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Students' Understanding of Mathematical Concepts and Learning Independence by Using Discovery Learning and Group Investigation at SMK Multi Karya

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Abstrak: *Penelitian ini bertujuan untuk: (1) Perbedaan kemampuan memahami konsep matematika siswa yang diajar oleh pembelajaran penemuan dan penyelidikan kelompok (2) perbedaan kemandirian belajar siswa yang diajar oleh pembelajaran penemuan dan penyelidikan kelompok (3) interaksi antara kemampuan matematika awal dengan model pembelajaran pada kemampuan memahami konsep matematika (4) interaksi antara kemampuan matematika awal dengan pembelajaran Model pada kemandirian belajar matematika. Penelitian ini dikategorikan ke dalam jenis penelitian kuasi-eksperimental. Populasi penelitian ini adalah seluruh siswa kelas XI TKJ dan MM SMK Multi Karya dan sampelnya kelas XI MM 2 (Percobaan 1) dan XI TKJ 3 (Percobaan 2). Hasil penelitian adalah: (1) terdapat perbedaan kemampuan memahami konsep matematika siswa yang diajar dengan model pembelajaran discovery dan jenis investigasi kelompok model pembelajaran kooperatif, (2) terdapat perbedaan kemandirian belajar siswa yang diajar dengan model pembelajaran discovery dan investigasi kelompok, (3) Tidak ada interaksi antara kemampuan matematika awal dengan model pembelajaran pada kemampuan memahami konsep matematika (4) Tidak ada interaksi antara kemampuan matematika awal dengan model pembelajaran pada kemandirian belajar matematika.*

Kata kunci: discovery learning, group investigation, concept understanding, learning independence

Abstract: *This study aims to: (1) The differences in the ability to understand mathematical concepts of students who are taught by the discovery learning and group investigation (2) the differences in the learning independence of students who are taught by the discovery learning and group investigation (3) the interaction between early mathematical abilities and the learning model on the ability to understand mathematical concepts (4) the interaction between early mathematical abilities and the learning model on the learning independence mathematics. This research is categorized into the type of quasi-experimental research. The population of this study were all students of class XI TKJ and MM SMK Multi Karya and the samples were class XI MM 2 (Experiment 1) and XI TKJ 3 (Experiment 2). The results of the study are: (1) there are differences in the ability to understand mathematical concepts of students who are taught by the discovery learning model and the group investigation type of cooperative learning model, (2) there are differences in the learning independence of students who are taught by the discovery learning model and the group investigation, (3) There is no interaction between early mathematics ability and learning model on the ability to understand mathematical concepts (4) There is no interaction between early mathematics ability and learning model on mathematics learning independence.*

Keywords: discovery learning, group investigation, concept understanding, learning independence

Introduction

The rapid development of technology and information demands quality human resources, comparative, innovative, competitive capabilities, and the ability to collaborate following 21st-century skills. One way to prepare human resources following the demands of the 21st century is through education. Education is changing students' behavior to become adult humans who can live independently and as members of society in the natural environment where the individual is located (Praptiwi & Handhika, 2012; Sagala, 2017).

Students learn how they should learn through various experiences. Teachers also teach students how they should learn; however, they change through different aspects such as mental, physical and emotional. Students learn how they should learn through different experiences. At the same time, teachers teach students what they need to know. Changes in students' knowledge, skills and emotions are observed through cognitive, motor and emotional experiences(Rachmayani, 2014).

Learning is the process of two synergistic activities, namely, teachers' teaching and students' learning. One of the learning processes at school is learning mathematics (Fajar et al., 2019; Hutagalung, 2017).

Mathematics is a discipline that is studied from elementary education to college. Mathematics is an essential subject because learning mathematics can contribute to solving everyday problems and in the world of work, improve thinking and argumentation skills, and provide support in the development of science and technology that need to be mastered well by students, especially since elementary school age (Fatqurhohman, 2016; Mohammad Takdir Ilahi, 2012).

Permendiknas No. 22 of 2006 concerning the standard content of mathematics subjects aims to make students have the ability to:

1. Math classes teach students to understand and apply concepts and formulas to solve problems. They also teach students to relate images and understand mathematical relationships.
2. Reasoning through patterns and traits allows people to make generalizations, perform math calculations and explain mathematical ideas and statements.
3. Understanding solutions — including completing mathematical approaches and interpreting obtained results — is a key part of solving problems.
4. Using tables, charts, graphs and other media to clarify a problem or situation. This also includes using symbols. It's important to possess a positive attitude when learning mathematics.
5. This includes being tenacious, confident, curious, attentive and interested in the subject. Mathematics is useful in many aspects of life, and those who value its usefulness will benefit from these positive attitudes.

To achieve this goal, teachers should be able to design mathematics lessons to help students develop an understanding of concepts, reasoning, problem-solving, communication, and respect for mathematics. In line with the objectives of mathematics education, understanding mathematical concepts is an integral part of mathematics lessons because mastering a concept will significantly assist students in learning mathematics (Eva, 2010).

Agustina (2018) Students must demonstrate conceptual understanding in addition to knowing and remembering subject matter. This means they must be able to explain concepts in a way that's easy to understand, interpret data and use images in a cognitively appropriate manner. Mastering multiple subject matter allows students to demonstrate conceptual understanding; otherwise, demonstrating conceptual understanding through knowledge of only one subject is unlikely.

The state considers understanding mathematical concepts to be a ability that involves comprehending operations, relationships, and ideas in mathematics. In order to measure this understanding, the state uses indicators

1. After learning new concepts, it's essential to restore what you already know.
2. Objects can be classified based on math concepts.
3. Algorithms can be used to apply the concept to new situations.
4. Examples of the concepts being studied can be used to prove their validity.
5. Alternatively, counterexamples can disprove concepts.
6. Presenting ideas in different formats is the fifth step.
7. Math concepts need to be related both internally and externally.

Understanding concepts in learning mathematics is essential so that students do not experience difficulties in learning mathematics. But in reality, the teaching and learning process in the classroom only discusses the material being studied without instilling mathematical concepts in students. This is what causes mathematics to be considered a complex subject and is still feared because students think that mathematics is full of memorizing formulas and confusing numbers (Fatqurhohman, 2016; Sugandi, 2013).

The higher the understanding, mastery of the material, and learning achievement, the higher the level of learning success. For this reason, teachers should be able to improve a good understanding of the concept of students so that students are able to obtain good learning outcomes (Fithriyah et al., 2021). However, the reality is not as expected. This can be seen from the results of interviews with class VIII teachers of SMP Negeri 17 Kendari; many students do not get good learning results. In Class VIII, which is spread over seven classes, the average test results are always far below the KKM. Students often have difficulty understanding questions and find it difficult to determine the formula to use, even though mathematics is not material to be memorized but requires reasoning and understanding of concepts (Fajar et al., 2019).

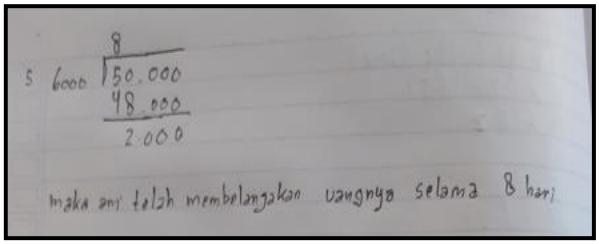
Furthermore, students generally do not have a good understanding of concepts, especially in the matter of graphs of trigonometric functions. This can be seen from the answers of 2TS1 students at SMK Telkom Sandhy Putra during daily test 1 for the basic competence of drawing or reading graphs of trigonometric functions. For example, when students are asked to draw a diagram of a trigonometric function, they cannot remove it correctly, so they cannot give a valid reason or explanation for the graph (Indah & Farida, 2021).

A common understanding of students' mathematical concepts was also found from the results of research by (Hutagalung, 2017)namely, students, when given a concept understanding test, most students were less able to complete it. This can be seen from the number of students who ask the teacher which formula is appropriate. In addition, judging from the process of completing student answers, only some of them answered with the correct steps and solutions. As for the students whose responses were lacking, several errors were found in answering the questions, including conceptual mistakes, facts, procedures, and principle errors (Subekti & Jazuli, 2020).

To confirm the allegations related to the low ability of students, the researchers also gave questions to several students of SMK Multi Karya related to the prerequisite material before being treated to the line and series material with the following questions:

> *Ibu memberikan uang pada Ani Rp. 50.000 dan Ani membelanjakan uang tersebut Rp. 6.000 setiap hari. Jika sekarang sisa uangnya Rp. 2.000, maka Ani telah membelanjakan uangnya selama … (hari).*

The results of student answers are shown in Figure 1.1



From the process of student's answers above, it shows that students do not have a good understanding of mathematical concepts because students are not yet able to understand the information known in the questions well and it is also seen that students are not able to use, utilize and choose algorithms correctly (one of the indicators of understanding the concept mathematics).

Responding to related problems, they still have at least a deep conceptual understanding, so the learning process in the classroom must be changed. In the learning process, the teacher must make students think, ask questions, and explore, and guide students to find concepts or formulas so that the learning process is more meaningful. Through a learning model that is believed to improve students' understanding of mathematics.

In this case the authors chose two types of learning, namely Discovery learning and Group Investigation (GI). discovery learning models and group investigations are able to provide changes to the ability to understand students' mathematical concepts. This is what makes researchers feel the need and have conducted research entitled "Differences in Students' Ability to Understand Mathematical Concepts Using Discovery and Group Investigation Learning at SMK Multi Karya.

Method

This type of research is quantitative research with a quasi-experimental method. This study aimed to determine the differences in the ability to understand mathematical concepts and students' independent learning through the Discovery Learning and Group Investigation.

This research was conducted at SMK MULTI KARYA which is located at Jl. STM No. 10 Medan, North Sumatra. The reason for choosing this location is because similar research has never been conducted at the school. The time of the study was carried out in the odd semester of the 2022/2023 Academic Year with Lines and Series teaching materials.

The population in this study were all students of class XI SMK Multi Karya majoring in Computer Networking and Multimedia Engineering for the academic year 2022/2023 which consisted of 6 classes, namely XI TKJ 1, XI TKJ 2, XI TKJ 3, XI MM 1, XI MM 2 and XI RPL. Based on random drawing by lottery from 6 class XI SMK Multi Karya majoring in Computer Networking and Multimedia Engineering, 2 classes were selected, namely class XI TKJ 3 as the experimental class I to be taught with discovery learning models and class XI MM 2 as the experimental class II to be taught with the group investigation learning model.

After selecting 2 classes and applying each learning model, a final test is given to see and measure the ability to understand mathematical concepts. In this study, the final test given was in the form of a description of 6 questions. Before the test is feasible, it is

necessary to conduct experiments that allow it to be continued with the necessary statistical tests as the basis for testing the hypothesis, including the normality test of the data and the homogeneity of variance test. The last stage is a two-way ANOVA test that is adapted to the formulation of the problem, which is to see the importance of differences in students' ability to understand mathematical concepts and the interaction of learning with early mathematical abilities.

Table 1. Research design

Experiment Class	Treatment	*Posttest*
Experiment I	X_1	T
Experiment II	X_2	T

Information :

X_1= Learning treatment with learning model *discovery learning*

X_2= Learning treatment with group investigation learning model

T = *Posttest*

The criteria for grouping students based on the mean $\bar{x}$ and standard deviation (SD) are presented in Table 2 below.

Table. 2 Criteria for Grouping Student Ability Based on Early Mathematical Ability

Early Mathematical Ability	**Category**
EMA ≥ $\bar{x}$+SD	High
$\bar{x}$ – SD < EMA < $\bar{x}$+SD	Medium
EMA ≤ $\bar{x}$ – SD	Low

Result and Discussion

As a result of this research was conducted to compare the differences in students' independent learning and ability to comprehend mathematical concepts. This study uses cooperative learning models and discovery learning models to gather data from groups with high, medium and low early mathematical abilities. The results were analyzed with descriptive and inferential statistics; inferential statistics aim to provide effective comparisons between groups with different early abilities. Additionally, the study compares the effects of cooperative learning and discovery learning on students' ability to understand concepts, with effects analyzed by students' early ability. The inferential statistical analysis aims to determine the differences in students' ability to understand mathematical concepts. It also aims to determine the effect of cooperative learning — which uses discovery learning models — on students' independence in terms of mathematics and concept understanding. Additionally, the analysis aims to draw conclusions about the effect of these interactions on students' abilities with regards to their independent learning and concept understanding.

This study obtains three sets of data: student ability test results, independence questionnaire results and results from classes I and II. The following table summarizes descriptive analysis of students' early mathematical ability.

Tabel 3. Description of Students' EarlyMathematics Ability Results

Class	**Maximal Score**	**N**	$x_{\min}$	x_{maks}	$\overline{x}$
Experiment I	100	31	27	86	60.45
Experiment II		30	20	93	60.77

Furthermore, the grouping of KAM (high, medium, and low) provided that students who scored $KAM \geq \overline{X} + SD$ were grouped in high math ability, students who had grades $(\overline{X} - SD < KAM < \overline{X} + SD)$ were grouped in moderate power mathematics, while students who have rates $KAM \leq \overline{X} - SD$ grouped in low ability. The summary of the calculation results is presented in table 4 below: The outline of the results of the descriptive analysis of students' early mathematical ability data is shown in the following table.

Tabel 4. Description of Student Grouping Based on EMA

KAM Category	Statistics	Learning Methods	
		Discovery Learning	*Group Investigation*
High	N	6	8
	Average	83.50	89.25
	Standard Deviation	1.22	3.11
Medium	N	20	16
	average	60.70	59.38
	Standard Deviation	12.98	12.01
Low	N	5	6
	Average	29.40	26.50
	Standard Deviation	3.29	8.68

From the recapitulation of table 4 above, ability obtained that in experimental class I, the early skills of students for the high category were six students, and 20 students were moderate. Five students were low, while in the experimental class II the students' early abilities for the high category were eight, medium 16 students, and down six students. Student.

Two-way ANOVA Calculation Results on Students' Mathematical Concept Understanding Ability Test Results

Tabel 5. Result of Two-way ANOVA

Tests of Between-Subjects Effects

Dependent Variable: Kemampuan_Pemahaman_Konsep

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	5413.575[a]	5	1082.715	44.915	0.000
Intercept	266361.429	1	266361.429	11049.550	0.000
Kemampuan_Awal	5058.159	2	2529.079	104.915	0.000
Model_Pembelajaran	368.068	1	368.068	15.269	0.000
Kemampuan_Awal * Model_Pembelajaran	16.902	2	8.451	0.351	0.706
Error	1325.835	55	24.106		
Total	388389.000	61			
Corrected Total	6739.410	60			

a. R Squared = .803 (Adjusted R Squared = .785)

Based on table 5 above, it can be concluded that: Student comprehension of mathematical concepts was evaluated using two-way ANOVA analysis. The results

indicated a knowledge significance value of 0.41, which is lower than sig. < 0.05. Therefore, the null hypothesis — that there are no differences in understanding between students taught with group investigation learning and those taught with discovery learning — is rejected. Consequently, it can be concluded that these two teaching methods do lead to differences in student understanding.

A dependent variable is influenced by two or more independent variables working together. This study examined how early mathematical ability affected the ability to understand math concepts. Data analysis revealed no interaction between students' early abilities — high, medium and low — and the learning model— which involved group investigation and discovery learning on the ability to understand students' mathematical concepts.

This is by a significance value greater than 0.05, which is 0.666 for the interaction of early mathematical abilities and learning models, so that H_0 is accepted. Thus, this shows no interaction between the students' early mathematical skills and the learning model. More details are presented in Figure 2 below:

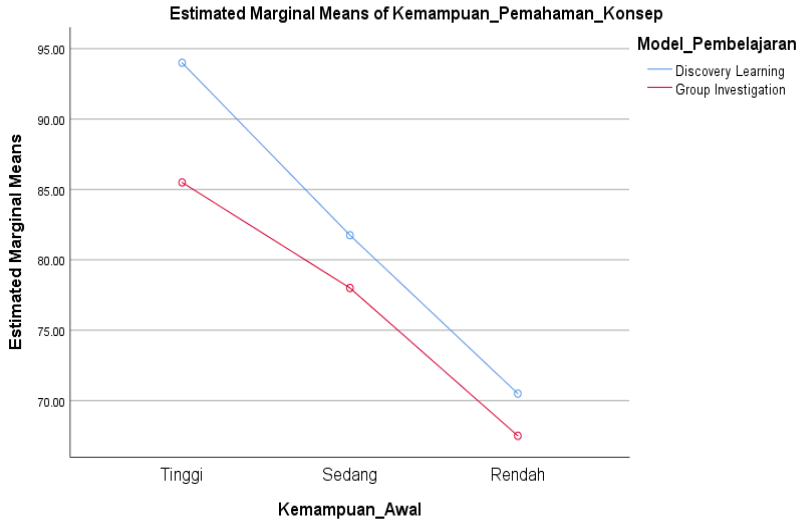


Figure 2. Interaction between KAM and Learning Models on Ability to Understand Mathematical Concepts

The figure above shows the lines that do not intersect; there is no interaction between the two factors, namely the learning model factor and students' early mathematical abilities.

Conclusion

After analyzing data, findings and discussions, several conclusions were reached regarding SMK Multi Karya's ability to understand math concepts and students' independence in learning. These conclusions were reached after the data was presented and discussed:

1. There are differences in the ability to understand mathematical concepts of students who are taught using the discovery learning and group investigation at SMK Multi Karya. This can be seen from the results of the two-way ANOVA where the sig. < alpha (0.041< 0.05).
2. There are differences in the independence of students' mathematics learning who are taught using the discovery and group investigation learning model at SMK Multi Karya. This can be seen from the results of the two-way ANOVA where the sig. < alpha (0.036 < 0.05).

3. There is no interaction between the learning model and students' early mathematical abilities (high, medium, and low) on students' ability to understand mathematical concepts at SMK Multi Karya. This can be seen from the results of the two-way ANOVA where the sig. > alpha (0.666> 0.05).
4. There is no interaction between the learning model and students' early mathematical abilities (high, medium, and low) on students' mathematics learning independence at SMK Multi Karya. This can be seen from the results of the two-way ANOVA where the sig. > alpha (0.654 > 0.05).

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