EDUMATSAINS
JURNAL PENDIDIKAN MATEMATIKA DAN SAINS
E-ISSN:2527-7235
Volume 10 Issue. 1, July 2025, pp 44-59
http://ejournal.uki.ac.id/index.php/edumatsains

Enhancing Students' Chemical Representation Ability Through Problem-Based Learning Assisted by Nearpod on Electrolysis Cell Material

Nurida Siti Fatimah Zain[1*], Cucu Zenab Subarkah[2], Yulia Sukmawardani[3], Sari[4]

[1,2,4]Chemistry of Education Departement, UIN Sunan Gunung Djati Bandung, Bandung, Indonesia 40614
[3]Master of Science Education Departement, UIN Sunan Gunung Djati Bandung, Bandung, Indonesia, 40614
e-mail: ***nurida.zain@gmail.com**,

Article Info

Article history:
Received : June 23rd 2025
Revised : July 21st 2025
Accepted : July 25th 2025
Available online : July 31st 2025

https://doi.org/10.33541/edumatsains.v10i1.7066

Abstract

This study aims to show an increase in students' chemical representation ability through the integration of Problem-Based Learning (PBL) assisted by Nearpod on electrolysis cell material and describe student activities and their ability to complete worksheets. This study used a pre-experimental method with a one-group pretest-posttest design and involved second-semester students in the basic Chemistry 2 courses. The results showed that the improvement in chemical representation ability was in the medium category (N-Gain: 0.68), learning activities were carried out very good (88.86%), and the student's ability to complete worksheets was also classified as high (average score: 89.52). These findings indicate that integrating PBL assisted by Nearpod is an effective, innovative approach to improving students' chemical representation ability, particularly in abstract electrolysis cell material, by encouraging active participation and conceptual understanding.

Keywords: Problem-Based Learning, Nearpod, Chemical Representation Ability, Electrolysis cell.

1. Introduction

21st-century learning requires students to master critical thinking, problem-solving, collaboration, and the ability to utilize technology in learning (Nurhayati et al., 2021; Nursaya'bani et al., 2025). These skills can be developed through a learning process that actively involves students (Septiyanti et al., 2021). However, in chemistry learning, student involvement is often not optimal. This occurs due to an imbalance in understanding chemical representations macroscopic, submicroscopic, and symbolic, which makes it difficult for students to connect chemical concepts with everyday life and solve contextual problems (Safitri et al., 2019). These difficulties result in a learning process that tends to be dominated by memorization rather than a genuine understanding of the concepts and their application to real-life contexts (Mejia & Padilla, 2025). This indicates that a learning model is needed that not only emphasizes problem-solving but also develops students' chemical representation ability.

The Problem-Based Learning (PBL) model is a learning approach that is more relevant to the demands of 21st-century learning, as it is student-centered, collaboration, and the development of critical thinking skills in solving real-world contexts (Setiawan, 2021).

Research conducted by Sunarya et al. (2024) suggests that the PBL model can significantly enhance student learning outcomes, particularly when instruction is aligned with real-world contexts. This finding aligns with the results of Kasanah & Ardhana (2024), who suggest that the PBL model can enhance student engagement and enthusiasm in problem-solving and connecting concepts to real-world contexts, thereby potentially optimizing the development of students' chemical representation ability. This confirms that integrating the PBL model not only develops critical thinking skills but also develops chemical representation ability.

In the era of globalization, the development of information technology demands a transformation in learning by utilizing more interactive and relevant digital technologies (Graham et al., 2023). This challenges educators to utilize digital media in visualizing abstract concepts in chemistry learning (Lin & Wu, 2021). Therefore, in addition to using the PBL model that encourages active student involvement in problem-solving, interactive digital media that can visualize chemical representations comprehensively are also needed (Arsani et al., 2020). Interactive digital media equipped with images, animated videos, and simulations can effectively present information and facilitate the development of chemical representation ability (Farida et al., 2017).

Nearpod (https://nearpod.com/) is one of the digital media that can be utilized because it combines various features such as videos, texts, quizzes, and interactive activities in one web-based platform that is easy to access without requiring ample storage space and is available for free (Feri & Zulherman, 2021). The use of Nearpod has shown its effectiveness in encouraging increased learning motivation among students in chemistry learning (Naumoska dkk., 2022). Nearpod provides a web content feature to make it easier for teachers to insert and direct students to external websites without leaving the learning session (Aryani dkk., 2023). In addition, Nearpod provides features such as prepared learning videos that can be inserted into the Nearpod platform so that students can watch videos without being interrupted by advertisements. Using animated media, such as animated videos in chemistry learning, can develop students' chemical representation ability (Azzajjad dkk., 2020). This is proven by comparing students' average chemical representation ability on chemical equilibrium material taught with animation media, which reached 75.67 (macroscopic),79.17 (submicroscopic), and 72.58 (symbolic), higher than students who were not taught with animation media, which only reached 59.72 (macroscopic), 20.69 (submicroscopic), and 54 (symbolic).

One of the topics that requires good chemical representation ability is electrolysis cells. This topic requires an understanding of observable phenomena in both experiments and everyday life (macroscopic), explanations at the particle level that cannot be directly observed, such as electron movement (submicroscopic), and the ability to use symbols or equations representing the reactions occurring in the electrolysis cell process (symbolic) (Sukmawati, 2019). Based on the findings of Ahmad et al. (2021), most students often experience difficulties with this material because they often misunderstand concepts at the particle level, resulting in negative feedback. These findings are in line with the results of research by Anwar et al. (2024), which showed that chemistry is still often taught at the macroscopic and symbolic levels of representation, while the submicroscopic level is neglected, causing students to have difficulty in understanding the concepts comprehensively (Mujibaturrahmi dkk., 2022). This is related to the weak chemical representation ability of students, particularly in integrating the three levels of representation comprehensively (Lin & Wu, 2021).

Thus, integrating the PBL model with the use of interactive media, such as Nearpod, is a relevant strategy for creating active and meaningful chemistry learning. Students are not only involved in the problem-solving process but can also visualize chemical representations of abstract concepts, such as electrolysis cells, through interactive media. This is supported by research by Ilahi et al. (2022), which shows that the use of interactive media can improve students' chemical representation ability with an average N-Gain score of 0.50 in the moderate category.

However, to date, no research has been found that examines the integration of the PBL model with Nearpod media to enhance chemical representation ability on electrolysis cell material. This opens up opportunities for this study to contribute theoretically to the development of problem-based chemistry learning models integrated with digital technology, while offering practical implications for the effectiveness of chemistry learning and improving representation ability through comprehensive visualization of chemical representation.

The novelty of this study resides in integrating the PBL model with the Nearpod media in electrolysis cell material, which has not been widely researched to date. This study is expected to enhance students' chemical representation ability on electrolysis cell material through this approach. Specifically, this study aims to describe students' activities and abilities in completing problem-based worksheets assisted by Nearpod and analyze the improvement of students' chemical representation ability in electrolysis cell material after implementing the PBL model assisted by Nearpod.

2. Methods

This study used a pre-experimental method with a quantitative approach and a one-group pretest-posttest design. This design was used to measure student performance before and after treatment without a control group, thereby improving representation ability within the same group (Sugiyono, 2017). The treatment involved applying the PBL model assisted by Nearpod on electrolysis cell material.

The study participants were 36 second-semester Chemistry Education student enrolled in the Basic Chemistry 2 course during the 2024/2025 academic year at UIN Sunan Gunung Djati Bandung. Sampling was conducted using purposive sampling by selecting students who were present and met the inclusion criteria, namely having completed the prerequisite course Basic Chemistry 1, not having received material on electrolysis cells, and not having experience using the Nearpod media in the learning process.

Learning follows five stages based on the PBL model syntax: problem orientation, organizing students to learn, guiding group investigations, presenting results, and analyzing and evaluating the problem-solving process. During the learning process, Nearpod media supports it through the integration of videos and web content features, as well as other interactive features that encourage active student participation in the investigation and group discussion processes.

Data collection was conducted using three types of instruments that had been validated by three expert lecturers and tested prior to use in the research. Observation sheets were used to monitor and assess the implementation of problem-based learning. Worksheets were used to encourage active student participation and guide the process of investigation and problem-solving in groups with the assistance of Nearpod (Marthin et al., 2024). The written test consisted of 10 multiple-choice questions and two essay questions. The questions describe chemical representation ability, including macroscopic, submicroscopic, and symbolic representation, which are used to measure the improvement in students' representation ability before and after the treatment. The questions were analyzed using Anates software to assess their validity, difficulty level, discriminating power, and reliability, and the results showed that all questions were deemed suitable for use.

Data analysis was performed using descriptive and inferential statistical techniques. The percentage of student activity was calculated from the observation results and grouped into five categories of performance (ranging from very good to very poor). The scores on the student worksheets were analyzed quantitatively to measure problem-solving skills and the development of chemical representation ability, with grouping based on predetermined value intervals. The pretest and posttest data were tested for normality using the Shapiro-Wilk test with SPSS software. The normality test result indicate that the data are not normally distributed (<0.05). Therefore, the Wilcoxon test was used to determine the significant difference between the pretest and posttest results. If the significance value is <0.05, H_0 is rejected, and H_a is accepted, but if the significance value is >0.05, H_0 is accepted, and H_a is rejected. After that, N-Gain analysis was used to measure the increase in improvement in chemical representation ability. The N-Gain value was obtained by comparing the difference between the posttest and pretest scores and then dividing it by the maximum scores and the pretest scores. The interpretation of the N-Gain test results is based on the criteria presented in Table 1.

Table 1. Interpretation of N-Gain (Sundayana, 2016)

N-Gain Score	Category
$G < 0.3$	Low
$0.3 \leq G \leq 0.7$	Medium
$G > 0.7$	High

3. Result and Discussion

In the preliminary stage of the learning process, students were given questions that linked the material on electrolysis cells to everyday phenomena, such as the application of metal coating and purification, to stimulate their curiosity and establish an initial connection between the concept of electrolysis cells and its application in the real world. After that, students took a pretest and received an initial explanation of the basic concepts of electrolysis cells. Next, students are divided into small groups to discuss and work on problem-based experiment worksheets with assistance from Nearpod. This media provides interactive features such as web content that inserts interactive electrolysis simulations from the Pearson Education website, open-ended questions, draw it, and learning videos that support the visualization of chemical representations. In addition, Nearpod encourages active student engagement during learning (Paramita, 2023). In addition to presenting information in audio-visual form, students also actively test and apply their understanding in solving contextual problems through simulations and are encouraged to develop and use their chemical representation ability to analyze problems, which is expected to positively impact improving their chemical representation ability. An example of a simulation display through the web content feature of the Nearpod media is shown in Figure 1

Figure 1. Web Content Display of Electrolysis Simulation on Nearpod

Additionally, other interactive features used in this study are illustrated in the figure below.

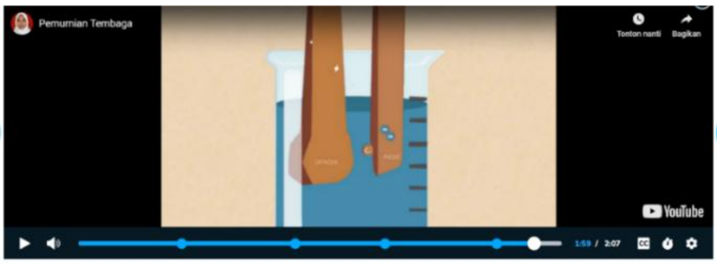

Figure 2. Nearpod Video About Copper Purification

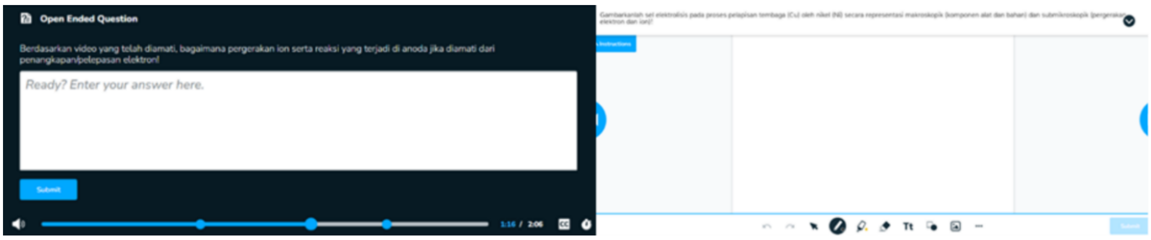

Figure 3. Open-Ended Question and Draw It Features on Nearpod

3.1. Students' Ability in Completing Problem-Based Worksheets and Student Activities during Learning

The student worksheets used in this study were experimental worksheets based on the PBL model stages. These worksheets contained questions on developing chemical representation ability in electrolysis cell material. The worksheets were completed in groups of six to seven students. The worksheet is structured according to the PBL syntax, which consists of five stages: problem orientation, organizing students for learning, guiding group investigation, presenting results, and analyzing and evaluating the problem-solving process.

The first stage is problem orientation, where students are instructed to observe images and read texts regarding electroplating and metal purification presented in the worksheet. The problems given at this stage can attract students' attention, facilitate their understanding of electrolysis cells, and help them formulate solutions to the problems given. This aligns with the research by Tambunan et al. (2024), which found that the problem orientation stage in the PBL model can increase students' interest and motivate them to be more active in the problem-solving process. Student activities during the problem orientation stage can be seen in Figure 4.

Figure 4. Student Activities during the Problem Orientation Stage

The second stage was to organize students to learn. Students were instructed to develop central ideas, formulate problems, and make hypotheses based on the discourse presented. The average score obtained at this stage was 88.88, which was interpreted as very good. These results indicate that students could identify problems and formulate hypotheses relevant to the discourse. Most groups could answer according to the relevant formulations and hypotheses regarding the factors that affect metal plating and purification.

The third stage is guiding group investigations. At this stage, students are instructed to conduct simulations using Nearpod to encourage them to investigate problems in depth. The simulations conducted were on copper plating by nickel, copper purification, and nickel purification with variations in time and electric current. After that, students completed nine questions on the worksheet related to the simulations they conducted. The worksheet results showed that the average score or this stage was 88.26, which was a very good interpretation. This approach encourages active involvement and provides opportunities for students to hone, test, and develop critical thinking skill. These findings align with the research by Pohan & Rambe (2022), which indicates that implementing the PBL model can encourage students to critical thingking in problem-solving. The following activities of students during the group investigation guidance phase are shown in Figure 5, while examples of questions and answers provided by students can be seen in Figure 6.

Figure 5. Student Activities in the Group Investigation Guidance Stage

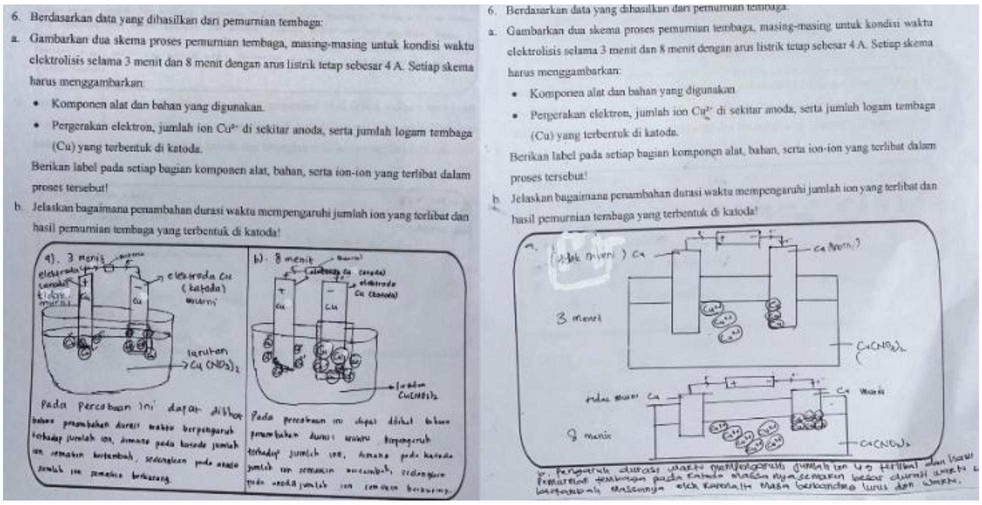

Figure 6. Sample Questions and Answers from Groups 3 and 6

Based on one of the sample questions and student answers, both groups gave fairly good answers. Students could describe the effect of adding time on the mass produced in the copper purification process, as indicated by the increased number of ions involved in the anode and cathode. The results indicate that most students could describe the copper purification process macroscopic through illustrations of the apparatus and submicroscopic by describing the ions involved in the process. This ability is evident from how students related changes in duration to increases in the number of ions at the electrodes, indicating the mass of metal formed during the purification process. These findings align with the results of Yusuf et al. (2024), which show that the longer the time used, the greater the thickness of the layer formed at the cathode. This is due to the increased number of ions formed on the cathode surface during the extended time.

The fourth stage is presenting the results, where students are instructed to present the simulation results and the work on the worksheet. The average group presentation score was 86.5, which was interpreted as very good. This achievement indicates that students can effectively communicate their understanding of the material through structured presentations supported by simulation results. These results align with Iftitahurrahimah et al., (2020) research, which shows that the effective implementation of the PBL model can enhance students' communication skills in presenting discussion outcomes. Student activities during the presentation of discussion outcomes can be observed in Figure 7.

Figure 7. Student Activities in the Discussion Results Presentation Stage

The fifth stage is analyzing and evaluating the problem-solving process, where students are instructed to draw conclusions based on the simulation results. The worksheet results in completing this stage, which obtained an average of 94.44. This achievement shows that students can draw conclusions based on the problem-solving process through simulation. This finding is consistent with the research Simangunsong et al. (2023), which shows that applying the PBL model through an in-depth investigation and evaluation process can enhance students' conceptual understanding and problem-solving skills.

Thus, the average score for student worksheet completion across all stages of PBL was 89.52, with all stages receiving a very good interpretation. This finding reflects the important role of interactive media such as Nearpod in visualizing chemical representations and encouraging active student engagement during the learning process. Table 2 recapitulates problem-based worksheet assessments.

Table 2. Recapitulation of Problem-Based Learning Worksheet Assessment

No	Learning Stages	Average Score	Interpretation
1	Organizing for Learning	88.88	Very good
2	Guiding Individual and Group Investigations	88.26	Very good
3	Presenting the Results	86.5	Very good
4	Analyzing and Evaluating Problem-Solving Processes	94.44	Very good
	Mean	89.52	Very good

The results obtained from the worksheet aligned with the student’s activities during learning using the PBL model. Two observers used observation sheets to observe the implementation of student activities during PBL assisted by Nearpod. Figure 8 visualizes the data from observing of student activities based on the PBL stages.

.

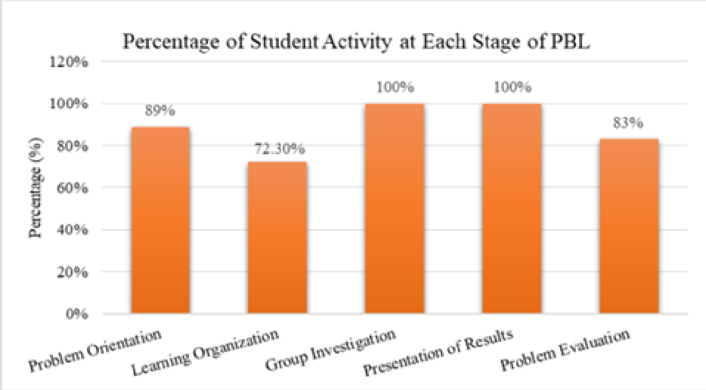

Figure 8. Percentage of Student Activity Based on PBL Stages

Based on the graph above, the highest participation occurred in the stage of guiding group investigations (100%) and presenting results (100%). This was followed by student orientation to the problem (89%) and evaluation of the problem-solving process (83%). The high level of student activity in this finding indicates active involvement and good cooperation in completing the Nearpod-assisted worksheet. This finding is in line with the research by Nurlatipah et al. (2025), which states that using Nearpod in the learning process using the PBL model has been proven to increase active involvement, improve understanding, develop critical thinking skills, and enhance learning effectiveness. The lowest participation was observed in the stage of organizing students for learning (72.33%), which still falls within the good category. This is attributed to insufficient collaboration and the reliance of some students on specific group members to identify key ideas and formulate problems and hypotheses.

However, the average percentage of student activity in all stages of PBL was 88.86%, which is interpreted as very good. This finding shows that the results obtained in the worksheet assignment align with student activity during PBL assisted by Nearpod. This active involvement allows students to more easily build a comprehensive understanding of concepts through visualization, exploration, and discussion, thereby positively impacting the development of their chemical representation ability. This aligns with the research by Kasanah & Ardhana (2024), which shows that PBL learning using worksheets effectively develops students' chemical representation ability.

3.2. Impact on Chemical Representation Ability

The improvement in chemical representation ability was observed from the data obtained from the pretest and posttest. The results of data analysis using the Shapiro-Wilk normality test showed that the data were not normally distributed ($p < 0.05$), as shown in Table 3.

Table 3. Normality Test Result

	Shapiro-Wilk		
	Statistic	**df**	**Significance**
Pre-test	0.871	36	< 0.001
Post-test	0.955	36	0.145

Based on the results, the data were not normally distributed. Therefore, the analysis was continued using the Wilcoxon test. The Wilcoxon test results showed a significant difference between the pretest and posttest scores ($Z = -5.237$, $p < 0.001$), indicating an increase in students' chemical representation ability after the implementation of the PBL model assisted by Nearpod on electrolysis cell material. The Wilcoxon test results are presented in Table 4.

Table 4. Wilcoxon Test Results

Statistical Test	Z	Significance
Wilcoxon	-5.237	< 0.001

Further analysis of this improvement was conducted by calculating N-Gain, which resulted in an average of 0.68 (medium category). Students were grouped into three categories based on their Basic Chemistry 1 scores (high, medium, and low). The results of the improvement in chemical representation ability are shown in Table 5.

Table 5. Overall N-Gain Test Results

No	Achievement Group	Test		N-Gain Score	Interpretation
		Pre-test	Post-test		
1	High	24.67	75.96	0.67	Medium
2	Medium	20.77	74.02	0.66	Medium
3	Low	23.29	77.26	0.71	High
	Mean	22.91	75.74	0.68	Medium

The data above shows that the implementation of the PBL model assisted by Nearpod has a positive impact on improving students' chemical representation ability, with an average medium improvement category in electrolysis cell material. This finding aligns with the research by Ahmad et al. (2021) and Ilahi et al. (2022), which shows that interactive media, such as animation and simulation effectively improve students' chemical representation ability. In addition, research by Kasanah & Ardhana (2024) states that applying the PBL model can develop chemical representation ability compared to conventional learning models.

Unlike previous studies, this study specifically highlights the improvement of students' chemical representation ability through the implementation of the PBL model assisted by Nearpod on electrolysis cell material. In addition, it adds analysis of macroscopic, submicroscopic, and symbolic representations. The integration of Nearpod in learning not only increases student engagement but also provides visualizations that support chemical representation ability. Nearpod interactive features, such as simulations, animated videos, and quizzes, help students understand the electrolysis cell process from real phenomena to explanations at the particle and chemical symbol levels. Thus, students' chemical representation ability can develop optimally compared to conventional learning not supported by technology. This finding aligns with the research by Farida et al. (2017), which states that interactive media such as animations, images, and simulations can facilitate the development of chemical representation ability.

3.3. The Improvement Based on Test Indicators and Chemical Representation

The improvement in students' chemical representation after the implementation of the PBL model assisted by Nearpod on electrolysis cell material can be analyzed based on the N-Gain value for each test indicator. There are two test indicators that combine two representations, macroscopic and submicroscopic. The first indicator involves analyzing the results of the electrolysis experiment and describing the movement of electrons and ions based on the presented data, showing an improvement in the high category with an N-Gain value of 0.98. This can be attributed to the learning process where students conducted simulations and watched animated videos of the electrolysis experiment in Nearpod, which visualized the macroscopic and submicroscopic representations in the form of experimental apparatus and the movement of electrons and ions.

The second indicator in the combination of two representations, macroscopic and submicroscopic, is analyzing the images of the experimental apparatus and the differences in ions involved in the copper plating process by nickel, which is then re-plated with chromium, showing an increase, but in the low category with an N-Gain of 0.10. This finding indicates that some students are still unable to integrate the two representations, particularly in the submicroscopic representation, by analyzing the differences in the movement of the ions involved. This is consistent with the findings of Permatasari et al. (2022), who reported that many students face challenges in the submicroscopic representation when visualizing and interpreting particles such as ions and molecules.

The combination of two submicroscopic and symbolic representations consisting of one test indicator, namely describing the movement of electrons and ions and writing the redox reaction equation based on the picture presented, experienced an increase in the medium category with an N-Gain of 0.61. This shows that students have been able to combine two representations, namely submicroscopic and symbolic.

The combination of two representations, macroscopic and symbolic, consists of one test indicator, namely analyzing the product produced from the electrolysis experiment based on the standard reduction potential (E°) data presented, which experienced an increase in the high category with an N-Gain of 0.81. This shows that students have been able to combine two representations, namely macroscopic and symbolic. This finding aligns with the research by Sukmawati (2019), which found that most students were able to use the pattern of combining two representations, macroscopic and symbolic more effectively.

The combination of three representations, macroscopic, submicroscopic, and symbolic, consists of four test indicators. The first indicator analyzes the relationship between current, time, and mass of the substance formed at the cathode based on Faraday's law in the form of a picture, showing an increase but in the low category with an N-Gain of 0.21. This finding indicates that some students are still unable to integrate the three representations, particularly at the submicroscopic and symbolic levels, as students were instructed to select images based on the apparatus setup and the number of ions produced from Faraday's calculations. This is consistent with the findings Elvina & Latisma (2022), who reported that only 9% of students could understand the submicroscopic representation, which is still considered low.

The second indicator, in the combination of three representations, macroscopic, submicroscopic, and symbolic, is analyzing the results of the electrolysis experiment based on the data presented, which showed an increase in the high category with an N-Gain of 1.00. This finding indicates that students have been able to combine the three levels of representation. This ability is evident from the students' answers, which write down the redox reactions that occur symbolic and describe the movement of ions and electrons at the submicroscopic level and relate them to the macroscopic phenomena observed based on the data. This is because the implementation of the PBL model assisted by Nearpod, which presents animated videos and interactive quizzes, helps increase student engagement in developing chemical representation ability in electrolysis cell material. This finding is in line with the research Utari et al. (2017), which shows that interactive animation media based on chemical representation effectively improves students' chemical representation ability.

The third indicator in the combination of three macroscopic, submicroscopic, and symbolic representations is analyzing images of the components of tools and materials used, describing the movement of ions and electrons, and writing down the redox reactions that occur based on the images presented, showing moderate improvement with an N-Gain of 0.64. The fourth indicator involves analyzing electrolysis experiment data, with students instructed to describe the components of the apparatus and materials at the macroscopic level, the movement of electrons and ions at the submicroscopic level, and to write down the redox reactions that occur symbolic, showing an improvement in the high category with an N-Gain of 0.72. This may have occurred because, during the learning process, students conducted simulations and watched animated videos of electrolysis experiments in Nearpod, which visualized macroscopic, submicroscopic, and symbolic representations. This finding indicates that students could integrate the three levels of representation coherently when the questions began with macroscopic representation, followed by submicroscopic, and finally, symbolic representation. This is consistent with the research Safitri et al. (2019), which found that students could integrate the three levels of representation coherently when the question pattern started with macroscopic representation, followed by submicroscopic, and finally, symbolic representation.

In symbolic representation, there is one test indicator, namely the application of the concept of electrolysis to calculations based on the presented data, which shows an increase in the high category with an N-Gain of 0.77. This increase may have occurred because, during the learning process, students conducted simulations on Nearpod media, which generated experimental data, and were then instructed to apply it to calculations included in symbolic representation. This finding aligns with other studies, which indicate that the use of interactive simulation and animation-based media, such as Nearpod, can help students visualize abstract chemical concepts, thereby enhancing their conceptual understanding and chemical representation ability (Ahmad et al., 2021; Lin & Wu, 2021). After analyzing the data based on test indicators, improvements in ability at each level of chemical representation are evident from the average N-Gain scores shown in Figure 9.

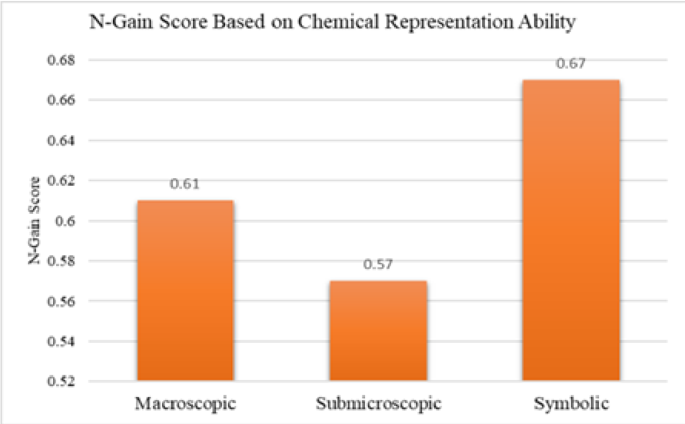

Figure 9. N-Gain Score Based on Chemical Representation Ability

Based on the graph above, the highest increase was in symbolic representation ability, followed by macroscopic representation, and finally submicroscopic representation. Overall, the increase in all three levels of representation was in the medium category. These findings reinforce that the integration of PBL model assisted by Nearpod not only encourages active learning but is also effective in improving students' chemical representation ability.

4. Conclusion

This study shows that integrating the PBL model assisted by Nearpod significantly improves students' chemical representation ability, trains critical thinking skills in problem-solving, and active involvement in learning electrolysis cell material. The improvement in representation ability can be seen from the N-Gain value, which is 0.68 (medium category). Learning activities were carried out very good, with a percentage of 88.86%, and students' ability to complete worksheets showed very good results, with an average score of 89.52. These findings indicate that combining the PBL model with interactive digital media such as Nearpod can be an effective solution to help students understand abstract chemical concepts through visualizations that support chemical representation. This study also contributes to developing digital technology-based chemistry learning in higher education.

5. References

Ahmad, N. J., Yakob, N., Bunyamin, M. A., Winarwo, N., & W, H, Akmal. (2021). The Effect of Interactive Computer Animation and Simulation on Students' Achievement and Motivation in Learning Electrochemistry. *Jurnal Pendidikan IPA Indonesia*, *10*(3), 311–324. https://doi.org/DOI: 10.15294/jpii.v10i3.26013

Anwar, D. M., Subarkah, C. Z., & Sukmawardani, Y. (2024). Analysis Of Student Misconceptions On Atomic, Molecular, and Ionic Matter: The Foundation of Developing Augmented Reality As An Innovative Solution. *SPIN Jurnal Kimia & Pendidikan Kimia*, *6*(1), 72–82. https://doi.org/https://doi.org/10.20414/spin.v6i1.9487

Arsani, I. A. A., Setyosari, P., Kuswandi, D., & Dasna, W. (2020). Problem-Based Learning

Strategies Using Multiple Representations and Learning Styles to Enchance Conceptual Understandings Of Chemistry. *Periódico Tchê Química*, *17*(35), 860–876. https://doi.org/DOI: 10.52571/PTQ.v17.n35.2020.72_ARSANI_pgs_860_876.pdf

Aryani, P. I., Patmawati, H., & Santika, S. (2023). Penerapan Nearpod Sebagai Media Pembelajaran Interaktif Berbasis Web. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *7*(3), 2966–2976. https://doi.org/https://doi.org/10.31004/cendekia.v7i3.1349

Azzajjad, F. M., Ahmar, D. S., & Syahrir, M. (2020). The Effect of Animation Media in Discovery Learning Model on Students' Representation Ability on Chemical Equilibrium Materials. *Journal of Applied Science, Engineering, Technology, and Education*, *2*(2), 204–209. https://doi.org/https://doi.org/10.35877/454RI.asci22125

Elvina, A., & Latisma, D. (2022). Deskripsi Pemahaman Multirepresentasi Kimia Siswa pada Materi Larutan Elektrolit dan Non Elektrolit. *Orbital: Jurnal Pendidikan Kimia*, *6*(1), 1–15. https://doi.org/10.19109/ojpk.v6i1.12009

Farida, I., Liliasari, L., Sopandi, W., & Widyantoro, D. H. (2017). A web-based model to enhance competency in the interconnection of multiple levels of representation for pre-service teachers. In *Ideas for 21st Century Education* (pp. 359–362). Routledge. https://doi.org/10.1201/9781315166575-84

Feri, A., & Zulherman. (2021). Development of nearpod-based e module on science material "energy and its changes" to improve elementary school student learning achievement. *International Journal of Education and Learning*, *2*(1), 165–174. https://doi.org/https://doi.org/10.31763/ijele.v3i2.400

Graham, C. R., Danaa, G., Purevsuren, T., Martinez, A., Spricigo, C. B., Camilotti, B. M., & Batsukh, T. (2023). Digital Learning Transformation in Higher Education: International Cases of University Efforts to Evaluate and Improve Blended Teaching Readiness. *Education Science*, *13*(11), 2–19. https://doi.org/https://doi.org/10.3390/educsci13111143

Iftitahurrahimah, Andayani, Y., & Al Idrus, S. W. (2020). Pengaruh Model Problem Based Learning (PBL) Terhadap Kemampuan Komunikasi Siswa Materi Pokok Larutan Elektrolit Dan Non-Elektrolit. *Jurnal Pijar MIPA*, *15*(1), 7–12. https://doi.org/http://dx.doi.org/10.29303/jpm.v15i1.1289

Ilahi, A. K., Subarkah, C. Z., & Sukmawardani, Y. (2022). Penerapan Media Pembelajaran Laboratorium Virtual untuk Meningkatkan Kemampuan Representasi Kimia pada Materi Sel Elektrolisis. *Prosiding Seminar Nasional Kimia*, *7*, 25–37.

Kasanah, I. D., & Ardhana, I. A. (2024). The Effect of Problem-Based Learning Model on Multiple Representations Ability of XI-Grade Student on Acid-Based Topic. *UNESA Journal of Chemical Education*, *13*(1), 25–29. https://doi.org/https://doi.org/10.26740/ujced.v13n1.p25-29

Lin, C.-Y., & Wu, H. (2021). Effects of different ways of using visualizations on high school students' electrochemistry conceptual understanding and motivation towards chemistry learning. *Chemistry Education Research and Practice*, *22*, 786–801. https://doi.org/http://dx.doi.org/10.1039/D0RP00308E

Marthin, F. E., Oktavia, B., Hardeli, & Kurniawati, D. (2024). Development of Problem-Based Learning Student Worksheet Integrated with Ethnoscience on Acid-Base Material. *JPPIPA: Jurnal Penelitian Pendidikan IPA*, *10*(7), 3886–3893.

https://doi.org/https://doi.org/10.29303/jppipa.v10i7.7930
Mejia, A. R., & Padilla, K. (2025). A Problem-Based Learning Electrochemistry Course for Undergraduate Students to Develop Complex Thinking. *Education Science*, *15*(3), 320. https://doi.org/https://doi.org/10.3390/educsci15030320
Mujibaturrahmi, Winarni, S., & Hanum, L. (2022). Patterns of Students' Macroscopic, Submicroscopic, and Symbolic Representation Ability in Acid-Based Topic. *EduChemia: Jurnal Kimia Dan Pendidikan*, *7*(2). https://doi.org/http://dx.doi.org/10.30870/educhemia.v7i2.14250
Naumoska, A., Rusevska, K., Blazhevska, A., & Stojanovska, M. (2022). Nearpod as a tool for increasing students' motivation for learning chemistry. *International Journal of Education and Learning*, *4*(1), 89–99. https://doi.org/10.31763/ijele.v4i1.616
Nurhayati, A. D., Ayuningtyas, P. L., & Yuliasari, H. (2021). Peningkatan Collaboration Skills dalam Kegiatan Praktikum Fisika Dasar Mahasiswa Program Studi Teknologi Pangan UNU Purmokerto. *EduMatSains : Jurnal Pendidikan, Matematika Dan Sains*, *5*(2), 211–224. https://doi.org/https://doi.org/10.33541/edumatsains.v5i2.2237
Nurlatipah, D. D., Windayani, N., Sari, & Sukmawardani, Y. (2025). Enhancing Cognitive Learning Outcomes On Carboxylic Acids Through Nearpod-Assisted Problem-Based Learning: A Study In Organic Chemistry Course. *Chemica Didactica Acta: Journal of Chemistry & Chemistry Education*, *13*(1), 54–65. https://doi.org/https://doi.org/10.24815/jcd.v13i1.46010
Nursaya'bani, K. K., Falasifah, F., & Iskandar, S. (2025). Strategi pengembangan Pembelajaran Abad Ke-21: Mengintegrasikan Kreativitas, Kolaborasi, dan Teknologi. *JIIP (Jurnal Ilmiah Ilmu Pendidikan)*, *8*(1), 109–116. https://doi.org/https://doi.org/10.54371/jiip.v8i1.6470
Paramita, P. E. (2023). Exploring Student Perceptions and Experiences of Nearpod: A Qualitative Study. *Journal on Education*, *5*(4), 17560–17570. https://doi.org/https://doi.org/10.31004/joe.v5i4.4249
Permatasari, M. B., Rahayu, S., & Dasna, I. W. (2022). Chemistry Learning Using Multiple Representations: A Systematic Literature Review. *Journal of Science Learning*, *5*(2), 334–341. https://doi.org/https://doi.org/10.17509/jsl.v5i2.42656
Pohan, R. F., & Rambe, M. R. (2022). Penerapan Model Pembelajaran Problem Based Learning (PBL) dalam Kimia Teknik untuk Meningkatkan Kemampuan Berpikir Kritis Mahasiswa Prodi Teknik Sipil Fakultas Teknik UGN Padangsidimpuan Tahun Akademik 2020/2021. *JagoMIPA: Jurnal Pendidikan Matematika Dan IPA*, *2*(1), 14–25. https://doi.org/https://doi.org/10.53299/jagomipa.v2i1.138
Safitri, C. N., Nursa'adah, E., & Wijayanti, I. E. (2019). Analisis Multiple Representasi Kimia Siswa Pada Konsep Laju Reaksi. *EduChemia: Jurnal Kimia Dan Pendidikan*, *4*(1), 1–12. https://doi.org/https://dx.doi.org/10.30870/educhemia.v4i1.5023
Septiyanti, R., Subarkah, C. Z., Helsy, I., & Irwansyah, F. S. (2021). Chemical representation ability with application of CORE (chemical observations, representations, and experimentation) learning model on chemical equilibrium material online learning. *Education of Science, Technology, Engineering, and Mathematics Internasional Conference (ESTEMIC)*, 1–6. https://doi.org/https://doi.org/10.1063/5.0119097
Setiawan, A. (2021). Problem Based Learning (PBL) Model For The 21st Century Generation. *Social, Humanities, and Educational Studies (SHES): Conference Series*, *4*(6), 290–

296. https://doi.org/https://doi.org/10.20961/shes.v4i6.68457

Simangunsong, I. T., Jelita, P., & Panggabean, D. D. (2023). Problem Based Learning Terhadap Penguasaan Konsep dan Kemampuan Pemecahan Masalah Mahasiswa. *Natural Science: Jurnal Penelitian Bidang IPA Dan Pendidikan IPA*, *9*(2), 156–166. https://doi.org/https://doi.org/10.15548/nsc.v9i2.5805

Sugiyono. (2017). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*. Alfabeta.

Sukmawati, W. (2019). Analisis level makroskopis, mikroskopis dan simbolik mahasiswa dalam memahami elektrokimia. *Jurnal Inovasi Pendidikan IPA*, *5*(2), 195–204. https://doi.org/10.21831/jipi.v5i2.27517

Sunarya, R. R., Hijriansyah, R., Aisyah, R., & Purliantoro, D. (2024). Implementation of problem solving-based electron configuration e-modules to improve student learning outcomes. *Jurnal Pendidikan Kimia Indonesia*, *8*(1), 11–20. https://doi.org/https://doi.org/10.23887/jpki.v8i1.70029

Sundayana, R. (2016). *Statistika Penelitian Pendidikan*. ALFABETA.

Tambunan, S. M., Purba, J., & Panggabean, F. T. M. (2024). The Influence of Problem Based Learning and Media to Increase Student Interest and Learning Outcomes. *Jurnal Inovasi Pembelajaran Kimia*, *6*(1), 120–129. https://doi.org/10.24114/jipk.v6i1.57337

Utari, D., Fadiawati, N., & Tania, L. (2017). Kemampuan Representasi Siswa pada Materi Kesetimbangan Kimia Menggunakan Animasi Berbasis Representasi Kimia. *Jurnal Pendidikan Dan Pembelajaran Kimia*, *6*(3), 414–426.

Yusuf, A., Alijrih, F. A., Sabri, A. A., & Gibran, S. O. (2024). Pengaruh Waktu Dalam Proses Electroplating Dengan Pelapisan Kuningan Terhadap Ketebalan dan Ketahanan Baja Karbon. *Jurnal Ilmu Teknik*, *1*, 193–199. https://doi.org/http://dx.doi.org/10.62017/tektonik