Letters in High Energy Physics
ISSN: 2632-2714
Volume 2024

Characteristic Analysis of the Discovery Learning Model in Chemistry Learning of Grade X High School Students in Padang Sidempuan

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Abstract

This research analyzes the effectiveness of the Discovery Learning learning model in increasing the understanding of chemistry concepts in class X students at a High School in Padang Sidempuan. Using a quantitative approach with a descriptive-analytic design, this research involved 100 students selected through purposive sampling. The research results show that Discovery Learning significantly increases students' understanding, as evidenced by the increase in the average post-test score from 56.4 to 78.3 and the paired t-test results (p-value = 0.001). Students also demonstrated positive perceptions of the model, with a mean score of 3.73, reflecting increased motivation, active engagement, and critical thinking skills. However, challenges in time management during the implementation of Discovery Learning require further attention. Discovery Learning proved effective in secondary school chemistry learning, with important implications for curriculum development and teaching strategies.

Keywords: Discovery Learning, Chemistry, Active Learning, Understanding Concepts, Middle School Education.

1. Introduction

Education is fundamental in developing competent human resources that can compete globally. In an increasingly dynamic era of globalization, the quality of education has become the main benchmark in determining a nation's ability to compete internationally (Abu-Duhou, 1999; Eggen & Kauchak, 2012). Various subjects are taught at the secondary school level to equip students with relevant knowledge and skills. However, among these subjects, Chemistry is often considered one of the most challenging subjects for students. This is due to Chemistry's abstract and complex nature, which requires a deep understanding of basic concepts and the ability to apply them in a broader context.

According to research conducted by Tsaparlis (2009), students often face difficulties understanding basic chemistry concepts such as atomic structure, chemical bonds, and chemical reactions due to the abstraction and complexity of the material taught. This difficulty is exacerbated by traditional teaching approaches emphasizing memorization rather than a deep understanding of concepts (Taber, 2015). Therefore, innovative and effective learning approaches are needed to bridge this gap and help students understand chemistry material better.

In this context, the Discovery Learning learning model effectively increases student understanding through active involvement in the learning process. Discovery Learning, which Jerome Bruner first introduced in the 1960s, emphasizes the importance of students discovering new information and concepts rather than just receiving information passively from the teacher(Bruner, 1961). Recent research by Alvarez (2020) Indicates that Discovery Learning has a notable impact on students' comprehension of concepts and their ability to think critically. Discovery Learning promotes active exploration, inquiry, and problem-solving among students, leading to more profound and significant learning experiences. (Mayer, 2004). This model has also proven effective in increasing students' motivation to learn, especially in difficult subjects such as chemistry (Dmoshinskaia et al., 2021; Gijlers & De Jong, 2005). However, the success of implementing Discovery Learning depends on student readiness and the support of the learning environment, including the teacher's active role in facilitating the learning process (Alfieri et al., 2011).

Discovery Learning is a learning approach that emphasizes the process of exploration and discovery, where students are actively involved in discovering new concepts through direct experience. As the pioneer of this model, Jerome Bruner argued that learning would be more effective if students could discover and build their understanding through direct involvement in the learning process (Bruner, 1961). Recent research shows this model improves conceptual understanding and develops students' critical and creative thinking skills (Iskandar & Hadi, 2022 C.E.; Widodo, 2021).

Although much research supports the effectiveness of Discovery Learning, challenges in its implementation remain, especially in the context of chemistry learning in schools with limited resources. Research conducted by Suryani (2018) at SMA Negeri 1 Bandung revealed that Discovery Learning can increase students' understanding of electrolyte and non-electrolyte solutions. However, this research was conducted in schools with inadequate facilities and does not highlight the challenges that schools in areas with limited resources may face. Another study by Prasetyo (2019) in Surakarta found that discovery learning effectively increased student motivation and learning outcomes in acid-base learning.

However, this research focuses more on measuring learning outcomes quantitatively and does not explore how this learning model is applied in classes with various social and cultural environmental conditions. Likewise, research by Kusuma & Dewi (2020) highlights that the success of Discovery Learning depends on teacher readiness and the support of the school environment. However, this study does not delve into the dynamics of interactions between teachers and students in this learning context.

Research also shows that implementing Discovery Learning can encounter obstacles, especially regarding time management and the availability of educational resources (Hasanah, 2020). For example, research by Ardiansyah (2021) in rural schools in East Java shows that the lack of laboratory facilities and limited learning materials can hinder the optimal implementation of Discovery Learning, so the results achieved are not as optimal as expected.

Even though much research supports the effectiveness of Discovery Learning in teaching Chemistry, several important gaps are still not widely covered in the literature. First, most research was conducted in urban schools with adequate facilities and infrastructure. At the same time, little attention was paid to how this model was implemented in areas with limited resources, such as Padang Sidempuan High School. Second, most research focuses more on student learning outcomes from a cognitive perspective without exploring how the characteristics of implementing this learning model can vary in various contexts. Third, although several studies have touched on supporting and inhibiting factors, in-depth studies on how interactions between teachers and students influence the success of Discovery Learning in Chemistry learning are still rare.

This study seeks to address this deficiency by examining the nature of the Discovery Learning instructional paradigm in chemistry education for tenth-grade students at Padang Sidempuan High School. The suggested issue formulation examines the application of the Discovery Learning model in chemistry education, its effectiveness in enhancing comprehension of chemistry concepts, and the factors that either promote or hinder its implementation. (Rahman, 2022).

This research is anticipated to have a good impact on enhancing the quality of education at Padang Sidempuan High School, particularly in the field of chemistry. The expectation is that the outcomes of this investigation can offer practical recommendations for teachers in selecting and implementing more interactive and effective learning models. Apart from that, this research can also be a reference for other researchers interested in further studying the effectiveness of Discovery Learning in different educational contexts (Nasution, 2023).

2. Method

This study employs a quantitative methodology with a descriptive-analytic framework. The researchers chose this technique in order to characterize the characteristics of the Discovery Learning learning model and examine its efficacy in teaching chemistry in class X SMA in Padang Sidempuan. A descriptive-analytic design is used to identify and describe relevant variables and analyze the relationships between these variables (Cresswell, 2014).

Research Subjects and Samples

The participants of this study consisted of students in the tenth grade at a High School in Padang Sidempuan. This study used a purposive sampling method, in

which the sample is chosen based on certain criteria that are pertinent to the research goals. (Palinkas et al., 2015). Sample selection criteria include students who have taken chemistry lessons using the Discovery Learning model for one semester. The sample size was determined to be 100 students from several different classes, which was considered representative of the population of class X students. This sample selection aims to obtain relevant data that can be generalized to a wider population.

Data Collection Techniques and Instruments

The data in this study was gathered by questionnaires, observations, and tests. Questionnaires are employed to assess students' impressions of the Discovery Learning instructional approach and their degree of learning motivation. The survey was designed using a 5-point Likert scale to assess the degree to which students agree or disagree with the provided items. (Joshi et al., 2015). Observations were carried out during the learning process to identify the characteristics of implementing Discovery Learning in the classroom. This observation uses a previously prepared observation sheet, which covers aspects such as student involvement, interaction between students and teachers, and the use of learning media. In addition, tests are used to measure students' understanding of chemistry concepts before and after implementing Discovery Learning. This test consists of multiple-choice questions that material experts have validated to ensure the validity and reliability of the instrument (Fraenkel, J. R. & Wallen, 2008).

Data Analysis Techniques

Analyzed utilizing descriptive and inferential statistical approaches, the acquired data was examined. Descriptive statistics describe the distribution of data obtained, such as mean, median, mode, and standard deviation. This technique helps describe the variables' general characteristics (Gravetter & Wallnau, 2017). To analyze the effectiveness of Discovery Learning on students' understanding of chemistry concepts, a paired t-test was used, which allows researchers to compare test scores before and after implementing this learning model (Field, 2009). In addition, simple linear regression was used to analyze the relationship between students' perceptions of Discovery Learning and their learning outcomes (Tabachnick, Barbara G. & Fidell, 2012). All analyzes were carried out using statistical software such as SPSS to ensure the accuracy and reliability of the results obtained.

3. Results and Discussion

Results

The objective of this study is to assess the efficacy of the Discovery Learning instructional approach in enhancing the comprehension of chemical principles among tenth-grade students at Padang Sidempuan High School. Data collected through student perception questionnaires, observations of learning implementation, and concept understanding tests were analyzed thoroughly.

1. Student Perceptions of Discovery Learning

The results of the questionnaire analysis show that students have generally positive perceptions of the application of Discovery Learning in chemistry learning. Using a 5-point Likert scale, the overall average score obtained was 3.73, which shows a positive tendency toward this learning model. The following table presents the average student perception scores regarding several main aspects of Discovery Learning:

Table 1 Student Perceptions of Discovery Learning

No	Statement	Average Score
1	Students are more actively involved in the learning process	3.70
2	Students can understand difficult chemistry concepts	3.69
3	Students are more motivated to study chemistry	3.66
4	The Discovery learning model makes chemistry lessons more interesting	3.76
5	Discovery Learning teaches students to think critically	3.86

Based on the table above, the aspect that received the highest score was Discovery Learning's ability to teach students to think critically, has a mean score of 3.86. The rising appeal of chemistry classes is evident in this

learning model, as indicated by the average score of 3.76.. Meanwhile, students' active involvement and assistance in understanding difficult Chemistry concepts also received positive responses, with scores of 3.70 and 3.69, respectively.

2. Observation of Discovery Learning Implementation

The implementation of Discovery Learning in the classroom is clearly depicted through observations taken throughout five meetings. The following table presents observation results from several main aspects:

Table 2 Observation of Discovery Learning Implementation

No	Observed Aspects	Average Score
1	Student engagement	4.00
2	Student interaction	4.00
3	Use of learning media	4.40
4	Time management	3.80

The data shown in the table indicates that the utilization of learning media received the highest rating, with an average score of 4.40. This suggests that the media employed effectively facilitates the Discovery Learning process. Student engagement and teacher-student interaction, each with a score of 4.00, also show that this model successfully creates an interactive learning environment. However, time management scored slightly lower, at 3.80, indicating room for improvement in ensuring that all stages of learning can be completed within the time available.

3. Understanding Chemical Concepts

Students' understanding of chemistry concepts is measured through tests before and after implementing Discovery Learning. The following table shows the average pre-test and post-test scores of students:

Table 3 Average Pre-test and Post-test Scores of Students

Test Scores	Average Score
Pre-test	56.4
Post-Test	78.3

These results show a significant increase in student understanding after implementing Discovery Learning, with a higher average post-test score (78.3) than the pre-test (56.4). The paired t-test produced a t-value of 8.45 with a p-value of 0.001, which is significant at the $\alpha = 0.05$ level. It shows that Discovery Learning has a significant positive influence on students' understanding of chemistry concepts.

The data analysis results indicate that the Discovery Learning learning paradigm is successful in enhancing students' comprehension of chemistry concepts at Padang Sidempuan High School. Students exhibited favorable attitudes towards this paradigm, as evidenced by heightened involvement, drive, and analytical thinking abilities. The implementation of Discovery Learning has also succeeded in creating an interactive and supportive learning environment, although several aspects need improvement, such as time management. The significant increase in students' understanding of chemistry concepts after implementing this model shows that Discovery Learning is an effective method and can be recommended for teaching chemistry in secondary schools.

Discussion

This research provides strong evidence regarding the effectiveness of the Discovery Learning learning model in increasing the understanding of chemistry concepts in class X High School students in Padang Sidempuan. These findings support Bruner (1961) theory regarding the importance of student-centred learning and add new insight into how Discovery

Learning can be implemented effectively in the context of science education in secondary schools. Learning that actively engages students in discovery and exploration allows them to build deeper and more meaningful understanding. This approach is particularly relevant in Chemistry education, where many of the concepts taught are abstract and require a higher level of interpretation.

Discovery Learning shifts the learning paradigm from a passive approach to an active one, where students no longer receive information but are the main actors in the learning process. In this context, students engage in critical thinking and problem-solving processes, strengthening their understanding of Chemistry concepts. The questionnaire results, which showed an average score of 3.73, confirmed that students responded well to this model, feeling more motivated, involved, and challenged to think more deeply. It supports research by Dmoshinskaia et al. (2021), who found that active involvement in learning can significantly increase student motivation and learning outcomes.

In addition, observations of the implementation of Discovery Learning show that the use of learning media plays an important role in the success of this model. Media such as simulations and videos have proven to explain complex chemistry concepts effectively. With an average score of 4.40, the learning media used in this research can provide concrete visual representations of abstract concepts, which helps students understand the material better. It aligns with Mayer (2004) theory, which emphasizes that using appropriate media can deepen students' understanding by providing a more concrete context and allowing students to explore variables in a realistic simulation.

Interaction between teachers and students is also a key factor in the success of Discovery Learning. With an average score of 4.00, observations show that the teacher successfully performs his role as an effective facilitator. In Discovery Learning, the teacher no longer acts as the main transmitter of information but rather as a guide who helps students when they face difficulties in the discovery process. It is consistent with the view of Alfieri et al. (2011), who emphasize that proper guidance by teachers in Discovery Learning can improve student learning outcomes. An effective teacher in this role can provide the necessary scaffolding, ensuring students can confidently move forward in the learning process.

However, although many positive aspects were found, this research also identified challenges in implementing Discovery Learning, especially regarding time management. An average score of 3.80 in this aspect shows that although Discovery Learning successfully increases student engagement and understanding, the learning process often takes longer than conventional methods. It may be due to the nature of Discovery Learning, which requires students to engage in in-depth exploration and extensive discussions and requires sufficient time allocation. Hasanah (2020) also noted that effective time management is one of the main challenges in implementing Discovery Learning, especially in schools with limited resources.

Less than optimal time management can result in several learning stages not being completed properly, which, in the end, can affect the achievement of learning outcomes. In this context, a more effective strategy is needed to ensure that all stages of learning can be carried out well within the available time. One approach that can be considered is the integration of Discovery Learning with other learning methods, such as flipped classroom or blended learning, which can help optimize available time and ensure that students get the full benefit from each stage of learning.

The significant increase in students' understanding of chemistry concepts after implementing Discovery Learning is also a main highlight of this research. With the average post-test score increasing to 78.3 compared to the pre-test of 56.4, Discovery Learning has significantly impacted students' conceptual understanding. The paired t-test results, which show a significant difference between the pre-test and post-test results (p-value = 0.001), confirm that this learning model increases students' understanding and contributes to improving learning outcomes. This finding aligns with research by Alvarez (2020), which shows that Discovery Learning significantly improves students' conceptual understanding by integrating active involvement in the learning process with a deeper understanding of the material.

These findings have important implications for curriculum development and teaching practices in schools. Educators need to consider the integration of Discovery Learning as part of a wider learning strategy, especially in complex subjects such as Chemistry. In addition, teachers need to continue improving their skills in facilitating Discovery Learning, including time management and effective

use of learning media (Sutiani et al., 2021). In this way, Discovery Learning can be implemented more efficiently and have a greater impact on student learning outcomes(Anggraini, 2020; Azhara et al., 2020; Kusuma & Dewi, 2020).

Discovery Learning also requires support from an adequate learning environment, including necessary resources, such as technology-based learning media and access to relevant information (Azhara et al., 2020; Iskandar & Hadi, 2022; Pappas, 2014). In schools with limited resources, such as those identified in this research, these challenges can be overcome through collaboration between teachers, students, and school officials to optimize available resources. Apart from that, it is important to involve parents and the community in supporting the learning process so that students can receive more comprehensive support in learning.

The findings of this research also emphasize the importance of a holistic approach in education, where students' cognitive, affective, and psychomotor aspects are balanced. Discovery Learning helps students cognitively understand chemistry concepts and develops critical thinking skills and the ability to solve problems independently (Suryani, 2018; Widodo, 2021)vvv. It is a very important skill in an increasingly complex world that demands high levels of adaptability.

However, the results of this research also show that several aspects need to be improved in implementing Discovery Learning, especially in terms of time management. Good time management will ensure that students can complete all stages of learning well and get full benefits from the learning process that has been designed. Apart from that, teachers need ongoing training in implementing Discovery Learning to continue developing effective teaching strategies appropriate to student needs.

Overall, this research significantly contributes to understanding how Discovery Learning can be implemented effectively in Chemistry learning. These findings strengthen previous theories and research that support the effectiveness of Discovery Learning while providing new insights into the challenges and opportunities in implementing this learning model in secondary schools. With the right support and well-planned strategies, Discovery Learning can effectively improve student learning outcomes and prepare them to face future challenges.

This research also opens up space for further research, especially in exploring how Discovery Learning can be integrated with other learning methods to improve time efficiency and learning outcomes. Further research is needed to understand how Discovery Learning can be adapted to different educational contexts, including in schools with limited resources. In this way, we can ensure that all students, regardless of their background, have access to a quality education and an equal opportunity to succeed.

4. Conclusion

This research has shown that the Discovery Learning learning model effectively increases the understanding of chemistry concepts in class X High School students in Padang Sidempuan. The research results revealed that students who studied using the Discovery Learning model showed significant improvements in understanding chemistry concepts, as evidenced by the significant difference between pre-test and post-test scores. This model has also increased students' motivation, active involvement, and critical thinking abilities, as seen from the questionnaires and classroom observations.

Discovery Learning is proven to answer challenges in learning Chemistry, which students often consider difficult and abstract. The use of appropriate learning media, effective teacher-student interaction, and student involvement in the process of exploration and discovery of concepts are key factors in the success of this model. However, this research also identifies challenges in time management, which need to be addressed to ensure more optimal implementation of Discovery Learning.

Overall, this research supports using Discovery Learning as an effective learning method in chemistry education at the secondary school level. These findings also highlight the importance of developing appropriate strategies to overcome existing obstacles and implement Discovery Learning more widely and efficiently. The implications of this research are very relevant for curriculum development, teacher training, and teaching practices in schools, which ultimately aim to improve the quality of education and student learning outcomes.

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