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Implementation of Discovery Learning Module Human Circulatory System Towards Improving Students'Cognitive Learning Outcomes and Scientific Attitude

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A B S T R A C T

Science learning requires learning that encourages students to discover new knowledge through exploration and investigation. This study aims to investigate the implementation of the use of discovery learning module human circulatory system towards improving student's cognitive learning outcome and scientific attitude. The type or research used is quasi-experimental using Pretest-posttest nonequivalent control group design. The population of this study was 56 students of class VIII MTs N 2 Pekanbaru. The sample for this study consists of Class VIII A as the control group and Class VIII B as the experimental group. The data collection instrument was in the form of a cognitive learning outcome test and scientific attitude questionnaire. Data analysis was carried out by descriptive analysis and inferential analysis using the SPSS version 23 application. The results of this study indicate, the Discovery Learning-based module focusing on the human circulatory system demonstrates a positive significant impact on enhancing both cognitive learning outcomes and scientific attitudes, that there are differences in student cognitive learning outcomes and and scientific attitude between the control and experimental groups and the use of the discovery learning module human circulatory system is effectively used towards improve student's cognitive learning outcomes and scientific attitude.

1. Introduction

Indonesia has undergone ten curriculum changes influenced by globalisation, ecological challenges, and advances in science and technology. According to Sekarsari and Wicaksono (2023), Curriculum 2013 is designed with a competency-based approach to prepare students for the demands of the 21st

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century through the development of skills such as enquiry, reasoning, observation, and demonstration of knowledge. A comprehensive curriculum should include various aspects of learning that stimulate students' critical, analytical and creative thinking, enabling them to engage in problem solving, research, discussion and collaboration. In addition, the curriculum should accommodate individual differences by providing learning methods that suit the needs and learning styles of each student. According to Arifin (2022), this approach gives each student the opportunity to develop maximum potential in various areas of knowledge and skills, focusing on knowledge transfer as well as the development of skills needed to adapt and contribute in an ever-evolving society.

Students' critical thinking abilities are very necessary to shape students' cognitive strengths (Agustia, 2024). Currently, many pedagogical approaches still prioritise teacher-centered, lecture-based learning methods. In this method, the teacher plays the main role as a giver of information, while students tend to be passive recipients. As a result, the learning environment created often does not support active participation from students. The students lack the confidence to express their opinions or viewpoints. They also tend to show reluctance to speak or perform in front of their peers for fear of being wrong or getting negative reactions (Rozali et al, 2022, Putri et al, 2020)

This method, which does not encourage student collaboration, reduces opportunities for group work and idea sharing, hindering the development of crucial social and teamwork skills. Purnasari and Sadewo (2020) found that this approach needs further evaluation and development to foster a more dynamic and collaborative learning environment where students feel more comfortable and confident in participating. This issue contributes to suboptimal learning outcomes, and potential solutions involve implementing change-oriented, student-centered learning systems. Shifting the focus from teacher-oriented to student-oriented education requires innovative and creative learning models. According to Sekarsari and Wicaksono (2023), Discovery Learning is a suitable approach to implement.

According to Lestari (2020), the Discovery Learning model is one of several instructional approaches used to actively engage students in inquiry and independent investigation. This approach aims to ensure that the knowledge and skills acquired by students are retained for a longer period. This viewpoint is reinforced by Fajri (2019), who states that the Discovery Learning model is an approach that does not provide pre-packaged concepts but instead requires students to independently construct their own learning concepts. Furthermore, according to Sitepu (2022), students have the opportunity to actively ask and answer questions, express ideas, demonstrate responsiveness, and gain comprehensive understanding of their responsibilities as students. The Discovery Learning model is expected to be used in science learning.

The implementation of Integrated Science learning should cultivate critical thinking skills and conceptual mastery among students. Critical thinking skills are one of the intellectual objectives of science learning in the 2013 curriculum, as

students are expected to utilize these skills in their lives to solve emerging problems (Herlina, 2015). In general, the learning conducted by teachers tends to emphasize knowledge aspects. This results in students being less trained to develop their reasoning abilities in problem-solving and apply the concepts they have learned to real-life situations. Consequently, the intended goals and essence of true learning have not been achieved. Continuing Professional Development is provided institutionally, teachers will get the opportunity to develop professionally, and students will also be benefited through it (Afroz, 2024).

Based on direct observations while teaching the Human Circulatory System topic to 8th-grade students in the academic year 2020/2021 at MTsN 2 Pekanbaru, it was found that students' learning outcomes in science subjects were still low. The low learning outcomes can be seen from the failure to achieve minimal individual proficiency in learning as expected. This indicates that student activities are still low, and a scientific attitude is not evident in their learning. The low student activities are caused by several factors, such as the teacher's use of inappropriate teaching models for the delivered content, uninteresting learning resources, and a teaching strategy that still focuses on the teacher. As a result, many students are not actively engaged in the learning process. Additionally, the learning activities conducted so far tend to focus only on the aspect of memorization (Yuliati, 2016).

Through interviews with several Science Subject Teacher Study Group (MGMP IPA) teachers regarding the Human Circulatory System topic, similar challenges were found concerning the low learning outcomes of students in that topic. The Human Circulatory System topic consists of several sub-topics that are quite extensive and need to be understood. Students are required to comprehend the material, including its definition, components, mechanisms of the human circulatory system, examples of diseases, and their prevention methods. One possible solution is to create an active learning module that involves problem-solving discussions in groups, such as a Discovery Learning-based learning module.

With Discovery Learning, students are invited to discover key concepts through independent exploration and investigation, guided by the teacher (Tyas et al, 2020, Wafa et al, 2022). This approach not only improves concept understanding, but also trains critical and analytical thinking skills. In the context of learning the topic of Human Circulatory System, this module can include various activities such as simulations of circulatory mechanisms, case studies on related diseases, and group projects to design disease prevention strategies. Thus, a Discovery Learning-based active learning module can be an effective tool to improve student learning outcomes on this complex topic (Safitri et al, 2023; Fathiyah et al,2023).
An interesting and systematic module includes content, materials, methods, evaluations, and can be used independently (Depdiknas, 2017). Rahayu (2015) argues that modules can support students in active learning and enhance the effectiveness of learning. To achieve this effectiveness, the developed module should enhance students' learning motivation and be effective in achieving the expected competencies. According to Handoko (2016), a biology module based

on Discovery Learning is effective in empowering social, skill, and knowledge learning outcomes.

The research conducted by Silalahi (2024) demonstrates the importance of Discovery Learning in education. Furthermore, the research findings indicate that the learning outcomes of students using the Discovery Learning model and the Base Learning model in chemistry subjects differ. Challenges are seen as obstacles that must be overcome. Teachers will feel comfortable, enthusiastic, and optimal in delivering the material and conducting the teaching-learning process (Wardiana & Asroyani, 2022). With the responsible pursuit of knowledge through the Discovery Learning model, the best results are naturally achieved (Patandianan, 2022).

In his research, Batubara (2014) states that inquiry-based and discovery learning strategies can improve students' learning outcomes in science subjects. By using the Discovery Learning-based module, students can directly engage in learning, resulting in a positive learning experience and improved learning outcomes and scientific attitudes in science subjects. Teachers play a crucial role in cultivating students' scientific attitudes. A scientific attitude refers to students' response to new knowledge through certain methods in the learning process. Teachers must be able to select appropriate learning strategies that suit the students' conditions in the classroom. The choice of a suitable strategy has an impact on the success of a learning activity (Zainabun,2020; Asri et al, 2024).

Efforts to improve students' learning outcomes and scientific attitudes using the Discovery Learning module that makes students more active and engaged through exploration and investigation of scientific concepts. Teachers can use this module for more interesting and interactive learning, providing challenging activities such as experiments, simulations, case studies, and group discussions.

According to Puti (2015), the use of science modules has significant potential in improving students' process skills and scientific attitudes. Science process skills include the ability to observe, classify, measure, predict, and conclude. A good module is designed to train these skills through various practical activities that require the application of the scientific method. For example, in the topic of Human Circulatory System, modules may include activities such as measuring pulse rate, simulating blood flow, or analysing data on heart health.

In addition to process skills, science modules help shape scientific attitudes in students, such as curiosity, openness, healthy skepticism, perseverance, and objectivity. Through Discovery Learning, students are encouraged to be critical, ask questions, and evaluate data objectively. The module not only improves academic learning outcomes, but also develops science process skills and scientific attitudes essential for long-term learning. (Utomo et al, 2020; Safitri et al, 2022).

Based on the observed changes in curricula, previous research, and field observations, the purpose of this study is to investigate the implementation of the

Discovery Learning-based module on the Human Circulatory System topic to enhance students' learning outcomes and scientific attitudes.

2. Methodology

The implementation of the Discovery Learning module was carried out using a Quasi Experimental design with a nonequivalent control group design research design. The experimental research design involves the independent variable of cognitive's student outcomes and scientific attitude. The research design can be seen in Table 1.

Table 1. Experimental Research Design

Class	Pretest	Treatment	Posttest
Experiment	O_1	X	O_2
Control	O_3	-	O_4

Source: (Creswell, 2013)

Description:
O_1 = *Pretest* in experimental class
O_3 = *Pretest* in control class
X = The treatment given is the Discovery Learning module human circulatory system.
O_2 = *Posttest* in experimental class
O_4 = *Posttest* in control class

Before conducting the experiment, the normality and homogeneity tests were performed to determine the control and experimental groups for the research. The normality test used was the Kolmogorov-Smirnov test, and the homogeneity test conducted was the Levene's statistic. In addition to determining the groups, the normality and homogeneity tests will also be conducted on the research data to determine the subsequent hypothesis testing.

Descriptive analysis in this study is used to examine the cognitive learning outcomes of students as observed through their scientific attitude. The achievement of cognitive learning outcomes is focused on individual achievement. This research is considered successful if a minimum of 80% of students achieve scores equal to or above the minimum mastery criteria. The determination of students' learning outcomes based on the scores obtained is calculated using the formula:

$$N = \frac{w}{n} \text{ x } 100\ \%$$

Description:
N = Score obtained by students
w = Number of correct answers
n = Number of test items

The process of obtaining cognitive learning outcomes involves several aspects within the cognitive domain measurement. Students' cognitive abilities can be assessed based on variables C1 (remembering), C2 (understanding), C3 (applying), C4 (analyzing), and C5 (creating). The criteria for the category of student cognitive student outcomes can be seen in Table 2.

Table 2. Category of Cognitive Learning Outcomes

Interval (%)	Category
0 – 74	Low
75 – 82	Currently
83 – 91	Tall
92 – 100	Very High

(Kemendikbud, 2017)

To determine the level of students' scientific attitudes, the researcher compares them with the score criteria that have been modified based on the number of questionnaire items and the number of answer choices for each statement. The calculation results of the research questionnaire are based on 30 statements and the predetermined number of subjects, resulting in score criteria as shown in Table 3.

Table 3. Criteria for Interpreting Scientific Attitude Questionnaire

Percentage (%)	Category
85 – 100 %	Very Good
69 – 84 %	Good
53 – 68 %	Fair
37 – 52 %	Poor
21 – 36 %	Very Poor

Source: Mastika, et al (2014)

Inferential analysis in this study was used to see significant differences in students' cognitive learning outcomes and scientific attitude when learning using discovery learning module and learning using conventional models. In this analysis using 3 tests with the help of SPSS version 23, namely the normality test using the Kolmogorov Smirnov technique, the homogeneity test using the Levene technique and hypothesis testing using the *Multivariate Analysis of Variance* (MANOVA) with *Test of Between Subjects Effects*.

3. Results and Discussion

The teaching module has been developed and compiled following the steps of Discovery Learning, which are implemented in each session. The module is also equipped with questions designed for students to apply the material learned in their daily lives and as a tool to measure students' ability to understand and master the material on the human circulatory system. This module contains images that support the circulatory system material and is equipped with a series of activities designed to support the achievement of learning objectives. The module content can be seen in Figure 1.

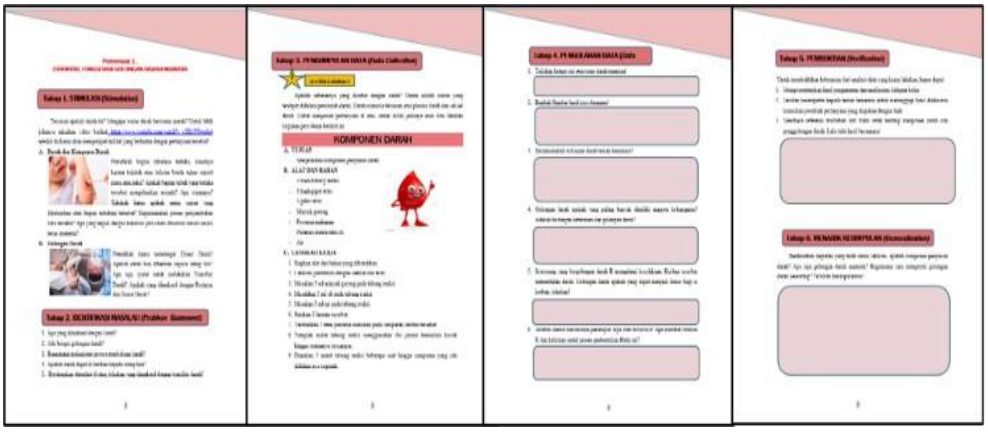

Figure 1. Contents of Discovery Learning-based Module

The material in the module is arranged based on the steps of Discovery Learning, which includes the stages of stimulation, problem identification, data collection, data processing, verification, to the final stage of drawing conclusions. The data analyzed in this study is the data on cognitive learning outcomes of experimental class and control class students on the material human circulatory system. Data on student's cognitive learning outcomes and scientific attitude were obtained from the pretest and posttest results which were carried out after applying the discovery learning module, namely class VIII B and the conventional model in class VIII A at MTs N 2 Pekanbaru.

In this study, Descriptive Data Analysis was conducted on students' learning outcomes using a written test consisting of 20 items. The results of the test were analyzed to determine students' cognitive abilities in solving questions related to the human circulatory system. After obtaining the final scores of the students, they were grouped into Table 4.

Table 4. Descriptive Analysis of Cognitive Learning Outcomes

No	Cognitive Level	Experimental Class		Control Class	
		Score	Category	Score	Category
1	C1	88	High	82	Currently
2	C2	86	High	80	Currently
3	C3	84	High	74	Low
4	C4	78	Currently	71	Low
5	C5	76	Currently	65	Low
	Average	83	High	75	Currently

Based on the table above, it can be seen that the students' ability in cognitive Level C2 in the Experimental class has the highest percentage, indicating that the students have understood and comprehended the material after receiving explanations from the teacher. To assess the ability at this level, the researcher used 4 Level C2 questions. The result showed an average score of 83, indicating a good level of cognitive ability. The lowest cognitive level score was observed in Level 5 (C5) with a score of 76. The low level of cognitive ability in C5 is one of

the impacts of students not being accustomed to working on questions at this stage.

Overall, this research has been successful, indicating that the science learning using the Discovery Learning-based module on the topic of the human circulatory system has achieved the minimum mastery criteria, as shown in Table 5.

Table 5. Descriptive Analysis of Scientific Attitudes

No	Scientific Attitudes Aspec	Experimental Class		Control Class	
		Score	Category	Score	Category
1	Curiosity	3,6	High	2,8	Currently
2	Critical thinking	3,4	High	2,5	Currently
3	Responsibility	3,7	High	2,9	Currently
4	Not Quick Make Decisions	3,9	High	2,7	Currently
	Average	3,6	High	High	Currently

Based on the table above, it can be seen that the students' scientific attitude in the experimental class is categorized as "High," indicating that learning using the Discovery Learning module can enhance students' scientific attitudes. The analysis of scientific attitudes shows that the category of critical thinking is still low in the control class, while in the experimental class, students' scientific attitudes are in the "High" category. This indicates that there is an influence of learning the human circulatory system on students' learning outcomes. Furthermore, there is a significant difference in the "Not quick to make decisions" aspect of scientific attitudes between the control and experimental classes. The experimental class obtained a score of 3.9, which falls into the "High" category, while the control class obtained a score of 2.7, falling into the "Medium" category.

The cognitive learning outcomes variable obtained an F-value of 8.891 with a significance level of 0.004. This result indicates a difference in learning outcomes between the experimental and control classes. The average score for cognitive learning outcomes in the experimental class is 83.0357, which is higher than the score of 75.3571 in the control class. Therefore, it can be concluded that the Discovery Learning-based approach is better/effective than conventional learning in learning science.

The scientific attitude variable obtained an F-value of 152.454 with a significance level of 0.000. This result indicates a difference in scientific attitude scores between the experimental and control classes. The average score for scientific attitude in the experimental class is 3.8036, which is higher than the score of 2.7143 in the control class. Thus, it can be concluded that Discovery Learning-based learning is better/effective than conventional learning in learning science.
The Discovery Learning model is used to enhance student engagement by encouraging collaborative problem-solving. Nelvianti et al. (2020) have provided evidence that the Discovery Learning approach involves students in active learning, enhances their knowledge and skills, and fosters their creativity in problem-solving.

From the research conducted on the use of the Discovery Learning-based module, an improvement in learning outcomes was observed during the learning process. The researcher conducted three learning sessions, during which observations were made on the science learning process. In each session, students engaged in learning following the stages of Discovery Learning, including stimulation, problem statement, data collection, data processing, verification, and generalization.

Effectiveness was assessed to determine the efficiency level of the Discovery Learning-based module recommended by the students. The data obtained were analyzed, and criteria were established for the six effectiveness stages after the module was used by the students. These stages were implemented to ensure that the product could be utilized by others, not limited to the researcher alone.

In the initial phase of teaching, the teacher developed a comprehensive schedule for one semester, a detailed course outline, and specific plans for each lesson. Setiyani's research (2019) supports the idea that the planning phase involves the development of various learning tools, including annual and semester programs, competency and basic competency mapping, syllabi, and lesson plans. The Discovery Learning approach was implemented in the teaching of science at junior high school level.

At the beginning of the lesson, the teacher provided the subject matter, and then the students were divided into two groups: the experimental group and the control group. In this context, the teacher stimulated the students' curiosity by presenting visual aids that encouraged them to articulate their perspectives, followed by the development of problem statements and hypotheses. The students attentively received instructions from the teacher on the methodology for collecting data and tried to complete the tasks by following the worksheets provided by the teacher. After completion, the students presented their work in the classroom. They were able to summarize the problems based on the formulated problem statements. At the end of the lesson, the teacher provided reinforcement and motivation for the learning efforts and began to draw conclusions about the activities conducted. The results of this research support the findings of previous studies (Nelvianti et al., 2020; Fajri, 2019; Sitepu et al., 2022) that pedagogical approaches involving stimulus provision to students, presenting initial problems, guide students' investigations according to the teacher's instructions.

Furthermore, the students proceeded to distinguish events that depended on challenges to accommodate the material into the learning process and then formulated hypotheses. During the data collection process, the students reinforced previously made statements by gathering data from various sources. After data collection, the students processed and interpreted the acquired data and information with confidence. Following the data processing to support the formulated hypotheses, the final stage involved drawing conclusions.

The Discovery Learning model is used to promote student engagement in various learning scenarios based on their individual capacities. Setiyani (2019) chose the

Discovery Learning approach to foster students' tendency to acquire, explore, and negotiate knowledge. The utilization of the Discovery Learning approach in science learning yields both positive and negative outcomes. The benefits derived from this approach are advantageous for teachers and students. However, the limitations associated with this approach can serve as a basis for evaluating the learning process, thereby facilitating improvements. In the context of continuous education, several benefits can be obtained from the interaction between teachers and students. It is essential to note that without such interaction, the learning process cannot be effectively facilitated.

Effective communication is also crucial in ensuring the smooth flow of continuous education programs. Additionally, teachers play a vital role in providing step-by-step guidance to students, minimizing misunderstandings, and enhancing understanding. Furthermore, learners can offer feedback by asking questions and exercising student autonomy in thinking and working.

The implementation of the Discovery Learning model at MTsN 2 Pekanbaru yields benefits in terms of teacher and student quality, as well as overall educational quality. According to the findings of studies on the Discovery Learning pedagogical approach, teachers report several benefits. These include fostering self-confidence among students, facilitating individual development and progress according to each student's potential, enabling new learning modalities, promoting student engagement, strengthening student learning, and eliciting satisfaction upon successfully solving problems.

The results of this research support the findings of studies conducted by Fadilah and Taufik (2022) and Sekarsari and Wicaksono (2023) that the Discovery Learning model offers several benefits. Firstly, it can enhance cognitive abilities and processes. Secondly, knowledge acquired through this model can strengthen understanding, retention, and transfer, while also providing a sense of joy as students are able to explore and achieve success. Thirdly, it can facilitate students' development at their own pace. Fourthly, it can reinforce self-concepts by promoting collaborative work among students and encouraging active idea generation by both teachers and students. Finally, it can stimulate critical thinking and initiative among students.

Based on interview findings conducted with science teachers, it can be concluded that the implementation of the Discovery Learning approach leads to increased student engagement and improved cognitive abilities, which is further supported by Nelvianti's (2020) findings stating that the implementation of the Discovery Learning method enhances learning outcomes. The learning model allows student involvement through active participation as they utilize their cognitive abilities to achieve desired outcomes. Acquiring knowledge related to discoveries can facilitate its application in various fields.

Furthermore, according to Sekarsari and Wicaksono (2023), the absence of the Discovery Learning pedagogical approach often results in miscommunication between educators and learners. This is because during the learning process,

students may become distracted and engage in socializing with peers from different groups or discussing topics unrelated to the task at hand. Their engagement in the educational process is relatively lower compared to their involvement in handling the given problem-solving tasks.

Teachers can address this issue by providing understanding to students, allowing them to promptly solve problems, and disciplining those who exhibit arbitrary behavior. Identifying potential weaknesses during the implementation of the Discovery Learning model can serve as a valuable tool for evaluating and improving the teaching methodology, thus enhancing its effectiveness. The Discovery Learning model typically requires collaborative problem-solving among students, but its implementation may face certain challenges.

The identified barriers can serve as limitations in the implementation of the Discovery Learning pedagogical approach, which can be overcome by teachers. Nelvianti (2020) has identified certain limitations of the Discovery Learning model, including the need for a significant amount of time and teacher interventions in the form of concise and clear information dissemination and questioning.

4. Conclusion

Based on the research findings, the Discovery Learning-based module on the human circulatory system has a positive and significant impact on improving learning outcomes and scientific attitudes of students in class VIII MTsN 2 Pekanbaru. The implementation of this module consistently showed a significant increase in students' understanding of the material. Therefore, the author recommends the use of this Discovery Learning module as one of the effective learning methods in the school environment. In addition, it is suggested that further research be conducted in various other fields of science using similar approaches, in order to deepen these findings and develop the application of the Discovery Learning module in the context of science learning more broadly that is expected to increase the effectiveness of science education and make a positive contribution.

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