Terakreditasi S4 sinta Science and Technology Index

pISSN 2685-0761
eISSN 2685-0850

JURNAL INOVASI PEMBELAJARAN KIMIA
(Journal of Innovation in Chemistry Education)
https://jurnal.unimed.ac.id/2012/index.php/jipk
email: Jinovpkim@unimed.ac.id

Recieved : 7 October 2024
Revised : 13 October 2024
Accepted : 27 October 2024
Publish : 31 October 2024
Page : 238 – 244

Implementation of Integrated Discovery Learning Model of Generic Science Skills to Improve HOTS

Ani Sutiani[1]* and Cinta Bela[2]

[1,2]*Chemistry Education Study Program, Universitas Negeri Medan, Medan*

**Email: anisutiani@unimed.ac.id*

***Abstract*:** *The purpose of this study was to determine the increase in students' high-order thinking skills after the application of the discovery learning model integrated with generic science skills on chemical equilibrium material in class XI of SMA Negeri 5 Tanjung Balai. The sampling technique was carried out using the random sampling technique, namely taking one class randomly by drawing lots. The design of this study was a one group pretest-posttest design. In learning, the test instruments used were cognitive levels C1 to C6, namely multiple choice questions. Through hypothesis testing using one sample T-Test, data significance was obtained < 0.05 so that it can be concluded that Ha is accepted, which means that the average value of students taught with the discovery learning model integrated with generic science skills on chemical equilibrium material reached a minimum of 75.*

Keywords *: discovery learning model; generic science skills; high-order thinking; chemical equilibrium*

INTRODUCTION

Chemistry is a branch of natural science that studies the chemical structure, composition of matter, changes in matter and the energy that influences changes in matter (Sutiani et al., 2022). One of the chemical materials discussed in this study is chemical equilibrium. One of the chemical materials discussed in this study is chemical equilibrium. Chemical equilibrium is a material that is considered very difficult by students because almost 75% of it contains mathematical calculations and the material is very abstract (Sinuraya et al., 2024).

Based on the observation results, it was obtained that 90% of students did not understand how to distinguish homogeneous and heterogeneous equilibrium, more than 90% of students did not understand how to analyze the effect of temperature, 96% could not determine the equilibrium constant value and 96% could not determine the relationship between kc and kp correctly. This is because the learning model used is a conventional model. To overcome this, it can be done by applying high-order thinking skills to students (Purba et al., 2022).

High Order Thinking Skills is the ability to connect, manipulate, transform knowledge and experience that has been owned to think critically and creatively (Simamora, 2022). The potential of science

education can be seen from the ability to communicate, think critically, solve problems, mastery of technology and the ability to adapt to change and the times (Purba et al., 2022).

To improve students' high-order thinking skills, especially in learning chemical equilibrium, can be assisted by the application of the discovery learning model. This model emphasizes the importance of students being scientific and playing an active role in finding concepts or principles that they have not previously discovered independently (Ginting et al., 2022). Discovery learning model has many advantages, one of which is cultivateing and improving students' curiousness, but behind the advantages, there are some disadvantages in this model, namely when students with admissions have difficulty in thinking, such as can overcome the weaknesses of the Discovery Learning Model, is to implement general science skills. General science skills are the basic abilities required by students in carrying out scientific work that result in students' understanding of the concept (Situmorang et al., 2023).

The results of the study obtained by (Susriani, 2021) by applying Discovery Learning learning in the material of chemical equilibrium, obtained data that in cycle I the average student learning was 70.40 with classical completeness of 76.67%, while in cycle II after reflection on the implementation of actions in cycle I, the average student learning outcomes increased by 73.60 with classical completeness of 90.00% in cycle II. Based on this study, it can be concluded that the level of student thinking, namely Higher Order Thinking Skill (HOTS) in the main material of chemical equilibrium through the Discovery Learning learning model has increased as expected. The application of learning models alone is not enough to improve students' high-level thinking skills, therefore appropriate teaching materials are needed, one of which is student worksheets (LKPD) (Zakiyah & Yonata, 2021).

In line with research (Sarita & Kurniawati, 2020) which states that the development of LKPD based on generic science skills can increase students' interest in learning, the success of LKPD contains indicators of generic science skills that are easy for students to understand. In addition, the results of the study conducted by SARAH showed that the average value of the experimental class using student worksheets was higher, namely 87.4, while the control class was 69.6. The results of the Independent Sample T-test obtained a Sig. (2-tailed) value of 0.00 <0.05, meaning that there is a positive and significant influence of the use of KGS-oriented LKS on students' understanding of the concept of chemical equilibrium (Virtayanti et al., 2019).

LITERATURE REVIEW

Discovery Learning

The Discovery Learning Model has an influence on improving student learning outcomes and critical thinking skills (Alfirdaus et al., 2024). Discovery Learning is learning to discover concepts, meaning, and causal relationships through organizing learning carried out by students. Principles of the Discovery Learning Model that is, students are asked to identify what you want to know then look for the information yourself form understanding as output. The steps of the Discovery Learning Model are (1) Stimulation;(2) Problem Statement; (3) Data Collection; (4) Data Processing; (5) Verification; (6) Generalizations. (Yunsyahana et al., 2022).

The advantages of the Discovery learning model are: (1) Students are required to be active; (2) Learning activities in Discovery learning are more meaningful; (3) Participants are taught to acquire investigative and reflective skills; (4) Participants are taught to learn new skills and strategies; (5) Encourage student independence; (6). Able to make students more likely to remember concepts and support improved group work (Khasinah, 2021). Meanwhile, the disadvantages are (1) Students who have cognitive limitations will experience

difficulty in abstract thinking; and (2) requires a lot of time to study (Fahmi et al., 2019).

Generic Science Skills

Generic Science skills are intellectual abilities resulting from a combination or complex interaction between scientific knowledge and skills. Generic skills are cognitive strategies that can relate to cognitive, affective, and psychomotor aspects that can be learned and left behind in students (Dibyantini & Azaria, 2020).

According to (Mulya et al., 2022) there are nine types of generic science skills that can be taught to students. The nine types of generic science skills are direct observation, indirect observation, awareness of scale, symbolic language, logical framework, logical inference, cause and effect, mathematical modeling and the ability to build concepts.

Learning Outcomes

Learning achievement is evidence that someone has learned, which can be seen from changes in the person's behavior from not knowing to knowing and from not understanding to understanding. Low student learning achievement is caused by the low learning process experienced by students. This requires teachers to make changes so that learning is more meaningful and acceptable to their students, so that students can obtain positive changes in learning achievement and changes in mindset. Learning achievement is expected to be obtained through learning experiences, while mindset will influence behavior and attitudes as the initial basis for acting (Purwaningsih, 2022).

Higher Order Thinking Skills

In chemistry subjects, students will often and even be familiar with critical thinking and high-order thinking skills. This can happen because chemistry learning requires high analysis in finding answers to each phenomenon studied. High-order thinking skills are closely related to thinking skills in accordance with the cognitive, affective, and psychomotor domains that are a unity in the learning and teaching process. High-order thinking skills are complex thinking processes in describing material, making conclusions, building representations, analyzing, and building relationships by involving the most basic mental activities (Susriani, 2021). When students are directed to be able to think critically, creatively and able to solve problems, it means that students are targeted to have high order thinking skills (HOTS) (Panggabean et al., 2021).

High Order Thinking Skills (HOTS) measures the ability to: (1) transfer concepts, (2) process and apply information, (3) relate different kinds of information, (4) solve problems using information, and (5) examine ideas and information critically. HOTS is defined as the ability to use the mind to solve problems at hand (Panggabean et al., 2022).

Teaching Materials

Teaching materials are all forms of materials used to help teachers/instructors in carrying out teaching and learning activities. By using teaching materials, teachers can save time in teaching, change the role of teachers from a teacher to a facilitator, improve the learning process to be more effective and interactive, one example is student worksheets. However, the learning process in schools in general still uses teaching materials in the form of textbooks that are only informative, educators are only focused on conventional teaching materials without any creativity to develop these teaching materials innovatively, so it is recommended to use more applicable books in the learning process (Silaban et al., 2019).

METHODS

The research conducted is quantitative research, with a one group pretest-posttest design. Sampling was done using a random sampling technique is class drawing. The independent variable of this research is the Discovery Learning model integrated with generic science skills. The dependent variable is high-order thinking skills. While the control variables are

chemical equilibrium material, students and teachers.

The research instrument is a test instrument in the form of multiple choice questions with a cognitive level of C1-C6 as many as 25 questions that have been validated in advance. The results of the pretest and posttest will be analyzed using the *SPSS 25.0 for Windows Program*, with a significant level ($\alpha = 0.05$), if sig > $\alpha = 0.05$ (H_0 is accepted), while if sig < $\alpha = 0.05$ (H_a is accepted).

RESULT AND DISCUSSION

To measure students' high-level thinking skills, the multiple-choice test instrument consists of 25 questions representing each basic competency indicator (KD) on the chemical equilibrium material. The instrument used also meets the feasibility test consisting of validity, reliability, discriminatory power, level of difficulty and distractors. So this instrument is suitable for use to measure students' high-level thinking skills.

The results of the analysis of student learning scores before and after the application of the integrated discovery learning model of generic science skills on the chemical equilibrium material can be seen in Table 1

Table 1. Results of students' high order thinking skills

Treatment	N	Min	Max	Mean	Std. Deviation
Pretest	32	60	84	70	6.815
LKPD	32	68	899	78	5.730
Posttest	32	71	92	82	5.538

Based on Table 1, it can be concluded that the pretest results with a minimum score of 60 and a maximum score of 84 have an average score of 70 with a standard deviation of 6.815 in the sufficient category. The results of students who took the LKPD with the lowest score of 68 and a maximum score of 89 had an average score of 78 with a standard deviation of 5.730 in the good category. The posttest results with a minimum score of 71 and a maximum score of 92 had an average score of 82 with a standard deviation of 5.538 in the very good category. This shows that the learning provided is effective in improving students' understanding and mastery of the material.

Normality Test

To determine whether the data obtained is normally distributed or not, the Shapiro-Wilk test is carried out

Table 2. Results of the normality test of students' high-order thinking skills

Traetment	Sample	Sig.Data	Sig.Level
Pre-Test	32	0.106	
LKPD	32	0.351	0.05
Post-Test	32	0.599	

Based on Table 2, there are the results of the normality analysis test using Shapiro Wilk, namely the pretest value sig. 0.106 > 0.05, LKPD with sig 0.351 > 0.05, posttest with sig 0.599 > 0.05. Each shows that the pretest, LKPD and posttest data are normally distributed.

Homogeneity Test

By examining the extent of deviations that occur, the homogeneity test is used to estimate the degree of scattering of quantitative data or the degree of homogeneity of data within one data group. The homogeneity test used is the Levene test.

Table 3. Results of the homogeneity test of students' high-order thinking skills

Treatment	*Levene Statistic*	df_1	df_2	*Sig.*	*Sig.Level (α)*
LKPD	2.564	7	15	0.060	0.05
Post-Test	2.085	7	15	0.110	

Based on Table 3, it can be concluded that the significance value of the LKPD is 0.060 > 0.05 and the posttest sig is 0.110 > 0.05, which means that the LKPD and posttest data are homogeneous.

Hypothesis Test

Hypothesis testing in this study used SPSS 25.0 One Sample T-Test at a significance level of $\alpha = 0.05$, with the analysis results as in the table below.

Table 4. Results of the hypothesistest of students' high-order thinking skills

Treatment	*t*	*df*	*Sig. (2-tailed)*	*Mean Difference*
Pre-Test	-4.488	31	0.000	-5.406
LKPD	3.424	31	0.002	3.469
Post-Test	6.831	31	0.000	6.688

Based on Table 4, the results of the statistical hypothesis testing show that the pretest sig is 0.000 <0.05, the LKPD sig is 0.002 <0.05 and the posttest sig is 0.000 <0.05. Thus, the average pretest score of 70 and LKPD 78 is lower than the average posttest score of 82. This shows that there is a significant difference between before and after the implementation of the discovery learning model integrated with generic science skills. After conducting a one sample t-test, it can be concluded that the researcher's hypothesis "the average score of students taught with the discovery learning model integrated with generic science skills on chemical equilibrium material reaches a minimum of 75 is true.

Based on the overall results of the study, the pretest percentage of each indicator starting from question number 1 to number 25 showed a value of less than 70%. The pretest was conducted to determine the initial abilities of students before carrying out the learning process, from the pretest percentage value it is known that students' abilities in learning chemical equilibrium are still low, including correlating the concept of chemical equilibrium, measuring the equilibrium constant price based on pressure and measuring the degree of dissociation. For the average value of the posttest percentage of each indicator starting from question number 1 to number 25 showed a value of more than 90%. The results of the posttest percentage indicate the influence of the discovery learning model integrated with generic science skills on learning chemical equilibrium.

In line with the results of research conducted by (Izetbigovic et al., 2019) using a statistical test, namely the paired-sample t-test with a significance level of 0.05. The results of the research that has been conducted indicate that there is an increase in students' generic science skills on colloid material after the application of the discovery learning model. This is evidenced by the analysis of generic science skills with the N-gain test which obtained that 4 indicators are classified as moderate. The use of student-centered learning models appropriately can train students' generic science skills

CONCLUSION

Based on the results of the research and discussion above, it can be concluded that: there is an increase in high-level thinking skills of students taught using the discovery learning model integrated with generic science skills on chemical equilibrium material. This is indicated by the average pretest of 69.594 (sufficient) to 81.688 (very good). In addition, with data using the one sample t-test on the posttest value with a confidence level of 95% at a significance level of $\alpha = 0.05$, the posttest sig value is 0.000 <0.05, so (Ha is accepted) so it can be concluded that the average value of students taught with the discovery learning model integrated with generic science skills on chemical equilibrium material reaches a minimum of 75.

REFERENCE

Alfirdaus, S. K., Muallimin, M., & Usriyah, L. (2024). Model Discovery Learning Sebagai Upaya Meningkatkan Kemampuan Berfikir Kritis Pada Pembelajaran IPA Di Sekolah Dasar. *Jurnal Pendidikan Guru Madrasah Ibtidaiyah Al-Multazam*, *10*(1), 34–44. https://doi.org/10.54892/jpgmi.v10i1.255

Dibyantini, R. E., & Azaria, W. (2020). Pengaruh Penerapan Model Pembelajaran Berbasis Masalah Terhadap Kemampuan Generik Sains Siswa Pada Materi Larutan Penyangga. *Jurnal Inovasi*

Pembelajaran Kimia (Journal Of Innovation in Chemistry Education), *2*(2), 81–90. https://doi.org/10.24114/jipk.v2i2.19561

Fahmi, Setiadi, I., Elmawati, D., & Sunardi. (2019). Discovery Learning Method For Training Critical Thinking Skills Of Student. *European Journal Of Education Studies*, *6*(3), 342–351. https://doi.org/10.5281/zenodo.3345924

Ginting, F. A., Syahputra, R. A., Purba, J., Sutiani, A., & Dibyantini, R. E. (2022). Pengembangan Modul Berbasis Discovery Learning Terintegrasi Literasi Sains Pada Materi Laju Reaksi. *Jurnal Inovasi Pembelajaran Kimia (Journal Of Innovation in Chemistry Education)*, *4*(2), 167–176. https://doi.org/10.55904/educenter.v1i4.86

Izetbigovic, M. A., Solfarina, & Langitasari, I. (2019). Penerapan Model Discovery Learning untuk Meningkatkan Keterampilan Generik Sains Siswa. *EduChemia (Jurnal Kimia Dan Pendidikan)*, *4*(2), 164–174. https://doi.org/10.30870/educhemia.v4i2.6118

Khasinah, S. (2021). Discovery Learning: Definisi, Sintaksis, Keunggulan dan Kelemahan. *Jurnal MUDARRISUNA: Media Kajian Pendidikan Agama Islam*, *11*(3), 402–413. https://doi.org/10.22373/jm.v11i3.5821

Mulya, F. R., Rokhmat, J., & Ramdani, A. (2022). Validitas Perangkat Pembelajaran Fisika Model Discovery Untuk Meningkatkan Penguasaan Konsep dan Keterampilan Generik Sains. *Journal of Classroom Action Research*, *4*(2), 195–148. https://doi.org/10.29303/jcar.v4i1.1728

Panggabean, F. T. M., Pardede, P. O., Sitorus, R. M. D. S., Situmorang, Y. K., Naibaho, E. S., & Simanjuntak, J. S. (2021). Application of 21st Century Learning Skills Oriented Digital-Age Literacy to Improve Student Literacy HOTS in Science Learning in Class IX SMP. *Jurnal Mantik*, *5*(3), 1922–1930. https://iocscience.org/ejournal/index.php/mantik/article/view/1796

Panggabean, F. T. M., Silitonga, P. M., & Sinaga, M. (2022). Development of E-Modules to Improve Students' High Order Thinking Skills. *AIP Conference Proceedings*, *2659*(1). https://doi.org/10.1063/5.0114397

Purba, J., Sutiani, A., Panggabean, F. T. M., Silitonga, P. M., & Susanti, N. (2022). Hubungan Motivasi Belajar dan Kepercayaan Diri dengan Kemampuan Literasi Kimia serta Dampaknya Terhadap HOTS Mahasiswa. *Jurnal Inovasi Pembelajaran Kimia (Journal Of Innovation in Chemistry Education)*, *4*(2), 191–201. https://doi.org/10.24114/jipk.v4i2.39459

Purwaningsih. (2022). Peningkatan Hasil Belajar Melalui Model Pembelajaran Penemuan Pada Peserta Didik Kelas Viii Smp Negeri 8 Cikarang Utara Kabupaten Bekasi. *EDUCATOR : Jurnal Inovasi Tenaga Pendidik Dan Kependidikan*, *2*(4), 422–427. https://doi.org/10.51878/educator.v2i4.1929

Sarita, R., & Kurniawati, Y. (2020). Pengembangan Lembar Kerja Peserta Didik (LKPD) Kimia Berbasis Keterampilan Generik Sains. *Journal of The Indonesian Society of Integrated Chemistry*, *12*(1), 31–39. https://doi.org/10.22437/jisic.v12i1.

7846

Silaban, R., Panggabean, F. T. M., Sitompul, S. M., Simarmata, P. R. S., & Silaban, I. Y. (2019). Pengembangan Pembelajaran Kimia Larutan Berdasarkan Ilmu Pengetahuan dan Pengaruhnya Terhadap Hasil Belajar dan Minat Siswa di Kelas XI SMA. *Jurnal Inovasi Pembelajaran Kimia (Journal Of Innovation in Chemistry Education)*, *1*(2), 100–106. https://doi.org/10.24114/jipk.v1i2.15528

Simamora, K. F. (2022). Kemampuan HOTS Siswa Melalui Model PjBL Ditinjau dari Kemampuan Literasi Kimia Siswa. *Jurnal Inovasi Pembelajaran Kimia (Journal Of Innovation in Chemistry Education)*, *4*(1), 55–65. https://doi.org/10.24114/jipk.v4i1.33588

Sinuraya, E., Susanti, N., Panggabean, F. T. M., & Rismawati, E. (2024). Analysis of Students' Scientific Literacy Abilities with Application Problem Based Learning and Discovery Learning Models. *Jurnal Inovasi Pembelajaran Kimia (Journal of Innovation in Chemistry Education)*, *6*(1), 92–99. https://doi.org/10.24114/jipk.v6i1.57048

Situmorang, Y. K., Sinaga, M., Sutiani, A., Dibyantini, R. E., & Muchtar, Z. (2023). Analysis of Students' Initial Ability Based on Generic Science Skills in Reaction Rate Material. *Jurnal Inovasi Pembelajaran Kimia (Journal Of Innovation in Chemistry Education)*, *5*(1), 28–36. https://doi.org/10.24114/jipk.v5i1.43133

Susriani, E. (2021). Upaya Peningkatan Higher Order Thinking Skill Siswa Melalui Model Pembelajaran Discovery Learning Pada Mata Pelajaran Kimia Kelas Xi.Mia.3 Di Sman 2 Kerinci Semester Ganjil Tahun Pelajaran 2019/2020. *LEARNING : Jurnal Inovasi Penelitian Pendidikan Dan Pembelajaran*, *1*(2), 204–211. https://doi.org/10.51878/learning.v1i2.590

Sutiani, A., Muchtar, Z., Dibyantini, R. E., Sinaga, M., & Purba, J. (2022). Analisis Kemampuan Guru-Guru Kimia SMA Sumatera Utara Dalam Mengintegrasikan TPACK. *Jurnal Inovasi Pembelajaran Kimia (Journal Of Innovation in Chemistry Education)*, *4*(2), 112–131. https://doi.org/10.24114/jipk.v4i2.39259

Virtayanti, I. A., Abudarin, & Wijayanti, E. (2019). Pengaruh Lembar Kerja Siswa Berorientasi Keterampilan Generik Sains Dengan Model Pembelajaran Discovery Learning Terhadap Pemahaman Konsep Kesetimbangan Kimia. *Karangan: Jurnal Bidang Kependidikan, Pembelajaran, Dan Pengembangan*, *1*(1), 17–23. https://doi.org/10.55273/karangan.v1i01.3

Yunsyahana, F., Auliah, A., & Djangi, M. J. (2022). Keefektifan Model Pembelajaran Discovery Learning Terhadap Hasil Belajar Peserta Didik Kelas X MAN Bantaeng. *Jurnal Inovasi Pembelajaran Kimia (Journal Of Innovation in Chemistry Education)*, *4*(1), 92–100. https://doi.org/10.24114/jipk.v4i1.33436

Zakiyah, F., & Yonata, B. (2021). Pengembangan LKPD Berorientasi Guided Discovery Learning dengan Internet Assisted Learning untuk Melatihkan Keterampilan Berpikir Kritis. *Jurnal Inovasi Pembelajaran Kimia (Journal Of Innovation in Chemistry Education)*, *3*(1), 46–55. https://doi.org/10.24114/jipk.v3i1.22765