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Increasing Students' Activity and Learning Outcome Used Guided Discovery Model Assisted by PhET

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Abstract: The purpose of this study is to increase student's activity and learning outcome using guided discovery assisted by PhET (Physics Education Technology). The specific purpose of this study is to describe: 1) the implementation of the lesson plan, 2) activity, and 3) learning outcomes. The type of study that used is a classroom action research by Kemmis and Mc Taggart model that consists of two cycles. The subject of this study is the 24 students of class XII one of the vocational schools in the Banjarmasin city. The data is obtained through observation and test. The results of study in cycles I and II show: 1) the average score of implementation of the lesson plan increased from good category to very good category, 2) the student's activity has increased 3) the learning outcomes increased from 0% to 87.5% and has been declared complete in cycle II. It can be concluded that the used implementation of guided discovery with PhET can increase activity and learning outcomes.
Keywords: Activity, guided discovery, learning outcomes, PhET.

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INTRODUCTION

Physics learning is taught through a series of scientific processes to gain knowledge. The scientific process is; taking measurements, experiments, and discussions. The process requires the active role of students to directly involved in learning activities so that students can understand the existing concepts (Sari, Gunawan, & Harjono, 2016).

Improving teaching and learning in the classroom requires efforts to improve the understanding of teachers, students, materials used for learning, and interaction between them (Yuliani & Saragih, 2015). During the learning process, students are required to carry out activities to pay attention, listen to, and digest the lessons given by the teacher, and it is expected that active students ask the teacher about things that are unclear. The learning model must require students to be actively involved in the learning process (Sasmita, 2017). This shows the importance of student activities in learning activities because if there is no activity, there is no learning.

The results of observations conducted in class XII one of the vocational schools in the Banjarmasin city showed that learning was still teacher-centered, lacking the learning model used by the teacher, and low activity of students during the learning. The results of interviews with physics teachers of class XII one of the vocational schools in the Banjarmasin city showed that the learning applied so far was learning by lecturing method, besides that student of class XII rarely conducted experiments on physics materials taught by teachers, this was due to limited laboratory equipment.

Based on the observations of class XII students in one of the vocational schools in the city of Banjarmasin during physics learning activities, the results obtained for 1) the activity of expressing opinions, presenting the results of the experiments, listening to demonstration observations from the teacher, conducting experiments, analyzing, and concluding the experimental results included in the category no active, 2) listening to teacher explanations with quite active categories. The low activity of students will have an impact on their learning outcomes. This can be seen based on the average value of student learning outcomes is 43.04 below the minimum passing grade is 76. Classical completeness for students who get a score above the Passing Grage is 51.42%, while students who score under the passing grade is 48.57%. It is necessary to apply classroom action research to find a solution to the problem. Class action research is needed from the application of alternative learning models that can improve student learning activities to improve student activity and learning outcomes are 1) problem based learning (Widayanti, 2014), 2) cooperative (Erlinda, 2017), 3) guided inquiry (Sasmita, 2017), and 4) guided discovery (Syaifulloh & Jatmiko, 2014).

One of the efforts made by the teacher to overcome the low activity and learning outcomes of students of class XII one of the vocational schools in the Banjarmasin city are to apply learning models that are suitable for physics learning. The appropriate model to be applied is a guided discovery model. Bruner stated that the guided discovery model is one of the learning models that was developed by raising the curiosity of students by giving pleasure during the learning process by making an invention of knowledge independently (Jannah & Supriyono, 2015).

The process of discovery in the teaching and learning process can be done through experiments. Students carry out investigations based on their initial experience and knowledge

through discussion or exchanging opinions with friends, reading and or trying by themselves to find the truth or new knowledge (Adhim & Jatmiko, 2015). The advantages of discovery learning include increasing students' experience in learning, exploring creativity and increasing self-confidence, learning to solve problems independently, and having critical thinking skills. The guided discovery learning model has a positive effect on learning outcomes (Adhim & Jatmiko, 2015; Kariani, Ali, & Saehana, 2018; Wati & Joko, 2015), improve student character (Suriasa, 2018), improve science literacy (Rosdiana, Boleng, & Susilo, 2017), improve students' flexible thinking skills (Putri, Fadiawati, & Rudibyani, 2014; Sari, Fadiawati, & Tania, 2015), improve the ability to think creatively (Rudyanto, 2016) and increase student activity (Sasmita, 2017). The disadvantage of the discovery learning model is that it requires considerable time in its implementation (Sari et al., 2016).

Discovery learning at the investigation stage uses laboratory equipment in learning so that the scientific concepts of students are built (Allo, Jatmiko, & Agustini, 2017). But not all schools have complete laboratory equipment. The limitations of laboratory equipment can be overcome by using a virtual laboratory.

Computer simulations are utilized in virtual laboratories. A virtual laboratory is a form of an interactive multimedia object consisting of various heterogeneous formats including text, hypertext, sound, images, animation, video, graphics, and simulations (Sari et al., 2016). One type of virtual laboratory is PhET (Physics Education Technology). PhET interactive simulation is a site created by the University of Colorado with the main sponsors of The William and Flora Hewlett Foundation and National Science Foundation which is downloaded free of charge from the PhET website (http://phet.colorado.edu) for the benefit of classroom teaching and individual learning (Perkins, Adams, Dubson, Finkelstein, Reid, Wieman, & LeMaster, 2006). One of the simulations provided by PhET is for physics learning. PhET simulation is a simulation media that provides various scientific simulations that can be used as a solution to solve previous problems (Maulani, Wati, Misbah, Dewantara, & Mahtari, 2018). The advantages of PhET simulations are emphasizing the relationship between real-life phenomena and the underlying knowledge and trying to create visual and conceptual models that can be understood by students (Perkins et al., 2006).

PhET simulations can also overcome the shortcomings of applying guided discovery models related to the time of conducting experiments that are too long. Learning the discovery of a virtual laboratory assisted students in solving problems in their groups faster (Hariyanto, 2016). Learning with virtual laboratories is more efficient because the management of learning is carried out faster than learning with real laboratories (Syaifulloh & Jatmiko, 2014). The use of PhET can also foster student interest in learning (Saregar, 2016). Students who learn through discovery learning assisted by PhET simulation program packages will have higher learning achievements than students who learn using discovery learning only (Hariyanto, 2016). However, these studies only measure student learning outcomes, have not measured student activity. Therefore, this study uses guided discovery model assisted by PhET, that are expected to improve student learning activities and outcomes.

The purpose of this study, in general, is to improve the activity and

learning outcomes of students of class XII one of the vocational schools in the Banjarmasin city by using guided discovery model assisted by PhET. The specific purpose of this study are, 1) to describe the implementation of lesson plan using a guided discovery model assisted by PhET, 2) to describe the activity of students of class XII one of the vocational schools in the Banjarmasin city during the study by using guided discovery model assisted by PhET, and 3) describe the learning outcomes of class XII one of the vocational schools in the Banjarmasin city after participating in the study using guided discovery model assisted by PhET.

METHOD

The type of study used is Classroom Action Research using the classroom action research model by Stephen Kemmis and Robbin Mc. Taggart. This study is carried out in two cycles, each cycle consisting of the stages of the plan, action, observation, and reflective.

The subjects of this study are 24 students of class XII one of the vocational schools in the Banjarmasin city. The object of this study is the activity and learning outcomes of students of class XII one of the vocational schools in the Banjarmasin city. Learning activities in the study subjects are only two cycles, each of which consisted of 2 meetings with an allocation of 2 x 40 minutes for each meeting. The tools and instruments used in this study are lesson plan, student worksheets, handout material, observation sheet for lesson plans and student activities, and student learning outcomes test sheets.

The data analysis technique in this study is that the implementation of the lesson plan that is carried out by two observers. The score for the implementation of the lesson plan from 2 observers is averaged and then interpreted with the assessment criteria in Table 1.

Table 1 Criteria for implementing Lesson Plan

Average Score	Category
$0.0 < X \leq 0.8$	Very Low
$0.8 < X \leq 1.6$	Low
$1.6 < X \leq 2.4$	Sufficient
$2.4 < X \leq 3.2$	Good
$3.2 < X \leq 4.0$	Very Good

(Widoyoko, 2016)

Student activity was observed by two observers. Criteria for evaluating student activities (Widoyoko, 2016) can be seen in Table 2. Reliability indexes are classified in Table 3.

Table 2 Criteria for student activity

Average Score	Category
$0.0 < X \leq 0.8$	Inactive
$0.8 < X \leq 1.6$	Less Active
$1.6 < X \leq 2.4$	Quite Active
$2.4 < X \leq 3.2$	Active
$3.2 < X \leq 4.0$	Very Active

Table 3 Reliability criteria

Reliability Score	Category
$r < 0.4$	Low
$0.4 \leq r < 0.8$	Moderate
$0.8 \leq r$	High

Indicators of success in this study are: 1) the implementation of the lesson plan at each meeting is carried out at least in good category with a score of> 2.4, 2) Minimum student activity in the active category with a score of> 2.4, 3) Student learning outcomes meet the classical completeness, namely the number of students who complete individually reaches ≥80% of all students.

RESULT AND DISCUSSION

Data that has been obtained by researchers is the implementation of the lesson plan, activity, and student

learning outcomes. The results of the study are discussed in each cycle carried out during the learning process in the classroom. The results of observations on the implementation of the lesson plan in the first cycle consisting of two meetings can be seen in Table 4.

Table 4 Recapitulation of Implementation of Lesson Plan Cycle I

Observed Learning Phase	Meeting 1		Meeting 2	
	Mean	Criteria	Mean	Criteria
1	3.9	Very good	4.0	Very good
2	2.8	Good	3.2	Good
3	2.5	Good	2.5	Good
4	0.0	Insufficient	2.2	Sufficient
5	3.7	Very good	3.6	Very good
Reliability	0.99	High	0.98	High

Table 4 shows that overall, implementation at the first and second meetings has increased in phases 1, 2, and 4. The third phase has not increased, this is because students have spent a lot of time doing experiments. However, there is still a learning phase with insufficient categories, namely the 4th phase, where this phase is not carried out in the learning process cycle I in the first meeting, in this phase the teacher does not ask or guide students to present the results of the experiment, because the time in this phase is widely used for trial activities. The ability of students to conduct physics experiments is still low, so that the learning time is widely used for this activity, therefore the teacher must demonstrate each step of the experiment, especially in assembling PhET virtual laboratory tools based on student worksheets slowly and focusing students' attention, so students are easy to understand and trained in conducting experiments.

Based on analysis and trial cycle I there must be a revision of some components of the learning device in cycle II in the hope that learning devices guided discovery learning models can improve the activities and student learning outcomes in cycle II.

The action taken by the teacher in the second cycle is to rearrange the learning phase in the lesson plan of cycle II for the first and second meetings. The teacher must carry out each phase of learning as planned. Students are told to study the material to be studied in the second cycle.

The recapitulation results of the implementation of the lesson plan in the second cycle can be seen in Table 5. Table 5 shows that the results of the lesson plan recapitulation in the second cycle of the first and second meetings increase in each learning phase to reach a very good category and have met the predetermined success indicators.

Table 5 Recapitulation of the lesson plan implementation cycle II

Observed Learning Phase	Meeting 1		Meeting 2	
	Mean	Criteria	Mean	Criteria
1	3.8	Very good	4.0	Very good
2	3.6	Very good	3.8	Very good
3	3.8	Very good	3.8	Very good
4	3.2	Very good	3.5	Very good
5	3.8	Very good	3.6	Very good
Reliability	0.97	High	0.98	High

The efforts made by the teacher in rearranging the lesson plan scenario have been able to increase the average score of the implementation of the lesson plan in cycle II. This increase is the result of the reflection of cycle I. The lesson plan acts as a scenario for the learning process that the teacher must prepare before teaching. Therefore, the lesson plan should be flexible and allow the teacher to adjust it to the students' responses to learning.

The results also indicate that PhET interactive simulations can use with guided discovery models in physics learning. Guided discovery learning with PhET assistance makes students directly involved in learning activities. PhET simulation is feasible to be used as a medium to support the achievement of physics learning goals, students can carry out experimental activities such as conducting real experiments in actual laboratories (Syaifulloh & Jatmiko, 2014). The visual display in PhET simulations and direct interaction using this simulation will help students develop their mental models and their understanding of science (Wieman, Adams, & Perkins, 2008).

The observed student activity is a learning activity that carried out by students during the learning process, which is assessed by using student activity observation sheets. Student activity observed are stating opinion/giving response (A1), presenting experiment result (A2), listening teacher's explanation (A3), paying attention to teacher's demonstration (A4), conducting an experiment (A5), analyzing data (A6), and concluding experiment result (A7) Recapitulation of student activity can be seen in Figure 1. These results indicate that overall student activity is relatively low in the cycle I.

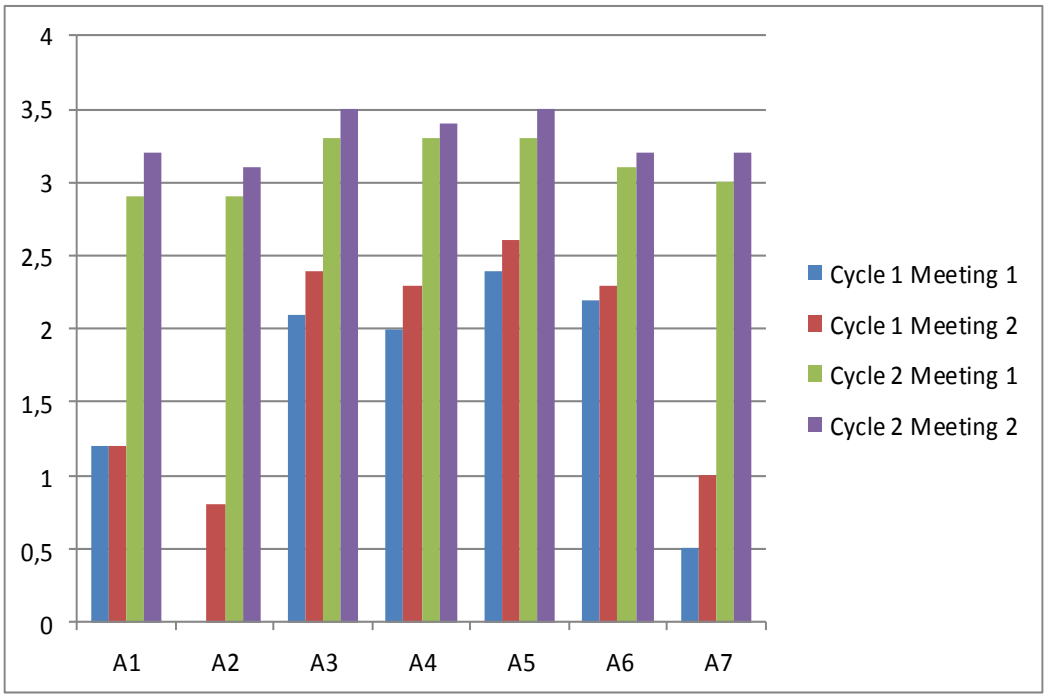

Figure 1 Increasing student activities

Table 6 Recapitulation of Learning Outcome Test Score

Qualification	Passing Grade	Number of Students		Classical Completeness	
		Cycle I	Cycle II	Cycle I	Cycle II
Pass	≥ 76	0 Student	21 Students	0%	87,5%
Fail	< 76	24 Students	3 Students	100%	12,5%
Total		24 Students	24 Students	100%	100%

Student activities in the first cycle were still low with inactive categories. This is because students are not used to learning using the discovery learning model and PhET. Students have never used PhET, so teachers spend more time explaining how to use PhET at the first meeting. The weakness of student activities in the learning cycle I was improved in cycle II.

The results of reflection on student activity in the first cycle together with the actions taken by the researcher in the second cycle are; students rarely express opinions or responses in the form of questions about things that have not been understood and discussed in group activities, therefore, in the second cycle the teacher gives intensive guidance to students who do not understand and are ashamed to ask questions. Class conditions during the learning process are not conducive, it seems that there are still students who do not pay attention, chat with friends beside him, and do things that are not related to learning activities. Therefore, the teacher must act decisively to rebuke students who make noise and try to focus on students during learning activities. This causes some learning time to be used for experimental activities. The action taken by the teacher in cycle II is to slowly explain each step of the experiment in the student worksheet, reintroduce, and demonstrate directly how to assemble PhET laboratory equipment. Also, the teacher must also guide students to analyze, conclude, and present the results of the experiment together so that all students can easily understand and become more confident. The average score of student activity in the first and second meetings of the second cycle increases for all observed activities and meets the predetermined indicators of success. This is because students are used to using guided discovery, and PhET models so that it can be told that the application of a guided discovery model assisted by PhET can increase student activity in physics learning.

The basis of Bruner's theory is Piaget's statement which states that children must play an active role while studying in class and children must be able to arrange learning material that has been studied with the final form that is with the level of development of children's thinking. The main theme of Bruner's theory is that education is a process of personal discovery by each student (Suyono & Hariyanto, 2015). The involvement of students in using mental processes to find their concepts or principles will lead to the discovery (Syaifulloh & Jatmiko, 2014).

Efforts that have been made by researchers have been able to increase student activity in cycle II. Based on Figure 1 the average score of student activity in the second cycle, which follows guided discovery learning assisted by PhET as a whole has increased to the active category in all aspects of observation. Learning by applying a guided discovery model assisted by PhET changes the learning conditions of students who are passively active. These results are in line with the other relevant researches Syaifulloh & Jatmiko (2014) that multimedia facilities can make learning more interesting, visual, and interactive. The guided discovery model is intentionally designed to increase the activity of

larger students (Yuliani & Saragih, 2015). Students are more interested and motivated to do activities in groups that use guided discovery (Achera, Belecina, & Garvida, 2015).

At the end of each cycle, the teacher gave learning outcomes test to determine the level of success of students in the learning activities that have been carried out. The test given for each cycle consists of 7 items in the form of a description test according to the learning objectives. Table 6 shows the classical completeness of student learning outcomes in the first cycle is at 0% with a mean score of 18.97. These results indicate that in the first cycle, there is no single value of student learning outcomes that are stated to be passing the minimum grade of 76 or classical. The lowest proportion of questions is question number 6 of 0.01. Based on the cognitive domain of Bloom's Taxonomy, which has been revised by Anderson and Krathwohl, this learning question includes in the type of analyzing (C4). Analyzing is solving a problem by separating and looking for the interrelationships of each part of the problem and finding out how these linkages can cause problems (Gunawan & Anggraini, 2015). The low learning outcomes of students in the first cycle, due to the limited time of the teacher in providing material reinforcement and train the reinforcement questions to students during learning activities.

Efforts made by researchers in the second cycle to improve the low learning outcomes of students in the first cycle are; the teacher provides examples of questions related to the learning material discussed, especially the questions with the level of analysis, then with students answer the questions, so students are directly involved in learning activities. Bruner said that the main purpose of education is that teachers must guide their students so that they can build their basic knowledge (Suyono & Hariyanto, 2015). Constructivism theory proposed by Piaget explains that teachers cannot simply transfer knowledge to students without the active role of students in the teaching and learning process. Therefore, students based on their cognitive maturity must be mentally active to build their knowledge structure (Suyono & Hariyanto, 2015). Improvements made by researchers in the second cycle provide an increase in student learning outcomes. Recapitulation of student learning outcomes in the second cycle can be seen in Table 6.

Student learning outcomes in the second cycle showed that students' ability to solve analyzing type learning questions (C4) increased. The analyzing type of learning questions in the second cycle are questions number 1, 3, 4, and 7 with the increased proportion that is obtained in each study result of test question. These results indicate that the students' ability to solve analyzing type learning questions is very good. Learning with guided discovery models assisted by PhET can improve student learning outcomes. Discovery learning will involve students directly in the process of understanding and constructing their knowledge or concepts. Thus the new knowledge that they acquire will be stored in long-term memory (Syaifulloh & Jatmiko, 2014). These results are in line with the other relevant researches Abdisa & Getinet (2012); Putrayasa, Syahruddin, & Margunayasa, (2014); Putri, Juliani, & Lestari (2017); Susanti, (2016) that the guided discovery is more effective in improving students' achievement, and influencing student science skills and student learning outcomes. The knowledge gained through this model is very personal and effective because it strengthens memory and gives pleasure to students because of the growing sense

of investigation and success (Fitri, 2015).

The use of PhET simulation media is supported by student worksheets as a guide for cognitive training or guidance for practical activities or demonstrations that can facilitate students in conducting discovery or investigation activities by the competencies to be achieved. Student worksheets contain titles, basic competencies, time of completion, tools and language, work procedures, and tasks that must be done. By using Student Worksheets, students can be trained to use PhET media, able to improve science process skills, scientific attitudes, and interest in learning (Maulani et al., 2018). Learning that is applied by using PhET virtual media with student worksheet as support is included in the category of very strong in achieving cognitive learning outcomes, products, and student process skills (Syaifulloh & Jatmiko, 2014).

CONCLUSION

The conclusion the results of the study it can be concluded that the use of PhET-assisted discovery models can improve student activities and learning outcomes with the result: 1) the average score of implementation of the lesson plan increased from good category to very good category, 2) the student's activity has increased, 3) the learning outcomes increased from 0% to 87.5% and has been declared complete in cycle II.

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