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

April 2026. 14(2)
e-ISSN: 2656-3061
p-ISSN: 2338-6487
pp. 427-433

The Impact of the Discovery Learning Model on Learning Outcomes in Basic Chemistry at SMAN 1 Sungayang

Widia Rahmanda, Elvy Rahmi Mawarnis*, Dwivelia Aftika Sari
Department of Tadris Kimia, FTIK, UIN Mahmud Yunus Batusangkar, Jl. Jendral Sudirman No. 137, Sumatera Barat, Indonesia 27217
*Corresponding Author e-mail: elvyrahmimawarnis@gmail.com

Article History
Received: 16-04-2026
Revised: 06-05-2026
Published: 08-05-2026

Keywords: Discovery Learning; Learning Outcomes; Basic Laws of Chemistry.

Abstract
This study explores the effect of the Discovery Learning model on student learning outcomes in basic chemistry at SMAN 1 Sungayang. This is a quantitative study with a quasi-experimental design in the form of a nonequivalent control group. The study population consisted of all 10th-grade students, with a sample of two classes selected through purposive sampling. The experimental group used the Discovery Learning model, while the control group received conventional instruction. Data analysis included tests of normality and homogeneity, followed by hypothesis testing. The results indicate that the Discovery Learning model significantly improves student learning outcomes, demonstrating its effectiveness in promoting active engagement and a deeper understanding of chemical concepts. Thus, this model can be used as an alternative in chemistry instruction to improve the quality of student learning outcomes.

How to Cite: Rahmanda, W., Mawarnis, E. R., & Sari, D. A. (2026). The Impact of the Discovery Learning Model on Learning Outcomes in Basic Chemistry at SMAN 1 Sungayang. Hydrogen: Jurnal Kependidikan Kimia, 14(2), 427-433. https://doi.org/10.33394/hjkk.v14i2.20584

https://doi.org/10.33394/hjkk.v14i2.20584

INTRODUCTION

Chemistry is a branch of Natural Sciences that studies the structure of matter, its properties, and the transformation of one substance into another, along with the energy that accompanies these transformations. In its instruction, chemistry is understood not only as a body of concepts and laws, but also as a scientific process that demands thinking and investigative skills. Therefore, chemistry instruction ideally integrates conceptual aspects with scientific processes so that students can fully understand concepts and apply them to everyday life (Suswati, 2021).

The abstract nature of chemistry often hinders students' understanding of the subject matter. Many chemical concepts cannot be directly observed, thus requiring critical thinking skills. Sebagian besar siswa kurang antusias selama proses pembelajaran kimia karena banyaknya materi yang harus dihafal. This situation tends to cause students to experience difficulties, lose interest, and ultimately demonstrate poor learning outcomes. This presents a challenge for educators to design instruction that can bridge the abstract nature of the material with meaningful learning experiences (Mawarnis et al., 2023). The success of chemistry instruction is influenced by various factors, including the teacher, students, subject matter, and the learning strategies or models employed. Selecting an appropriate instructional model is one of the keys to creating an active, effective, and engaging learning environment. Innovative instructional models are expected to increase learning motivation, student engagement, and in-depth conceptual understanding (Aunurrahman, 2011).

Field observations indicate that chemistry instruction is still dominated by conventional methods such as lectures and assignments. This approach tends to be teacher-centered and the lack of variety in the teaching models used by educators in the learning process, which causes students to become bored and results in an ineffective teaching and learning process because the models used fail to foster students' motivation and interest in learning. This leads students to be less active in their learning and more passive in responding to questions posed by educators, and it also affects their learning outcomes (Mawarnis, 2024).

This problem was also identified at SMAN 1 Sungayang. Based on observations and interviews, chemistry classes still center on teacher delivery, while students tend to simply take notes and work on exercises without developing in-depth understanding. Furthermore, student interaction during instruction remains low, as evidenced by minimal participation in asking and answering questions.

Student learning outcome data on the basic laws of chemistry showed that more than 50% of students had not met the minimum completion criteria. This indicates that the instructional process has not been effective in helping students develop a thorough understanding of the concepts. These low learning outcomes are also attributable to the limited variety of instructional models used by teachers.

Chemistry lessons in school contain many concepts that are quite difficult for students to understand, as they involve chemical reactions, calculations, and many abstract concepts. The material on the fundamental laws of chemistry is one of the topics in chemistry that is considered difficult and abstract (Wanti et al., 2024). The basic laws of chemistry are foundational topics that underpin subsequent chemical concepts, such as stoichiometry. This material covers several important laws, including the law of conservation of mass, the law of definite proportions, the law of multiple proportions, the law of combining volumes, and Avogadro's law. The complexity of these concepts requires instructional models that can help students build understanding in a gradual and meaningful manner.

One alternative instructional model that can be implemented is the Discovery Learning model. The Discovery Learning Model is a learning model in which students independently explore and seek out the content or concepts they need to learn, without the teacher providing comprehensive knowledge of the subject matter. There are six steps in the Discovery Learning Model: stimulation, problem formulation, data collection, data analysis, verification, and generalization (Putri et al., 2024).

This model emphasizes active student involvement in discovering concepts through investigation, data collection, and analysis. Through this model, students are encouraged to construct knowledge independently, resulting in deeper and more lasting understanding (Nugrahaeni, 2017). The Discovery Learning model also provides opportunities for students to develop critical, creative, and analytical thinking skills. Previous research has demonstrated that the use of the Discovery Learning model can improve student learning outcomes (Kurnianto, 2016). This is supported by research conducted by Isnaeni and Agustina (2018) on buffer solution material, which showed that instruction using the Discovery Learning model achieved a completion rate of 91.18% (31 out of 34 students).

Based on the foregoing, it is important to further examine the effect of implementing the Discovery Learning model on student learning outcomes in the basic laws of chemistry. This study aims to determine whether the use of the Discovery Learning model produces better learning outcomes compared to conventional instruction. The results are expected to contribute to the development of more effective and innovative chemistry instructional strategies.

METHOD

This study is a quantitative study using an experimental method. A quantitative approach was chosen because the study aims to test the effect of independent variables on dependent variables through statistical analysis of numerical data. The experimental method was used to determine the cause-and-effect relationship between the application of the discovery learning model and student learning outcomes.

Research Design

The research design used was a quasi-experimental design in the form of a nonequivalent control group design. This design was chosen because it was not possible to control for extraneous variables that might influence the researchers' treatment (Sugiyono, 2013).

Tabel 1. Research Design

Group	Pre-test	Treatment	Post-test
Exsperiment	O_1	X	O_2
Control	O_3		O_4

Description:

O_1 = Administration of the pretest for the experimental class before the treatment was administered

O_2 = Administration of the posttest for the experimental class after the treatment was administered

X = Learning treatment using the discovery learning model

O_3 = Administration of the pretest for the control class before the treatment was administered

O_4 = Administration of the posttest for the control class after the treatment was administered

Participant

The population in this study consisted of 193 tenth-grade students at SMAN 1 Sungayang. The sample was selected using a purposive sampling method to ensure that both the experimental and control groups had comparable academic abilities and participation levels, following tests for normality and homogeneity. Each group consisted of 26 students from SMAN 1 Sungayang.

Research Instruments

The research instrument consists of an objective multiple-choice test developed based on learning indicators. The quality of the research instrument was first assessed through validity and reliability tests. Validity testing was conducted through content validity (expert judgment), construct validity, and empirical validity using Pearson's Product-Moment correlation. The instrument was deemed valid if the correlation coefficient value was greater than the table r value (Arikunto, 2013). Reliability testing used the Cronbach Alpha coefficient with the assistance of SPSS software. The instrument was deemed reliable if the Cronbach Alpha value was greater than 0.60 (Purnomo, 2016). Subsequently, item analysis was conducted, including an assessment of difficulty level and discriminative power, to ensure the quality of the instrument prior to its use in data collection.

Data Collection

The data collection methods used in this study included tests, observations, and interviews. The primary instrument used was a learning outcome test consisting of 36 multiple-choice items that had undergone validity and reliability testing. A pretest was administered before the intervention to assess students' initial abilities, while a posttest was administered after the intervention to measure learning outcomes following the instruction. Observations and interviews were used as supplementary data to gather initial information regarding classroom learning conditions (Sukardi, 2013).

Data Analysis Techniques

The data analysis was conducted in stages, including preliminary tests and hypothesis testing. The preliminary tests consisted of normality tests and homogeneity tests.

Normality Test

This test was conducted so that researchers could determine whether the data obtained were normally distributed or not. The normality test was performed using the Shapiro-Wilk test, with a significance level (α) of 5% or 0.05; thus, if the p-value was greater than 0.05, the data were considered normally distributed (Sugiyono, 2013).

Homogeneity Test

This test is used to determine whether the data come from a heterogeneous population or not. The normality test uses Levene's test, with a significance level (α) of 5% or 0.05; thus, if the p-value is greater than 0.05, H0 is accepted and the data groups are considered homogeneous (Sianturi, 2018).

Hypothesis Testing

After conducting the prerequisite tests described above, a hypothesis test was then performed. The N-Gain test and the t-test were used to test the hypothesis. The N-Gain test was conducted to analyze students' learning outcomes after administering the pretest and posttest. N-Gain is calculated from the difference between the pretest and posttest scores, then normalized against the maximum score that can be achieved to categorize the results as low, moderate, or high. Meanwhile, the t-test used is the independent sample t-test, to assess the difference in means between two groups of data that are independent of one another. The hypothesis is accepted if the sig (2-tailed) value is < 0.05 and rejected if the sig (2-tailed) value is > 0.05. N-Gain and T-tests using SPSS 31(Sugiyono, 2013).

RESULTS AND DISCUSSION

Result

The results of this study present data analysis related to the effect of the Discovery learning model on student learning outcomes in the basic laws of chemistry. Data were obtained through learning outcome tests in the form of pretests and posttests administered to both the experimental and control classes.

Description of Learning Outcome Data

Based on the pretest data analysis, descriptive statistics were obtained as presented in Table 2.

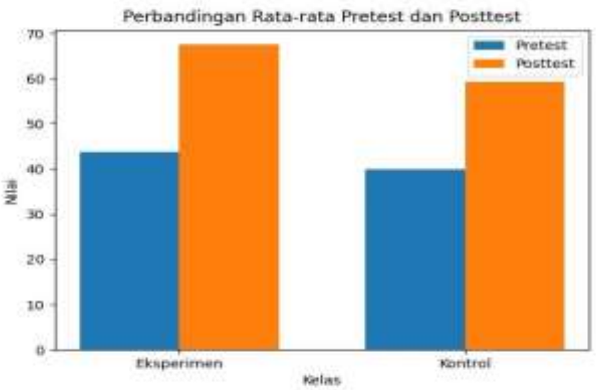
Table 2. Pretest Results Data for Experimental Class and Control Class

Value Criteria	Experimental Class	Control Class
N	26	26
Total Value	1140	1040
Average	43,85	40,00
Lowest Value	20	15
The highest score	75	80
Std deviation	17,45	20,04

Based on the pretest data analysis, the mean score for the experimental class was 43.85 and the mean for the control class was 40.00. This indicates that the initial abilities of students in both classes were relatively comparable, making them suitable for the experimental treatment. The posttest data analysis yielded descriptive statistics as presented in Table 3.

Table 3. Posttest Results Data for Experimental Class and Control Class

Value criteria	Experimental class	Control class
N	26	26
Total value	1755	1540
Average	67,50	59,23
Lowest value	40	35
The highest score	100	85
Std deviation	19,14	15.85



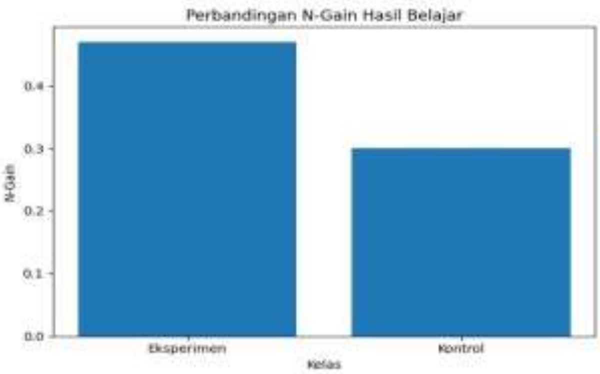
Graph 1. Comparison of Average Pretest and Posttest Scores for Experimental and Control Classes

Table 3 shows that posttest results indicate an improvement in learning outcomes in both classes. The mean posttest score for the experimental class was 67.50, while the mean posttest score for the control class was 59.23. This difference indicates that students taught using the Discovery Learning model achieved better learning outcomes than those taught using conventional instruction.

The graph shows a comparison of the mean pretest and posttest scores in the experimental and control classes. The pretest scores for both classes were relatively similar, indicating comparable initial student abilities. However, the posttest scores showed a more pronounced improvement in the experimental class compared to the control class, indicating that the Discovery Learning model is more effective in improving learning outcomes than conventional instruction.

Analysis of Learning Outcome Improvement (N-Gain)

Learning outcomes were analyzed using the N-Gain score. The results are presented in the graph 2.



Graph 2. N-Gain Analysis Results

The N-Gain analysis showed that the mean improvement in learning outcomes in the experimental class was 0.47 and in the control class was 0.30, both of which fall in the moderate category. However, the improvement in the experimental class was greater than that in the control class, indicating the effectiveness of the Discovery Learning model in improving student learning outcomes.

Prerequisite Analysis Test

Prior to hypothesis testing, prerequisite tests were conducted, including normality and homogeneity tests. The Shapiro-Wilk normality test showed that all data had a significance value > 0.05, indicating a normal distribution. The Levene homogeneity test yielded a significance value of 0.208 (> 0.05), indicating that the variances of both groups were homogeneous.

Hypothesis Testing

Hypothesis testing was conducted using an independent sample t-test to determine the difference in learning outcomes between the experimental and control classes. The results showed a significance value (Sig.) of 0.048 (< 0.05); therefore, H_0 was rejected and H_1 was accepted. This indicates a significant difference between the learning outcomes of students taught using the Discovery Learning model and those taught using conventional instruction. These results are consistent with previous research demonstrating that the Discovery Learning model can significantly improve student learning outcomes compared to conventional instruction (Hidayati et al., 2024).

Discussion

The results of this study indicate that the Discovery Learning model has a positive and significant impact on improving student learning outcomes in the basic laws of chemistry. This finding is supported by the differences in mean posttest and N-Gain values between the experimental and control classes. The steps of the Discovery Learning model are: providing stimulation, identifying problems (problem statement), collecting data, processing data, verification, and drawing conclusions (generalization) (Darmawan & Wahyudin, 2018).

Conceptually, the advantage of Discovery Learning lies in the active involvement of students in the learning process. In the stimulation stage, students are presented with probing questions, contextual problems, or phenomena related to the learning material. This stage encourages students to be more focused and engaged with the material, rather than passively receiving information. This is consistent with Viastuti et al. (2024), who emphasized that providing stimulation at the beginning of instruction can enhance students' cognitive readiness to engage with the material.

In the problem statement stage, students are trained to identify and formulate problems based on the stimuli provided. At this stage, students develop critical and analytical thinking skills by formulating questions or tentative hypotheses. This aligns with the findings of Rahayu et al. (2025), who stated that this stage produces stronger critical thinking indicators because students learn to identify problems and practice critical reasoning skills.

In the data collection stage, students gather relevant information through reading, observation, discussion, or experimentation. This stage positions students as active participants in the learning process, consistent with Nikmah et al. (2025), who noted that data collection activities strengthen students' active engagement and improve their ability to find accurate and relevant information for problem-solving.

In the data processing stage, students analyze and interpret the data gathered to address the formulated problems. This is consistent with Viastuti et al. (2024), who stated that the data processing stage in Discovery Learning strengthens students' critical thinking skills.

In the verification stage, students check the results of data processing against relevant theories or learning resources, which helps to reduce conceptual errors. This aligns with Martir et al. (2024), who stated that this stage facilitates students in logically verifying the relationship between findings and learning concepts, thereby strengthening conceptual understanding.

The final stage, generalization, allows students to draw conclusions independently, making the knowledge gained more meaningful and enduring. This aligns with Rahmatunnisa et al. (2025), who stated that this stage facilitates reflective and synthetic thinking because students must synthesize their learning outcomes and connect them to broader knowledge.

Based on the data analysis, there was a difference in mean posttest scores between the two classes. The experimental class obtained a mean posttest score of 67.50, while the control class obtained a mean of 59.23. Both classes showed improvement in learning outcomes from pretest to posttest following each respective treatment. The N-Gain analysis showed that the mean N-Gain in the experimental class was 0.47 and in the control class was 0.30, both in the moderate category.

The improvement in student learning outcomes was attributable to motivation during instruction, particularly in the experimental class, as evidenced by students' active participation and their ability to articulate argu-ments during learning activities. These findings are consistent with previous research, Kurnianto (2016), which showed that discovery learning can improve learning outcomes. The higher N-Gain scores in the experimental class indicate that the active engagement and problem-solving opportunities provided by the discovery learning model foster better student understanding compared to conventional methods.

The prerequisite tests showed that both the experimental and control class data were normally distributed and homogeneous at a significance level of α = 0.05. This indicates that both classes had comparable variance. In the hypothesis test, the independent sample t-test was used with a significance level of 0.05. Based on the posttest data, the Sig. (2-tailed) value was 0.048 ($< \alpha = 0.05$), indicating that H_0 is rejected and H_1 is accepted. The conclusion is that the mean learning outcomes of the experimental group were significantly better than those of the control group (Ngatno, 2015).

These findings are consistent with Jerome Bruner's constructivist theory of discovery learning, which posits that learning is more meaningful when students discover concepts independently through exploration and investigation. In the Discovery Learning model, students do not merely receive information; rather, they actively engage in observing, identifying problems, collecting data, processing information, and drawing conclusions.

However, the implementation of the Discovery Learning model is not without its challenges. This study found that the model requires a longer time allocation and strong classroom management skills from the teacher, particularly in classes with a large number of students. This is consistent with Saefuddin and Budiarti (2014), who noted that the Discovery learning model is less efficient when applied to large classes, as it requires more time to guide students in discovering concepts. Therefore, careful instructional planning is necessary for this model to be implemented optimally.

Overall, the results of this study indicate that student learning outcomes in classes using the Discovery Learning model are significantly better than those in classes using conventional instruction. Therefore, the Discovery Learning model is effective in improving student learning outcomes, particularly for conceptual material that requires in-depth understanding.

CONCLUSION

Based on the results of the research and data analysis that have been conducted, it can be concluded that the use of the discovery learning model has a significant influence on student learning outcomes in the material of basic chemical laws at SMAN 1 Sungayang. This is shown by the difference in average learning outcomes between the experimental class and the control class, where the experimental class using the discovery learning model obtained a higher average score than the control class using conventional learning. In addition, the results of the analysis of learning improvements using the N-Gain index showed that the experimental class had a higher increase than the control class, although both were in the moderate category. These findings indicate that the discovery learning model not only improves the achievement of final learning outcomes, but also contributes to increasing students' conceptual understanding more effectively. The results of the hypothesis test using the t-test showed that there was a significant difference between the two groups, so the alternative hypothesis (H_1) was accepted and the null hypothesis (H_0) was rejected. Thus, it can be stated that the learning outcomes of students taught using the discovery learning model were better than those taught using conventional learning.

RECOMMENDATION

Future research is recommended to explore the integration of technology and Discovery Learning to further enhance teaching effectiveness. Additionally, it is recommended to investigate the impact of this model on other cognitive skills, such as critical thinking, scientific attitudes, and science process skills.

BIBLIOGRAPHY

Arikunto, Suharsimi. (2013). *Research Procedures A Practical Approach*. Jakarta: PT. Rineka Cipta.

Aunurrahman. (2011). *Learning and* Teaching. Bandung: Alfabeta Publisher.

Darmawan, D., & Wahyudin, D. (2018).*Learning Models in Schools(Nita, Ed.)*. PT Remaja Rosdakarya.

Hidayati, F., Hidayah, N., & Rochmawan, A. E. (2024). The Effect of Cooperative Learning Methods on Student Outcomes Learning Islamic Religious Education for Grade VIII Students at SMP IT MTA Karanganyar.*Al'ulum Journal of Islamic Education.*

Isnaeni, I., & Agustina, Y. (2018). An increase in learning outcomes of students is through the development of archive e-module based on the flipbook with discovery learning model.*Journal of Business and Management Educationn*, 4(3).

Kurnianto, H., Masykuri, M., & Yamtinah, S. (2016). The influence of the discovery learning model accompanied by student activity sheets (LKS) on student learning achievement in the salt hydrolysis material of Class XI SMA Negeri 1 Karanganyar in the 2014/2015 Academic Year.*Journal of Chemical Education (JPK*), 5(1).

Martir, L., Sayangan, YV, & Beku, VY (2024). Application of the discovery learning model in improving the critical thinking skills of elementary school students in science learning.*Journal of Mathematics and Natural Sciences Education*, 14(3). https://doi. org/10.37630/jpm.v14i3.1829

Mawarnis, E. R. (2024). Innovative Teaching Tools: Creating a Guided Inquiry Chemistry E-Module with FLIP PDF Support for Understanding Atom Developmentand the Periodic System of Elements. *Edusainstika: Jurnal Pembelajaran MIPA*, 3(2).

Mawarnis, E. R., Ramadhani, S., & Herman, M. (2023, November). Development of module integrated with quranic verses based on discovery learning on reaction rate material. In *Proceedings of the International Conference on Social Science and Education (ICoeSSE 2023)* (p. 110). Springer Nature.

Ngatno. (2015).*Business Research Methodology*. Institute for Educational Quality Assurance and Development. University Diponegoro Semarang.

Nikmah, U., Andriani, V., Zuliastuti, V., Inayati, VR, & Chasanah, U. (2025). Implementation of Discovery learning method to improve student learning outcomes in science learning at MI Tarbiyatul Islamiyah Winong. *DARUSSALAM: Scientific Journal of Islamic Education*, 1(2).

Nugrahaeni, A., Redhana, IW, & Kartawan, IMA (2017). Implementation of the Discovery Learning Model To Improve Critical Thinking Skills and Chemistry Learning Outcomes.*Indonesian Journal of Chemical Education*, 1(1).

Purnomo, RA (2016).*Economic and Business Statistical Analysis with SPSS*.Ponorogo: CV Wade Group.

Putri, P. F., & Mawarnis, E. R. (2024). Development of Discovery Learning-Based Laboratory Instructions Integrated with Quranic Values for Senior High School Grade XI. *Edusainstika: Jurnal Pembelajaran MIPA*, *4*(1).

Rahayu, R., Safriana, S., Fatmi, N., Sakdiah, H., & Widya, W. (2025). The Influence of the Discovery Learning Model Based on Teaching Modules on Students' Cognitive Learning Outcomes in Static Fluid Material.*Journal of Education and Physical Sciences*,5(1). https://doi.org/10.52434/jpif.v5i1.42241

Rahmatunnisa, A., Patmawati, H., & Mulyani, E. (2025). The Impact of PBL and Discovery Learning Models Learning towards Improving Students' Mathematical Reflective Thinking Based on Initial Abilities.*Congruent Journal*, 4(3).

Rostika, D. (2020). Implementation of the STAD Cooperative Learning Model to Improve Learning Outcomes Chemistry.*Indonesian Journal of Educational Development*, 1(2).

Sari, D. A., Herman, M., Putri, S. D., & Hidayati, H. (2025). The Impact of Problem-Based Learning (PBL) Module on Critical Thinking Skills on Electrolyte and Nonelectrolyte Solutions. *Hydrogen: Jurnal Kependidikan Kimia*, 13(1).

Sugiyono. (2019).*Quantitative research methods*.Bandung: Alfabeta.

Sukardi. (2013).*Classroom Action Research Method: Implementation and Development.* Jakarta: Bumi Script.

Suswati, U. (2021). Implementation of Problem Based Learning (PBL) to Improve Chemistry Learning Outcomes.*Innovation Journal Teaching and Education Science*, 1(3).

Viastuti, R., Poerwanti, JIS, & Chumdari, C. (2025). Application of the Discovery Learning Model for Improving Critical Thinking Skills in Science Learning for Grade IV Elementary Schools.*Didactics of Dwija Indria*, 12(5).

Wanti, S., Mawarnis, E. R., & Herman, M. (2024). Designing POGIL Based Student Worksheets for Buffer Solution Learning at SMAN 2 Sawahlunto. *Hydrogen: Jurnal Kependidikan Kimia*, 12(5).