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JURNAL KEPENDIDIKAN KIMIA
https://e-journal.undikma.ac.id/index.php/hydrogen/index

December 2025. 13(6)
e-ISSN: 2656-3061
p-ISSN: 2338-6487
pp. 1256–1263

# Science Literacy Ability with The Discovery Learning Model on Thermochemistry Subject Material

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**Article History**
Received: 03-12-2025
Revised: 20-12-2025
Published: 31-12-2025

**Keywords**: Science Literacy; Discovery Learning; Thermochemistry

**Abstract**
This research is motivated by students' inability to connect the scientific knowledge they learn to everyday phenomena related to chemistry, particularly thermochemistry. This problem stems from a lack of student motivation and interest in chemistry learning, partly due to the extensive scope of the chemistry material. The learning process at State Senior High School 15 Pekanbaru uses the lecture method and tends to memorize concepts and theories. During the learning process, teachers have not yet implemented scientific literacy in explaining the material and relating it to everyday life. However, low scientific literacy makes students less able to find information related to problems, thus making them reluctant to do so. The research was conducted in grade XI of State Senior High School 15 Pekanbaru in the odd semester of the 2024/2025 academic year. The research design used an equivalent pretest-posttest group design with two classes: a control class and an experimental class. The population of this study consisted of classes XI A, XI B, XI C, XI D, and XI E. The sample used was Class XI A as the experimental class, which was given the discovery learning model, while Class XI B as the control class was not given the discovery learning model. Data collection was conducted using pretest scores as initial data for normality and homogeneity tests, and the difference between pretest and posttest scores for hypothesis testing. The results of the hypothesis test calculation using the t-test obtained t count > t table, i.e., with df, thus the research hypothesis was accepted. The application of the discovery learning model can be recommended as an alternative to improve students' scientific literacy skills, especially in thermochemistry.

**How to Cite:** Linda, Abdullah, & Albeta, S. W. (2025). Science Literacy Ability with The Discovery Learning Model on Thermochemistry Subject Material. Hydrogen: Jurnal Kependidikan Kimia, 13(6), 1256–1263. https://doi.org/10.33394/hjkk.v13i6.18640

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## INTRODUCTION

Education can be defined as a conscious effort to naturally shape one's personality and develop competencies through enrichment by acquiring basic information. Education currently stands in the 21st century, also known as the Industrial Revolution 4.0, marked by the rapid development of Science and Technology (IPTEK). The current pace of IPTEK development is extremely rapid, therefore, the younger generation must be equipped with both hard and soft skills to meet 21st-century standards and prepare a quality generation. One of the skills needed to enhance knowledge and skills is scientific literacy. A person who utilizes scientific literacy will be able to understand scientific concepts and apply scientific process skills to evaluate everyday decisions related to society and the surrounding environment (Sari et al., 2022).

Scientific literacy is the knowledge and understanding of scientific concepts and processes that are used as considerations in making decisions regarding problems that occur around us, whether related to natural phenomena and their changes or their relationship to societal, cultural, and economic developments. Scientific literacy directs an individual's ability to use

science as a solution to every problem they face. Scientific literacy is typically measured based on the conceptual knowledge of science and decision-making skills using scientific content, procedural, and epistemological knowledge. Competencies emphasized for inclusion in scientific literacy assessments include (1) identifying scientific questions, (2) explaining scientific phenomena, and (3) using scientific evidence (Winarni, 2020).

The low scientific literacy of Indonesian students can be seen in several studies, including research conducted by (Huryah, 2017) on the analysis of the biological science literacy achievements of 10th-grade high school students in Padang City, which stated that the scientific literacy of high school students in Padang City is still low. This is supported by research conducted by (Rahmadani, 2018) on the scientific literacy skills profile of high school students in Karanganyar, which states that the average scientific literacy score for 10th-, 11th-, and 12th-grade students at a private high school in Karanganyar was 52.22%, which is considered low.

Students' scientific literacy skills remained low from 2000 to 2018, with scores below the PISA average. This indicates that students lacked understanding of scientific concepts and processes and were unable to apply the scientific knowledge they learned in everyday life. Students' low scientific literacy is generally attributed to learning activities that do not yet lead to scientific literacy development. Furthermore, low scientific literacy is caused by several factors, including school infrastructure, human resources, school management, learning methods and models, facilities and infrastructure, teaching materials, and teaching programs or systems (Sutrisna, 2021).

Researchers interviewed chemistry teachers at State Senior High School 15 Pekanbaru, and found that students struggled to connect the scientific knowledge they learned with everyday phenomena related to chemistry, particularly thermochemistry. This problem stems from a lack of student motivation and interest in chemistry learning, partly due to the extensive scope of chemistry material. Meanwhile, the learning process at Pekanbaru State Senior High School 15 uses lecture methods and tends to memorize concepts and theories. During the lessons, teachers fail to apply scientific literacy in explaining the material and relating it to everyday life. However, low scientific literacy makes students less able to find information related to problems, making them reluctant to seek it out.

To address this issue, providing a relevant context is a necessity, one of which is through the use of the discovery learning model. The discovery learning model emphasizes self-directed learning, encompassing strategic steps such as defining problems, formulating hypotheses, collecting and processing data, and presenting conclusions. With the discovery learning model, students are guided to search and discover for themselves, thus gaining experience as researchers and problem solvers. This activity will ultimately become a memorable learning experience for students.

## METHOD

This research is a quasi-experimental study. It involved an experimental class and a control class. The research design used in this study was an equivalent pretest-posttest group design, which uses existing classes as groups, selecting classes with similar conditions, in this case based on intelligence level. This can be seen in the following table 1.

The population in this study were 5 classes of 11th grade students at SMA Negeri 15 Pekanbaru. The sample representing a population with the same characteristics is called the research sample. The sample in this study consisted of 2 classes as the experimental class and the control class, namely class XI A with 30 students and class XI B with 30 students. The

sampling technique in this study used purposive sampling. The method used to collect data in this study was a test. The data collected were obtained from pretest and posttest scores. The data analysis techniques used were normality tests, homogeneity tests, and hypothesis tests.

Table 1. Research Design

| *Groups* | *Pretest* | *Treatment* | *Posttest* |
|---|---|---|---|
| Experiments | $0_1$ | X | $0_2$ |
| Control | $0_3$ | - | $0_4$ |

In this study, the object to be analyzed is students' scientific literacy skills using an assessment instrument in the form of pretest/posttest questions with thermochemistry material using the discovery learning learning model which is believed that the discovery learning model can improve the scientific literacy skills of class XI students of State Senior High Schol (SMA Negeri) 15 Pekanbaru. The following is a framework for thinking in this study.

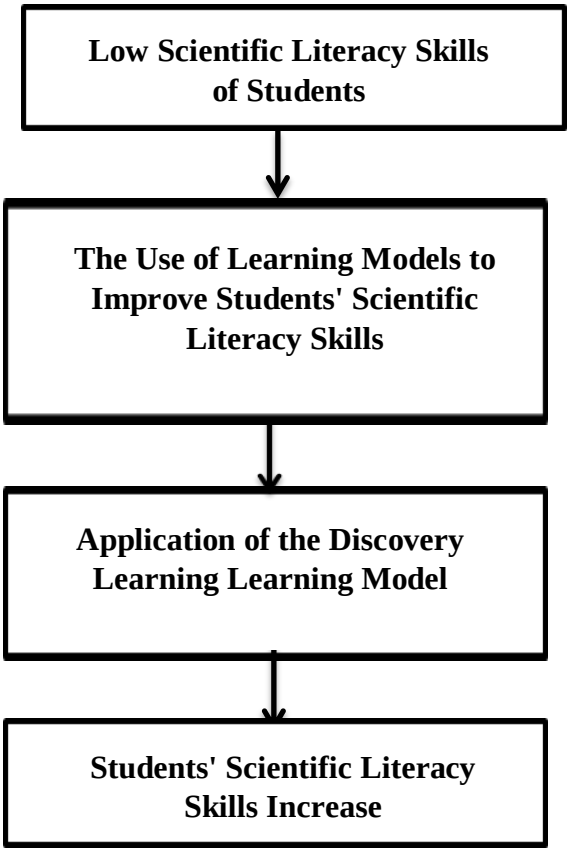


Figure 1 Thinking Framework Chart

## RESULTS AND DISCUSSION

### Results

The results of this study are quantitative data. The analysis consisted of initial and final stages. The initial stage consisted of normality and homogeneity tests, while the final stage consisted of hypothesis testing.

#### *Normality Test*

The initial data analysis stage of this study was to test for homogeneity and normality. Based on data analysis using SPSS Statistics 26, the normality test result are shown in Table 2.

Table 2. Results of SPSS Normality Test Analysis of Pretest Scores

| Test of Normality | staistics | df | Sig. | Decision |
|---|---|---|---|---|
| *Pretest* Class XI A | 0,061 | 45 | 0,158 | Normally distributed |
| *Pretest* Class XI B | 0,043 | 45 | 0,129 | Normally distributed |

Table 2 shows the results of the normality test for class XI A and XI B values with a significance (sig) > 0.05. This indicates that class XI A and class XI B are normally distributed.

***Homogeneity Test***

The data homogeneity test, as a prerequisite for the research, used the normally distributed . Pretest scores of classes XI A and XI B. The results of the homogeneity analysis of the pretest scores indicate that classes XI A and XI B are a homogeneous class pair. The results of the homogeneity analysis are presented in Table 3.

Table 3. Results of SPSS Variance Homogeneity Test Analysis of Pretest Values

***Tests of Homogeneity of Variances***

| | | *Levene Statistic* | *df1* | *df2* | *Sig.* |
|---|---|---|---|---|---|
| ***Pretest*** | ***Based on Mean*** | 0.251 | 1 | 88 | 0.618 |

Table 3 presents the results of the homogeneity test of pretest scores for students in grades XI A and XI B analyzed using SPSS. The results indicate that both classes are relatively homogeneous, as they have a significance (sig) > 0.05.

***Hypothesis Testing***

The results of the N-Gain (Normalized Gain) calculation presented in Table 4 indicate an increase in students' scientific literacy skills in the knowledge aspect in both groups, the Experimental and Control groups. The Experimental group obtained an N-Gain value of 0.443, while the Control group obtained an N-Gain value of 0.366. Based on the N-Gain criteria, the improvement in both groups falls into the Moderate category (because it falls within the range of $0.3 \leq$ N-Gain $< 0.7$). Although both groups showed improvement in the same category, the slightly higher N-Gain value in the Experimental group (0.443) compared to the Control group (0.366) indicates that the treatment given to the Experimental group (possibly a specific learning model) had a relatively better effect on improving students' scientific literacy knowledge compared to the Control group.

Table 4. Results of N-gain Analysis of Experimental and Control Classes

| Science Literacy | *N-Gain* Experimental | Category | *N-Gain* Control | Category |
|---|---|---|---|---|
| a. knowledge aspect<br>b. competency aspect | 0,443 | Moderate | 0,366 | Moderate |

Table 5. Results of SPSS Analysis of Hypothesis Testing

***Group Statistic***

| Class | N | Mean | std. Deviation | std. Eror Mean |
|---|---|---|---|---|
| N-gain Experimental Class | 30 | 50,78 | 12.152 | 1.812 |
| N-gain Control Class | 30 | 42,00 | 11.251 | 1.677 |

Table 6. Hypothesis Test Results (Significance Test)

| Class | N | $\bar{X}$ | ∑X | ∑X2 | $S_{gab}$ | $t_{table}$ | $t_{calculated}$ |
|---|---|---|---|---|---|---|---|
| XI A | 30 | 50,7778 | 2285 | 122525 | 11,71040 | 1,66235 | 3,5559 |
| XI B | 30 | 42 | 1890 | 84950 | | | |

The calculation results obtained $t_{calculated}$ = 3.5559 while the $t_{table}$ obtained with the probability of 1 – $\alpha$ with $\alpha$ = 0.05 and dk = 88 is 1.66235. It can be seen that $t_{calculated} > t_{table}$ namely 3.5559 > 1.66235. It can be concluded that the implementation of the Discovery Learning learning model can improve the ability of scientific literacy in thermochemical material for class XI of SMA Negeri 15 Pekanbaru.

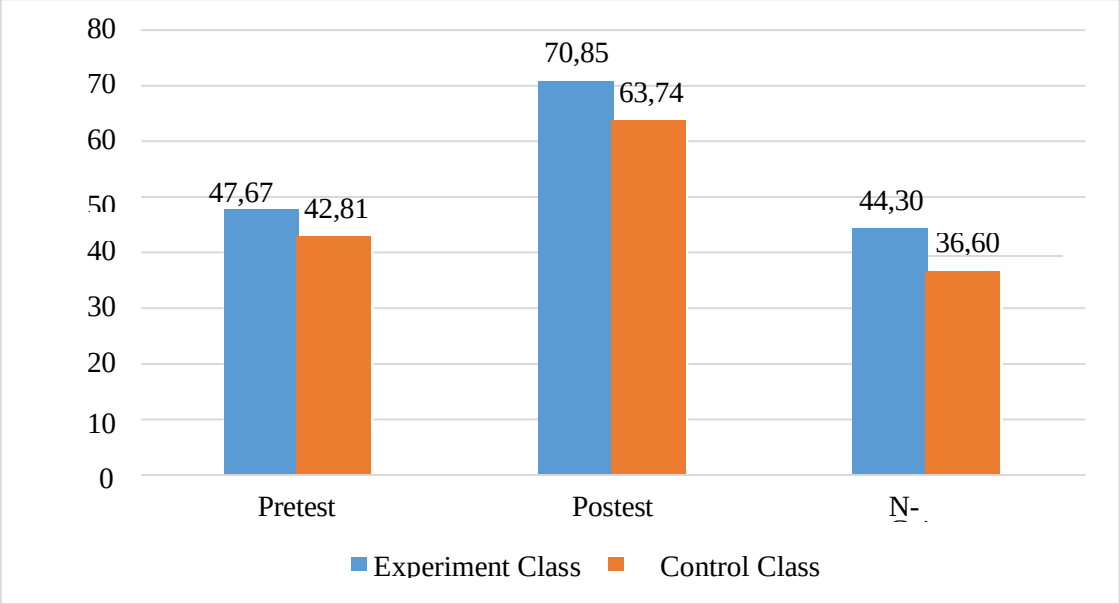


Figure 2. Improvement in Students' Science Literacy in the Experimental Class and Control Class

Figure 2 shows that the N-Gain in the experimental class was 44.30, higher than the control class, which was 36.60, although both were in the moderate category. However, this difference must first be tested against the research hypothesis to determine the significance of the increase in N-Gain in the experimental and control classes. This study aims to determine whether the differences in the increase in all aspects of scientific literacy are significant or not. Statistical tests were conducted to test the significance of N-Gain in the experimental and control classes as a procedure to prove the research hypothesis.

**Discussion**

This study was conducted to determine students' scientific literacy skills in thermochemistry by implementing the discovery learning model in the experimental class and the control class without it. The learning in the experimental and control classes covered the core topic of thermochemistry, including subtopics such as exothermic and endothermic reactions, thermochemical equations and standard enthalpy changes, calorimeters, Hess's law, and bond energy. This material was presented in four meetings in both the experimental and control classes.

The teacher began by giving students a pretest at the beginning of the study to measure their initial understanding of the thermochemistry material. This pretest consisted of questions designed to assess students' knowledge of the basic concepts of thermochemistry. The purpose of this pretest was to determine the extent to which students understood the material before the learning process began. The pretest results provide an overview of students' level

of understanding at the beginning of the study and also serve as a comparison to measure the improvement in students' critical thinking skills after the implementation of the learning model. Then, at the end of the meeting, the teacher administered a posttest to both classes (experimental and control). This posttest was designed to measure the extent to which students' understanding of thermochemistry improved after being treated using the discovery learning model. The researchers then calculated the difference between pretest and posttest scores, which were then analyzed statistically to determine whether there was an improvement in the scientific literacy skills of eleventh-grade students at SMAN 15 Pekanbaru in thermochemistry using the discovery learning model.

The results of the study revealed that both the experimental and control classes improved their scientific literacy. These results indicate that both the experimental class using the discovery learning model and the control class not using the discovery learning model improved students' scientific literacy. However, based on the N-Gain test, the improvement in the experimental class was greater than that in the control class, with a moderate score. This indicates that the discovery learning model can significantly improve students' scientific literacy compared to the non-discovery learning model.

To test the hypothesis of a significant difference between the N-Gain test and the control class, normality tests, homogeneity tests, and t-tests were conducted. The results are presented in Table 4.2. Table 4.2 shows that the data in the experimental and control classes were normally distributed, non-homogeneous, and significant. Thus, it is concluded that there is a significant difference between the N-gain value in the experimental class using the discovery learning model and the control class that does not use the discovery learning model, and this indicates that H0 is rejected. Therefore, it can be concluded that the experimental class with discovery learning has a significant impact on scientific literacy better than the control class that does not apply discovery learning. This result is supported by several previous studies, namely research conducted by El Islami, et al. (2016) which concluded that discovery learning can improve students' scientific literacy in the moderate category with an N-Gain value of 39, and research conducted by Shellawati, et al. (2018) which concluded that students' scientific literacy increased significantly after the implementation of the discovery learning model, as well as research conducted by Arief (2015) which concluded that overall the application of levels of inquiry in science learning on the theme of global warming can improve the scientific literacy of junior high school students; and research conducted by Brickman, et al. (2009) also concluded that the discovery learning model can further improve students' scientific literacy.

The learning process using the discovery learning model was carried out for 4 meetings and each meeting lasted 90 minutes in the experimental class. The first phase of stimulation (providing stimulation) at the first meeting began with the teacher greeting and taking attendance of students and conveying the learning objectives that students must achieve in the learning process. The teacher began the learning process by providing stimulus in the form of Q&A problems related to exothermic and endothermic reactions at the first meeting. Giving problems at the beginning of learning aims to arouse students' curiosity about the material being taught. The teacher asked students to pay attention to the image of boiling water on the stove (water evaporation) on the projector, students were asked to answer the teacher's question "Does a chemical reaction occur in this process, children?" then the teacher explained that the process of boiling water on the stove occurs water evaporation which is an endothermic reaction. The Q&A process between the teacher and students was completed, then the teacher began to briefly explain the material related to exothermic and endothermic reactions. This explanation of the material was to provide students with an overview of the material to be learned. At the first meeting, students were still not conducive and focused in learning.

The difference in scientific literacy skills between the experimental and control classes stems from the discovery learning model, a student-centered learning process. This student-centered learning model encourages students to be active in learning and gathering information, providing them with hands-on scientific literacy experiences. The use of the discovery learning model in the experimental class assisted students in improving their scientific literacy skills. Research by Multiara (2019) revealed that the discovery learning model significantly impacted students' scientific literacy skills, and its use in the experimental class resulted in students being more active in their learning than in the control class.

A challenge encountered in implementing the discovery learning model was that during the learning process, the teacher attempted to impose a time limit on the problem statement stage. This is where students select problems relevant to their reading, formulate hypotheses, and express them in declarative sentences as temporary answers to the questions posed. However, at this stage, students required more time than the allotted time. This impacted presentation and evaluation times, which were shorter than the allotted time. The solution used to overcome this problem is to manage time as well as possible for the next meeting and always remind students when the discussion time is up, besides that, teachers are also required to manage and guide the discussion.

## CONCLUSION

Based on the results of data analysis and processing, it can be concluded that the discovery learning model can improve students' scientific literacy skills and there is a difference in the increase in scientific literacy of students in the experimental and control classes at SMA Negeri 15 Pekanbaru with the discovery learning model on thermochemistry material. The discovery learning model makes students more active in following lessons, more courageous in expressing opinions, and easier to understand the concepts taught. By involving students directly in the process of stimulation, problem statement, data collecting, data processing, verification and generalization, this model helps students think more deeply and logically. Thus, this model can be used as an excellent alternative to improve students' scientific literacy skills in chemistry material at school.

## RECOMMENDATIONS

Based on the conclusions obtained, the researcher recommends the discovery learning model as an alternative chemistry learning model to improve students' scientific literacy skills, especially in thermochemistry material.

## ACKNOWLEDGEMENTS

The author would like to thank the Principal of SMA Negeri 15 Pekanbaru for granting permission to conduct research at the school and gratitude to Mr. Abdullah, S.Si, M.Si and Mrs. Dr. Sri Wilda Albeta, S.Pd, M.Pd for their guidance and supervision, as well as to all parties involved in the execution of this research.

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