

The Development of Student Worksheets based on Guided Inquiry by Class and Laboratory Activity for Reaction Rate Material at the 11th Grade in High School

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Abstract - One of the teaching materials that can be used to improve students' understanding of reaction rate materials is guided inquiry-based student worksheets. Student worksheets are created using guided inquiry cycles consisting of orientation, exploration, concept formation, application, and cover. Student worksheet is also packed with involving three levels of chemical phenomena namely macroscopic, microscopic, and symbolic. This study aims to produce a teaching material in the form of student worksheet which is then tested validity, practicality, and effectiveness that can be used as a teaching material in chemistry learning in the 11th grade. Research and Development (R & D) has been used as a method in this type of research. The development model used in this research is the Plomp model which consists of three stages: preliminary research, prototyping stage, and assessment phase. The result of the validity test showed that the student worksheet obtained a score of 0.85 with the category as high. The practicality test at the one-to-one, small group and field test stages give a value of 0.86, 0.80, and 0.78 with all three values being in very high categories. In the effectiveness test obtained gain score of students from learning outcomes before and after using student worksheet is 0.71 which is in the high category and the average student activity at each meeting 80%. Based on these results, it can be concluded that the guided inquiry-based student worksheet has been valid, practical, and effectively used in the chemistry learning process at the rate material of the reaction.

Keyword - Students Worksheet; Guided Inquiry; Reaction Rate.

I. INTRODUCTION

Chemistry is an important science in science that studies the matter and the changes that come to it (Sirhan, 2007: 2; Chang, 2011: 1). Chemistry subjects are classified as difficult and abstract subjects so that learners are afraid to learn them (Kasmadi and Indraspuri, 2010: 574). According Sunyono, et al (2009: 2), in the learning process students are given less direct experience in observing a chemical reaction. This is due to a lack of understanding of chemistry concepts and interests of learners to chemistry lessons so that learners consider the subject matter of chemistry is abstract and difficult to understand. The abstract concept can be described using submicroscopic levels in multi-level representations. Multiple representations consist of three levels, namely macroscopic, submicroscopic and symbolic

levels. In general, chemical learning that occurs today limits only on two levels of representation, macroscopic and symbolic. Learning at the submicroscopic level is presented only through lectures and discussions, so learners assume the learning materials of chemistry are abstract and difficult to understand or learn (Nurpratami, et al, 2015: 353; Sunyono, 2012: 486).

Based on the author's analysis of five chemistry teachers and students in three high schools in Padang (SMA Negeri 1, SMA Negeri 5 and SMA Pertiwi 1) have found the problems experienced by students that the level of student understanding was relatively low, students difficult in concept such reaction rates, understood the order of the reaction and the factors that affect the reaction rate. In addition, in the learning process, teachers were still using

teaching materials such as textbooks and student worksheets. Student worksheets used contained material descriptions and training questions, have not involved three levels of chemical representation and have not used learning models. This is in line with the opinion of Arafat, et al (2013: 47) which states that student worksheet used in the school in the form of a summary of the subject matter which is accompanied by a collection of questions, especially multiple choice questions. In addition, the questions contained in the student worksheet can be answered by looking at the material in the student worksheet so that less train students think and find the concept of chemistry.

One way to assist students in learning and to improve students' understanding of reaction rate metrics is by the presence of teaching materials involving three multi-level representations. One of the teaching materials is the student worksheet. In accordance with the chemical characteristics that must be understood by considering the connectedness of the three levels of representation, the teaching materials must be developed by meeting these criteria (Nurpratami, 2015: 353).

Nurfidianty and Mulyani (2015: 22) stated that the use of student worksheet will not produce satisfactory results without the use of learning model in the learning process. One of the learning models that can be used is the inquiry learning model (Dwiyanti, et al, 2017: 1). According to Pratiwi (2015: 33) the type of inquiry that is suitable for high school level is guided inquiry, since guided inquiry provides more direction for students who are not ready to solve problems with inquiry without assistance due to lack of experience and knowledge. Therefore, this developed student worksheet applies the guided inquiry learning model so it is called the guided inquiry based student worksheet.

According to The College Board (2012: 15) all processes in guided inquiry are incorporated in one cycle. The simplest cycle was triggered by Lawson and Abraham consisting of exploration, concept formation, and application. However, Hanson (2005: 1) developed a guided inquiry learning cycle into 5 stages: orientation, exploration, concept formation, application and cover.

The orientation stage is the stage of connecting old knowledge with new knowledge. Stage students analyze data and collect data applied at the exploration stage. At this stage students are given a model of images, graphics, data tables and others. The concept forming stage is the stage where the teacher leads a brief discussion to introduce the concept and interpret the data. Each of its concepts is

explored with one or more models and guided by critical-thinking question or key question. The key question is the heart of guided inquiry activity (Hanson, 2005: 2-3). When students explore the model and answer the key questions given the students have entered the stage of concept formation. Once the concept is identified and understood, it is strengthened and expanded in the application stage. At the application stage is the stage of giving practice and questions. At the closing stages the students make inferences, reflect on what they have gained, and assess their performance.

This student worksheet has been used for in-class activities and for laboratory activities. Activities in the classroom is the activity to find the concept by exploring the model of images, graphics, and tables that represent a concept. While the activity in the labor in question is the activity to find the concept of data obtained during practicum activities. Activities in the laboratory are very important in science and chemistry learning. Bayram, et al (2013: 988) also states that students will be better understood when involved in laboratory activities. Activity in the labor begins with a preliminary question or pre-lab guiding questions. American Chemical Society [ACS] (2012: 10) writes questions in the pre-lab should guide students to connect old knowledge with activities to be performed in the laboratory. In the final process of learning is given a final question or post-lab assessment. Questions in the post-lab lead students to use the concepts they have gained to analyze a phenomenon.

This study aims to produce a valid, practical and effective guided inquiry student based worksheet to improve students' understanding of reaction rate.

II. METHOD

Research and Development (R & D) has been applied as a method of this research. Research development is the research used to produce a specific product and test the effectiveness of the product (Sugiyono, 2012: 297). The development model used is the Plomp model consisting of three main stages, namely: (1) preliminary research aims to get an overview of the product characteristics developed so that it can be used in the learning process. This stage consists of needs analysis and context analysis. (2) prototyping stage aims to design problem solving that has been identified at the initial investigation stage. (3) Assessment phase is the final stage in educational research. After the development phase has been completed, the next step is to conduct large group trials of one class to see the

effectiveness and effectiveness of guided inquiry-based student worksheets (Ploomp and Nieveen, 2013: 30).

In this preliminary stage has been done needs analysis, context analysis and student analysis which aims to get a description of the product's characteristics developed so that it can be used in the learning process. Needs analysis is done by interviewing five high school chemistry teachers in Padang city to get information about the problems that occur in the process of learning chemistry While student analysis aims to analyze the characteristics of students as a picture for designing teaching materials. The results of this needs analysis are then taken into consideration in the design and development of student worksheets.

In the context analysis phase, curriculum and concept analysis are performed. Curriculum analysis is conducted on the current curriculum. This analysis aims to formulate indicators and learning objectives in accordance with the competencies expected by the national curriculum 2013. While the concept analysis aims to identify, detail, systematically arrange the necessary concepts and be used as a reference in the development of guided inquiry based student worksheets.

At the prototyping phase has been developed a series of prototypes. The prototype is evaluated by reference to formative evaluation. Formative evaluation in this research consists of self-evaluation, expert review, one to one evaluation and small group evaluation.

In the phase assessment, a large group test (field test) is performed. Field tests conducted on the class to look at the practicalities and effectiveness of the product being developed.

III. RESULT AND DISCUSSION

A. The Development Result

1. Preliminary Research Phase

This stage have been identified or analysis before designing or developing the product. The results of the analysis are described below:

a. Needs Analysis

This stage has been collected information on the problems contained in the study of chemistry, especially on the material reaction rate. Needs analysis is done on teachers and students. Researchers collected information by interviewing five high school chemistry teachers in Padang City.

Based on the results of interviews of chemistry teachers concluded that students are still difficulties in understanding the material reaction rate is related to the factors that affect the rate of reactions, equations and reaction order. In addition, teaching materials used in the learning process is a textbook and student worksheet from the publisher. Student worksheet used contains a description of the material and exercise questions. Training questions can be answered by the students see the material in the student worksheet so that less train students to think critically and find the concept of chemistry. In addition, the teaching materials have not involved three levels of chemical representation and have not used learning models.

Based on the results of needs analysis, teachers expected teaching materials that could guide students to find the concept so that it can last long in memory. In addition, teachers also expected teaching materials that involve three levels of chemical representation, easy to understand and have color combinations of interest so that it can cause student interest to learn.

b. Students Analysis

Student analysis is an analysis of student characteristics that include academic ability, learning motivation, and student age. Students analyzed were 11th grade high school average age 15-17 years. According to Piaget the level of thinking of children of that age at the stage of formal operational development, where at this stage students have the ability to think logically, abstract, and can draw conclusions (Dahar, 2011: 136). At the stage of formal operational development students have been able to deduce something through available information. Such information can be images, tables, graphics, and more. This is in accordance with Abidin (2014: 153) which states guided Inquiry is an inquiry that is relevant to psychological high school students because in certain processes students still receive guidance and teacher guidance in carrying out its inquiry process.

c. Curriculum Analysis

Curriculum analysis has been done by understanding and analyzing the current curriculum of curriculum 2013 revision 2016. This analysis is in the form of Core Competence (KI), Basic Competence (KD) analysis aimed at formulating indicators of competency achievement and learning objectives to be achieved by students. So it can be known important concepts on the learning of chemistry, especially on the material reaction rate.

d. Concept Analysis

Conceptual analysis is the identification of key concepts in the material to be discussed. The main concepts to be discussed at the rate material of the reaction are the concept of reaction rate, collision theory, factors affecting the rate of reaction, the equation of the reaction rate and the reaction order.

2. Development or Prototyping Phase

The results obtained in the preliminary phase are used as guidance in developing student worksheets based on guided inquiry. The result of development carried out in this phase is below:

a. Prototype I

Prototype I started from the design and manufacture of student worksheet based guided inquiry on the material reaction rate consisting of five stages namely, orientation, exploration, concept formation, application and cover. Student worksheets are designed to contain cover, introduction, table of contents, title / identity of the material and instructions on using student worksheets, core competencies, basic competencies, indicators, learning objectives and implementation of guided inquiry steps in classroom and laboratory activities.

After the designing and making of the student worksheet based on inquiry is completed, the next step is formative evaluation in the form of self-evaluation. This stage focuses

on the completeness aspects of the student based worksheet component based on guided inquiry using check list.

The results of self-evaluation indicate that student worksheet components exist and are appropriate. However, there are some errors that occur that is the error of writing words, spaces and writing capital letters and errors in the description of the model presented in the classroom activity. After the evaluation, it was revised by correcting the errors of writing words and errors in the description of the model presented in the student worksheet so that the resulting worksheet based on inquiry is guided on the material of the reaction rate for the 11th grade of Senior High School.

b. Prototype II

Prototype II is validated to experts to see the validity of student worksheet based guided inquiry consisting of four aspects, namely content, constructs, language and graphics. Evaluation tool used is student guided inquiry sheets validation worksheet. Validation is done by seven expert validators. In addition to assessing student worksheets, validators are also required to provide suggestions for improvements to the student worksheet. The suggestions provided by the validator are then used as a reference to revise the student worksheet developed. The purpose of revising the student worksheet is to improve the part of the student worksheet that is deemed to be incorrect or to be added before the student worksheet is used or tested.

The result of the validation of student worksheet based on guided inquiry can be seen in Table 1.

Table 1. The results of the validation of student worksheet based on guided Inquiry

No	Rated aspect	Components	Criteria
1	Content Component	0,85	Very high
2	Construct Component	0,85	Very high
3	Language Component	0,89	Very high
4	Graphical Component	0,84	Very high
	Average	0,85	Very high

Based on the average result of validation of student worksheet based guided inquiry conducted by the validator is 0.85 categorized as very high.

c. Prototype III

Phase III prototype development is to conduct formative evaluation activities. One to one evaluation has been done. Then, the test of validity by experts has been applied, then

conducted one to one test to three students with high ability, medium and low.

In one-on-one trials also conducted interviews with students informally. This is done to request responses and suggestions of students to the student worksheet that has been developed, and then tested the practicality to know the extent of benefits, ease of use, attractiveness and efficiency

of time against student worksheet developed. The evaluation tool used is a questionnaire of student responses and interview sheets. Based on the results of test of practicality (one to one) shows that student worksheet based guided inquiry on the material reaction rate obtained an average of 0.86 categorized as very high.

d. Prototype IV

The work done on prototype IV is to test the practicality of the student worksheet developed by evaluating small groups of six students. This small group evaluation is done by explaining the steps of student guided inquiry in student learning. The purpose of small group evaluation is to identify the deficiencies of Prototype III. Based on the results of the practice of student worksheet on small group trials is 0.80 categorized as high. It can be concluded that the student worksheet based on inquiry is guided on the material of the class XI reaction rate can be continued in the next stage that is large group test (field test).

3. Assessment Phase

In the assessment phase a large group test was conducted to obtain results on the effectiveness and effectiveness of a guided inquiry-based student worksheet produced.

The practice of guided inquiry-based student worksheet has been obtained from the result of questionnaire analysis of teacher's response to chemistry subjects and students' responses. Practicality testing is carried out to determine the extent to which benefits or ease of use, presentation aspect, and ease of interpreting by using guided inquiry-based student worksheets.

The effectiveness of the student worksheet is observed from student learning outcomes and learning activities. Student learning outcomes done by giving test result of learning. These learning outcomes are related to changes in learning outcomes before and after using guided inquiry based student worksheets developed. Student learning activity done by giving observation activity observation student activity sheet.

a. Practicality

- 1) Practicality is based on teacher's response questionnaire

Practicality data was obtained based on the teacher's response questionnaire. The practicality questionnaires filled by two teachers aim to get information on the practicality of the student worksheet based on the teacher's consideration. The result of teacher questionnaire response

data analysis obtained the average of practicality student worksheet value of 0.71 categorized as high.

- 2) Practicality is based on student's response questionnaire

Practicality test based on student response questionnaire is done after the students follow the learning using student worksheet developed in accordance with the schedule that has been determined. Practicality test is done by giving questionnaires of practicality to students after using guided inquiry based student worksheet.

Based on the data obtained from the practice of student worksheet on a large group test (field test) based on the questionnaire of student responses, it obtained the level of practicality of student based inquiry based inquiry on all aspects assessed obtained an average value of 0.78 categorized as high.

b. Effectiveness

Large group test (field test) also aimed to know the effectiveness of student worksheet that has been designed; the effectiveness criteria of student worksheet can be seen from the influence of the use of student worksheet on learning outcomes and student learning activities. Here are the results of data analysis of the effectiveness of student worksheet that has been used.

- 1) Student activity

Student activity is an activity or student behavior that occurs during the learning process by using student worksheet that has been developed. Learning activities are observed each time the lesson uses a guided inquiry based student worksheet. Student activity is one of the aspects used to look at the effectiveness of the student worksheet that has been designed.

The student activity assessment categories consist of answering key questions, asking the teacher, responding to the teacher's questions, doing the exercises, summarizing the results of the discussion, answering the pre-lab questions, practicing and answering the post-lab questions. The result of student activity observation obtained by percentage of student activeness when using student worksheet based on inquiry is 80%. It has been shown that student learning activities during student categorized as effective worksheet.

2) Student learning outcomes

The effectiveness test of the guided inquiry based student worksheet is assessed from changes in the students' learning outcomes before (pretest) and after (posttest) using the developed product. The purpose of pre-tested to determine the initial ability of students before learning to use products developed. Trials were conducted on a single class of 29 students. Based on the calculation of N-gain obtained average learning outcome was 0.71. According to Hake's criterion (2002: 3), it has been shown that student learning outcomes have increased categorized as high. In addition learning using student worksheet based guided inquiry itself can be categorized effective because > 60% of students have learning outcomes above the KKM that is as much as 79% of students or 23 people.

B. Discussion

1. Validity

Validity is an assessment of the design of a product. A valid product is an instrument that can measure what should be measured (Sukardi, 2011: 31). Validation comes from the word "valid" which etymologically means precise, true, valid, and valid (Latisma, 2011: 82). This validation assessment includes aspects of the content, construct aspects, aspects of the discourse, and aspects of graffiti. The student worksheet developed was validated by four chemistry lecturers, one Indonesian lecturer and two high school chemistry teachers. This is done so that the deficiencies not encountered by an expert can be complemented and refined by other experts, so the quality of the developed content can be guaranteed quality and accuracy (Abdurrohim, 2016: 206).

Based on the validation result, the contents of the student worksheet developed are the corresponding material of the reaction rate, the interrelationship between the indicators to the KD and the learning objective with the indicator is correct. The model presented is in accordance with the taught material, the key question given can guide students to find concepts on the reaction rate material. This is in accordance with the function of the key questions in guided inquiry learning which are questions that guide students in exploring models and finding concepts (Hanson, 2006: 6). In addition, all student worksheet content is also referring to the achievement of learning objectives so that student worksheet can be used to guide students. According Sanjaya (2008: 173) if the teaching materials used in accordance with the learning objectives to be achieved then the teaching materials can guide students.

The result of the validation of student worksheet construct aspect was obtained by 0.85 as very high. This indicates that the student worksheet has been systematically arranged according to guided inquiry stage consisting of orientation, exploration, concept formation, application and cover. These learning steps are integrated in the student worksheet according to guidelines development of teaching materials by the Ministry of Education (2008). According to Rochmad, (2012: 14) that the aspects of validity can be seen from: (1) the validity of this content indicates that the student worksheet developed is based on a curriculum or on a strong theoretical rationale. (2) The validity of the construct shows the interrelationship of each other and is connected internally consistently between the components of the student worksheet.

The result of the validation of the linguistic aspect is 0.89 as very high. The instructions on using the student worksheet are clear. Student worksheets have used good and correct Indonesian rules so students can easily understand and understand the student worksheet developed. In addition, writing does not use local languages so that students can understand from different regions. This is in line with the opinion of Jannah (2013: 177) which states that the category is feasible on the language aspects obtained because the language used in textbooks developed is a language that is good and true in accordance with the standard Indonesian language and the writing of language does not use local languages, so it can be understood by all students from various regions.

Student worksheet validity of the graphical aspect has a value of 0.84 categorized as very high. This indicates that the layout is orderly, the images contained in the student worksheet are clearly visible, the font size used in the student worksheet is clearly legible and the colors used are good. According Hamdani (2010: 222), good layout and color can cause attraction to student's interest in learning.

2. Practicality

a. Practicality analysis based on the teacher's response questionnaire

Practicality is related to the use of teaching materials used in the learning process. Teaching materials are categorized as practical if they can be used to carry out logical, continuous learning without much of a problem. Practicality considerations can be seen from the following aspects. (1) Ease of use, (2) The time required in the implementation should be short, fast, and appropriate, (3) The attractiveness of teaching materials to student learning

interest (Sukardi, 2011: 52). Practicality data were analyzed by using kappa moment obtained from questionnaire of students' response practice and questionnaire of teacher's responsiveness.

The appraisal of students' worksheet was assessed by two chemistry teachers of SMA Negeri 5 Padang. The teacher responds positively to the student worksheet developed. This is seen from the average value of student worksheet practice is 0.71. This indicates that the overall practice criterion is high.

Based on the aspect of its ease of use, the guided inquiry-based student worksheet developed facilitate the teacher in implementing the learning, facilitate the teacher in achieving the learning objectives and facilitate the teacher to increase student activity in learning.

Based on time efficiency aspect and benefit, it is found that the implementation of learning using student worksheet based on inquiry is guided to be more efficient and learning materials can be felt by students in the structure of science and daily life. From all aspects assessed student worksheet scores with a high category, thus the student worksheet designed has been practically used by teachers in the learning process.

This indicates that the student worksheet produced facilitates the teacher in achieving the learning objectives and facilitate the teacher to increase student activity in learning. This is in line with the function of instructional materials (1) guidelines for teachers in directing all activities in the learning process, (2) guidelines for students who will direct all activities in the learning process, (3) tool evaluation achievement / mastery of learning outcomes (Ministry Education, 2008). It can be concluded that the student worksheet based on inquiry is guided on the material of the reaction rate that can be used by the teacher in carrying out the learning.

b. Practicality analysis based on student's response questionnaire

Practicality test by students is done three times that is in stage one-to-one, small group, and field test. The results of questionnaires of practicality at the one to one evaluation, small group and field test are 0.86, 0.80 and 0.78, respectively.

Based on the results of this practicality test, it appears that student based inquiry inquiry can facilitate students to understand and remember the concepts on the material content of reaction rate, the existence of key questions can

lead students to explore the model to find the concept. Assisted students consolidate the material after using the student worksheet. This showed that the process of delivering the message on the student worksheet goes well. This is because of the drawings on the student worksheet. Arsyad (2013: 12) states that the existence of image stimulus on teaching materials will provide better results in remembering, recognizing, recalling, and linking facts with concepts.

3. Effectiveness

The effectiveness test aims for the exposure of the product developed in the learning process. The effectiveness of the development of teaching materials can be seen from the results of student learning after using student worksheet and student activity during the learning process using student worksheet.

Rochmad (2012: 71) said that the effectiveness of a teaching material developed can be seen from the potential effects of quality learning outcomes and attitudes of students. The purpose of this study was to determine the effectiveness of the use of guided inquiry based student worksheets with classroom and laboratory activities at the reaction rate material in 11th grade high school.

The activity assessed from the use of this student worksheet has a percentage of liveliness is 80% categorized as effective. This is in line with Arifin's opinion (2018: 54) which states that the percentage of student learning activity when using the Chemo-entrepreneurship (CEP) module is 80% categorized as effective.

This has shown that learning by using guided inquiry will increase students' learning activities because to find students' concepts of analyzing data by discussing with their peers and at the confirmation stage students communicate the concepts they have acquired (The College Board, 2013: 6).

Based on differences in student learning outcomes in pretest and posttest shows that more than 79% of the 29 students whose learning outcomes are above the KKM are as many as 23 students. This is in line with Budimah's opinion (2014: 5) which states that learning is said to be effective if the value of students after learning scores above KKM equal to or more than 60%.

Changes in student learning outcomes before and after using the product developed seen an increase in student learning outcomes at the time of the initial test and final tests. This is consistent with those described by Bilgin

(2009), Myers (2012), and Parappiliy et al (2013) that students who learn to use inquiry are more easily understand concepts, can improve the ability to think critically (high order thinking) and improve results learning the students, as well as providing meaningful learning. Nasrudin, et al (2015: 40) also explained that the increase in student understanding is also because students understand the representation contained in the student worksheet.

IV. CONCLUSION

Based on the development and experiments conducted, this guided inquiry based student worksheet is declared as valid or suitable to be used as a learning resource because the average score obtained from the validator is 0.85% categorized as a very high level of validity.

The effectiveness of student worksheet based on the percentage of student learning activity by using guided inquiry-based student worksheet obtained by an average of 80% with effective category. While the effectiveness of student worksheet based on student learning outcomes, obtained an average of 79.9% categorized as effective. In addition, practicality based on student and teacher responses shows that students and teachers respond positively toward guided inquiry-based student worksheets with high practicality assessments, so that student worksheets are well received and used as teaching materials in learning the rate of reaction in the 11th grade.

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