Guided Discovery Worksheet for Increasing Mathematical Creative Thinking and Self-Efficacy

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RESEARCH ARTICLE

Guided Discovery Worksheet for Increasing Mathematical Creative Thinking and Self-Efficacy

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ABSTRACT

This research development aimed to develop of worksheet based on guided discovery for increasing mathematical creative thinking and student's self-efficacy. Development stage in this study is a preliminary study, planning, development of worksheet, worksheet validation, and field testing. The subject of this research is the students of class 10A[3] and 10A[5] MAN 1 Central Lampung in the Academic of 2017/2018. The data of this research were obtained by observation, interview, mathematicalcreative thinking ability test and self-efficacy scale. The result of the validity by subject matter expert and media expert showed that the worksheet is considered excellent. The Initial field testing results indicate that worksheet is included in either category. The field testing results showed that (1) the student's mathematical creative thinking aspect was effective because seen from the N-Gain of 0,54 which included in the category of moderate improvement and (2) the student's self-efficacy was effective because seen from the N-Gain of 0,36 which included in the category of moderate improvement. It can be concluded that worksheet based on guided discovery effective way to improve the mathematical creative thinking ability and student's self-efficacy.

1. INTRODUCTION

The curriculum of primary and secondary education that is used today is the 2013 curriculum. 2013 Curriculum is a curriculum applied to replace the 2006 curriculum or Education Unit Level Curriculum. The 2013 curriculum began to be piloted in 2013 by turning some schools into stub schools. Currently, almost all levels of education from basic to upper secondary by using the 2013 Curriculum.

In the 2013 Curriculum, there are changes, including in the aspects of assessment and learning materials. In the learning material, there is a streamlined material and material added. Suppose that at the senior high school level, there are compulsory subjects and specializations. From class X students have taken majors according to their interests and talents consisting of IPA, IPS, Language, and Religion (especially for Madrasah Aliyah). All majors receive mandatory compulsory mathematics, while science majors get additional lessons as lessons of interest such as specialist mathematics.

Mathematics is an important lesson because it is universal (Mursalin, 2016; Amalia, 2018; Setiawaty, 2018). Mathematics also has a role to increase the quality of students to act logically, rationally, critically, and creatively (Fonna, 2018; Mursalin, 2014). Thus, mathematics cannot be separated from the ability to think. One of the ability to think in learning mathematics is the creative thinking ability. Some scholars say that creative thinking in mathematics is a combination of logical and divergent thinking based on intuition but in consciousness that takes into account flexibility, eloquence and novelty (Noer, 2011; Afandi, 2018; Winarso, 2018), further the ability to think creatively in mathematics is called the mathematical creative thinking ability.

The mathematical creative thinking ability is one of ability to discover new ideas and solve math problems creatively (Mursalin et al, 2018; Gonzalez, 2017). According to Purwaningrum (2016) indicates the creative thinking ability is the ability to find many possible answers to a problem. In addition to the creative thinking ability, it is also necessary independence in problems solving. The independence of this learning will lead to confidence in students. This was supported by Liu and Koirala (2009:1) who stated that mathematical achievement and self-confidence had a positive relationship.Confidence in problems solving presented hereinafter called self-efficacy.

According to Ormrod (2008: 20), self-efficacy is the assessment of a person about his own ability to run certain behaviors or achieve certain goals. More simply according to Somakim (2010: 49) self-efficacy is synonymous with "Self-Confidence". Based on the opinion of the expert's self-efficacy is one of confidence in his ability to do something for a purpose. Self-efficacy refers to the perception of an individual's ability to organize and implement actions to display specific skills (Turgut, 2013; Graham; 2005; Margolis, 2006).

Some research conducted by Kisti, H.H and Fardana, N.A (2012) states that the development of self-efficacy is important to support student's mathematics learning achievement because self-efficacy can support students' creativity ability. A student who has a high

self-efficacy will be high also creativity. Achievement of mathematics learning in Indonesia is under other countries. This is supported by survey results from Trends International Mathematics and Science Study (TIMSS) 2015 (Rahmawati, 2016; Nasir, 2018) which states that the achievement of science and math of elementary school students in 48 and 50 countries that follow the study. The achievement of the science of Indonesian students' grade 4 is ranked 45th out of 48 countries, while mathematics is ranked 45th out of 50 participating countries. In general Indonesian students are weak in all aspects of content and cognition, both for math and science.

Alleged cause of the low ability of students' mathematical creative thinking is teacher-centered learning (Evers et al, 2002). This model causes students do not develop their mindset. The teacher explains the subject matter and gives an example of the problem, then gives the exercise a matter of which the process of completion is similar to the example. So that the ability and potential of students less well explored in particular the mathematical creative thinking ability and student's self-efficacy. To overcome these problems, one effort to improve the mathematical creative thinking ability and self-efficacy through learning that involves learners directly, so that learners will be more leverage in interpreting a knowledge gained (Masitoh, 2018; Akay, 2010). This is in line with the learning process in the curriculum of 2013 that is student-centered. Student-centered learning one can use guided discovery learning models (Katuuk, 2014;Faisal, 2015; Uce, 2016; Hakim, 2017)

Guided discovery model is a teaching method that regulates teaching so that learners acquire knowledge that has not been known, in part or entirely found itself with teacher guidance. To facilitate the learning process using guided discovery learning model, a tool such as the Student Activity Sheet (worksheet). The worksheet is a student activity sheet that can be done independently as well as a group that contains guides for learning activities. This worksheet aims to maximize the students' comprehension capabilities in accordance with indicators in learning. One of the mathematics materials that match the guided discovery learning model and the mathematical creative thinking ability and self-efficacy is the Three-Variable Linear Equation System (TVLES), because this material is creatively and confidently found in the concept by the learners with the teacher's guidance. Thus, in order to construct a solid mathematical understanding, it is necessary to develop a worksheet.

The purpose of this research is to produce a worksheet product based on guided discovery to improve the mathematical creative thinking ability and student's self-efficacy, to find out how the effectiveness of learning using the worksheet in improving the student's mathematical creative thinking ability, to know how the effectiveness of learning using the worksheet in improving the student's self-efficacy.

2. METHODS

This type of research is Research and Development (R & D). The developed product is based Guided Student Worksheets to improve the mathematical creative thinking ability and student's self-efficacy.

Borg & Gall (1989) states that there are 10 steps for implementing research and development strategies: (1) Research and information collecting, (2) Planning, (3) Design/preliminary form of product, Preliminary field testing, (5) revision of Main product revision, (6) Main Field Testing, (8) Operational product revision test, (9) Final product revision, (10) Dissemination and implementation.

This worksheet development research is limited, meaning that the R & D stage in this research is its implementation only until step seven. This is due to limited time, energy and cost. The explanation of the research development steps is explained as follows:

1. Introduction Study Stage
   At this stage, a preliminary study is analyzed needs either by observation, interview or questionnaire.
2. Product Design
   The design stage of the product and the instrument is to make the design of the worksheet to be developed and the instruments to be used as an assessment
3. Expert and Revision Validation
   The initial product generated is a mathematical worksheet that is tested by an expert through an expert validation questionnaire. Expert tests conducted are media expert test and expert material test
4. Initial Field Test and Revision
   Initial products that have been tested are tested by the initial field test. Individual test by testing the draft on a class that has not received TVLES material in order to know the legibility and attractiveness of the worksheet
5. Field Test
   The draft that has been tested in the initial group test, it is tested to a larger group. In the field test stage uses pretest-posttest control group design.

Instruments used in this study consisted of two types of instruments, namely nontest and tests. The instruments are described as follows:

The non-test instrument, this non-test instrument consists of several forms that are tailored to the steps in development research. There are two types of non-test instruments used, namely interviews and questionnaires. Interviews were used during the preliminary study in the form of interview guidelines, to determine the initial conditions of students and the use of textbooks in schools. The questionnaire uses a Likert scale with four choices of answers that are tailored to the research stage and the purpose of the questionnaire.

Test Instruments, this instrument is a test of mathematical creative thinking ability. This test is to find the effectiveness of learning with guided discovery models. This test is given individually and aims to measure the mathematical creative thinking ability.

The data of the research was obtained from the interview in the preliminary study stage, review, various relevant research journals, and the review of mathematics textbooks of class-X senior high school curriculum in 2013, and the test instrument of mathematical creative thinking ability. The data are used as the reference for the preparation of the worksheet based on guided discovery.

Data analysis techniques in this study are explained based on the type of instruments used in each stage of development research, namely preliminary data analysis, worksheet validation analysis, and analysis of the effectiveness of learning using worksheet based guided discovery.

Data from the questionnaire results at the worksheet validation stage were analyzed qualitatively. In the worksheet validation stage, the data obtained are expert suggestions and comments, which are used as guidelines to improve worksheet. The data analysis of questionnaire result of the legibility and interest of the students is done descriptively qualitative.

Quantitative data is obtained from the test of mathematical creative ability. The data collection of this research is done by giving

the test of mathematical creative thinking before and after learning. The data obtained were analyzed using inductive statistics.

The analyzing of the test used is t-test. The t-test is used to find the effectiveness of worksheet. Furthermore, from the pretest and posttest data computed the gain index to find out the improvement of the mathematical creative thinking ability before and after learning.

3. RESULTS AND DISCUSSION

Based on the identification of emerging problems, the development of worksheet-based guided discovery becomes an alternative to overcome them. Some things of concern from the preliminary research results are as follows:

a) The results of observation indicate that the teacher still uses conventional learning method in mathematics learning.
b) Teaching textbooks used by teachers in the form of private publications worksheet and textbook Curriculum 2013.
c) Percentage of students who achieve mastery learning below 50% on TVLES material.
d) From the scale of the list of questions about the ability of creative thinking, students' difficulties are in TVLES material.
e) Some suggestions given by teachers during interviews are using the worksheet tailored specifically to support student's mathematical creative thinking ability, using guided discovery models.

The next step is to develop a worksheet. The results of Preparation worksheet preliminary study indicate the need for product development in the form of the worksheet to support student independence in learning. The worksheet is based on KI, KD, and material indicators. Based on these guidelines, the writing of the worksheet is divided into (1) The initial section; (2) core parts; and (3) The closing section. The prepared worksheet includes components: title page, worksheet title and worksheet identity,Group Identity, basic competencies and achievement indicators, tools/materials, and instructions for using the worksheet.

The worksheet begins with the presentation of problems and drawings to help students get into the stage of formulating the problem of looking at the overall what will be learned and then write down the problem to be solved. Next, there are some questions related to the problem presented. The next stage students are directed to collect data that has been obtained from the formulation of the problem. The material section is presented to facilitate the students in the construction phase of the conjecture. The stage of conjecture preparation is used to solve the mathematical problem in the form of calculation. The next stage is the withdrawal of conclusions from the completion of mathematical problems given. The worksheet final stage is the application of the concept.

The next step is expert validation. The worksheet that has been prepared then submitted to the material experts and media experts in order to get validation. The validation of the material experts indicates that the assessment of the worksheet content or material aspects is in the very good category. However, in terms of content, it takes some revision on the suggestion of the validator.

Further validation results from media experts indicate that aspects of construction and technical aspects already have very good criteria, but the worksheet should be revised before being used in the field. Revision is made by fixing the worksheet that is replacing the words that are less precise, correct typing errors, or changes the design worksheet. The revised results are reconstructed with material experts and media experts until a reasonable the worksheet is obtained and declared ready for use in the initial field trial phase.

The next step is an initial field trial. Initial field trials were conducted on grade X students who had not received TVLES material but had obtained two linear equations in class IX. This trial aims to determine the legibility and interest of students who use the worksheet based guided discovery before being used in field tests. The subject of the initial field trials was six students of class X with different abilities. The results of improvements from this trial are the accuracy of writing a page with a list of contents. The instrument used in this trial is the scale of student response. Based on the results of the scale, the worksheet is included in either category.

The results of worksheet material expert validation test are included in the very good category, and the result of the validation test of media expert on the worksheet is included in the very good category. Based on the results of the validation test, the worksheet meets the feasibility so that it can be tested.

The test performed after the expert is the initial field test. The field trials were conducted in class XA^5 as an experimental class and class XA^3 as control class at MAN 1 Central Lampung with 45 students for each class. At this stage, the worksheet is based on the discovery of guided revisions in the previous stage. During learning, each group is given on the worksheet of development outcomes and the teacher plays a facilitator that directs learning to work effectively.

Field testing is a test conducted to determine the effectiveness of the worksheet based guided discovery of the mathematical creative thinking ability.

Table 1. The Average of Mathematical Creative Thinking

Data	Experiment	Control
Pre-test	14,56	15,67
Post-test	61,06	38,89
Index gain	0,54	0,28

Based on the results of data analysis, obtained scores of student's mathematical creative thinking ability as presented in Table 1. Furthermore, the test of two average equation to the final score (post-test) ability of mathematical creative thinking. After the test, obtained sig value for the ability of mathematical creative thinking of 0.00 is smaller than 0.05. It means there is a difference in the ability of students' mathematical creative thinking using the worksheet based on guided discovery and students who do not use the worksheet based guided discovery. Furthermore, when viewed from the value of the gain index in the experimental class that is 0.54, the improvement of students' creative thinking ability using the worksheet based guided discovery including the category of being, concluded the worksheet based guided discovery effectively improve the ability of mathematical creative thinking.

Further tests conducted to determine the effectiveness the worksheet based guided discovery of students' self-efficacy. Based on the results of data analysis, obtained the self-efficacy score of students as presented in Table 2.

Table 2. The Average Student's Self Efficacy

Data	Experiment	Control
Pre-test	51,50	51,37
Post-test	69,08	63,27
Index gain	0,36	0,24

Based on the results of data analysis, obtained the self-efficacy score of students as presented in Table 2. Furthermore, the two-point equality test with the students' self-efficacy posttest. After the test, obtained sig value for student self-efficacy of 0.00 which is smaller

than 0,05. This means that there is a difference in self-efficacy of students using the worksheet based on guided discovery and students who do not use the worksheet based on guided discovery. Furthermore, when viewed from the value of the gain index in the experimental class that is 0.36 then the increase of self-efficacy of students using the worksheet based guided discovery including the category is, it can be concluded the worksheet based guided discovery effectively improve the students' self-efficacy.

Causes of students using the worksheet based guided discovery have better mathematical creative thinking abilities than students who do not use it (conventional learning) because when working on the worksheet based guided discovery, students are familiarized with challenging issues and cognitive conflicts within themselves students who stimulate students to do exploration and investigation to solve the problem.

In the problem solving, students are trained to explore ideas and construct knowledge independently without being too dependent on the teacher. In addition, each of the guided discovery-based learning stages present in the worksheet provides students with opportunities to develop students' mathematical creative thinking ability.

Based on the analysis of achievement indicators of mathematical creative thinking ability, it was found that for all aspects, the percentage of achievement of class indicators using the worksheet based guided discovery higher than the class that did not use the worksheet based guided discovery. The highest indicator percentage is in the fluency indicator and the originality of the student's ability to spark a lot of ideas and be able to provide relevant ideas to solve the mathematical problems and able to express his own opinion in giving an answer. While the indicator with the lowest percentage is the indicator of flexibility is the ability of students to be able to solve math problems thoroughly in various ways. Achievement of indicators of mathematical creative thinking after learning can be seen in Table 3.

Tabel 3. Data for Achieving Creative Thinking Indicators Mathematically After Learning

No.	Indicator	Percentage	
		Experiment	Control
1.	Sensitivity	66,11	53,89
2.	Fluency	80,00	42,50
3.	Flexibility	24,72	24,44
4.	Originality	72,78	44,72
5.	Elaboration	61,94	28,61
	Average	56,13	61,11

The worksheet based guided discovery that increases the mathematical creative thinking ability to be derived from effectiveness standards caused by several factors. The first factor is the formulation of the worksheet based guided discovery in accordance with the learning steps so as not to cause inequality between the learning process and the media used. Second, the presentation of mathematical creative thinking questions attracts students to find the mathematical concepts learned because mathematical creative thinking makes the students more thorough in understanding a concept and can relate it to other concepts in general. So finding this deep concept makes learning mathematics more meaningful. Students need peers to become special learning partners in working on the problem of mathematical creative thinking. From the observation of the achievement of the indicator, it can be concluded that the students not only need guidance from the teacher but from their peers. This is in line with Vygotsky's opinion (in Abidin, 2012) that social interaction through the zone of proximal development (ZPD) can enhance students' intellectual development.

Based on the analysis of achievement of self-efficacy indicator it is estimated that for all aspects, the percentage of achievement of class indicators using the worksheet based discovery is guided higher than the class that does not use the worksheet based guided discovery. The highest percentage of indicators is in the vicarious experiences indicator, ie the ability of students to compare their mathematical ability with others and the students' view of their mathematical ability and others. While the indicator with the lowest percentage is the verbal indicator persuasions is the ability of students to understand the meaning of mathematical sentences in the problems of mathematical creative thinking. The achievement of indicators of mathematical creative thinking after learning can be seen in Table 4.

Tabel 4. Data Achieving Self Efficacy Indicators After Learning

No.	Indicator	Percentage	
		Experiment	Control
1.	Authentic Mastery	69,56	61,22
2.	Vicarious Experiences	70,37	59,63
3.	Verbal Persuasions	68,52	64,81
4.	Physiological Indexes	68,79	64,35
	Average	69,31	62,50

Increased self-efficacy occurs because of social interaction between groups, students' self-confidence began to look in cooperation when problem-solving. Students can identify themselves with peers. When a peer succeeds in doing a task well, then the student will have a good judgment about his own success in doing the same task, so that the process of self-confidence can develop. This is similar to that disclosed by Zeldin (2000) states that observing the success of others, students can do an assessment of his own ability.

Verbal persuasion indicator is one indicator of self-efficacy. This indicator explains the direct feedback of the words of the teacher or the more mature person. This indicator is one of the indicators in improving self-efficacy. This is because teachers often give positive confidence to the students so that students are more passionate about doing the task. The words of teacher motivation make students have positive beliefs to encourage and empower their abilities. This reinforces student self-efficacy. The application of the group work system also enables students to gain support from peers when they feel incapable of performing a given task.

Psychological index of students is the last indicator of self-efficacy. This indicator explains the students' assessment of the abilities, advantages, and disadvantages of a given task. In learning using the worksheet based guided discovery that contains questions of mathematical creative thinking, make students interested to find the mathematical concepts studied, and they are accustomed to doing the questions that are numerical and related to the numbers. This makes students have a positive view of their math abilities.

Based on the description above, it can be concluded that learning by using the worksheet based guided discovery effectively in improving the mathematical creative thinking ability and student's self-efficacy. This is because, in the process of discovery in learning by using the worksheet based guided discovery, the problem builds on the knowledge reconstructed by the students themselves through the knowledge they have and the students develop their ideas according to their perceptions, as revealed in the theory of constructivism.

As students construct the knowledge they possess and develop their ideas, students must think mathematically to keep students away from erroneous and hasty decisions and must have confidence in their abilities so that no matter how difficult a given mathematical problem is, they can finish it well and more thoroughly. This is in line with the opinion of Victoriana (2012: 6), that the characteristics of individuals who have high self-efficacy is looking at the problem as a challenge to overcome not a threat, give high effort to what is done, and increase efforts when faced with failure.

4. CONCLUSION

Based on the results and research discussion obtained that the worksheet based guided discovery development stage is based on the following stages: preliminary study using interview and observation guidelines, planning the study starting with reviewing the materials to be prepared in the worksheet, the worksheet drafting for draft for guided discovery-based learning, initial field trials, revise the results of initial field trials, field trials, then improvements to the product of field trials.

The guided discovery-based worksheet is effective to improve students' mathematical creative thinking ability. This can be seen from the improvement of mathematical creative thinking ability using the guided discovery-based worksheet in the medium category. The guided discovery-based worksheet is effective for improving student's self-efficacy. This can be seen from the improvement of self-efficacy using on the guided discovery-based worksheet in the medium category.

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