IOSR Journal of Research & Method in Education (IOSR-JRME)
e-ISSN: 2320–1959.p- ISSN: 2320–1940 Volume 9, Issue 4 Ser. II. (Jul. - Aug .2019), PP 21-25
www.iosrjournals.org

Development of Physics Based on Guided Discovery Learning Model to Improve Students Learning Result with PhET Simulation Programmed

PuspitaWidyagarini[1*],Tjipto Prastowo[2], Raharjo[3]
[1]*Student of Postgraduate State University of Surabaya*
[2]*Lecturer, Physics Department State University of Surabaya*
[3]*Lecturer, Biology Department State University of Surabaya*
**corresponding author: PuspitaWidyagarini*

Abstract. *This research was intended to produce physics learning materials with guided discovery model valid, effective and improved learning result who applied on 11th grade of senior high school.The method of data collection used observation method and test. Analysis method of research from analysis tested do, analysis of student activity, and analysis of student learning result expert. The research can be obtained that development of physics learning by Guided discovery learning model valid. Lesson plan of guided discovery done step by step, then can describe the category of effective based on guided discovery model.The conclusion of this research indicates that physics learning with guided discovery learning model are valid, positive and effective to improve the students physics concept and students activity on senior high school programmed.*
Keywords*: Guided Discovery Learning, Student Learning Result, PhET Simulation*

Date of Submission: 13-07-2019 Date of acceptance: 29-07-2019

I. Introduction

Physics Learning is implemented to increase the thinking process, learning process and scientificaffect to communicate of life skills. The involvement of students in the teaching and learning process is an implementation of student motivation in the process, of course, aside from receiving the subject matter from the teacher. Students can play an active role by doing activities that support the learning process such as by discussing, reading and understanding the subject matter, carrying out the tasks instructed by the teacher or looking for other material sources that can help them in understanding the lesson and others.

Physics learning in School, teachers often to teaching accordance with the applicable curriculum, no attention to some important aspects related to the learning process and character of students.The success of the teaching and learning process is measured by the student's ability to work on exam questions. However, the fact is that students do not understand the meaning of physics formulas. The situation and the conditions can lead to the students felt depressed during the learning Physics. Based on the results of interviews with one of physics teachers at MAN Sidoarjo, as well as observations on teaching and learning activities there are several learning problems that still become obstacles in the teaching and learning process.These problems include: (1) lack of laboratory equipment; (2) learning is still dominated by teachers (teacher-centered); and (3) students are less active in conveying ideas and tend to be listeners because students are embarrassed to ask questions or convey ideas and teachers lack understanding of students, (4) rarely do skill activities to find facts from a physics concept.

One of effort that can be done by the teacher to overcome this problem is to design a teaching and learning process that can: involve the active role of students; interpret physical concepts and formulas; use media that can describe abstract concepts; and provide opportunities for students to argue so that they can grow and train students' skills.The learning process that involves students can be created by the teacher, one of them through the method of discovery.This is supported by the opinion of Asmani (2010), the discovery method is a way to develop active student learning methods by finding themselves, investigating on their own, then the results obtained will be long lasting in memory and can improve students' thinking processes.According to Suryosubroto (2012), a teacher has applied a guided discovery method, no guided guidance and inquiry method.On guided discovery, the teacher presents a problem, gives guidance on solving, and guides students in terms of recording data. Guided discovery is designed to teach concepts and relationships between concepts.

One of the material that must be accepted by 11th grade of senior high school is the kinetic gas theory. The kinetic gas theory has unique characteristics; this material is abstract so it needs to be concretized.Through

the guided discovery learning model, students are invited to concretize the results of the kinetic gas theory equations that have been carried out by Boyle, Charles, and Gay-Lussac.

In the kinetic gas theory, the tools in real laboratories are still present in this school, and to make their own costs are not small and the tools made tend to be simulation only.So that the *PhET* simulator in this activity can help support the learning process to find relationships between variables on the kinetic gas theory.From the subject matter, the kinetic theory of gases tends to suggest microscopic material.Based on*PhET* simulator about kinetic gas theory material students can find out the form and state of the gas in a closed space if the temperature is constant or the pressure is fixed or the volume is fixed.

II. Development Method

Learning design uses the Kemp (1994) model approachThe development of learning devices model Kemp et al (1994) is a continuous circle. Each development is directly related to the revision activity. Device development can be started from any element in the circle.According to Ibrahim (2002) a developer can start the development process from any component and each step of device development is directly related to "activity".Because the curriculum that applies in Indonesia is goal oriented, the development process should start from the goal.he flow steps of the design of the development of Kemp's learning model (1994) are described:

a. **Analysis of Objectives and Subjects**

The first activity carried out in planning the development of learning devices is to determine the subject matter in which the indicators are included.The subject is a component of subjects that discusses the contents of the field of knowledge to be studied. In physics subjects the subject of the kinetic gas theory, the competencies listed in the 2013 curriculum, basic competency is to understand the kinetic gas theory in explaining the characteristics of gas in a closed space.

b. Student Analysis

Student analysis is very important to do at the beginning of planning, namely by paying attention to the characteristics, abilities and experiences of students. The analysis in question includes students' academic, social, maturity, culture and learning styles.

c. Task Analysis

Analysis of tasks to know and carry out skills activities that will be carried out. Task analysis is an analysis of the entire task which includes content analysis, procedural analysis, and concept analysis. The details of each analysis are described:

Application in class is the first test step (limited trial). Learning tools that have been developed are applied in classroom learning activities. Test I was conducted to see the suitability of learning and devices with student characteristics.Trials are intended to look at the learning effects and characteristics of the instruments developed. The scenario for the implementation of trial I was to carry out teaching and learning activities in 3 meetings. At the beginning and end of the meeting a concept understanding test was conducted. At the end of the meeting students were given a questionnaire for students' responses to the implementation of learning starting from the LKS, to the atmosphere of learning in the classroom.

III. Education Research Instrument

The validity sheet of the learning device is used to obtain data on the validity of the learning device. The validation sheet is filled by experts who review and assess the learning tools developed by the researcher. Instrument for RPP validation sheet, LKS validation sheet, knowledge test validation sheet, validation sheet for student performance sheet instrument, student attitude assessment instrument validation sheet.

The implementation of learning is observed using the implementation observation sheet by two observers who can observe all learning activities. Implementation learning data was obtained by using the learning implementation observation sheet. The calculation of the reliability of the observation instrument for learning implementation is as follows: $$Percentage\ of\ agreement = \left[1 - \frac{A-B}{A+B}\right]\ x\ 100\%$$

Information:

A : the frequency of the aspect of activity observed by the observer which gives a highfrequency.

B : the frequency observed by the observer which gives a high frequency.

The instrument developed is said to be reliable if it has a percentage of ≥ 75% (Borich, 1994).

The student activity observation sheet is filled by four observers who make it possible to observe and follow all student activities in learning activities.

Student learning outcomes data are taken from three aspects, namely cognitive, psychomotor, and affective.

A. Cognitive Aspects

Data on learning outcomes aspects of knowledge obtained from cognitive tests. as many as 20 MCQs refer to Bloom's revised taxonomy of domain C3 (apply), C4 (analyze), C5 (evaluate).

B. Psychomotor Aspects

Data on the learning outcomes of science and psychomotor process skills are obtained from student performance tests in conducting inquiry activities under the observation of two people. The aspects of science and psychomotor process skills are assessed, namely formulating problems, formulating hypotheses, determining variables, measuring volume, measuring temperature, measuring time, making graphs, analyzing the results of experimental data, and concluding experimental results. Calculation of instrument reliability assessment of science and psychomotor process skills uses the following formula:

$$Percentage\ of\ agreement = \left[1 - \frac{A-B}{A+B}\right]\ x\ 100\%$$

Information:

A : the frequency of the aspect of activity observed by the observer which gives a high frequency.

B : the frequency observed by the observer which gives a high frequency.

The instrument developed is said to be reliable if it has a percentage of ≥ 75% (Borich, 1994).

C. Affective Aspects

The observation sheet aspects of student attitudes have several aspects that are judged to be related to student attitudes, namely gratitude, caution, honesty, and responsibility.

IV. Discussion

A. Development of Learning Physics Materials

Learning developed in this study include: 1) Learning Plans; 2) Student Worksheets; and 3) Form of assessments according: student attitude assessment instruments, cognitive aspect test instruments, and performance test instruments. The process of developing learning devices refers to the model approach of Kemp et al (1994).

The Learning Plan (RPP) developed by the researcher begins by specifying the subject in which it contains indicators. The subject is a component of subjects that discusses the contents of the field of knowledge to be studied. In physics subjects the subject of the kinetic theory of gas, the competencies listed in the 2013 curriculum, its basic competency is to understand the kinetic theory of gases in explaining the characteristics of gases in closed spaces.

The learning implementation plan that was developed by the researcher was then validated by 2 experts with an average score based on 3 aspects which included: aspects of the format that got a score of 3.63 with very valid categories, content aspects got a score of 3.67 with very valid categories, and aspects of language gained score 3.67 with a very valid category. The average results of RPP validation from the three aspects are 3.65 with a very valid category (Ratumanan & Laurens, 2006). Based on this, the developed RPP is very valid for use by teachers in learning by paying attention to the validator's suggestions and improvements. Suggestions and improvements to RPP in general, namely: 1) time allocation should be more detailed in each phase of learning; 2) description of activities in the RPP so that they are made more operational; 3) indicators are at least the same as learning objectives and must be broken down according to what is taught.

The learning physics materials developed by researchers are the Student Activity Sheet (LKS). The LKS toolkit is assessed based on three aspects of the format, content aspects, and language aspects. The results of an average assessment of 2 expert validators on the student activity sheet consisting of three aspects, namely: 1) aspects of the format get a score of 3.60 with very valid categories, 2) content aspects get a score of 3.70 with very valid categories, and 3) language aspects score 3.60 with a very valid category. The average results of LKS validation from the three aspects are 3.63 with very valid categories (Ratumanan& Laurens, 2006). These results indicate that worksheets developed are appropriate for use by teachers in learning.

The learning physics materials developed is an assessment instrument of learning outcomes in the form of: student affective assessment instruments, mastery test instruments, cognitive aspects and psychomotor instruments.The instrument of learning outcomes in cognitive aspect is an assessment tool used to measure the mastery of aspects of students' knowledge of kineticgas theory. The development of the mastery test concept is based on the content of material that has been determined by the Government in the form of Core Competencies (KI) and Basic Competencies (KD). The questions developed were 20 items.

The questions that have been developed by the researchers are validated by experts on average shows that the aspects of the contents of this device get a score of 3.60 and the test questions are stated to be very valid, from aspects of language and question writing to a score of 3.70 and declared valid (Ratumanan& Laurens, 2006). These results indicate that the cognitive test developed is appropriate to be used as a teacher to measure the mastery of the physics knowledge of the kinetic gas theory. Suggestions and general improvements by the validator are the questions must be adjusted to the indicators and the realm of thinking.

Psychomotorinstruments test were developed to assess students' science and psychomotor process skills. Indicators of science process skills to be assessed are formulating problems, formulating hypotheses, identifying variables, compiling experimental data, making graphs, analyzing data, and formulating conclusions.

The student's affective instrument test is an assessment instrument with a student's attitude observation sheet during learning using a guided discovery model learning device. In order for each indicator to be observed in learning activities, the researcher develops an operational description of the student's attitude assessment rubric. The results of the assessment of the development of the student attitude observation sheet by two experts on average showed that from the aspect of content, language and conclusions got a score of 3.75 which was stated to be very valid (Ratumanan & Laurens, 2006).

B. Testing of Learning Physics Materials

Based on the analysis of the implementation of the use of learning devices observed by two observers. Observations were carried out for 3 meetings which were the implementation of RPP 1, RPP 2, and RPP 3. The implementation of the RPP consisted of three activities, namely introduction, core activities, and closed activities. The three main sections have been adapted from a guided discovery model that has been developed specifically to engage students actively to try to find information and knowledge on their own with guidance and guidance given by the teacher. Overall out of the 3 replications all the stages of activities in the RPP in the first trial were carried out and on average the overall implementation score was 3.45 with a fairly good category (Ratumanan& Laurens, 2011). The instrument for implementing the RPP has an average reliability of 92.46% and is categorized well (Borich, 1994).

The high average score and the good category are due to all the learning stages being carried out and several other things. First, in the preliminary activity; in the initial phase the teacher starts PBM by praying to instill awareness and gratitude for the greatness of God, the teacher motivates students to implement PBM and observe natural phenomena related to the kinetic theory of gases, the teacher asks students how the heat and temperature changes are experienced objects, the teacher orientates students to the problems of the kinetic theory of gas, and the teacher conveys cognitive, affective and psychomotor learning goals.

Second, at the core activity, the teacher reminds related material and process skills to be used, Organizing students to learn (forming groups, preparing tools and materials needed), guiding students to plan in groups, guiding students to experiment in groups, guiding students analyze and make conclusions, guide students to compile reports on experimental results, guide students to present reports on experimental results, guide students to review learning outcomes and answer problems at the beginning of learning.

Third, in the closing activity the teacher analyzes and provides feedback related to the process of discovery made by students and reminds students to learn the next material.

The value of the pretest is used to determine the aspects of students' initial knowledge. The posttest value obtained by students illustrates the learning outcomes of students' knowledge after taking guided discovery model learning. The sensitivity of the items is used to determine whether the questions developed are good or not, can be seen from the level of sensitivity of each item. The results of the analysis in the posttest showed that indicators 1 and 20 scored below 0.30 and the other indicators scored above 0.30 (Gronlund& Linn, 1995).

The increase shown by the results of the analysis using n-gain shows that the application of the development of guided discovery model physics learning tools is effective in increasing the mastery of aspects of knowledge and understanding of students' concepts in the kinetic theory of gas. Students respond very strongly to cognitive tests.

Learning outcomes aspects of student attitudes obtained from observers' attitudes of students during learning which include religious attitudes and social attitudes of students, religious attitudes observed during learning are gratitude, social attitudes observed are careful, responsible, and honest, gratitude the greatness of God on an average of 15 students observed during the study was 78.33% for three meetings in the Good category.

The attitude of prudence of students during the two replications observed by conducting guided discovery learning was 74.44% for three meetings in the Good category (Kemendikbud, 2013), At the first meeting there were students who were not careful so that they dropped the thermometer and measuring cup the next meeting there were no students who damaged the experiment equipment, the Teacher reminded them to be more careful in conducting the experiment. This indicates that by using a guided discovery model students can be more careful when carrying out and using experimental tools.

The attitude of responsibility on an average of 15 students observed during the implementation of guided discovery learning was 72.78% for three meetings in the Good category (Kemendikbud, 2013). At the first meeting there were two students who did not return the experimental tools and materials, the end of the teacher's teaching reminds them to be responsible for what we do including returning the tools and materials that

we borrow, at the next meeting all students return the tools and materials they borrow. This indicates that using a guided discovery model students can be more responsible during the experiment.

The honest attitude of students during conducting guided discovery learning was 76.11% for three meetings in the Good category (Kemendikbud, 2013). At the first meeting there were two students who were walking around looking for a cheat sheet and asking another group. not honest with still walking looking for a cheat sheet, at the end of the lesson the teacher reminds to be honest with what we do including returning the tools and materials that we borrow, at the next meeting all students are honest in writing the experiment and not cheating, this indicates that using the discovery model guided students can be more honest during the experiment.

V. Conclusion

Based on the results of the discussion, it can be concluded that the guided discovery model physics learning device developed has been valid, practical, and effective to improve learning outcomes and activities of students of the MAN Sidoarjo.

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PuspitaWidyagarini ." Development of Physics Based on Guided Discovery Learning Model to Improve Students Learning Result with PhET Simulation Programmed." IOSR Journal of Research & Method in Education (IOSR-JRME) , vol. 9, no. 4, 2019, pp. 21-25.