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Analysis of Discovery Learning to Improve High Level Cognitive Learning Outcomes Based on Student Metacognitive Characteristics

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Abstract
The application of learning models has a significant impact on how students are involved in learning. The learning approach known as "discovery learning" places great emphasis on students' active participation in obtaining new information. The aim of this research is to determine high-level cognitive learning outcomes through discovery learning by paying attention to students' metacognitive characteristics. However, in reality, in the field, students' cognitive learning outcomes are still very low and students are still unable to manage the abilities they already have. The data obtained in this research was analyzed using experimental methodology and the Solomon Four Groups Design type of research. The population used in this research was all fourth grade students at Al Kautsar Elementary School, totaling 216 people divided into 8 classes. The sample used in this research was based on a cluster random sampling technique consisting of 4 classes, so the total sample used was 112 students. Non-parametric tests such as the Man Whitney test were used to analyze data using SPSS 26 software. The significance level for experimental and control group 1 was 0.001, and the significance level for experimental and control group 2 was 0.000. These results were obtained from students completing essay questions totaling 10 items. This shows that there is a significant difference between the learning outcomes of students who use the Discovery Learning method and conventional methods.

Keywords: discovery learning, high level cognitive learning outcomes, metacognitive

INTRODUCTION

Entering the Industrial Revolution 4.0, information and communication technology is now experiencing very rapid progress. The industrial revolution 4.0 paradigm is largely the result of advances in science and technology. All aspects of life have changed due to the development of information technology in Indonesia, but education has experienced the most significant changes (Pratama et al, 2020). Apart from that, technological advances are also being made to meet the educational needs of the 21st century (Ikhtiarti et al, 2020). Student-centered learning is a hallmark of 21st century education. Consequently, to integrate 21st century learning effectively, educators must be able to create innovative teaching strategies by incorporating technology into learning, and developing various interesting and fun teaching techniques (Inayati, 2022). The skills that must be developed in implementing 21st century learning are not only limited to the ability to read or the ability to remember, but also learning that can develop students' intellectual skills and abilities

The skills in question include the 4C skills which include Communication, Collaboration, Critical Thinking and Creativity which can be developed through quality education (Anwar, 2022). Quality education can develop various abilities, such as solving problems in everyday life, and improving students' thinking abilities. Thinking skills are one of the life skills that need to be developed through the learning process. The learning process currently being held is based on the Independent Curriculum (Anagun, 2018).

Educational institutions provide curricula with the aim of improving the quality of teaching. Puspita & Tirtoni, (2023), the aim of the independent curriculum in elementary schools is to take the education system in a brighter direction and place elementary schools on a logical and correct path towards its goals and objectives. This curriculum helps prepare the country's future generations to face the challenges of the industrial revolution 4.0 by prioritizing freedom and independence (Alfath et al, 2022). A learning process that is independent, dynamic, and meaningful has character is prioritized in implementing the independent curriculum. Furthermore, this curriculum covers reading skills, knowledge, abilities and attitudes towards the use of technology. Students who are free to think and learn from any source can seek knowledge and find answers to the real problems they face (Aransyah et al, 2023). Teachers are also given the freedom to choose teaching materials that suit their students' interests and learning needs through an independent learning curriculum, so that it will improve students' cognitive learning outcomes (Inayati, 2022).

Additionally, Anderson & Krathwohl, (2001) defines cognitive learning outcomes as thinking skills, such as the ability to remember, understand, apply, analyze, evaluate and create. Throughout the learning process, both internal and external factors can have an impact on students' achievement of learning goals. Internal factors are factors that come from within the student, such as biological, psychological and intellectual characteristics. Outside influences such as those originating from family, society and school are referred to as external forces. Students who actively participate in the learning process can achieve better cognitive learning outcomes and develop higher-order thinking abilities (Ahyana & Syahri, 2021). This indirectly means that educators must hone their abilities in developing new teaching strategies so that they can ultimately guide students in mastering higher order thinking skills. Therefore, teachers can apply learning that focuses on higher level thinking to develop overall personal thinking. Learning based on higher order thinking allows students to fully apply their knowledge and abilities in forming critical and creative reasoning (Cholily et al, 2019).

According to Anderson & Krathwohl, (2001), tests that cover the highest level of Bloom's taxonomy include analysis (C4), evaluation (C5), and creation (C6), used to test cognitive domains that focus on higher-level thinking. To achieve high-level cognitive learning goals, educators must present challenges to their students during learning activities. For example, students are asked to analyze problems related to their daily lives, students are asked to find solutions to solve these problems and then present the results of their analysis in front of the class (Sumarli, 2018). High-level thinking ability is referred to as the ability to apply skills, knowledge, reasoning and reflection to solve problems, make decisions and create something innovative. High-level cognitive learning outcomes are closely related to metacognition skills (Pratama et al, 2020).

Metacognition was originally defined as the ability to think about thinking, namely the ability to understand how one thinks (Flavell, 1979). However, the definition of metacognition is actually not that simple, metacognition skills are skills that students have in controlling their thinking processes consciously (Ma'rifah et al, 2021). Metacognitive skills are high-level thinking skills about ways of thinking that involve cognitive processes (Livingston, 1997). This expression describes metacognitive abilities as high-level thinking skills about ways of thinking that involve cognitive processes. Students can develop higher-level thinking with the help of metacognitive skills, and this can ultimately have an impact on increasing students' higher-level cognitive learning outcomes.

Additionally, Febriana (2019) states that metacognition involves understanding cognitive activities, strategies for managing cognitive processes, and skills in understanding, implementing, and planning cognitive activities. There are two components of melted cognition: (1) cognitive knowledge, and (2) cognitive experience, which includes; planning, monitoring and evaluation. Planning skills include activities to rethink important information, knowledge to be used, strategies and appropriate time allocation to solve problems. Monitoring skills are the ability to think in controlling strategies and the time needed to solve problems. Evaluation skills are defined as assessing the results and strategies that have been used, including reviewing and implementing improvements (Amzil & Stine-Morrow, 2013).

Improving student learning outcomes is directly related to metacognitive abilities. Research by Priantiningtias & Azizah (2021) show this because a positive correlation was found between students' cognitive learning outcomes and their metacognitive skills. This is demonstrated by the results of data analysis which shows that there is a fairly large relationship between learning outcome variables and metacognitive ability variables at the 0.01 level. The influence of metacognitive abilities on learning outcomes produced findings of 90.7% in the strong correlation category, with a correlation value of 0.952. This means that if students have strong metacognitive abilities, then they can get good learning results. However, evidence from observations, tests and interviews conducted by researchers at Al Kaultsar Elementary School shows that students' metacognitive abilities are still relatively low.

Researchers' observations in class IV of Al Kaultsar Elementary School on July 13 2023, produced information that students' cognitive capacity was relatively low, this shows that their learning outcomes were still at a low level cognitive stage. This can be seen during learning activities, especially when solving problems. This can be shown by students' responses to learning. When they are given story-based questions that require higher level thinking, such as analysis (C4) and evaluation (C5), students often appear confused by the questions and give inappropriate answers to the questions. The majority of students have difficulty applying the metacognitive skills needed to solve problems

because they still find it difficult to respond to questions asked by the teacher. They also have difficulty planning the best course of action when faced with a problem, and they often work on tasks quickly without considering the answer.

When carrying out initial trials, the researcher paid attention to each student's response. When students were given stimuli for the questions given, most students were able to respond well to the stimuli given by the researcher and knew how to solve the problems in the questions. Question is given, meaning the problem is related to low results. Students' cognitive learning is not only caused by students' low understanding of the material they are studying but also students' low awareness of their abilities. In other words, the main factor causing low student cognitive learning outcomes is students' low metacognitive abilities.

Learning strategies are another factor that influences poor student cognitive learning outcomes. Based on the findings of interviews conducted with fourth grade teachers at SD Al Kautsar, the application of learning models can also influence how successful students are in learning. If the model used is not appropriate to the learning environment or does not match the scope of the subject matter and student characteristics, of course this will affect the way students respond to and participate in learning activities, which in the end can affect student learning outcomes. Innovative learning has been implemented in learning activities by Al Kautsar Elementary School teachers. However, sometimes there are certain students who still experience difficulties in learning activities.

Based on the explanation above, efforts that can be made to overcome this problem are by introducing students to the idea of actively participating in class. In this case, students are allowed to express their opinions, so that it will encourage critical thinking that involves their cognitive processes. This will ultimately affect how well students learn cognitively. The use of the Discovery Learning model is a learning technique that can improve high-level cognitive learning outcomes depending on students' metacognitive abilities (Amanda et al, 2020). A number of studies have proven the fact that the discovery learning paradigm can improve students' cognitive learning outcomes based on their metacognitive characteristics.

According to Kuswara et al. (2023), discovery learning can help students become autonomous learners and foster the development of high-level cognitive thinking patterns. The Discovery Learning model learning process encourages student activities to find answers to questions given by the teacher through their learning experiences, independent learning experiences train students to use thinking skills (Pangestuti et al, 2019). Discovery learning provides students with the opportunity to discover a concept through examples found in everyday life (Muhammad & Juandi, 2023).

Students should be able to participate actively in the learning process to encourage higher level thinking abilities. Students who use the discovery learning model actively seek knowledge about the subject matter to be more independent in their learning activities (Fitriyani et al, 2023). Involving students in the thinking process, being able to help them find new information, and fostering higher-level thinking abilities are the main goals of implementing the discovery learning paradigm (Sakti et al, 2020).

Discovery learning has several advantages, including: 1) this method can help students improve and enhance students' cognitive skills and processes, 2) this method allows students to develop quickly and according to students' abilities, 3) because of discussion activities, students become more respectful of each other. , 4) provide a

feeling of joy and happiness if students succeed in carrying out an experiment, and 5) learning activities foster optimism because the learning results or findings lead to the truth. Meanwhile, the weaknesses of the discovery learning model include: 1) this method requires students to have an initial understanding of the concepts being studied, otherwise they will experience difficulties in learning discovery, and can even cause them to feel disappointed; 2) implementing this method takes a long time, so it is not suitable for learning with a short duration and also classes with large students, 3). teachers and students must be familiar with this method and must be consistent in its implementation (Kementerian Pendidikan dan Kebudayaan, 2013).

Based on research conducted by Prasetyo & Abduh (2021), shows that students' cognitive learning outcomes can be improved by following the steps of the Discovery Learning approach. research conducted by Gulo, (2022), implementation model discovery learning in learning Biology can improve learning outcomes student. And also supported by Mayuni et al, (2021), the application of the discovery learning model can improve students' science learning outcomes due to several factors, namely discovery learning in accordance with the constructivist view which sees students constructing their own knowledge, providing opportunities for student-centered classroom activities and enabling students to learn by utilizing various learning resources that do not only make the teacher the only source of learning and learning activities involve all students' abilities maximally to search and investigate regularly, critically and logically so that Students can discover their own knowledge, attitudes and skills as a form of change behavior. Based on this description, it can be seen that the Discovery learning model is used to improve learning outcomes, thinking abilities and student learning activities. However, in this research the focus is on student learning outcomes based on metacognitive characteristics through discovery learning.

METHOD

In this research, researchers used quantitative methods with a quasi-experimental type of research. Experimental research is an activity carried out by a researcher by collecting evidence related to a hypothesis. The research design used is the Solomon four group design which can be described in Table 1.

Table 1. Research design designed by Solomon Four Group Design

Group	Pre test	Treatment	Post test
E_1	O_1	X	O_2
K_1	O_3	-	O_4
E_2	-	X	O_5
K_2	-	-	O_6

Information:
E1 : Experimental Class 1 (discovery learning)
K1: Control class 1 (conventional learning)
El2: Experimental Class 2 (discovery learning)
K2: Control class 2 (conventional learning)
X: Treatment in the form of Discovery Learning
O1: pre test in experimental group 1
O2: post test in experimental group 1
O3: pre test in control group 1
O4: post test in control group 1
O5: post test in experimental group 2
O6: post test in control group 2

According to the design described above, the pre- and post-test findings in experimental class 1 which used discovery learning were compared with the findings of control class 1 which used conventional methods to assess learning outcomes. Apart from that, the findings after using discovery learning in experimental class 2 were compared with the findings after using conventional methods in control 2. The population used in this research was all 216 grade IV students at Al Kautsar Elementary School, starting from IV A to IV H. The research sample is a portion of the population selected for research. The sample for this study was selected using a cluster random sampling technique. If a population consists of several people or groups, this strategy is used. Each group has the same opportunity to be selected as a research sample (Sugiyono, 2017). Researchers randomly selected four class groups to serve as research participants. The student groups selected as research samples were Class IV A, B, C, and D.

Tests and questionnaires are two approaches used in this research to collect data. To evaluate student learning outcomes, ten essays centered on the HOTS level were used as pre- and post-test questions. On the topic of Plant Body Parts in CHAPTER 1: Plants as a Source of Life on Earth, the aim of this test is to collect data on high-level cognitive learning outcomes related to students' metacognitive abilities. After completing the pre- and post-test questions, students' metacognitive abilities are evaluated using a questionnaire. There are fifteen questions about planning, monitoring and evaluation in the questionnaire used.

To ensure the validity and reliability of the instruments used in this research, researchers tested the instruments. Sugiyono, (2017), defines validity as the degree of accuracy between the data on the research object and the strength that the researcher is able to report. To ensure the validity of the test questions that will be used in research, validity testing is carried out before the questions are tried out on students. Using SPSS 26 software, the validity test used in this research is the product moment person correlation coefficient in table 2, which is the calculation used in the validity test.

Table 2. Validity Test Results

Number	Validity test	Number of Test Instruments
1	valid question	10
2	Invalid Questions	0
Amount		10

Based on data from calculating the validity of the question instrument, information can be obtained that all question items are valid, meaning that all of the 10 questions tested can be used in the pre-test and post-test in this research.

Calculation of test reliability in this research uses Cronbach's Alpha calculations assisted by the SPSS 26 program which can be seen in table 3.

Table 3. Reliability Test Results

Reliability Statistics	
Cronbach's Alpha	N of Items
0.565	10

Information collected from the results of using the SPSS 26 program to calculate the reliability of the 10 questions in this study shows that the Cronbach's Alpha value is 5% or 0.565, indicating moderate reliability. It can be said that the essay items are considered reliable because rcount > rtable or 0.565 > 0.374.

FINDINGS AND DISCUSSION

Findings

The application of Discovery Learning to fourth grade students at Al Kautsar Elementary School aims to examine high-level cognitive learning outcomes based on students' metacognitive characteristics. This research was carried out in two meetings using material from Chapter 1. Plants as a source of life on earth. Topic A parts of the plant body. The first stage of this research involved collecting the necessary data, such as assessing students' metacognitive skills in relation to cognitive learning outcomes by administering five essay questions centered on higher-order thinking to fourth grade students at Al Kautsar Elementary School. These data are taken into account and become the basis for analyzing high cognitive learning outcomes according to students' metacognitive characteristics.

The essay questions that students were asked to complete during the research were intended to collect information before and after treatment in order to assess the learning outcomes of fourth grade students at SD Al Kautsar. Data on student learning outcomes obtained before receiving treatment is called pre-test data, while data on student learning outcomes obtained after receiving treatment on students in both the experimental and control groups is called post-test data. There are ten essay-based questions. There is a minimum score of 0 and a maximum score of 100 for each question. Findings before and after the test for control class 1 which was taught conventionally, as well as experimental class 1 which was taught using discovery learning.

Descriptive statistical tests, normality tests, homogeneity tests, Wilcoxom sign rank tests, and non-parametric tests using Mann-Whitney were all used in the analysis of this research data using SPSS version 26. Descriptive statistical tests are used to describe or illustrate data, without the intention of being interesting conclusion. The results of the descriptive statistical test data can be seen in Table 4.

Table 4. Descriptive Pre-Test Post-Test Results for Experimental and Control Class 1

Test	The number of students	KKM	Number of Students Completed Studying	Lowest Value	The highest score	Average
Pre-Test Experimental Class 1	28	75	4	55	82	63,04
Post Test Experimental Class 1	28	75	28	77	91	85,86
Pre-Test control class1	28	75	3	50	77	56,95
Post Test control class1	28	75	21	68	91	80,29

Based on Table 4, experimental class 1 students had an average pre-test score of 63.04 with the lowest score of 55, and an average post-test score of 85.86 with the lowest score of 77. Meanwhile, control class 1 students had the average pre-test score is 56.8 with the lowest score of 50, for the post-test average score is 80.29 with the lowest score.

Table 5. Results of Descriptive Data Pre Test Post Test Experiment Class 1 & Control 1

Test	The number of students	KKM	Number of Students Completed Studying	Lowest Value	The highest score	Average
Post Test Experimental Class 2	28	75	28	82	91	85,96
Post Test control class 2	28	75	13	55	86	72,89

Experimental class 2 students got the lowest post-test score of 82 with an average score of 85.96 according to the data in table 5 above, while control class 2 students got the lowest score of 55 with an average score of 72.89. To find out whether the values or data are distributed regularly or not, the researcher carried out a normality test on the pre-test and post-test results in experimental class 1, control class 1, and experimental class 2, control class 2. The researcher used the Kolmogorov-Test method Smirnov to perform normality tests. If the resulting significance value (p) exceeds $\alpha = 0.05$ ($p > 0.05$), then the interpretation is said to be consistently distributed. The findings of using SPSS 26 software to process normality test data in Table 6 are as follows.

Table 6 Results of Normality Test Data

	Treatment Group	Kolmogorov-Smirnov[a]		
		Statistic	df	Sig.
Student Learning Results	Pre-Test Experimental Class 1	0.287	28	0.000
	Post Test Experimental Class 1	0.304	28	0.000
	Pre-Test control class1	0.302	28	0.000
	Post Test control class1	0.206	28	0.004
	Post Test Experimental Class 2	.246	28	0.000
	Post Test control class 2	0.184	28	0.016

A significant value of 0.000 was achieved by experimental class 1, a significant value of 0.000 by control class 1, a significant value of 0.000 by experimental class 2, and a significant value of 0.016, namely less than 0.05 by control class 2 in the pre-post post-test findings. In other words, the data is not normally distributed. The researchers use a homogeneity test to ensure whether the samples they collect are homogeneous or not. The one-way ANOVA test was used in this study to test data homogeneity. If as indicated by the significant value (p) obtained, then the interpretation is considered to have a regular distribution (a). Table 7 Results of homogeneity test data processing using SPSS 26 software are as follows.

Table 7. Results of Homogeneity Test Data

Class IV	Sig (2-tailed)	Information
Experimental class 1 and control class 1	0,000	Inhomogeneous
Experimental class 2 and control class 2	0,002	Inhomogeneous

Table 7 above provides information showing that the value is 0.000 and the value obtained in the experimental class and control class 2 is 0.002, which is less than 0.05. This result shows that the data is not homogeneous. The Mann-Whitney test is

used to determine whether or not there are differences between two independent samples which can be seen in table 8.

Table 8. Wilcoxom Signed Ranks Test Data Results.

Test Statistics[a]			
	Pre-Test Experimental Class 1 Post Test Experimental Class 1	Pre-Test control class1 Post Test control class1	Post Test Experimental Class 2 Post Test control class 2
Z	-4.654[b]	-4.613[b]	-4.548[c]
Asymp. Sig. (2-tailed)	.000	.000	.000

Table 8 above provides information showing that the Asymp (2-tailed) value is 0.000. Conclusion "Hypothesis Accepted" because the value of 0.000 is less than 0.05 (0.000<0.05).

Based on the results of the data prerequisite test, it shows that the data is not distributed and is not homogeneous. So then a non-parametric test is carried out using the Mann-Whitney test, to test the hypothesis with the following conditions:

a. If the value of Asymp.Sig. (2-tailed) > 0.05, then H0 is accepted
b. If the value of Asymp.Sig. (2-tailed) < 0.05, then H0 is rejected

Table 9. Mann-Whitney U test data results

Class IV	**Sig Value (2-tailed)**	**Information**
Experimental class and control class 1	0,001	Hypothesis Accepted
Experimental class and control class 2	0,000	Hypothesis Accepted

Because Asymp, sig, (2-tailed) in the experimental and control groups produces results of 0.001 < o.o5 in the experimental and control group 1 and 0.000 < 0.05 in the experimental and control group 2, then Table 9 above contains the necessary information to describe the idea that "the hypothesis is accepted". Based on this, there is a significant difference between the learning outcomes of students who apply discovery learning and students who apply conventional methods.

Next, an analysis of high-level cognitive learning outcomes was carried out based on students' metacognitive skills using a questionnaire. The questionnaire in this research was given to students after the students were given post test questions in experimental class 1, control class 1 and experimental class 2, control class 2. The aspects of measuring students' metacognitive skills in this research consisted of planning, monitoring and evaluating. Researchers used a Likert scale. to determine scores from the form of questions and questionnaire measurements.

Discussion

The results above show that discovery learning is proven to be able to foster high-level cognitive learning outcomes based on students' metacognitive characteristics with the Merdeka Belajar curriculum. This can be seen when the learning process takes place using the Discovery Learning learning model, students find it easier to understand the subject matter at each meeting because students are actively involved in learning activities such as searching for information and connecting the knowledge they already have with new knowledge regarding plant body parts, photosynthesis and plant reproduction processes. Through this activity students are able to build their own knowledge concepts.

This is in accordance with constructivist theory which is constructive in terms of abilities and knowledge in the learning process, therefore in constructivist theory students are required to be able to improve their abilities in constructing new understanding (Mulyadi, 2022). This is in line with the use of the model used in this research, namely the Discovery learning learning model. Discovery learning provides students with the opportunity to discover a concept through examples found in everyday life.

Students' thinking abilities can also be developed through metacognition skills because metacognition skills are mental activities in cognitive structures that consciously regulate, control and evaluate students' thinking processes (Azizah et al, 2019). Flavell (1979), first introduced metacognition, metacognition is interpreted as a thinking ability that involves thinking processes at a high level. Metacognitive skills can give students the ability to understand how they learn, organize learning strategies, and monitor and evaluate their understanding.

Students' thinking abilities can be developed by enriching meaningful experiences through decision making and problem solving related to analyzing, evaluating and creating (Puspitasari et al, 2020). High-level thinking skills are not just about remembering, restating and referring to an event, but high-level thinking skills emphasize students' mindset in analyzing information, solving a problem and making the right decision regarding a problem (Alifah et al. 2020). Through creative and critical thinking, students are able to study problems systematically in facing various challenges (Ahyana & Syahri, 2021).

CONCLUSION

Referring to the presentation of research results and discussions previously presented, it can be concluded that the application of Discovery can improve high-level cognitive learning outcomes based on students' metacognitive characteristics. This is proven by the results of students' answers to the questions given. Discovery learning is more effective in improving student learning outcomes compared to applying conventional methods. Discovery learning places greater emphasis on students' active participation in building their skills and knowledge in learning activities, so that students are more enthusiastic in participating in learning activities. Data on student learning outcomes can be shown from the Mann-Whitney results in the experimental class and control class 1 of 0.00 and in the experimental class and control class 2 of 0.01. This means that there is a significant influence of the application of Discovery Learning on students' high-level cognitive learning outcomes. The limitation of this research is that it can only be tested on classes IV A, B, C, and D due to time constraints. It is hoped that this research can be carried out further to determine whether or not there is an influence of Discovery Learning on high-level cognitive learning outcomes based on students' metacognitive characteristics in material or other learning.

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