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The Discovery Learning Model: Students' Mathematical Literacy and Mathematical Disposition Abilities

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Abstract. Mathematical literacy and mathematical disposition abilities need to be mastered by students to support their learning process and solve various mathematical problems. In this article, the researchers report the junior high school students' mathematical literacy and mathematical disposition abilities after being given treatment using the discovery learning model for one semester. This research employed a quasi-experimental design with a 2x2 factorial design. The population of the research was students of state junior high school (SMPN) in Central Lampung Regency. The researchers used the cluster random sampling technique to determine 64 students (experimental class n = 32 and control class n = 32) as the samples. The instruments used to collect the data were a description test for mathematical literacy abilities and questionnaires for mathematical disposition abilities. The Multivariate Analysis of Variance (MANOVA) was used to analyze the data with a significance value of 5%. Based on the calculations, the p-value of mathematical literacy abilities was 0.000 and the p-value of mathematical disposition abilities was 0.000 so that the p-value of each ability was less than 0.05. Therefore, the discovery learning model influenced students' mathematical literacy and mathematical disposition abilities, either partially or simultaneously. The results of mathematical literacy abilities were better than the mathematical disposition abilities.

INTRODUCTION

Mathematics learning contains critical, systematic, and careful visions to develop logical reasoning, self-confidence, a sense of beauty to the regularity of elements in mathematics, and objective and open attitudes [1]. Mathematics has an essential role in life. Therefore, the scientific approach can help for the achievement of the objectives of learning mathematics, because the objectives of learning mathematics emphasize the pedagogical aspects. The activities that can be done to achieve the objectives of mathematics learning are observing, asking, trying, reasoning, presenting, and creating. In the objectives of mathematics learning, the curriculum contains the aspects of mathematical literacy development, namely formulating, using, and interpreting mathematics in many contexts of daily life [2].

Mathematical literacy in the PISA framework is used as a stepping stone in interpreting the concept of literacy. Mathematical literacy abilities conveyed by PISA lead to mathematical modeling abilities. Mathematical literacy abilities are also a strength in mathematical thinking to solve everyday problems so that the learners are ready to face life challenges (Yasin et al., 2020; Astuti, 2018). Knowing and understanding the role of mathematics in real life require mathematical literacy abilities since these abilities are individuals' capacities that must be possessed by students [5]. Mathematical literacy can help students to understand the role and usefulness of mathematics in everyday life [6]. Bolstad also reported that principals and teachers in Norway link mathematical literacy as a benefit that can be used in the context of personal, work, and social life [7]. This fact indicates that mathematical literacy skills are essential for students to understand mathematics not only in theory, but also to train students' reasoning, concepts, problem-solving, and communication [2]. Besides mathematical literacy skills, one of the goals of mathematics education is an attitude of appreciating the usefulness of mathematics or having a mathematical

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disposition. Mathematical disposition allows students to relate and appreciate mathematics so that it creates a tendency to think and act positively [8]. Therefore, mathematical literacy abilities and mathematical disposition abilities are two of the many abilities that students must possess in learning mathematics to maximize the learning outcomes.

The importance of mathematics learning cannot be separated from its role in various aspects of life. A person who studies mathematics can be accustomed to thinking systematically, scientifically, and critically to increase his creativity. Therefore, a teacher must be good at choosing a learning model by considering the circumstances and conditions, learning materials, and sources so that the application of learning models can be effective and support the success of learning [9]. Many ways can be done to overcome problems in learning, one of which is the selection of the right learning model. One of the learning models that can be applied is the discovery learning model.

Several studies related to the discovery learning model have been carried out by previous researchers. The studies found that the discovery learning model can improve students' concept understanding [11], improve the scientific knowledge competence of fourth graders of SD Gugus IV [12], improve creative thinking [13], improve learning outcomes [14], and improve the analogy abilities of junior high school students [15]. Other researchers have also investigated the mathematical literacy abilities that can be improved by applying the project-based learning model [16], the metaphorical thinking learning model [17], the problem-based learning model [18], and RME learning assisted by Adobe Flash CS6 [19]. Besides mathematical literacy skills, mathematical disposition abilities have also been studied before. The conclusion of these studies resulted in the finding that the ability of mathematical disposition can be improved by problem-posing learning model [20], problem-based learning model [21], ad CORE learning model [22].

Several previous studies have applied discovery learning models to various abilities. However, no researchers have applied it to see its effect on mathematical literacy abilities and mathematical disposition abilities, either partially or simultaneously, on fifteen years old students in Central Lampung Regency, Lampung Province. Therefore, the researchers conducted this research to see the effect of the discovery learning model on mathematical literacy abilities and mathematical disposition abilities.

METHOD

This type of research uses quantitative research because the data collected is in the form of numbers (quantity). a quasi-experimental design with posttest only control group design using 2x2 factorial design used in this study.

TABLE 1. 2x2 Factorial Design

Learning Model (X)	Ability (Y)	
	Mathematical Literacy (Y1)	Mathematical Disposition (Y2)
The discovery Learning (X1)	X1 Y1	X1 Y2
Direct Instruction (X2)	X2 Y1	X2 Y2

SMPN students in Central Lampung Regency with an average age of 15 years become the population in this study. The Cluster Random Sampling technique as a sampling technique was chosen with the consideration of giving samples in groups in existing schools and classes. The samples of this research consisted of 32 students in the experimental class (learning by the discovery learning model) and 32 students in the control class (learning by Direct Instruction). The data analysis technique performed in this research was the Multivariate Analysis of Variance (MANOVA) with a significant value of 5%. The data had been obtained using a set of literacy test instruments that consisted of four description questions and a mathematical disposition questionnaire that consisted of twenty questions.

TABLE 2. The Indicators of Mathematical Literacy Abilities [1]

No	Aspects	Achievement Indicators
1	Content	Able to write a basic algorithm
2		Able to convert problems into mathematical models
3	Process	Able to carry out simple procedures
4		Able to formulate mathematical problems
5		Able to use concepts, facts, procedures, and mathematical reasoning

No	Aspects	Achievement Indicators
6	Context	Able to interpret problems and then solve them
7		Able to use mathematical skills in solving problems
8		Able to express flexible views according to context

TABLE 3. The Indicators Mathematical Disposition Abilities [2]

No	Indicators
1	Using mathematics with confidence, communicating opinions, presenting reasons, and solving problems.
2	Investigating mathematical opinions flexibly and trying to find other ways or alternatives in solving problems.
3	Doing mathematics assignments diligently.
4	Doing mathematics assignments with curiosity, interest, and inventiveness.
5	Monitoring and reflecting on performance and reasoning.
6	Appreciating mathematics applications.
7	Appreciating the role of mathematical culture and value as language and tool

Before the treatment, the samples were given a pretest to determine their initial knowledge. Then, the treatments were given on the concept of the Two-Variable Linear Equation System. This material was chosen because it is often used and is very much needed in everyday life[3]. After the treatments had been completed, a posttest and questionnaires were administered to measure students' mathematical literacy and mathematical dispositions abilities. The stages of the discovery learning model are presented in Figure 1.

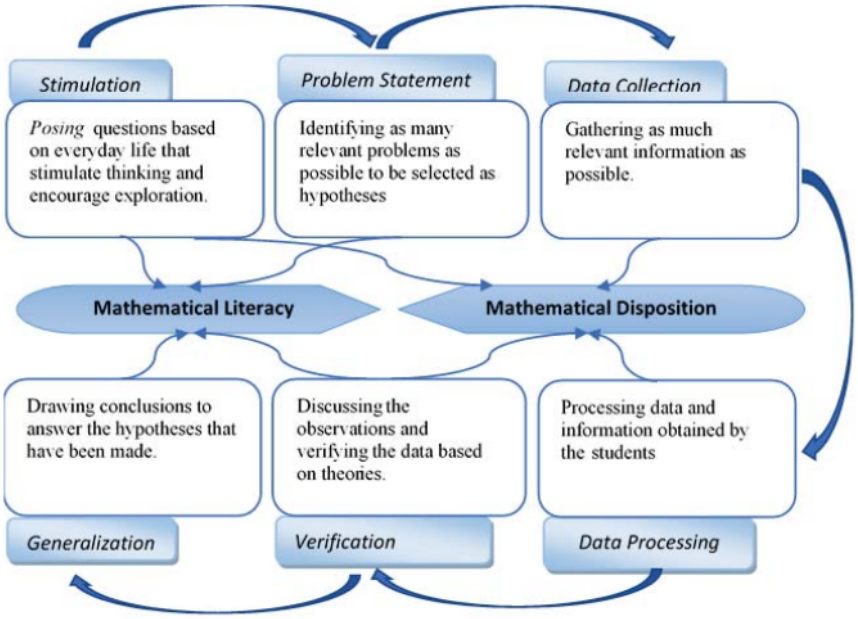

FIGURE 1. The Syntax of the discovery Learning Model

Based on Figure 1, the discovery Learning model has six stages, namely stimulation, problem statements, data collection, data processing, verification, and generalization. This learning model can train students' mathematical literacy and mathematical dispositions abilities. The stimulation, problem statement, verification, and generalization steps are to train students' mathematical literacy abilities, while the stimulation, data collection, data processing, and verification are to train students' mathematical disposition abilities.

RESULTS AND DISCUSSION

Data on literacy ability and disposition were collected after the treatment was completed in both the experimental class and the control class, the researcher presents the results in Table 4.

TABLE 4. The Data Description of Mathematical Literacy Abilities

Class	x_{max}	x_{min}	Central Tendency Measure			S
			$\bar{x}$	M_e	M_o	
Experimental	86	35	67	69	81	15.026
Control	74	25	55	57	70	14.268

Table 4 shows that the final test scores for the mathematical literacy skills of the class treated with the direct instruction model (control class) were not better than the class treated with discovery learning (experimental class), the value of central tendency, and its diversity shows this.

TABLE 5. The Data Description of Mathematical Disposition Abilities

Class	x_{max}	x_{min}	Central Tendency Measure			S
			$\bar{x}$	M_e	M_o	
Experimental	70	56	63	63	65	3.809
Control	69	49	59	59	64	5,306

Table 5 shows that the final test scores for the mathematical disposition abilities for the experimental class were better than the control class. It can be seen from the value of the central tendency and its diversity.

Before carrying out the analysis using Multivariate Analy of Variance (MANOVA), the data must first meet the assumption tests, namely normality and homogeneity test. The results of the calculation are presented in Tables 6 and Table 7.

TABLE 6. Normality Test Results

Information		$L_{observed}$	$L_{critical}$	n	Test Decision
Mathematical Literacy Abilities	Experimental	0.1243	0.1542	32	H_0 is accepted
	Control	0.1376	0.1542	32	H_0 is accepted
Mathematical Disposition Abilities	Experimental	0.0762	0.1542	32	H_0 is accepted
	Control	0.0643	0.1542	32	H_0 is accepted

Based on Table 6, the $L_{observed}$ value was less than $L_{critical}$. Therefore, the data from each group came from a normally distributed population. Furermore, the homogeneity test results of the mathematical literacy and mathematical disposition abilities are presented in Table 7.

TABLE 7. Homogeneity Test Results

Group	$x^2_{observed}$	$x^2_{critical}$	Test Decision
Literacy	0.0829	3.481	H_o is accepted
Disposition	3.3427	3.481	H_o is aceepted

The results of the homogeneity test calculation show that X2observed was less than X2critical. Therefore, the sample data was homogeneous. The next step was to test th scovery learning model on mathematical literacy and mathematical disposition abilities partially. The MANOVA test results are presented in Table 8.

TABLE 8. Partial Test Results

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Class	Mathematical Literacy Ability	2232.562	1	2232.562	10.260	.002
	Mathematical Disposition Ability	185.641	1	185.641	8.658	.005

Table 8 shows that the p-value of mathematical literacy abilities was lower than the specified significant value (5%). Therefore, the discovery learning model influenced students' mathematical literacy abilities. Also, the p-value of mathematical disposition abilities was lower than the specified significant value (5%). Therefore, the discovery learning model influenced students' mathematical disposition abilities.

After testing each ability, the next step was to test the discovery learning model on mathematical literacy and mathematical disposition abilities simultaneously. The MANOVA test results are presented in Table 9.

TABLE 9. Manova Test Results

Effect		Value	F	Hypothesis df	df error	Sig.
Class	Pillai's Trace	.263	10.867a	2.000	61.000	.000
	Wilks' Lambda	.737	10.867a	2.000	61.000	.000
	Hotelling's Trace	.356	10.867a	2.000	61.000	.000
	Roy's Largest Root	.356	10.867a	2.000	61.000	.000

In Table 8 the results of the MANOVA test show that the four tests, Pillai trace, Wilks lambda, Hotelling trace, and Roy's largest, yielded a p-value of 0.000, which means that the four tests resulted in a p-value lower than significant level value (5%). Therefore, the discovery learning model influenced students' mathematical literacy and mathematical disposition abilities simultaneously.

These results are in line with Mawaddah's research that the discovery learning model can improve the ability to understand concepts. [4]. Research conducted by Ni Putu Sri Adnyani, IB Surya Manuaba, DB. Kt. Ngr. Semara Putra discovered that the discovery learning model assisted by audio-visual media significantly affecting the science knowledge competence of fourth-graders of SD Gugus IV [5]. Research conducted by Septiani Wahyu Tumurun, Diah Gusrayani, and Asep Kurnia Jayadinata found that the discovery learning model could better improve students' creative thinking skills [6].

Mathematical literacy is a standard that must be mastered by students in improving their competency skills [7]. According to PISA, the term "literacy" does not only contain the knowledge as a domain but also assessment and the ability to implement the knowledge [8]. Besides, mathematical literacy focuses on students' ability to analyze, reason, and communicate ideas effectively in solving problems [9]. In the process of solving problems, students will realize or understand which mathematical concepts are appropriate to use. Individual abilities in problem-solving involve high-level cognitive aspects that require basic skills in formulating and carrying out a series of activities in answering questions[7].

The increasing mathematical literacy abilities are also influenced by the students' curiosity towards mathematics. Curiosity or mathematical disposition is a strong desire, awareness, tendency, and dedication to think and act mathematically in a positive way and based on faith, piety, and noble character [2]. According to NCTM, the interest and appreciation that students have towards mathematics are called mathematical dispositions. Disposition is not just an attitude but also a tendency to think and act positively. Mathematical disposition is a strong desire, tendency, awareness, and dedication in students to think and act mathematically [10]. This tendency is related to interest, self-confidence, and the willingness to reflect on their thoughts [11].

Mathematical literacy and mathematical disposition abilities in this research are influenced by the discovery learning model. There are six steps of the discovery learning model. Four stages (simulation, problem statement, verification, and generalization) influence the four indicators of mathematical literacy abilities. On the other hand, the other two stages (data collection and data processing) specifically influence the seven indicators of mathematical dispositional abilities. The discovery learning model also emphasizes the students' activeness during the learning process to find a new concept facilitated by the teacher or using the provided media [12]. Besides encouraging students' curiosity, the results of statistical analysis and testing in this research affirmed that there was an influence of the discovery learning model on the mathematical literacy and mathematical disposition abilities, either partially or simultaneously.

CONCLUSION

Based on the results of the analysis and discussion, it can be concluded that the discovery learning model influenced students' mathematical literacy and mathematical disposition abilities, either partially or simultaneously. The discovery learning model positively influenced mathematical literacy and mathematical dispositions abilities compared to the direct instruction learning model. In general, the result of mathematical literacy abilities is better than the mathematical disposition abilities based on the two treatments.

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