



**The Effect of Students' Worksheet in the Model of
Discovery Learning Against the Students' Ability of
Reasoning and Mathematical Communication in the
Faculty of Mathematics and Natural Science of State
University of Medan**

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Abstract

One of the beginning activities in improving the learning was to design the learning device that refers to a model in order to make learning easier. The design of learning can be used as a starting point in efforts the improvement of learning quality. It means that the improvement of learning quality should be start from the improvement of the learning design quality, and design the learning with a system approach. In order to be an interesting learning device, in the making of it should be adjusted with the methods and models that according with the needs of students to make a meaningful learning.

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This study was an experiment research which was done to the students of education program with the aims to : (1) Knowing the differences of students reasoning ability that thought by using students' worksheet in the model of discovery learning and the model of talk learning.; (2) Knowing the differences of students mathematical communication ability that thought by using the students' worksheet in the model of discovery learning and talk learning; and (3) Resulting the learning device of mathematic such a worksheet based discovery learning that was feasibility to improve the students' ability of reasoning and mathematical communication.

Keywords: Discovery Learning; Talking Learning Model; Worksheet; Reasoning; Mathematical Communication.

1. Introduction

One of the beginning activities in improving the learning was to designing the learning device that refers to a model in order to make learning easier. The design of learning can be used as a starting point in efforts the improvement of learning quality. It means that the improvement of learning quality should be start from the improvement of the learning design quality, and design the learning with a system approach [1-4]. In order to be an interesting learning device, in the making of it should be adjusted with the methods and models that according with the needs of students to make a meaningful learning.

Learning in college, the lectures should always inovating in create an inovative learning by design the learning device as a media which can used in the process of learning [5]. The effort of designing the learning device as the media in the process of learning was important to do to make an effective and efficient learning. So the competence that should be achieved by the students can be dominated. One of them was by using students' worksheet. Students were expected can dominated the concept through the worksheet guide and work together in their own group. [6].

Besides the learning device, the factor that affect the low quality of education, include reasoning and mathematical communication of students [7-8]. Mathematics, reasoning and mathematical communication can't be separated, that was mathematics understood by reasoning and reasoning understood and trained by learn mathematic until we can communicate it. This explanation shows students to get reasoning and communicating good to develop their mindset. But, in the fact shows that the students' ability of reasoning and mathematical communication was still low [8]. It can be seen by the low achievement of students if they gave questions that were different with the example. Students who know the basic concepts couldn't connecting between condition that related to solving the different problem.

The low ability of reasoning and mathematical communication of students were influence by some factors. One of the factor was the learning process. In the learning process, learning models play an important thing and one of the main supporting of a leacture in teaching. Model used by the lecture will be affected to the way students learn, so we need a model which can support the students become more active and can understand the material thought [8]. In discovery learning, students pushed to find by themselves and transform the complex

information, check new information according to the memory, and do the development become information or ability that according to the environment and place and time they live. [9]. *Image* from the model of discovery learning was a learning theory that defined as a learning process that will be happened if students weren't thought with the final learning, but wished that they organize it by themselves [9].

In contrast to the talking model, students only receive material from the lecture without being forced to think further and in depth about the content that is being delivered. Talking model is how to present the lessons through a verbal utterance or explanations directly to groups of students [10]. This learning model is a model which can be said to be traditional, because since the first model has been used as a means of oral communication between teachers and students in the process of teaching and learning [11]. For it is one of the solutions offered in the repair process of learning mathematics specially to improve the students' ability of reasoning and mathematical communication that is using the students' worksheet based discovery learning model.

2. Review of Literature

2.1. Discovery Learning

Discovery is a method/ strategy that centered on students where the groups of students faced to a question to find an answer about the questions in a procedure and group structure outlined clearly. Discovery method is defined as a teaching procedures concerned with teaching, individual, manipulation object and experiment, before getting the generalization [12]. So the discovery method is a component of learning practice includes learning method that promote an active learning, oriented to the process, directing itself, find itself and reflective. Discovery learning model is a series of learning activities that involve the whole student to the maximum ability to search for and investigate the systematic, logical and critical, so that students can find out for themselves knowledge, attitudes, and skills as a form of behavior changes.

From some of the opinions above it can be concluded that discovery learning model is a model which in the teaching and learning process allow the students to discover themselves, steer themselves, find their own, investigate own concept and fundamental of knowledge, attitudes and skills so as to give rise to changes in student behaviour.

Steps in the Process of Discovery Learning

The steps of *discovery learning* as follow [13]:

1. Stimulation

First of all at this stage the students are exposed to something that give rise to their confusion, and then proceeded to not give a generalization, that desire to investigate themselves. Stimulation at this stage serves to provide the learning interaction conditions that can develop and assist students in exploring materials.

2. *Problem Statement*

In this stage the teacher gives the opportunity to the students to identify as many agendas of relevant problems with learning materials, then one of them is selected and formulated in the form of the hypothesis.

3. *Data collection*

When the exploration takes place, the teacher also gives the opportunity to the students to gather information that relevant to prove as many true or whether the hypothesis. At this stage serves to answer questions or prove the validity of hypothesis.

4. *Data processing*

Data processing is an activities and information that have been obtained good students subsequently interpreted, and they processed and interpreted on a certain level of trust. Data processing functions as the formation of concepts and generalizations.

5. *Verification*

At this stage, the students carefully checks to prove true or whether the hypothesis set out with alternative findings, associated with the results of the data processing.

6. *Generalization*

Stages of generalizations/draw conclusions that can be made into general principles and applies to all event or a similar problem, having regard to the results of the verification, then formulated the principles that underly the generalization.

From the explanation above, concluded that discovery learning model is a learning that pushed to the importance of structure understanding or important ideas against a science discipline, through the active involvement of students to learn.

2.2. Talking Learning Model

Talking method is a method that how to present the lessons through a verbal utterance or explanations directly to groups of students [13,14]. This method is a method which can be the traditional method, because this method has been historically used as a communication tool between teachers with oral learners in the process of teaching and learning."

Steps of Talking Method

There are a few things to be done at the stage of preparation or at the stage of implementation, as follows :

1) Stage of Preparation

- a) Formulating the objectives to be achieved.
- b) Define the main topics that will be taught.

2) Stage of Implementation

a) Opening steps

- (1) Teachers tell the objectives to be achieved.
- (2) Teachers ask or give essay to instruct the attention of students to the material that will be teaching.

b) Presentation steps

The presentation step was the submission of material by way of learning to speak. In order for our high quality talking as a method of learning, then the teacher should keep the attention of the students to stay focused on learning material that is being delivered.

c) The steps of ending or close talking

- (1) Guiding the students to draw conclusions or encapsulates the subject matter newly presented.
- (2) Stimulate the students to respond or provide such reviews about the material that have been presented.
- (3) Conduct an evaluation to know the students' ability to master the learning that have been presented.

2.3. The Ability of Mathematical Reasoning

There are two kinds of reasoning, i.e. deductive reasoning and inductive reasoning [15]. Deductive reasoning is a way of thinking which the general conclusion drawn from the statement that is special, the withdrawal of conclusions using syllogisms (construction of reasoning). Syllogism consists of sentences statement in logic/reasoning called proposition. The proposition that became the basis of a false assertion is called the premise, while the conclusion is called the conclusion. Syllogisms serves as the process of proof of right and wrong to an opinion, thesis or hypothesis about certain issues. Deduction stemmed from a common opinion in the form of a legal theory, or the methods in concoct an explanation about a specific incident or in drawing conclusions.

When find or prove a principle, developed the mindset of inductive and deductive. Students are observed to see traits of some of the cases, see patterns and make conjectures about the relationship that exists between the cases, as well as further states the applicable common relationships (generalization, inductive reasoning). In addition, students also need to be conditioned receive in advance a relationship which is clearly the truth, then use that relationship to locate the other relations (deductive reasoning). So either inductive or deductive reasoning, both of which are very important in learning mathematics. Mathematical reasoning ability of the students in the study need to be developed. As for the indicators that show the existence of reasoning in

mathematics among others [16]: (1) present the mathematical statements orally, written, pictures and diagrams, (2) ask the alleged, (3) conducting mathematical manipulation, (4) draw conclusions, compiling evidence, provide a reason or evidence against some of the solutions, (5) draw conclusions from the statements, (6) checking the validity of an argument, (7) specify the nature of the symptom pattern or mathematically to make generalizations. So the ability of mathematical reasoning is the thinking ability according to the flow of a particular frame of mind based on the concept or understanding has been obtained in advance. Then the understanding concept or interconnected to each other and applied in new issues so that a new logical decision is obtained and can be accounted for or confirmed.

As for the aims of mathematical reasoning ability are to make students can use reasoning in a pattern and nature, doing manipulation of mathematics in making a generalization, sompile evidence, or explaining ideas and mathematics statement [16]. Besides that, its also expected students can use mathematic as the way to reasoning (think logic, ctitical, systematic and objective). From the explanation above, concluded that to solve the problem, students need to have a reasoning ability which can retrieved from learning mathematics.

2.4. The Ability of Mathematical Communication

The communication is an essential part of human life. Similarly in life at school. Communications play an important role in mathematics. Everyone with an interest in mathematics will require communication in the treasuries of more information. NCTM stated that communication is the essential part of mathematics and mathematics education [17]. Without good communication, then the development of mathematics will be hampered. This fact is a challenge for the community of mathematics education in their efforts to communicate what they already believe, and evaluation, get to know the students such that students be educated mathematically. Communication become something major in teaching, judging, and in learning mathematics.

The ability that are included in mathematical communication are [18] :

- a. Stated a situation, picture, diagram, or real object to a language, symbol, idea or mathematics model.
- b. Explain idea, situation, and mathematics relation orally or writings.
- c. Listening, discussion, and writing about mathematics.
- d. Reading with an understanding of writing mathematical representation.
- e. Making conjecture, formulated the defenition, and generalization.
- f. Exposing back an essay or paragraph of mathematics in own language.

Communication can be classified to some way. We can divide communication to :

- a. Verbal Communication (communication with some words)

Verbal communication divide in two i.e orally verbal communication and paper verbal communication.

- b. Nonverbal communication (communication without using words or messages state through medium but not linguistic medium).

National Council Teacher of Mathematic suggests that mathematics as a tool of communication is the development of language and symbols to communicate mathematical ideas so that students are able to: (1) disclose and explain their thinking about mathematical ideas and their relationship, (2) Formulating the mathematical definition and make a generalization obtained through the investigation (discovery), (3) Reveals the mathematical ideas verbally and in writing, (4) read the discourse of Mathematics with understanding, (5) Explain and ask questions against the mathematics studied, and (6) to appreciate the beauty and the power of mathematical notation and its role in developing the mathematical idea [19]. There are five aspects of communication, that are : representation, listening, reading, discussions, and writing [20].

- a. Representation is (1) a new shape as a result of transition from a problem, or idea, (2) translation a diagram or physical model into a symbol or words.
- b. Listening is an important aspect in a discussions. Listening carefully against the state from friends in a group can also help students construct more completely knowledge of mathematics and set the strategy to answer more effective.
- c. Reading is the activity of the understanding of a text that are actively to seek answers to questions that have been compiled. There are five steps to help the reader to be able to find the necessary information in a text or document, the fifth steps are to: (1) Formulating the objectives that search a text to find out something, (2) determine how the information contained in a document can be easily found, (3) summarize the information presented in the text, (4) integrate with what had been known before, (5) If this step doesn't rewarding the objectives then back to step (2).
- d. Discussion is a means to express and reflect the mind of students. There are several advantages of class discussions, namely: (1) can accelerate understanding and proficiency learning material using strategy, (2) help students construct mathematical understandings, informing that the mathematicians are usually not solve problems in singly, but together with other experts in building a team, and (3) help students analyze and troubleshoot wisely.
- e. Writing is an activity undertaken knowingly to disclose and reflect on the mind. Writing for students have usability and advantages, namely: (1) in order that students can summarize the lessons with their own language, (2) so that students can make their own questions that are useful to reflect on the focus that they did not understand, (3) in order for students can explain the procedure of the settlement and how to avoid a mistake, (4) so that the students can explain the terms that appear in their own language and (5) so that the students can write reports that can help the understanding of the students.

3. Methods

This study was a quasi experiment, that was a research means to know whether or not a result of something that is imposed to the students, in other words, the experiment research was trying to search whether or not the causal relation [21]. Its implementation involves two groups of experiments, i.e. classes that are taught by using a model Discovery Learning was referred to as experimental class A and class being taught by using a model of talking called as an experimental class B. The design of the research using *Pretest-Posttest Control Group Design*. The sample that has been taken was grouped by two groups of experiment i.e the first group as experimental class of A and second group as experimental class of B. Both sample class give the pretest to find

out the ability or students understanding about the material that will be taught before we do the learning and to retrieve the homogen sample.

4. Results

This study is an experiment with the design was a *pre-test-post-test control group design*. Population in this study was all students from faculty of mathematics and natural science in the 1st semester by taking 2 class for sample (experimental class A and B) through the technique of random sampling. The data retrieved through the test of mathematical reasoning ability and mathematical communication ability. The data was analyze by using two way ANAVA test. Before we use the test, first we do the homogeneity test and normality test with the significancy as 5%. The analysis result shows that the average value of problem solving test in experimental class was 34,64 and control class was 22,71 with the sig = 0, $0 < \alpha = 0,05$ then found the different of students' reasoning thought using the help of students' worksheet in the model of discovery learning with the model of talking, the average value of communication ability in experiment and control was 13,3 and 7,58 with the p-value (2-tailed) was 0, and $0 < \alpha = 0,05$ so, there was a different between the students' ability of mathematical communication taught by discovery learning using students' worksheet and talking model.

4.1. The Test Result of Mathematical Reasoning Ability

Processing and analysis the beginning and ending data aims to find out the students' reasoning ability before and after retrieving the discovery learning model in experimental class A and students' reasoning ability before and after retrieving the talking model in experimental class B. Based on the data retrieved that the score of processing data against the score of reasoning ability test collected and analyze to find out the different between students' reasoning ability taught using discovery learning model and talking model. The data retrieved from the result of students' reasoning from class A or B.

Table 1: Data of Reasoning Ability from Both Group of Learning

Statistics	Model of Learning			
	Discovery		Talking	
	Pretest	Posttest	Pretest	Posttest
Amount of Students	32	32	33	33
Average Value	16,38	34,64	13,39	22,71
Standard Deviation	6,879	9,539	6,084	8,150

The table above seen that the average value of students' pretest taught by discovery learning dan talking model and also seen that the average value of students' posttest taught by using discovery learning and talking model. From the data we can make a diagram that shows the comparison of students's ability of reasoning between

discovery learning (DL) and talking model (PC), as follows :

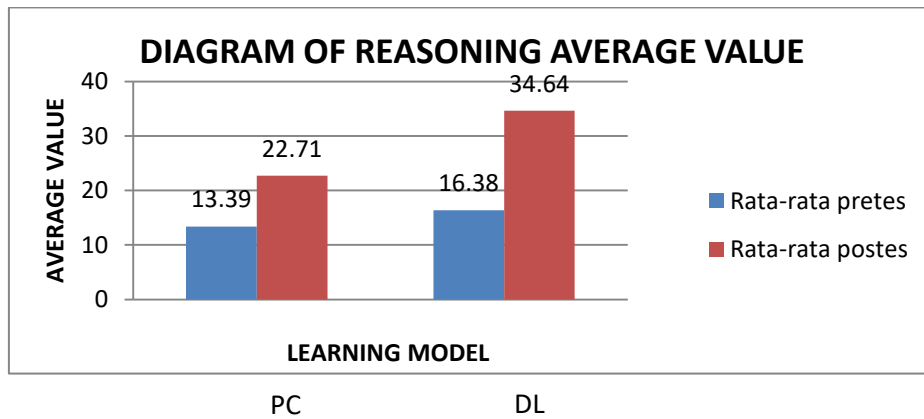


Figure 1: The Average Score of Reasoning Ability

From the data in table 1 and from diagram from figure 1 above retrieved that before learning, the average value of mathematical reasoning ability that taught by discovery learning model use students’ worksheet was only 16,38, while the average value of students’ mathematical reasoning ability that taught by talking model was only 13,39. After learning, there’s different average value between both group of the students. Students who taught by discovery learning retrieved average value of reasoning ability as 34,64 while students who taught by talking model retrieved average value as 22,71.

4.2. The Test Result of Mathematical Communication Ability

Processing and analysis the beginning and ending data aims to find out the students’ mathematical communication ability before and after retrieving the discovery learning model in experimental class A and students’ mathematical communication ability before and after retrieving the talking model in experimental class B. Based on the data retrieved that the score of processing data against the score of mathematical communication ability test collected and analyze to find out the different between students’ mathematical communication ability taught using discovery learning model and talking model. The data retrieved from the result of students’ mathematical communication from class A or B.

Table 2: Data of Students’ Mathematical Communication Ability From Both Group of Learning

Statistics	Model of Learning			
	Discovery		Talking	
	Pretest	Posttest	Pretest	Posttest
Amount of Students	32	32	33	33
Average Value	4,23	13,38	4,44	7,58
Standard Deviation	2,474	3,244	2,412	2,487

Generally, the diagram that describe the average score of mathematical communication ability as served in table 2 seen from this figure belows :

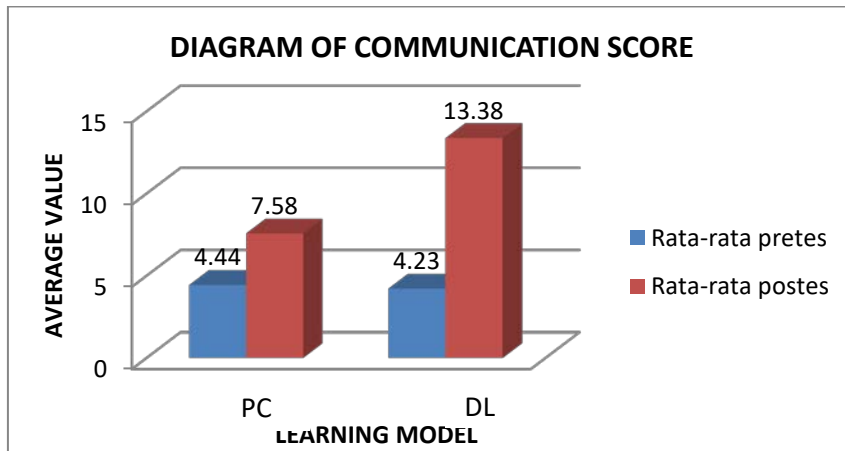


Figure 2: The Average Score of Mathematical Communication Ability

From the data in table 2 and from diagram from figure 2 above retrieved that before learning, the average value of mathematical communication ability that taught by discovery learning model use students' worksheet was only 4.23, while the average value of students' mathematical communication ability that taught by talking model was only 4,44. After learning, there's different average value between both group of the students. Students who taught by discovery learning retrieved average value of mathematical communication ability as 13,38 while students who taught by talking model retrieved average value as 7,58.

5. Discussions

Related to the repair of the learning process through the use of a learning model that aims to improve the learning result of students, it has been done through several preliminary studies by the research team. Among them : The Implementation of Cooperative Learning Strategy Type STAD (*Student Teams Achievement Division*) to improve the students' ability of mathematical problem solving [22], The Improvement of Problem Solving and Mathematical Communication Ability Of Junior High School Students by Using Problem Based Learning [23] (Purba). Other research that related to mine were : Resolution to Increase Capacity by Using Math Students Learning Guided Discovery Learning [24], The Effort to Improve The Students' Ability of Mathematical Reasoning Through The Model of Group Investigation in Integers Topic [25], The Improvement of Students' Representation and Mathematical Communication Ability in Transformation Topic By Using Think-Talk-Write Strategy with The Help of Domino Card [26] (Surya).

The research result of Yohana (2016) were also same, that was the comparison students' reasoning ability by using discovery learning model with the problem based learning model by the help of Wingcom in students of Junior High School [27] show the improvement of mathematical reasoning ability that showed by the differentiation of pretest and posttest score. The innovation done in those research have succeeded in increasing the students' ability of mathematical reasoning and communication and get a good responses against the process

of learning that were not monotonous centered on teachers/lectures. Based on the experience of the researchers who has several times doing research can as sure has a high level of success of this research. Research team has experienced and success in repaired the learning process through the innovation of using model and learning media. The research result has also implemented in the class as a contribution to the improvement of learning.

6. Conclusions

Based on the data result analysis against the average score of pretest that has done to the students' group who retrieve learning through the model of discovery learning using students' worksheet with the average value as 16,38 and at the students' group who retrieve learning only by the model of talking with the average value as 13,39. From the data test result of pretest score against both group of students concluded that both group have same ability at the beginning or there's no significant different. After giving the discovery learning for experimental class A and talking model for experimental class B, then retrieved that posttest score of mathematical reasoning ability for both class. The posttest score of students' mathematical reasoning ability at experiment class was 34,64 and the standard deviation was 9,539 and also the score of students' mathematical reasoning ability at the control class was 22,71 and standard deviation was 8,150.

While for the students' mathematical communication ability, based on the data analysis against the score of pretest that has done to the students' group who retrieve learning through the model of discovery learning with the average value as 4,23 and at the students' group who retrieve learning through the talking model with the average value as 4,44. From the data test result of pretest score against both group of students concluded that both group have same ability at the beginning or there's no significant different. After giving the discovery learning for experimental class A and talking model for experimental class B, then retrieved that posttest score of mathematical communication ability for both class. The posttest score of students' mathematical communication ability at experiment class was 13,38 and the standard deviation was 3,244 and also the score of students' mathematical communication ability at the control class was 7,58 and standard deviation was 2,487.

From the test shows that there's a difference between the post test score of students reasoning ability at class A and B. Based on the hypothesis test by using two way ANAVA analysis then retrieved the acore of students mathematical communication ability through F count was 104.912 with the signifficancy of $\alpha = 0,000$. Because the extent of signifficant value of communication ability less than $\alpha = 0,05$, then concluded that there's no difference between the mathematical communication ability for students who taught by using the model of discovery learning and learning by using the talking model is rejected so that the difference between students' mathematical communication ability who taught by using the model of discovery learning and talking model is accepted.

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