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Implementation of the Prediction, Observation, Explanation, Elaboration, Write, Evaluation (POE2WE) Learning Model to Improve Students' Critical Thinking Skills on the Topic of Salt Hydrolysis

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Abstract

Students' persistently low critical thinking skills in chemistry are particularly consequential for salt hydrolysis, which requires conceptual analysis, scientific reasoning, and logical problem-solving. This study examined the effectiveness of the Prediction, Observation, Explanation, Elaboration, Write, and Evaluation (POE2WE) learning model in improving Grade XI students' critical thinking skills at SMAN 1 Koto Kampar Hulu. An experimental method with a randomized control group pretest–posttest design was employed. The sample comprised 60 students: 30 students from Class XI.3 as the experimental group and 30 from Class XI.4 as the control group. The experimental group received instruction through the POE2WE model, whereas the control group was taught using a deep learning approach. Data were collected using pretest and posttest measures of critical thinking skills and analyzed through normality and homogeneity tests, gain analysis, and a t-test. The experimental group achieved a higher mean score improvement than the control group (44.17 vs. 37.67). The t-test yielded a calculated value of 2.564, exceeding the critical value of 2.001 at $\alpha = .05$. Moreover, the experimental group obtained an N-gain of 0.82, categorized as high, whereas the control group achieved an N-gain of 0.61, categorized as moderate. These findings demonstrate that the POE2WE model effectively improves students' critical thinking skills in learning salt hydrolysis. The improvement was supported by students' active engagement throughout the predicting, observing, explaining, elaborating, writing, and evaluating stages.

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This study provides empirical support for adopting POE2WE as an instructional model to strengthen critical thinking in chemistry education.

Keywords: Chemistry Education; Critical Thinking Skills; POE2WE Learning Model; Salt Hydrolysis; Student Engagement

INTRODUCTION

Advancements in science and technology require education systems to produce students capable of applying knowledge analytically, rather than merely memorizing information (Putri, 2023). In the context of 21st-century learning, critical thinking is a crucial skill, as it encompasses analyzing information, evaluating evidence, providing reasoning, and making rational decisions (Aryani & Hadi, 2025). Instruction that fosters higher-order thinking skills aligns with the demands of the Kurikulum Merdeka (Independent Curriculum), which creates space for developing analytical and problem-solving abilities (Nurdianti & Kurino, 2026).

These issues are evident in chemistry instruction at SMA N 1 Koto Kampar Hulu. Pre-research interview results indicate that only 48% of students met the Learning Objective Mastery Criteria (KKTP) for the topic of salt hydrolysis, while 52% failed to reach the standard score of 80. Furthermore, students tend to provide brief answers, ask only basic questions, and lack fully developed, concept-based argumentation. This situation reflects the nature of the salt hydrolysis topic, which requires students to connect salt types, hydrolysis reactions, solution properties, and pH calculations.

Salt hydrolysis integrates conceptual understanding with calculations, thereby requiring reasoning skills that go beyond simple rote memorization. Research on developing critical thinking tests within the context of salt hydrolysis demonstrates that this topic can effectively measure specific sub-indicators of critical thinking and problem-solving (Setyawan & Patonah, 2022). Other studies on the same topic indicate that problem-based learning can enhance students' critical thinking skills and learning engagement (Syahana et al., 2023).

One relevant instructional model is POE2WE, which comprises Prediction, Observation, Explanation, Elaboration, Write, and Evaluation. The prediction stage encourages students to formulate initial hypotheses; observation provides evidence; explanation requires argumentation based on observational findings; elaboration extends the

application of concepts; writing facilitates written reflection; and evaluation reassesses understanding. This framework provides a structure for students to actively construct knowledge and develop critical thinking processes (Aritisna et al., 2026).

Previous research has reported the benefits of POE2WE for critical thinking; for instance, in PhET-assisted science instruction, it yielded an N-gain of 0.64 in the experimental group compared to 0.41 in the control group (Panggabean et al., 2023). Another study at the high school level also reported differences in critical thinking skills following the implementation of POE2WE compared to conventional instruction (Malik et al., 2022). However, the research underpinning this article specifically applies POE2WE to the topic of salt hydrolysis at SMA N 1 Koto Kampar Hulu, measuring improvement via pretest-posttest differences and N-gain. This specific focus constitutes the study's contextual novelty.

Theoretically, this research is grounded in the constructivist view that students build understanding through experience, the testing of ideas, and reflection. The stages of POE2WE provide these experiences sequentially, thereby aligning with the requirements of the salt hydrolysis topic and the development of critical thinking skills. This study aims to determine the improvement in students' critical thinking skills through the implementation of POE2WE and to categorize the level of improvement regarding the topic of salt hydrolysis.

METHODS

This study employs a quantitative approach using an experimental method with a randomized control group pretest-posttest design. It was conducted at SMA N 1 Koto Kampar Hulu during the 2025/2026 academic year, spanning from December 2025 to June 2026 and encompassing stages such as preparation, instructional implementation, data processing, and reporting. The instructional treatment for the two sample classes involved three sessions covering the topic of salt hydrolysis.

The study population consisted of all Grade XI students at SMA N 1 Koto Kampar Hulu for the 2025/2026 academic year, comprising classes XI.1, XI.2, XI.3, and XI.4. Samples were selected from classes demonstrating equivalent initial proficiency based on prerequisite tests; subsequently, the experimental and control classes were assigned randomly using a spin wheel. Class XI.3 was designated as the experimental class and XI.4 as the control class, with each consisting of 30 students.

Data were collected using a critical thinking skills test comprising a pretest and a posttest of 20 items developed based on Robert Ennis's critical thinking indicators and aligned with the learning outcomes for salt hydrolysis. The instructional materials utilized included teaching modules, student worksheets (LKM), teaching aids, instructional media, and evaluation questions. The student worksheets were developed by the researcher and validated by the supervising lecturer prior to use.

The research process began with administering a pretest to the population classes to assess initial proficiency and select the sample classes. Following normality and homogeneity testing, two classes meeting the criteria were selected and randomly assigned as the experimental and control groups. The experimental group received instruction using the POE2WE model, while the control group received instruction without the POE2WE model. After three sessions, both groups took a posttest featuring the same questions to measure improvements in critical thinking skills (Hasibuan et al., 2026).

Data analysis was conducted using descriptive and inferential statistics. Normality was assessed using the Lilliefors test, homogeneity was tested to ensure the equality of variances, and hypothesis testing was conducted using a right-tailed t-test at a significance level of 0.05 (Mubarok et al., 2020). Improvements in critical thinking skills were also calculated using the N-gain to determine the category of improvement.

RESULTS

Testing of the research data can be conducted once the prerequisite analysis tests specifically normality, homogeneity, and hypothesis tests have been performed.

Table 1. Normality Test Results

Class	N	Mean	S	Lmax	Ltable
XI.3 (Experimental)	30	39.17	13.070	0.0608	0.161
XI.4 (Control)	30	39.00	11.173	0.1231	0.161

Source: Processed data, 2026

Table 1. The normality test results indicate that the pretest scores for classes XI.3 and XI.4 are normally distributed. The Lmax values were 0.0608 for class XI.3 and 0.1231 for class XI.4, while the Ltable value was 0.161. Thus, both classes meet the normality prerequisite.

Table 2. Homogeneity Test Results

Class	N	Fcalculated	Ftable	Note
XI.3	30	1.36	1.86	Homogeneous
XI.4	30	1.36	1.86	Homogeneous

Source: Processed data, 2026

Table 2, showing the results of the homogeneity test, indicates that the calculated Fvalue (1.36) is lower than the Ftable value (1.86). These results demonstrate that the variances of both classes are homogeneous, allowing them to be used as research samples.

Table 3. Comparison of Mean Pretest, Posttest, and Score Differences

Class	N	Pretest	Posttest	Difference
Experimental (XI.3)	30	39.16	89.16	44.17
Control (XI.4)	30	38.66	76.33	37.67

Source: Processed data, 2026

Following the treatment, the experimental class's average score rose from 39.16 on the pretest to 89.16 on the posttest. In the control class, the average score increased from 38.66 on the pretest to 76.33. The mean increase was 44.17 for the experimental class and 37.67 for the control class.

Table 4. Normality Test Results for Pretest-Posttest Difference Scores

Class	N	L-Max	L-Table	Difference	Note
Experimental (XI.3)	30	0.1297	0.161	9.199	Normally Distributed
Control (XI.4)	30	0.1076	0.161	1.104	Normally Distributed

Source: Processed data, 2026

Based on Table 4, which presents the normality test results for the pretest-posttest difference scores, the data for both the experimental and control classes were found to be normally distributed. For the experimental class (XI.3), comprising 30 students, the calculated Lmax value was 0.1297, while the Ltable value at the applied significance level was 0.161. Since Lmax (0.1297) < Ltable (0.161), the pretest-posttest difference score data for the experimental class is considered normally distributed.

For the control class (XI.4), also comprising 30 students, the calculated Lmax value was 0.1076, while the Ltable value was 0.161. Since Lmax (0.1076) < Ltable (0.161), the pretest-posttest difference score data for the control class is also considered normally distributed. Thus, it can be concluded that the pretest-posttest difference score data for both the experimental and control classes are normally distributed, thereby satisfying one of the prerequisites for conducting parametric statistical analysis in the subsequent stage.

Table 5. Hypothesis Test Results for the Improvement of Critical Thinking Skills

Class	N	Mean difference	S	tcalculated	ttable
Experimental	30	44.17	9.818	2.564	2.001
Control	30	37.67	11.043	2.564	2.001

Source: Processed data, 2026

Based on Table 5, the hypothesis test results indicate a difference in the improvement of critical thinking skills between the experimental class and the control class. In the experimental class, which consisted of 30 students, the mean difference between pretest and posttest scores was 44.17, with a standard deviation (S) of 9.818. Meanwhile, in the control class, which also consisted of 30 students, the mean difference was 37.67, with a standard deviation of 11.043.

The calculation results show a calculated tcount of 2.564, whereas the critical t-value ttable is 2.001. Since tcount (2.564) > ttable (2.001), the null hypothesis H_0 is rejected and the alternative hypothesis H_a is accepted. Thus, there is a difference in the improvement of critical thinking skills between students who underwent instruction using the POE2WE model and those in the control class. The mean score difference in the experimental class (44.17) was higher than that of the control class (37.67). This indicates that the improvement in students' critical thinking skills in the experimental class was greater than in the control class following the implementation of the POE2WE instructional model.

Table 6. Categories of Improvement in Critical Thinking Skills Based on N-Gain

Class	N	Pretest	Posttest	N-gain	Category
Experimental	30	39.16	89.16	0.82	High
Control	30	38.66	76.33	0.61	Medium

Source: Processed data, 2026

Based on Table 6, the N-gain calculation results indicate an improvement in students' critical thinking skills in both the experimental and control classes. In the experimental class, comprising 30 students, the mean pretest score was 39.16 and the mean posttest score was 89.16. The calculated N-gain value was 0.82, placing it in the high category. Meanwhile, in the control class of 30 students, the mean pretest score was 38.66 and the mean posttest score was 76.33. The resulting N-gain value was 0.61, falling into the medium category. These results show that the N-gain value for the experimental class (0.82) was higher than that of the control class (0.61). This indicates that the improvement in students' critical thinking skills in the class implementing the POE2WE learning model fell into the high category, whereas the improvement in the control class fell into the medium category. Thus, the

implementation of the POE2WE learning model resulted in a greater improvement in critical thinking skills compared to the instruction in the control class.

DISCUSSION

The research results indicate that the implementation of the Prediction, Observation, Explanation, Elaboration, Write, and Evaluation (POE2WE) learning model enhances students' critical thinking skills regarding the topic of salt hydrolysis. This is evident from the hypothesis test results, where the calculated tcount was 2.564, while the critical ttable was 2.001 at a 5% significance level. Since tcount exceeded ttable, the null hypothesis H_0 was rejected and the alternative hypothesis H_a was accepted. These results demonstrate a difference in the improvement of critical thinking skills between students taught using the POE2WE model and those taught without it. These findings confirm the research objective: that the POE2WE model can improve students' critical thinking skills in the context of salt hydrolysis.

The improvement is further supported by N-gain analysis. The experimental class achieved an average pretest score of 39.16, rising to 89.16 on the posttest, with an N-gain score of 0.82 (categorized as high). In contrast, the control class had an average pretest score of 38.66, increasing to 76.33 on the posttest, with an N-gain score of 0.61 (categorized as medium). This difference indicates that the improvement in critical thinking skills in the experimental class is evident not only in the higher posttest scores but also in the greater magnitude of improvement as reflected by the N-gain scores.

The sequence of POE2WE stages provides a learning experience that enables students to observe, analyze, explain, apply, write about, and evaluate the knowledge they have acquired. This explains why the improvement in critical thinking skills was greater in the experimental class than in the control class. Research by Novita et al., (2025) similarly shows that the POE2WE model positively influences students' critical thinking skills, as its instructional syntax fosters analytical, logical, and reflective thinking processes. Beyond test results, student engagement during the learning process also revealed differences between the experimental and control classes. Students in the experimental class appeared more active in making predictions, asking and answering questions, conducting observations, engaging in discussions, presenting discussion results, and responding to other groups' presentations. The results of the Student Worksheet (LKM) activities and evaluations across each session

also demonstrated improvement in class XI.3 during the implementation of the POE2WE model.

Conversely, in the control class where instruction followed a deep learning approach without the POE2WE model discussions tended to be dominated by a few active students. Other students were more passive, simply following the outcomes of the group discussions. This situation limited opportunities for students to express their opinions, respond to peers' arguments, and deepen their understanding through the discussion process. These findings align with research by Haryanti et al., (2024), which indicates that instruction lacking a structured model can result in lower student engagement during learning activities. The results are also consistent with previous studies demonstrating that the POE2WE model can foster critical thinking skills. Idrus et al., (2025) found that implementing the POE2WE model positively influenced critical thinking skills, as each instructional stage provided students with opportunities to engage in processes of reasoning and verification. These results support the current study's findings, which show a greater improvement in critical thinking skills in the experimental class compared to the control class.

The findings also align with research by Pitaloka et al., (2024), stating that the POE2WE model enhances critical thinking skills because its instructional stages encourage students to think analytically, present evidence-backed arguments, and draw logical conclusions. This parallel is evident in the activities of students in the experimental class, who did not merely receive information from the teacher but also conducted observations, discussed results, provided explanations, and evaluated learning outcomes. Research by Haryanti & Parwis, (2025) similarly demonstrates that the POE2WE model can improve critical thinking skills through student engagement in observing, analyzing, discussing, and evaluating learning outcomes. These findings reinforce the results of the current study, as the improvement in critical thinking skills within the experimental class was driven by active student participation at every stage of the POE2WE model.

Theoretically, the POE2WE stages are linked to the critical thinking processes employed in this study. In the Prediction stage, students are required to focus on the question at hand and formulate a hypothesis based on their existing knowledge (Laelawati et al., 2021). The Observation stage provides an opportunity to acquire and consider information based on observational findings (Sheppard, 2016). The Explanation stage encourages students to present arguments and provide reasons based on evidence (Masyhurah et al., 2026). The

Elaboration stage guides students to apply and connect concepts to other situations (Lestari et al., 2026). The Write stage helps students organize their thoughts systematically, while the Evaluation stage offers students the chance to reassess their understanding, arguments, and conclusions (Syafriani et al., 2025).

The research findings imply that the POE2WE learning model serves as a viable alternative for facilitating the development of students' critical thinking skills regarding the topic of salt hydrolysis. Implementing this model provides a clear instructional structure, ranging from making predictions to evaluating thought processes. This structure helps teachers guide students not only to understand concepts but also to utilize information and evidence in constructing knowledge. In practice, POE2WE can be implemented through group learning activities supported by student worksheets and simple observations or experiments. Such instruction creates space for students to express opinions, discuss observations, defend arguments, and formulate conclusions. During implementation, the teacher acts as a facilitator who poses guiding questions, moderates discussions, and ensures every student has the opportunity to participate.

The theoretical implications of this study indicate that instruction allowing students to engage in the processes of prediction, verification, explanation, application, writing, and evaluation can foster critical thinking skills. These findings also provide additional empirical evidence regarding the use of POE2WE in chemistry education, specifically for the topic of salt hydrolysis. However, the study has certain limitations that should be considered when interpreting the results. The research involved only two classes Class XI.3 as the experimental group and Class XI.4 as the control group, with 30 students in each. Therefore, the findings should be considered with caution if applied to different student groups or school settings.

CONCLUSION

The implementation of the POE2WE learning model regarding the topic of salt hydrolysis enhanced the critical thinking skills of Grade XI students at SMA N 1 Koto Kampar Hulu. The experimental class achieved an average posttest-pretest difference of 44.17, whereas the control class achieved 37.67; t-test results indicated that t-calculated (2.564) was greater than t-table (2.001). The N-gain score for the experimental class was 0.82 (high category), while the control class scored 0.61 (medium category). Thus, the research

findings demonstrate a difference in the improvement of critical thinking skills following instruction using the POE2WE model.

The study contributes empirical evidence regarding chemistry instruction on salt hydrolysis in secondary schools, specifically concerning the application of the POE2WE model to foster critical thinking skills. It also demonstrates that the stages of prediction, observation, explanation, elaboration, writing, and evaluation can be integrated into lessons requiring both conceptual connections and calculations. Future research should involve larger samples across multiple schools, extend the duration of the intervention, and employ instruments that measure thinking processes more comprehensively such as essay tests, argumentation rubrics, activity observations, and interviews.

REFERENCES

Al Idrus, S. W., Alamudi, F. Z., & Sofia, B. F. D. (2025). Pengaruh Model Pembelajaran POE2WE terhadap Kemampuan Berpikir Kritis Siswa Kelas XI SMAN 8 Mataram. *ANWARUL: Jurnal Pendidikan dan Dakwah, 5*(6), 933–944. https://doi.org/10.58578/anwarul.v5i6.8627

Aritisna, N. M. T. D., Ariawan, I. P. W., & Suparta, I. N. (2026). Implementasi Model Pembelajaran POE2WE untuk Meningkatkan Kemampuan Berpikir Kritis Siswa: Kajian Literatur Sistematik. *Imajiner: Jurnal Matematika dan Pendidikan Matematika, 8*(1), 33–40. https://doi.org/10.26877/imajiner.v8i1.25458

Aryani, I., & Hadi, M. S. (2025). Implementasi Gerakan Literasi di Sekolah Dasar: Implikasinya pada Kemampuan Berpikir Kritis Siswa Sekolah Dasar. *Jurnal Ilmiah Pendidikan Citra Bakti, 12*(2), 329–338. https://doi.org/10.38048/jipcb.v12i2.5116

Haryanti, A. S., Hidayat, S., Juansah, D. E., & Parwis, F. Y. (2024). The effect of the POE2WE model and students' critical thinking on the ability to write argumentations. *International Journal of Advanced and Applied Sciences, 11*(6), 237–244. https://doi.org/10.21833/ijaas.2024.06.025

Haryanti, A. S., & Parwis, F. Y. (2025). Implementation of the POE2WE learning model to improve critical thinking and report writing skills. *IJORER: International Journal of Recent Educational Research, 6*(6), 1868–1881. https://doi.org/10.46245/ijorer.v6i6.1016

Hasibuan, E. Y., Rasmiwetti, & Futra, D. (2026). Implementation of the POE2WE (Prediction, Observation, Explanation, Elaboration, Write, and Evaluation) learning model to improve understanding of chemical concepts regarding buffer solutions among Grade XI students at SMAN 2 Siak Hulu. *Journal of Multidisciplinary Science: MIKAILALSYS, 4*(3), 5416–5429. https://doi.org/10.58578/mikailalsys.v4i3.11796

Laelawati, M., Nana, & Sulistyaningsih, D. (2021). Analisis Model Blended POE2WE terhadap Keterampilan Proses Sains Siswa melalui Penggunaan Laboratorium Virtual pada Materi Dualisme Gelombang Partikel. *Jurnal Penelitian Pembelajaran Fisika, 12*(1), 83–89. https://doi.org/10.26877/jp2f.v12i1.7162

Lestari, F., Irvani, A. I., & Walriani. (2026). Analysis of the effectiveness of POE2WE model assisted by physics simulations in improving students' problem solving skills. *Omega:*

Jurnal Fisika dan Pendidikan Fisika, 10(2), 15–22. https://doi.org/10.22236/omega.v10i2.15804

Malik, A., Karmini, S. M., Agustina, R. D., & Nugraha, A. R. (2022). Comparison of the POE2WE model's effectiveness with the 5M scientific approach to problem-solving ability in simple harmonic motion. *EDUSAINS, 14*(2), 126–136. https://doi.org/10.15408/es.v14i2.28589

Masyhurah, D., Azhar, & Nor, M. (2026). The implementation of the POE2WE learning model assisted by PhET simulation to improve conceptual understanding of Grade XI students at SMAN 1 Bukit Batu. *JIPSI: Jurnal Ilmu Pendidikan dan Sains Islam Interdisipliner, 5*(2), 1–14. https://doi.org/10.59944/jipsi.v5i2.651

Mubarok, I., Nana, & Sulistyaningsih, D. (2020). Analisis Penerapan Model Pembelajaran POE2WE Berbasis Hands on Activity terhadap Kemampuan Berpikir Kritis Siswa. *EduFisika: Jurnal Pendidikan Fisika, 5*(2), 104–111. https://doi.org/10.22437/edufisika.v5i02.10804

Nurdianti, P., & Kurino, Y. D. (2026). Implementasi Kurikulum Merdeka Deep Learning melalui Model Problem Based Learning terhadap Berpikir Tingkat Tinggi. *Journal of Pedagogical Perspectives in Education, 1*(3), 355–368. https://doi.org/10.65634/j-ppe.v1i3.97

Nurdiyati, Novita, M., & Patonah, S. (2025). Analisis Keterampilan Berpikir Kritis Siswa dalam Pengembangan Modul Ajar Berdiferensiasi Berorientasi Education for Sustainable Development pada Materi Green Chemistry. *Didaktika: Jurnal Kependidikan, 14*(1), 167–178. https://doi.org/10.58230/27454312.1665

Panggabean, D. D., Naibaho, G. D. M., & Simangunsong, I. T. (2023). Improving students' concept with POE2WE learning model assisted by PhET Android simulation. *Jurnal Penelitian Pendidikan IPA, 9*(5), 2619–2624. https://doi.org/10.29303/jppipa.v9i5.2892

Pitaloka, N. A., Inayah, N., Huda, M. N., Setyawati, M., & Indratno, D. (2024). Fostering critical thinking skills and scientific epistemological beliefs through flipbook-assisted POE2WE. *Journal of Natural Science and Integration, 7*(2), 325–336. https://doi.org/10.24014/jnsi.v7i2.32666

Putri, R. A. (2023). Pengaruh Teknologi dalam Perubahan Pembelajaran di Era Digital. *Journal of Computers and Digital Business, 2*(3), 105–111. https://doi.org/10.56427/jcbd.v2i3.233

Setyawan, J., & Patonah, S. (2022). Profil Kemampuan Berpikir Kritis Siswa pada Pokok Bahasan Senyawa Karbon Kelas XI SMA Negeri 2 Mranggen. *Jurnal Inovasi Pembelajaran di Sekolah, 3*(2), 166–180. https://doi.org/10.51874/jips.v3i2.53

Sheppard, K. (2006). High school students' understanding of titrations and related acid-base phenomena. *Chemistry Education Research and Practice, 7*(1), 32–45. https://doi.org/10.1039/B5RP90014J

Syafriani, D., Dawolo, B. D. P., Butar Butar, L. A., Batubara, N., & Silitonga, S. (2025). Implementasi Kurikulum Merdeka dalam Pendidikan Indonesia: Kajian Literatur. *Insight: Indonesian Journal of Social, Humanity, and Education, 1*(2), 83–91. https://doi.org/10.70742/insight.v1i2.386

Syahana, S., Suyanta, S., Sari, D. R., Asmiati, L., & Pujiana, E. (2023). Design thinking as an effort to enhance critical thinking and science literacy in chemistry learning: A systematic review. *Jurnal Penelitian Pendidikan IPA, 9*(Special Issue), 275–284. https://doi.org/10.29303/jppipa.v9iSpecialIssue.4709