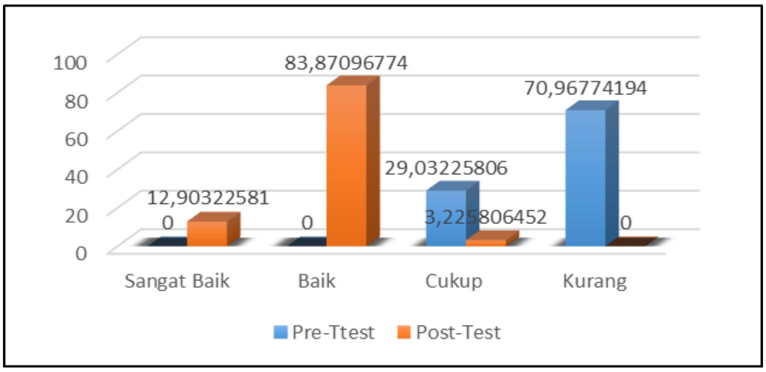

Figure1. Frequency Distribution and Percentage Score of Achievement on Pretest and *Postest.*

Based on Figure 1 shows that for the pre-test the majority of students get scores Learning outcomes are in the score below 19 with less categories while for the posttest the majority of students get a score of learning outcomes in the good category. At pretest there were 22 students or 70.97% of the total students taking scores under 19 with less categories. 9 students (29.03%) got enough scores in the category. While there are no students who get good or very good scores. As for the posttest there are 26 or 83.87% of the total students score in the good category, while for the very good category there are 4 students (12.90%) and there is only 1 student who scores in the category enough.

Capacity building Student learning outcomes were also analyzed using the normalized gain (N-gain) formula. N-gain is used to see how much the ability score increases. Learning outcomes after being taught by applying Interactive multimedia simulation-based learning tools. The following is a picture of the frequency of the relationship between pretest scores and posttest scores. The learning outcomes of students majoring in physics at the University Negeri Makassar.

Tabel 4 Distribution of Frequency and Achievement Percentage.

Interval	**Category**	**Frequency**	**Percentage (%)**
$g > 0,7$	High	8	19,51
$0,3 < g \leq 0,7$	Moderate	32	80,00
$g \leq 0,3$	Low	1	2,43

Based on the N-gain analysis shows for the test Learning outcomes have increased from before. In the high category, frequency 8 is obtained with a percentage of 19.51%, medium category with frequency 32 with a percentage of 80.00% and low category with frequency 1 with a percentage of 2.43%. The average N-gain obtained based on the results of the analysis is an average of 0.59 and based on the data in the N-gain category can be stated that the test results are in the medium category. The description of the percentage of N-gain The learning outcomes achieved by students of physics education as prospective teacher are shown in the following histogram.

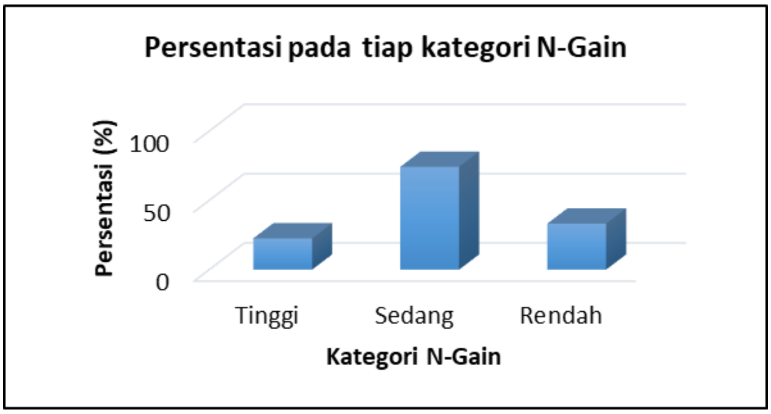

Figure 2 Histogram Distribution of Percentage of N-gain achievement.

Based on the results of descriptive statistical analysis shows that the average score of student learning outcomes is 50.96 from a maximum value of 76.00 after being taught (posttest) with the application of the application of Interactive multimedia simulation-based learning devices higher than the average score of student learning outcomes 15.72 before being taught (pretest) by applying the application of Interactive multimedia simulation-based learning tools. Based on the average score, it provides information that learning outcomes experience optimal improvement. Students after being taught with the application of Interactive multimedia simulation-based learning tools can build their own knowledge based on the performance of the process of the occurrence of a real event or from a learning experience. Students before being taught with the application of Interactive multimedia simulation-based learning tools tend to wait for the delivery of information from lecturers without real observation. In addition to learning with the application of learning tools based on Interactive multimedia simulation learning activities are carried out evenly in each group and provide opportunities for students to conduct their own experiments and students' attention can be centralized, provide motivation, students can actively participate, and gain direct experience.

Determination of the improvement of student learning outcomes after being taught with the application of the application of Interactive multimedia simulation-based learning devices was analyzed by normalized N-gain analysis. Based on the results of the analysis obtained an average N-gain of 0.59 which shows that student learning outcomes experienced an increase in the medium category. Improvement in the medium category Student learning outcomes are allegedly caused by the learning process with a fairly short time so that students have not maximally understood the whole concept learned. Besides that, it is influenced by various external factors that cannot be fully controlled by the lecturer (researcher) outside of class hours, such as student study hours at home, learning facilities at home.

The fact that supports the results of this study is that research conducted by Swandi et al (2015) shows that with the application of the application of Interactive multimedia simulation-based learning tools, physics concepts are no longer abstract and students are easier to understand the material shown in real life through demonstration activities. and students feel happy and have a pleasant learning experience (Yusuf & Widyaningsih, 2018). Other things that support the results of this study are the advantages of applying interactive multimedia simulation learning devices with the stages, namely the errors that occur from the lecture can be improved by the use of the application of Interactive multimedia simulation-based learning through observation, concrete examples, and presenting objects in fact. Student attention can focus on the lessons given. The use of Interactive multimedia simulation motivates students to study harder. In addition, students can actively participate and gain direct experience.

The research conducted by Bunga Dara et al (2016) states that the ability of students after learning by applying Interactive multimedia simulation-based learning tools is better before the use of the application of Interactive multimedia simulation (conventional) based learning devices. The learning process using the application of learning tools based on Interactive multimedia simulation is effective to use because students get an overview of the material taught through the media used so that learning with the application of Interactive multimedia simulation-based learning tools is effective on improving learning outcomes, especially in the cognitive domain, namely understanding concepts.

CONCLUSSION

Responding to this problem, the author's goal in using this software (TEALSim) is to provide a content-rich program and simulation to illuminate the concepts discussed in lectures, especially abstract concepts and high conceptual knowledge, providing insight into technology-based experimental methods and supervision of professional practice in a way that is attractive to students and provides ample opportunity to access learning resources. It is clear from our results that the use of Technology enabled active learning simulation accurately and effectively affects student activity and learning achievement. However, it remains to be seen in future studies whether the results of this study can be generalized.

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