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Analysis of the Influence of the Talking Stick Method in the Discovery Learning Model on Students' Conceptual and Cognitive Understanding of Redox Reactions Material

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ABSTRACT

This study examines the effect of the Talking Stick method in the Discovery Learning model on students' conceptual and cognitive understanding of redox reactions. The purpose of this study was to determine whether this interactive discussion-based learning strategy can significantly improve studens' understanding compared to conventional learning methods. This study used a quasi-experimental design involving 66 grade X MIPA students at SMA Negeri 2 Maros, who were divided into an experimental group (Talking Stick in Discovery Learning) and a control group (conventional method). Data were collected through pretest and posttest for four weeks. The results showed that students in the experimental group experienced significant improvements in conceptual and cognitive understanding. These findings indicate that the integration of the Talking Stick method in Discovery Learning can improve active learning and deepen students' understanding of abstract chemical concepts. This method can be applied to other complex science materials.

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INTRODUCTION

Chemistry learning is often considered a challenge for students, especially in understanding abstract concepts such as redox reactions. This concept requires a deep understanding of electron transfer, oxidation numbers, and the application of reactions in everyday life.(Yesilo)ğu & Köseoğlu, 2020b). However, research shows that many students have difficulty in connecting the macroscopic, microscopic, and symbolic concepts contained in redox reactions.(Christine Mundy & Potgieter, 2019). Therefore, a more interactive and exploration-based learning strategy is needed to improve students' conceptual and cognitive understanding of this material.

Discovery Learning is a learning approach that emphasizes active exploration and problem solving by students.(Roxana Jara et al., 2020). This model allows students to discover important concepts themselves through experiments, discussions, and data analysis. In the context of science learning, Discovery Learning has been shown to improve students' conceptual understanding and critical thinking skills.(Avi Hofstein & Hugerat, 2021). However, the success of implementing this model is highly dependent on the strategies used to actively involve students in the learning process.

One method that can be used in Discovery Learning is Talking Stick. This method encourages student participation in group discussions by using sticks as a rotating tool for speaking.(Mitchell RM Bruce et al., 2022a). The study was conducted by(Ravendhran Rangasamy, 2023)shows that the Talking Stick method can increase student interaction, strengthen communication skills, and help them understand concepts more deeply. In addition, this method can also reduce the tendency of students to be passive in learning, because they have the responsibility to convey their understanding to their classmates.

Conceptual and cognitive understanding are two important aspects in students' learning success. Conceptual understanding refers to students' ability to identify and explain basic concepts of redox reactions, such as the oxidation-reduction process and the role of electrons in these reactions.(Gyang, nd). Meanwhile, cognitive understanding is related to students' ability to apply the concept in problem solving, data analysis, and evidence-based decision making.(Yesilo)ğu & Köseoğlu, 2020b). Thus, improvements in these two aspects can have a significant impact on students' learning success in chemistry subjects.

Previous research shows that the application of Discovery Learning has generally provided positive results in improving understanding of chemical concepts.(Thompson, n.d.-a). However, there are still few studies that specifically examine the effectiveness of the Talking Stick method in the Discovery Learning model, especially in the context of redox reaction learning. Therefore, this study attempts to fill this gap by exploring the influence of the Talking Stick method on students' conceptual and cognitive understanding of redox reaction material.

In this study, an analysis was conducted on the comparison of learning outcomes between students who use the Talking Stick method in the Discovery Learning model and students who learn with conventional methods. This study

is expected to contribute to the development of more effective learning strategies in improving students' understanding of complex chemical concepts. In addition, the results of this study can also be a reference for educators in choosing the right learning method to improve students' active participation and critical thinking skills.

Thus, this study aims to analyze the effect of the Talking Stick method in the Discovery Learning model on students' conceptual and cognitive understanding of redox reaction material. More specifically, this study will test the effectiveness of this method in improving students' understanding, comparing it with other learning methods, and identifying factors that influence their success in learning chemistry.

THEORETICAL REVIEW

Discovery Learning Model in Chemistry Education

The Discovery Learning Model is a learning approach that emphasizes the active role of students in discovering concepts through exploration, experimentation, and independent reflection.(Hartman et al., 2022a). This model has six main stages, namely stimulation, problem identification, data collection, data processing, verification, and generalization.(Yesilo)ğu & Köseoğyou, 2020a). In the context of chemistry learning, Discovery Learning has been proven to be able to improve students' understanding of abstract concepts, such as redox reactions, through deeper, problem-solving-based learning experiences.(MRM Bruce et al., nd-b)

The Effectiveness of Discovery Learning on Conceptual and Cognitive Understanding

Several studies have shown that Discovery Learning can improve students' conceptual understanding and cognitive understanding in science learning.(Easa & Blonder, 2022a). Conceptual understanding includes how students understand and explain concepts, while cognitive understanding refers to students' ability to apply the concepts in a variety of new situations.(Yesilo)ğu & Köseoğlu, 2020b). The study was conducted by(Cooper & Stowe, 2018a)asserted that this method increased student engagement and encouraged them to develop a deeper understanding of chemical principles.

Talking Stick Method in Learning

The Talking Stick method is an interactive strategy in learning designed to increase student participation through a turn-taking system.(Purnama Sari & Candra Sayekti, 2023). In this method, students holding the talking stick must answer questions or convey their understanding of the material being studied. Research shows that Talking Stick is effective in increasing student activity and training speaking and critical thinking skills.(R Rangasamy, nd). In addition, this method also helps create a more inclusive and participatory learning environment.

Integration of Talking Stick Method in Discovery Learning

Integration of the Talking Stick method in Discovery Learning has the potential to increase learning effectiveness by combining active exploration with structured discussions.(Rohmi & Wahyuni, 2024). In this model, students are given the opportunity to express their exploration results in turns using talking sticks. This not only strengthens their understanding of chemical concepts but also improves communication and analytical thinking skills.(Raman et al., 2024). Other studies have shown that students involved in Talking Stick-based learning are more active in participating and show better understanding compared to students who learn through lecture methods.(Avi Hofstein & Hugerat, 2021).

The Role of Talking Stick in Enhancing Conceptual Understanding

Conceptual understanding is an important factor in students' learning success in chemistry.(Peleg et al., 2019a). The Talking Stick method helps students to build conceptual understanding by encouraging them to articulate ideas and concepts explicitly.(Christine Mundy & Potgieter, 2019). In addition, the interactions that occur in group discussions can also help reduce misconceptions that often occur in chemistry learning, especially in complex materials such as redox reactions.(Gyang, nd).

Talking Stick and Improving Students' Cognitive Understanding

Cognitive understanding refers to students' ability to apply learned knowledge in new contexts or in problem solving.(Hartman et al., 2022b). The Talking Stick method can help students improve these skills by encouraging them to connect the chemistry concepts they have learned with real-world applications.(Taber, n.d.-a). The study was conducted by(Thompson, nd-b)shows that this method is effective in improving higher-order thinking skills because students have to develop logical arguments in discussions.

Discovery Learning and Student Learning Motivation

Motivation to learn is an important aspect of learning effectiveness, and Discovery Learning has been shown to increase students' intrinsic motivation.(Jiménez, 2019a). Through this approach, students feel more in control of their own learning process, which ultimately increases their curiosity and engagement in class.(Cooper & Stowe, 2018b). Research conducted by(Zohar & Levy, 2019)also found that students who studied with this method showed an increase in self-confidence and persistence in solving chemistry problems.

Challenges in Implementing Talking Sticks in Discovery Learning

Although the Talking Stick method has many advantages, there are some challenges in its implementation. One of them is the initial resistance from students who are not yet accustomed to this learning format.(Ballard & Mooring, 2021a). Some students may feel uncomfortable speaking in front of their friends, so it takes time to adapt. In addition, the role of the teacher in facilitating the discussion is very important so that the interaction that occurs

remains productive and does not deviate from the learning objectives.(Cukurova et al., 2018).

Advantages of the Talking Stick Method Compared to Conventional Methods

Compared to conventional methods such as lectures, Talking Stick in Discovery Learning has a number of advantages. A study conducted by(Ungu et al., 2023)showed that students who learned with this method had higher levels of engagement and experienced significant improvements in their conceptual understanding. In addition, this method is also more effective in training communication and teamwork skills, which are important competencies in the modern world of education (Mitchell RM Bruce et al., 2022a).

Research Implications and Recommendations

Research on the application of the Talking Stick method in Discovery Learning still needs to be developed further, especially in the context of chemistry learning. More in-depth studies can be conducted to test the impact of this method on other variables, such as critical thinking skills or student creativity.(Easa & Blonder, 2022b). In addition, the development of learning models that combine Talking Stick with digital technology can also be an interesting research area for the future.(Jiménez, 2019b).

This study focuses on the influence of the Talking Stick method in the Discovery Learning model on students' conceptual and cognitive understanding. Therefore, there are three main variables in this study can be seen in Table 1 and Figure 1.

Table 1.Conceptual framework

Category	Description
Independent Variable (X)	Talking Stick Method in the Discovery Learning Model
Dependent Variable (Y1)	Student Conceptual Understanding – How well do students understand the theory of redox reactions.
Dependent Variable (Y2)	Student Cognitive Understanding – How well students can apply the concept of redox reactions in problem solving.

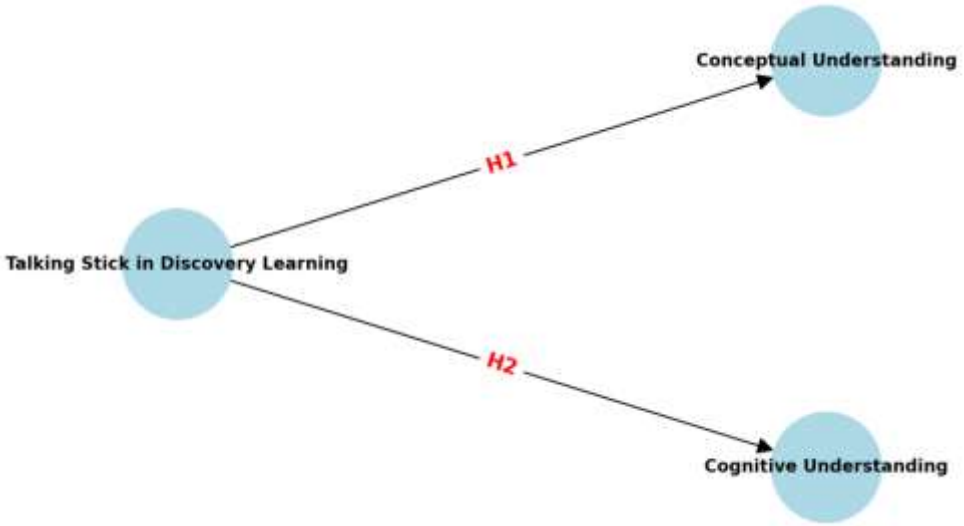

Figure 1.Conceptual framework

METHODOLOGY

This study aims to analyze the effect of the Talking Stick method in the Discovery Learning model on students' conceptual and cognitive understanding. To achieve this goal, this study uses a quantitative approach with a quasi-experimental design, namely the pretest-posttest control group design. In this design, there are two groups, namely the experimental group given treatment with the Talking Stick method in Discovery Learning and the control group who learn using conventional methods.

Research Design

The research design involved two groups, each given a pretest before the treatment to measure the initial level of student understanding. After that, the experimental group would learn using the Talking Stick method in Discovery Learning, while the control group would use the lecture and open discussion method. After the learning was completed, both groups were given a posttest to measure their improvement in understanding.

Population and Sample

The population in this study were all students of class X MIPA at SMA Negeri 2 Maros. From this population, 66 students were selected as samples consisting of 33 students for the experimental group and 33 students for the control group. The sampling technique used was purposive sampling, where classes that had relatively homogeneous academic levels were selected so that the research results were more valid.

Data collection technique

The data in this study were collected through several instruments, namely conceptual and cognitive understanding tests and observations. Conceptual and Cognitive Understanding Tests were given in the form of pretests and posttests. The questions used were based on the concept of redox

reactions to measure conceptual understanding, as well as HOTS (Higher-Order Thinking Skills) based questions to measure students' cognitive understanding in problem solving. Observations were carried out during the learning process to observe student involvement in discussions using the Talking Stick method.

Data Analysis Techniques

The collected data is analyzed using statistical techniques to test the research hypothesis. The steps of data analysis include:

a. The Normality Test (Shapiro-Wilk Test) is conducted to determine whether the pretest and posttest data are normally distributed.
b. The homogeneity test (Levene's Test) is used to ensure that the variance of the data from the two groups is comparable.
c. The t-test (Independent Sample t-Test) is used if the data is normally distributed, to compare the average learning outcomes between the experimental group and the control group.
d. The Mann-Whitney test is used as an alternative to the t-test if the data is not normally distributed.
e. The N-Gain Score is calculated to determine the extent to which students' understanding has increased after treatment compared to before treatment.

RESULTS

Data Analysis Steps

To analyze the results of this study, several statistical steps were carried out systematically. First, a descriptive analysis was conducted to determine the average, highest score, lowest score, median, mode, and standard deviation of student learning outcomes in the experimental group and the control group. These data provide an initial picture of the distribution of scores in both groups. After that, a normality test was conducted using the Shapiro-Wilk Test to determine whether the data were normally distributed. If the data were normally distributed, the Independent Sample t-test was used to see if there was a significant difference between the experimental group and the control group. If the data were not normally distributed, the Mann-Whitney Test was used as an alternative. Furthermore, a homogeneity test was conducted using Levene's Test to ensure that the two groups had comparable variances. Finally, the N-Gain Score was calculated to measure the effectiveness of the Talking Stick method in improving students' conceptual and cognitive understanding.

Descriptive Statistics Results

Descriptive dataconceptual and cognitive understandingstudents in the experimental group and control group are presented in Table 2.

Table 2.Descriptive Statistics of Learning Outcomes

Analysis Results	Experimental Group	Control Group
Number of Students	33	33

Analysis Results	Experimental Group	Control Group
The highest score	96	92
Lowest Value	52	40
Average value	82.56	71.54
Median (Me)	86	72.5
Mode (Mo)	83	72.3
Standard Deviation	11.25	12.91

The data shows that the experimental group had a higher average score than the control group, with scores more evenly distributed.

Normality Test Results

To determine whether the data is normally distributed, the Shapiro Wilk Test is performed. The results of the normality test are presented in Table 3.

Table 3.Normality Test (Shapiro-Wilk Test)

Group	*p-Value*	Interpretation
Experiment	**0.5725**	Data is normally distributed (p > 0.05)
Control	**0.3804**	Data is normally distributed (p > 0.05)

Because p > 0.05, both groups have a normal distribution, so an Independent Sample t-test can be performed.

Homogeneity Test Results

Homogeneity test was conducted using Levene's Test to see whether the variance of both groups is equal. The results are presented in Table 4.

Table 4.Homogeneity Test (Levene's Test)

Statistical Test	*p-Value*	Interpretation
Levene's Test	**0.2507**	Variance between groups is homogeneous (p > 0.05)

The test results show that the variance between the two groups is homogeneous, so the t-test can be performed.

Independent Sample t-Test Results

To determine whether there is a significant difference between the experimental and control groups, an Independent Sample t-test was conducted. The results are presented in Table 5.

Table 5. Independent Sample t-test

Group	p-Value	Interpretation
Experiment vs. Control	**0.00006**	Significant difference between experimental and control groups (p < 0.05)

Since $p < 0.05$, there is a statistically significant difference between the learning outcomes of the experimental and control groups. This shows that the Talking Stick method in Discovery Learning has a significant effect on improvingconceptual and cognitive understandingstudent.

N-Gain Score Results

To measure the extent to which students' understanding increased before and after treatment, the N-Gain Score was calculated. The results are presented in Table 6.

Table 6. N-Gain Score

Group	N-Gain Score	Effectiveness Category
Experiment	0.4624	Currently
Control	0.3451	Low

The experimental group experienced a higher increase in understanding compared to the control group. Based on the effectiveness category: The experimental group is in the "Medium" category (0.30 - 0.69). The control group is in the "Low" category (0.00 - 0.29). The Talking Stick method in Discovery Learning is more effective than the conventional method.

DISCUSSION

The results of this study indicate that the use of the Talking Stick method in Discovery Learning has an effect on students' conceptual and cognitive understanding of redox reaction material. The higher increase in the experimental group compared to the control group indicates that this interactive discussion-based learning strategy can help students build a deeper understanding.

In the context of chemistry learning, redox reactions are one of the concepts that require a strong conceptual understanding because they involve abstract concepts such as oxidation numbers, electron transfer, and theoretical relationships with macroscopic and microscopic phenomena. Research by(Taber, nd-b)showed that students often have difficulty in connecting symbolic representations with actual chemical processes. In this study, Talking Stick in Discovery Learning allows students to actively explore these concepts through discussion, thereby enhancing their understanding of redox reactions.

Conceptual understanding relates to how students understand fundamental concepts in redox reactions, such as how to determine the oxidation number of an element and how to identify the oxidation and reduction processes in a reaction. In this study, students in the experimental group were able to explain these concepts better after going through the Talking Stick discussion-based learning process. This is in line with research by(Christine Mundy & Potgieter, 2019)who found that structured discussions in class improved students' ability to construct clearer conceptual understanding and reduced misconceptions.

On the other hand, cognitive understanding involves students' ability to apply concepts that have been learned in new contexts or in problem solving. In this study, students in the experimental group showed better ability in solving problems based on problem solving, such as determining the substances that undergo oxidation and reduction in complex reactions. This supports the findings(Peleg et al., 2019b)which states that students who participate in group discussions are better able to apply chemical concepts in problem solving than students who only receive material passively through lectures.

The Talking Stick method in Discovery Learning also helps students to test their understanding independently before delivering answers in discussions. By having to speak in front of their friends, students tend to be more active in understanding the material before delivering their understanding. Research by(Avi Hofstein & Hugerat, 2021)shows that learning methods based on discussion and verbal interaction can improve students' analytical thinking skills, which are very important in building conceptual and cognitive understanding in the field of science.

In addition, the use of this method in Discovery Learning allows students to find their own concepts through the exploration process, not just receiving information from the teacher. This is in accordance with the principle of constructivism, where students build their own knowledge based on interactions with their learning environment.(Cooper & Stowe, 2018b). In this context, Talking Stick in Discovery Learning provides a more active learning experience, so that students not only understand the theory but are also able to apply the concepts they learn to various new situations.

However, although this method is effective in improving students' conceptual and cognitive understanding, there are several challenges in its implementation. Research by(Ballard & Mooring, 2021b)revealed that some students may feel less confident in speaking in front of the class, especially in a learning system that requires them to deliver answers directly. Therefore, in implementing this method, teachers need to create a supportive environment, where all students feel comfortable participating in discussions without fear or shame.

In this study, the results of statistical analysis show that the Talking Stick method in Discovery Learning significantly improves students' conceptual and cognitive understanding compared to conventional methods. This supports the findings of(Easa & Blonder, 2022a)which states that social interaction-based learning provides greater opportunities for students to build better understanding compared to passive learning.

Based on the results of this study, it can be concluded that the Talking Stick method in Discovery Learning has great potential in improving students' conceptual and cognitive understanding in chemistry learning. This method can be applied to other materials that require in-depth understanding, such as stoichiometry, chemical equilibrium, and thermodynamics, to help students build stronger connections between theory and practice in chemistry.

CONCLUSION AND RECOMMENDATIONS

Based on the results of research that has been conducted regarding the influence of the Talking Stick method in Discovery Learning on students' conceptual and cognitive understanding of redox reaction material, the following conclusions were obtained:

1) Talking Stick method in Discovery Learning has been proven to significantly improve students' conceptual understanding compared to conventional methods. Students who learn with this method are able to understand the concept of redox reactions better, including determining oxidation numbers, identifying oxidation-reduction processes, and connecting theories with real phenomena.
2) Talking Stick method in Discovery Learning has an effect on improving students' cognitive understanding. Students in the experimental group showed better ability in applying the concept of redox reactions in problem solving, such as analyzing reactions that occur in various contexts and compiling redox reaction equations more systematically.
3) Talking Stick method in Discovery Learning is more effective than conventional method. This is shown by the increase in conceptual and cognitive understanding results that are statistically significant, where students in the experimental group have a higher understanding compared to the control group.
4) Structured discussions in the Talking Stick method help students develop a deeper understanding of concepts. Through a turn-based speaking system, students get the opportunity to express their understanding, listen to classmates' perspectives, and build concepts through social interaction.

FURTHER STUDY

Suggestions that can be given for further research are as follows:

1) Using a larger and more diverse sample, future research could involve more schools and different levels of education, so that the research results can be more generalized to a wider population.
2) Measuring the long-term impact of the Talking Stick method in Discovery Learning, namely further studies can be conducted by conducting long-term evaluations to see whether the conceptual and cognitive understanding obtained by students persists for a longer period after the learning process is completed.
3) Adding other more comprehensive evaluation instruments, namely in addition to pretest and posttest, further studies can use interviews, HOTS (Higher Order Thinking Skills) based tests, or project-based case studies to gain a deeper understanding of the effectiveness of this method in improving students' analytical thinking and problem-solving skills.

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