Indonesian Science Education Research (ISER)
Available online
https://jurnal.unimed.ac.id/2012/index.php/iser
e-ISSN: 2715-4653
p-ISSN: 2797-6262

Influence Discovery Learning on Cognitive Skils and Science Process Skills of Grade VII Junior High School Students

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Accepted: September 12th, 2025. Published: September 12th, 2025

Abstract

This research aims to know the influence of Discovery Learning on the cognitive abilities and science process skills of grade VIII students. This study uses the method of the Quasi-Experimental Sampling technique using simple random sampling. The research sample consisted of two classes, namely class VII-4 (Experimental Class), which used the model Discovery Learning, and VII-5 (Control class), using learning direct instruction, each class consists of 31 students. The research instruments in this study were a multiple-choice cognitive ability test consisting of 30 questions and a science process skills observation sheet consisting of 19 statements. Data were analyzed using prerequisite tests and t-tests (independent sample t-tests). Based on the results of data analysis, there was a significant influence (sig 2-tailed) < 0.05, where 0.000 < 0.05 on cognitive abilities and Science Process Skills in the experimental class. Based on the hypothesis test, it was found that there was an influence of discovery learning on the cognitive abilities and science process skills of grade VII students on the solar system material at SMP Negeri 13 Medan, 2024/2025 academic year.

Keywords: Discovery, Science, Process, Skills, Cognitive

Introduction

Education plays a crucial role in national growth, as it shapes the quality of human resources and influences a nation's advancement (Kurniawati, 2022). The learning process involves choosing appropriate models, methods, and strategies, along with implementing evaluations to measure students' progress, as shown in their achievements across cognitive, affective, and psychomotor domains (Agustin and Aslam, 2022).

Learning outcomes are essential in education since they function as a foundation for assessing students' progress and guiding subsequent learning activities to reach the intended academic objectives (Agustin and Aslam, 2022). Cognitive learning outcomes encompass several domains related to students' thinking. The cognitive domain consists of six hierarchical levels: C1 (recall), C2 (comprehension), C3 (application), C4 (analysis), C5 (evaluation), and C6 (creation). The first two aspects are categorized as Low-Order Thinking (LOT), while the next four aspects are categorized as High-Order Thinking (HOT) (Nurlindayani et al., 2021).

The 21st century has become known as the knowledge era, where information is widely disseminated and technology is developing rapidly. One of the main characteristics of this century is the increasing integration of various scientific disciplines, making collaboration between scientific fields faster and more effective (Efendi et al., 2023). In the context of 21st-century education, learning is not only focused on outcomes but also emphasizes science process skills. These skills play a vital role in science education since they encourage students to engage actively in inquiry-based activities, including performing experiments, interpreting data, and making evidence-based conclusions (Angelia et al., 2022). Natural Science is a field of study that requires active involvement from students. Science is not merely a collection of facts, concepts, and principles, but also includes various activities to discover and acquire new knowledge (Sinaga & Hardinata 2025).

Science education should ideally provide students with direct, hands-on experiences to help them develop the ability to explore and understand their environment scientifically (Masus & Fadhilaturrahmi, 2022). Based on the 2022 findings of the Programme for International Student Assessment (PISA) published by the Organisation for Economic Co-operation and Development (OECD), Indonesian students still perform at a relatively low level, despite a high level of equity, the average science score of Indonesian students was recorded at 383, while the OECD average stood at 489 (Kemendikbudristek, 2023). This indicates that science learning in Indonesia still requires improvement to enhance student outcomes in the future. One possible solution is to implement a variety of learning models and align them with effective strategies to achieve learning objectives. This highlights a major challenge in education, particularly in science subjects how to develop students who not only achieve good academic results but also possess strong scientific process skills.

From the preliminary study carried out using observation methods at SMP Negeri 13 Medan in 2024, it was found that the implementation of science learning in class VII was still dominated by a teacher-centered approach. This condition causes low student involvement in the learning process, characterized by minimal collaborative activities between students and limited implementation of practical activities. Students consequently remain passive and show limited progress in cultivating scientific reasoning, which in turn affects the growth of their science process skills. This is reflected in the low interaction and cooperation of students during learning activities. In addition, teachers have not implemented interactive learning methods, such as the use of teaching aids, especially in delivering material on the solar system, which is thought to help students understand the material more deeply and meaningfully.

Teachers already have teaching modules containing learning models, but their classroom implementation is not yet appropriate. At SMP Negeri 13 Medan, teachers still frequently use traditional teaching methods, such as lecturing and question-and-answer sessions. These methods tend to be boring because students simply listen without actively engaging. As a result, learning becomes less engaging, and students struggle to understand the material,

especially challenging topics like the solar system. Because students are not encouraged to think and explore for themselves, their ability to understand the lesson deeply is reduced.

Research by Agustin et al (2024) also showed that low student learning outcomes in the solar system were due to teachers still using teacher-centered, rather than student-centered, methods. This method failed to help students think critically and understand the material independently. Such teacher-centered approaches tend to emphasize memorization and the transfer of information from teacher to student, while limiting opportunities for exploration, questioning, and problem-solving. As a result, students become passive recipients of knowledge and are less motivated to engage actively in the learning process. In contrast, student-centered methods such as inquiry-based learning or collaborative problem-solving are more effective in fostering critical thinking, conceptual understanding, and long-term retention of scientific concepts, including those related to the solar system.

From interviews with science teachers of grade seven, it was revealed that students' average cognitive achievement has not yet reached the expected standards. This indicates that the learning process is not fully effective, primarily because the learning strategies used have not been able to optimize students' potential to the fullest. This condition aligns with research conducted by Febriyana et al. (2021), which found that students at MTs Al-Falah experienced obstacles in understanding the solar system. This was evident in the low achievement indicators for classifying (26.62%), interpreting (11.51%), and the lowest level of conceptual understanding (15%). These findings reinforce the urgency of implementing a more varied and student-centered learning approach to improve deeper conceptual understanding.

Referring to the identified problems, one strategic solution that can be implemented is the use of an appropriate learning model that aligns with student characteristics and curriculum requirements. Students engaged in the discovery learning approach are guided to explore independently, reason critically, and identify the meaning, concepts, and interconnections among the materials, which allows them to formulate conclusions aligned with their cognitive development stage.

The model focuses on learning processes that stimulate learners to formulate questions, plan investigations or experiments, gather and interpret data, and independently derive conclusions from their own learning experiences. Discovery Learning, through this method, has been shown to foster key abilities, including critical thinking, creative problem-solving, innovation, and autonomous learning competencies that are crucial for addressing 21st-century challenges and for aligning with the goals of the Independent Curriculum (Muhammad et al., 2023).

The findings of Septi et al. (2021) show that the use of the discovery learning approach was found to greatly enhance students' science process skills, as it requires them to engage in activities such as planning, executing, and presenting findings. However, the study applied science process skill indicators drawn from experts, while at present, these indicators have been formally set by the Ministry of Education and Culture as part of the mandatory standards in the Merdeka curriculum. Supardi (2016) mentioned the proportion of science process skills is classified into five levels: very high, high, moderate, low, and very low.

Research Method

The study applies a quantitative method using an experimental design to examine hypotheses about the influence of discovery learning on learners' cognitive performance and scientific process skills. This research design uses Pre-test and Post-test group design. These findings suggest improvement in cognitive skills across both groups, with the experimental group taught using a discovery learning model. The study was conducted in the even semester of the 2024/2025 academic year at SMP Negeri 13 Medan. In this study, the population was all seventh-grade students consisting of 7 classes. The research employed a simple random sampling method, resulting in two selected groups: class VII-4 as the experimental group and

class VII-5 as the control group. The data were gathered through multiple-choice assessments to measure cognitive skills and observation sheets using a Likert scale, which were directly evaluated by five observers throughout the study to examine students' science process skills. Cognitive learning outcomes on the topic of force were measured with a multiple-choice test consisting of four answer options (a, b, c, and d). The test was conducted as both a pretest and posttest, each containing 30 items, while the total pool included 40 validated questions. The test instrument was developed by referring to the cognitive domains in the revised Bloom's Taxonomy. Each correct response was awarded a score of 1, whereas an incorrect response was assigned 0. For data processing, prerequisite analyses were carried out, including normality, homogeneity, and hypothesis testing using SPSS 2021. The decision rule for hypothesis testing was determined by the significance value (Sig), where H_0 would be rejected and H_a accepted if Sig < 0.05.

Result and Discussion

Result

1. Data Pre-test and Post-test Cognitive Skills Experimental and Control Group

The cognitive skills data of students, obtained from the pre-test and post-test administered to both the experimental and control groups, is presented in Figure 1.

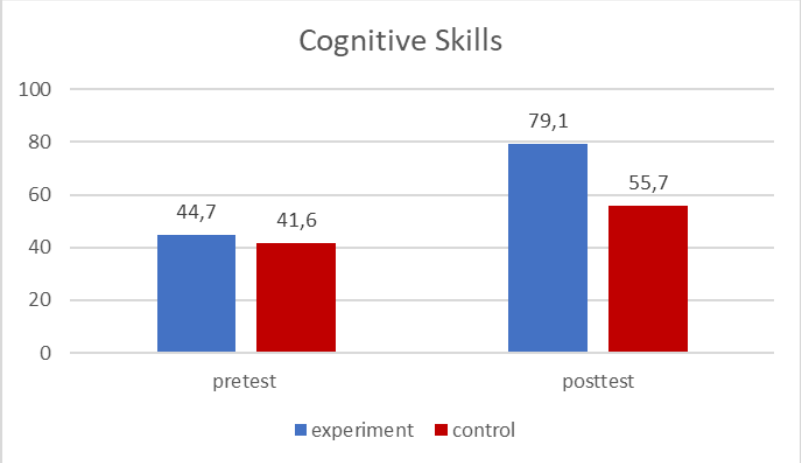

Figure 1. Value data pretest and posttest experimental and control classes

As shown in Figure 1, the control group obtained an average pretest score of 41.6 in cognitive skills, while the experimental group achieved 44.7. After the learning intervention, the posttest averages increased to 55.7 for the control group and 79.1 for the experimental group.

2. Result of Hypothesis Testing Cognitive Skills

To examine the influence of the discovery learning model on students' cognitive abilities, hypothesis testing is applied. When the data meet the assumptions of normality and homogeneity, the analysis is conducted using an Independent Sample t-Test (two-tailed) in SPSS version 21, based on pretest and posttest results of cognitive skills.

The results of the normality test the cognitive skills for the control and experimental classes can be seen in Table 1.

Table 1. Normality test results of the cognitive skills the experiment class and the control class

Data	Result	Category
Pre-test Eksperiment	0,683	Normal
Post-test Eksperiment	0,896	Normal
Pre-test Control	0,429	Normal
Post-test Control	0,053	Normal

Referring to Table 1, the normality test results show that the pre-test cognitive skill data of the discovery learning model class obtained a value of 0.683 > 0.05, while the post-test reached 0.896 > 0.05, which confirms that both datasets are normally distributed.

The result of the homogeneity test of the experimental and control groups can be seen in Table 2.

Table 2. Homogeneity test results the cognitive skills of the experimental and control classes

Data	Result	Category
Pre-test	0,817	Homogeneous
Post-test	0,445	Homogeneous

Referring to Table 2, the homogeneity test results show that the cognitive skill scores in the pretest obtained a value of 0.817 > 0.05, while the posttest yielded 0.445 > 0.05. These findings confirm that both the pretest and posttest data from the discovery learning group and the control group are homogeneous.

The results of the hypothesis test for the pretest data show 0.345 > 0.05; thus, based on the pretest data, it can be concluded that Ho is accepted and Ha is rejected. The results of the hypothesis test for the posttest data show 0.000 < 0.05, indicating that H_0 is rejected and H_a is accepted.

3. Description of Data Science Process Skills of Experimental and Control Group

The assessment of science process skills was carried out through observations made by five evaluators during the learning sessions, with students being graded according to their performance as outlined in the observation rubric. This skills assessment is conducted through an observation sheet in the form of a performance evaluation, where each indicator is assigned specific points ranging from 1 to 4. The points obtained are then converted into a final percentage as the assessment result. Across four sessions, observations were conducted in both the discovery learning group and the control group. The evaluation results from these sessions were averaged to determine the final score of students' science process skills, and the percentage outcomes are displayed in Figure 2.

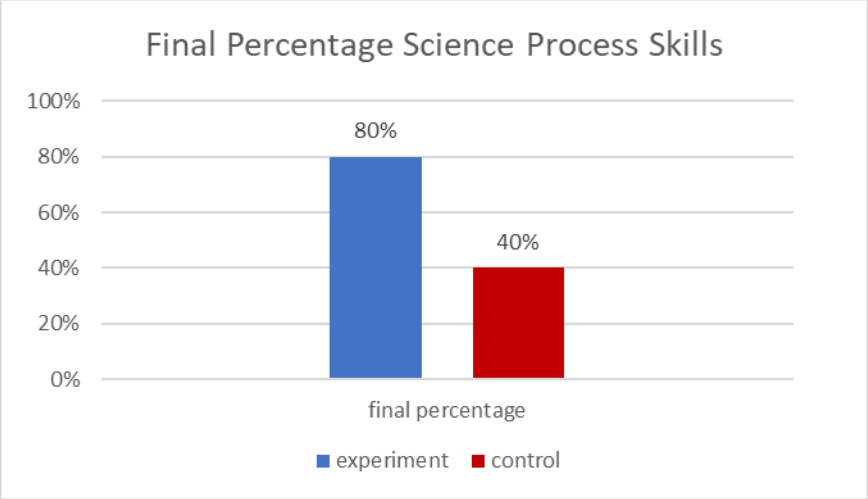

Figure 2. Value data final percentage science process skills

Figure 2 illustrates that there is a variation in science process skill scores between the class taught with the discovery learning model and the control group. The final percentage score of skills obtained by the discovery learning model class is 80%, which falls into the high category. The average skill score obtained by the control class is 40%, which falls into the low category. The category of the percentage of science process skills can be seen in Table 3.

Table 3. Category of the Percentage of Science Process Skills

Category	Percentage
very high	81%-100%
high	61%-80%
medium	41%-60%
low	21%-40%
very low	0%-20%

4. Results of Hypothesis Testing of Science Process Skills

The hypothesis test is applied to identify whether the discovery learning model influences students' cognitive abilities (Sudrajat, 2020). When the data meet the assumptions of normality and homogeneity, hypothesis testing is conducted on the posttest of cognitive abilities using SPSS version 21.

Table 4 presents the normality test outcomes of the science process skills for both the experimental and control groups.

Table 4. Normality test results of the science process skills the experiment and control group

Data	Result	Category
Eksperiment	0,123	Normal
Control	0,464	Normal

Referring to Table 4, the normality test results for science process skills showed a significance value of 0.123 > 0.05 in the discovery learning class and 0.464 > 0.05 in the control class, which means that the data in both groups follow a normal distribution.

The result of the homogeneity test of the science process skills of the experimental and the control group can be seen in Table 5.

Table 5. Homogeneity test results the science process skills of the experimental and control group

Data	Result	Category
Experiment and Control	0,181	Homogeneous

Referring to Table 5, the homogeneity test results for science process skills yielded a significance value of 0.181 > 0.05, which means that the data from the discovery learning group and the control group are homogeneous.

The hypothesis testing results on science process skills data yielded a significance value of 0.000, which is smaller than 0.05; therefore, the null hypothesis (H_0) is rejected and the alternative hypothesis (H_a) is accepted.

Discussion

1. The Effect of Discovery Learning on Cognitive Skills

Students cognitive abilities were measured through posttest scores after the learning process, both in the experimental class that applied the discovery learning model and in the control class that did not use the model. The pretest results in both classes showed low scores because the students had not yet understood the material to be studied. After receiving instruction on the material, both the experimental and control classes were given a posttest to determine the improvement in their cognitive abilities.

Applying discovery learning has demonstrated a positive effect on students' cognitive performance when compared to conventional instruction. Initially, both groups obtained low pretest scores since the material was not yet understood. However, following the learning activities, the experimental group taught with discovery learning showed a more significant increase in achievement than the control group.

The strength of discovery learning is that students actively participate in exploring information, engaging in discussions, recognizing problems, and independently generating solutions. Such activities help strengthen knowledge retention. By implementing the Discovery Learning model, learners become more involved in constructing subject concepts on their own, while teachers act as facilitators who provide general direction and create conditions that stimulate observation, experimentation, and analysis.

The role of the teacher in discovery learning is more as a facilitator who provides general guidance and creates an exploratory situation through observation, experimentation, and analysis. Meanwhile, the control class is more passive due to the dominance of teacher explanations. Previous research findings support that discovery learning not only enhances the cognitive domain but also the psychomotor skills of students, as well as fostering a sense of joy and enthusiasm in learning.

Gulo (2022) findings confirm that active learning through self-discovery makes learning outcomes more durable. Ridwan (2021) also stated that this model improves learning outcomes because students play an active role in identifying problems, finding solutions, drawing conclusions, and communicating findings. A crucial stage in this model is data collection, which, according to Hendrizal et al. (2022), can foster student activeness, collaboration, and responsibility through physical and mental activities in acquiring information. The teacher acts as a facilitator, providing general direction, while students explore the material through observation, experimentation, and analysis. Nurhamidah's (2021) research shows that the use of Student Worksheets in discovery learning encourages students to formulate and find their own solutions, while also increasing their enthusiasm for learning. Similarly, Saputri and Susanti (2024) stated that this model has a positive effect on learning outcomes in the cognitive and psychomotor domains.

Implementing the Discovery Learning approach encourages students to be more engaged in independently identifying the concepts within the lesson. The teacher only provides general guidelines and designs situations that encourage exploration through observation, experimentation, and analysis. This is different from the control class that is dominated by teacher explanations, where students tend to be passive and require a lot of correction. In the class that uses Discovery Learning, students are more independent in understanding the material, resulting in their answers being more accurate and aligned with learning objectives.

In conducting the research, the researcher encountered several obstacles, particularly related to time constraints. Each stage of the learning process requires careful planning and proper implementation, making the available time often feel insufficient. Moreover, the researcher needs to establish a supportive learning atmosphere to ensure the process is effective and students stay attentive. Therefore, it is recommended to extend the time allocation for each stage of data collection. This additional time is expected to provide students with greater opportunities to explore and delve deeper into the material being studied, making the learning process more meaningful and the outcomes more optimal. During the implementation of the research, there were several obstacles faced, especially related to time constraints. Each syntax in the implementation of learning requires optimal planning and execution, so the available time often feels insufficient. Additionally, the researcher must also be able to manage a conducive learning environment so that the learning process can proceed effectively and the students remain focused.

2. The Effect of Discovery Learning on Science Process Skills

Scientific process skills are acquired through practice that sharpens mental, physical, and social abilities, as well as helps students master learning material. A distinction was found in students' scientific process skills between the group taught using the discovery learning

model and the group taught without it, with the discovery learning class achieving a higher mean final percentage score.

Learners taught using the discovery learning model generally participate more actively in the learning process than those in the control group. The integration of science process skills is crucial, as it offers a richer and more meaningful learning experience. According to Saleh (2020), direct experience can help students understand the meaning of the activities they perform. Conversely, if learning takes place without meaningful engagement, the mastery of skills will require a longer period of time.

In line with the findings of Yuliati & Susianna (2023), the application of discovery learning improves scientific process skills. Based on Figure 4.3, in the observation aspect, the experimental class achieved 81% ("Very High" category), while the control class scored 46% ("Medium" category). In the questioning and predicting aspect, the experimental class obtained 82% ("Very High" category) and the control class scored 40% ("Low" category). In the aspect of planning and conducting investigations, the experimental class achieved 82% ("Very High" category) while the control class reached 39% ("Low" category). In the aspect of processing and analyzing data, the experimental class obtained 76.5% ("High" category) and the control class got 40% ("Low" category). In the aspect of evaluating and reflecting, the experimental class achieved 79% ("High" category) and the control class reached 48% ("Medium" category). Finally, in the aspect of communicating results, the experimental class obtained 78% ("High" category) and the control class reached 44% ("Medium" category).

In line with Jerome Bruner's (1960) perspective, learning becomes more effective when students are directly involved in discovering concepts through experience, rather than merely receiving information from the teacher. In experimental classes that apply this method, students are presented with challenging problems that stimulate curiosity and encourage them to predict the outcomes of experiments or certain situations. This approach emphasizes the importance of the discovery process in learning. Through this way, students can develop scientific process skills, such as predicting, analyzing, and connecting new knowledge with their prior experiences.

These results indicate that discovery learning encourages students to be more active in observing, questioning, predicting, planning, investigating, analyzing, evaluating, and effectively communicating learning results, in contrast to the control class, which tends to be passive.

In conducting the research, the researcher encountered several obstacles, particularly related to time constraints. Each stage of the learning process requires careful planning and proper implementation, making the available time often feel insufficient. Moreover, the teacher must ensure a supportive learning atmosphere to facilitate an effective learning process and maintain students' concentration. Therefore, it is recommended to extend the time allocation for each stage of data collection. This additional time is expected to provide students with greater opportunities to explore and delve deeper into the material being studied, making the learning process more meaningful and the outcomes more optimal.

It is recommended to increase the time allocated for each stage of data collection. The extra time aims to give students greater chances to investigate and gather detailed information about the studied material, enhancing the learning experience and promoting optimal outcomes.

Conclusion

Based on the breadth of the problems found, this study was limited to be more focused. First, the low average value of students' cognitive learning outcomes in the solar system material was focused on measuring cognitive abilities at levels C1 to C6. Second, students' underdeveloped science process skills were limited through training in the KPS aspect according to the indicators set by the Ministry of Education, Culture, Research, and Technology. Third, although teachers had used teaching modules based on learning models, their implementation was not optimal. Consequently, this research implemented a discovery learning model grounded in Jerome Bruner's theory, following these procedural steps:

stimulation (offering stimuli), problem statement (identifying the problem), data collection (gathering information), data processing (analyzing data), verification (validating findings), and generalization (formulating conclusions).

Based on the study and analysis of the data, it can be concluded that the Discovery Learning model impacts students' cognitive abilities and their scientific process skills in learning the solar system at SMP Negeri 13 Medan.

Based on the results and conclusions above, recommendations for further improvements can be made. Science teachers are advised to use the discovery learning model, especially in teaching science related to abstract concepts such as the solar system. This method has demonstrated effectiveness in improving students' cognitive achievements and science process abilities, as it allows learners to independently explore information connected to the concepts being taught. Science teachers should utilize interactive learning media such as simulations of planetary movement, educational videos, or simple teaching aids to support the discovery process for students. For science teachers who have not yet implemented Discovery Learning, it is recommended to apply this model as it can improve cognitive abilities and science process skills. Future research should be able to optimize the implementation of each syntax in the research and manage a conducive learning environment. It is recommended that future research increase the time for each stage of data collection, so that students can conduct more in-depth exploration of the material. Schools are advised to provide adequate facilities and infrastructure to support the smooth application of various learning models. This also supports the creation of a learning environment that allows the discovery learning model to function well.

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