JIPK 19 (2) (2025)

Jurnal Inovasi Pendidikan Kimia

https://journal.unnes.ac.id/journals/JIPK

Development of Problem-Based Learning Worksheets Integrated with Think–Pair–Share to Enhance Students' Critical Thinking Skills on Reaction Rate Topics

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Article Info

Received: 18-07-2024

Accepted: 10-07-2025

Published: 31-01-2026

Keywords:
LKPD
Problem-Based Learning
Think–Pair–Share
Critical Thinking
Reaction Rate

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Abstract

This study aimed to examine the feasibility, effectiveness, and practicality of a reaction rate worksheet based on Problem-Based Learning (PBL) integrated with the Think–Pair–Share (TPS) strategy to enhance students' critical thinking skills. This research employed a Research and Development (R&D) approach using the 4-D development model, consisting of the define, design, development, and dissemination stages. The developed worksheet was evaluated in terms of feasibility through expert validation, effectiveness through learning outcomes, and student responses. The feasibility results indicated that the worksheet was rated as very feasible, with material expert validation reaching 89.81% and media expert validation achieving 95.83%. In addition, the readability test yielded a score of 89.70%, which also fell into the very feasible category. The effectiveness of the worksheet was determined through a t-test analysis, showing that the calculated t-value exceeded the t-table value, indicating that the use of the worksheet effectively improved students' critical thinking skills. Classical learning completeness in the experimental class reached 80.56% (categorized as proper), while the control class achieved 44.44% (categorized as quite proper). Furthermore, the critical thinking score of the experimental class reached 82.43% (very critical), compared to 72.09% (critical) in the control class. Observational results also revealed that students in the experimental class demonstrated higher critical thinking abilities than those in the control class. Student responses to the worksheet were highly positive, with an average score of 85.81%, categorized as very good. Overall, the findings indicate that the PBL-based worksheet integrated with Think–Pair–Share is feasible, effective, and well-received as an instructional material for training students' critical thinking skills.

p-ISSN 1979-0503
p-ISSN 2503-1244

INTRODUCTION

Regulation of the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia No. 16 of 2022 on process standards for early childhood, primary, and secondary education emphasizes that student assessment should be aligned with learning objectives that foster critical thinking skills. Achieving contemporary learning objectives requires the implementation of the new learning paradigm, which prioritizes student-centered and competence-based instruction (Kusyanti, 2022). In this paradigm, teachers are no longer merely transmitters of information but act as facilitators who support students in achieving learning goals and developing higher-order thinking skills (Fitra, 2022). The Merdeka Curriculum represents an enhancement of the 2013 Curriculum, aiming to provide students with greater opportunities to develop their potential and

competencies. To prepare students as competitive human resources, education must integrate science and technology, equipping learners with 21st-century skills such as critical thinking, communication, collaboration, and creativity, enabling them to adapt effectively to various contexts (Indarta et al., 2022).

Chemistry encompasses observable phenomena, concepts, principles, hypotheses, and laws. Therefore, learning chemistry should go beyond rote memorization and actively engage students in discovering concepts, theories, and rules to understand everyday phenomena (Langitasari & Rogayah, 2021). However, chemistry learning is often limited to textbooks and teacher explanations that are not meaningfully connected to real-life contexts (Herdiawan et al., 2019). Reaction rate material, in particular, involves abstract concepts, calculations, graphs, and symbolic representations, as well as quantitative analysis of reaction speed and factors affecting reaction rates (Dita & Syafriyani, 2022). Mastery of this topic requires students to operate at higher levels of critical thinking.

Interviews with chemistry teachers at SMA Negeri 1 Banjarnegara revealed that although problem-based learning models have been applied in teaching reaction rates, the instructional tools used—particularly student worksheets—remain conventional and are not specifically designed to train 21st-century skills. As a result, students' critical thinking skills have not been optimally developed, and student participation in the learning process remains relatively low. To achieve learning objectives effectively, educators must master subject matter and apply appropriate techniques, approaches, strategies, models, and instructional media (Pontoh et al., 2022). Various learning models can be utilized to foster 21st-century skills, including discovery learning, Project-Based Learning, Problem-Based Learning, and design-based learning (Redhana, 2019). One cooperative learning strategy that effectively promotes student engagement is Think–Pair–Share, which involves individual thinking, paired discussion, and shared communication. Through this process, students are encouraged to actively seek solutions to problems, thereby developing critical thinking skills (Nuzhalifa, 2021). The integration of Think–Pair–Share with Problem-Based Learning is expected to optimize student involvement and enhance critical thinking abilities (Adella & Darussyamsu, 2023). Based on this rationale, this study proposes the development of a reaction rate worksheet based on Problem-Based Learning integrated with Think–Pair–Share, entitled "Development of a Problem-Based Learning Worksheet Integrated with Think–Pair–Share to Enhance Students' Critical Thinking Skills on Reaction Rate Topics."

METHODS

This study employed a Research and Development (R&D) design using the 4D model proposed by Thiagarajan (1974), which was simplified into a 3D model consisting of the define, design, and develop stages. The dissemination stage was conducted through limited publication. The research subjects were drawn from a senior high school in Banjarnegara, involving 36 students in the experimental group and 36 students in the control group. The research instruments included interview sheets, material expert validation sheets, media expert validation sheets, readability questionnaires, critical thinking skills test instruments, student response questionnaires, and observation sheets. Data analysis techniques included analyses of material validity, media validity, and readability to determine the feasibility of the developed worksheets. The analysis of students' critical thinking skills was conducted based on posttest results and observational data to examine the effectiveness of the worksheets. Meanwhile, student response analysis was used to identify students' responses toward the use of the worksheets in the learning process..

RESULT AND DISCUSSION

The definition stage was conducted through preliminary research in the form of interviews with chemistry teachers and students to obtain information and factual conditions in the field. The initial analysis revealed that chemistry learning had not been supported by LKPD specifically designed to develop 21st-century skills. Learning activities still relied mainly on textbooks and presentation media such as PowerPoint. In addition, only a small proportion of students demonstrated critical thinking skills, and the implementation of problem-based learning models had not been optimal because not all students actively participated in the learning process.

Student analysis indicated that learners tended to experience boredom and showed limited engagement during classroom activities. Students' motivation and enthusiasm for learning were not yet optimal, mainly due to the lack of innovation in instructional delivery and the limited use of varied and interactive learning media.

The presentation of learning materials and activities was then aligned with the intended learning objectives. At this stage, an analysis of the learning objectives sequence was conducted by identifying and detailing the tasks, materials, and concepts to be included in the LKPD. The learning process was structured into three main activities: (1) studying the concepts and rate law equations of reaction rates, (2) understanding reaction order, and (3) analyzing factors that affect reaction rates.

The design stage involved developing a draft of the reaction rate LKPD based on Problem-Based Learning integrated with Think Pair Share, along with the supporting research instruments. The LKPD was designed to be visually engaging in terms of color, shape, and size. It predominantly used a blue color scheme, a rectangular portrait layout, B5 paper size, and *Times New Roman* font with a size of 20 for titles and 15 for the main text. The LKPD format consisted of a cover, preface, table of contents, instructions for use, learning outcomes and learning objective flow, concept map, learning syntax, learning materials, learning activities, and a glossary. Supporting media such as images and videos were incorporated to enhance conceptual understanding and student engagement. The developed LKPD product is presented in Figure 1.

Figure 1. Sample Pages of the Developed Reaction Rate Worksheet

The supporting research instruments prepared in this study included teaching modules, learning media, test instruments, and questionnaires. The *Merdeka Curriculum* teaching module was developed in accordance with the reaction rate material and the learning model applied. The supporting learning media consisted of PowerPoint presentations and instructional videos. The test instrument was developed based on critical thinking skill indicators in the form of two-tier multiple-choice questions. The instrument underwent validation and try-out stages, resulting in 20 test items that were declared valid and reliable. The readability questionnaire and the student response questionnaire were also tested for feasibility based on expert validation. Therefore, all research instruments were deemed appropriate for use in this study.

The development stage involved the validation and trial implementation of the developed LKPD product. Validation was conducted to assess the feasibility of the product and to obtain suggestions and feedback from the validators, which were subsequently used as the basis for product revision. Material validation covered aspects of content feasibility, material presentation, and language use, with the results presented in Table 1. Media validation included aspects of visual appearance, consistency, and physical criteria of the LKPD, with the results presented in Table 2. In addition, a summary of the validators' suggestions and feedback used to refine the product is systematically presented in Table 3.

Table 1. Content Validation of Developed LKPD

Aspect	Percentage			Average	Criteria
	V1	V2	V3		
Content Feasibility	100	75	100	91.66	Very Valid
Material Presentation	100	75	95.83	90.28	Very Valid
Language	100	75	87.50	87.50	Very Valid
Average (%)	100	75	94.44	**89.81**	**Very Valid**

Table 2. Material Expert Validation Results of the Reaction Rate Worksheet

Aspect	Percentage			Average	Criteria
	V1	V2	V3		
Visual Appearance	100	100	87.50	95.83	Very Valid
Consistency	100	100	100	100.00	Very Valid
Physical Criteria	100	100	75.00	91.67	Very Valid
Average (%)	100	100	87.50	95.83	Very Valid

Table 3. Validators' Suggestions for Worksheet Improvement

No.	Suggestions
1	Images should be aligned with the content explanations.
2	The learning material should be clarified and elaborated.
3	The reference list should not use "et al." in author names.
4	Typographical errors should be corrected.

The average percentage of material expert validation was 89.81%, classified as "very valid", while the average percentage of media expert validation reached 95.83%, also categorized as "very valid." These results indicate that the developed worksheet is feasible for use in learning activities with only minor revisions based on the validators' suggestions and feedback. The material validation results are consistent with the findings of Simorangkir (2024), who reported that a developed worksheet achieved a "very feasible" category based on expert material evaluation. Similarly, the media validation results align with the study by Suhari et al. (2023), which concluded that the developed worksheet media were appropriate and suitable for instructional use.

After being declared feasible, the worksheet underwent a readability test and field trial. The readability test was conducted to determine the feasibility of the worksheet based on students' evaluations. The results showed an average readability score of 89.70% across all assessed aspects, indicating that the worksheet is suitable for use. This finding is in line with Nadhifa (2024), who reported that a developed worksheet was valid based on readability test results. Following the readability test, a field trial was conducted in which the control class used the standard school textbook, while the experimental class used the developed reaction rate worksheet. At the end of the learning process, a critical thinking skills test was administered to both classes to evaluate learning outcomes.

Table 4. Independent Samples t-Test Results

Variable	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2-tailed)
Score	1.367	0.246	3.544	70	0.001
			3.544	69.394	0.001

Table 5. Percentage of Students' Critical Thinking Skills by Aspect

Critical Thinking Aspect	Experimental Group (%)	Control Group (%)
Problem Identification	79.63	70.37
Supporting Sources	81.60	70.49
Analysis	79.20	66.67
Contradictory Facts	82.41	72.22
Personal Assumptions	84.72	73.61
Conclusion	87.04	79.17
Average	82.43	72.09
Category	Very Critical	Critical

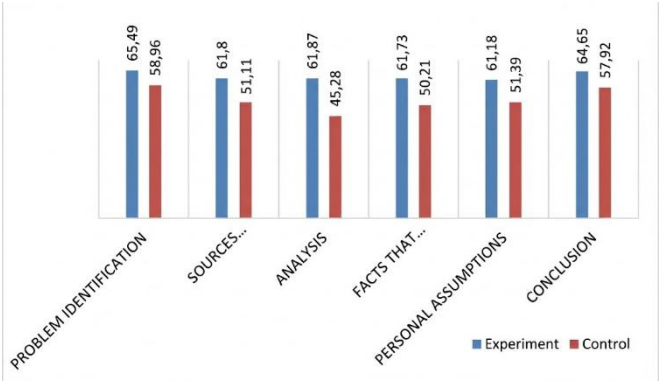

Figure 2. Results of students' critical thinking observations during the learning process

The test data were first analyzed using prerequisite statistical tests, including normality and homogeneity tests. Based on the Kolmogorov–Smirnov normality test, the significance values were 0.062 for the experimental group and 0.069 for the control group. Both values exceeded 0.05, indicating that the data were normally distributed. Furthermore, the homogeneity of variance test using Levene's test yielded a significance value of 0.246, which was greater than 0.05, indicating that the variances of the two groups were homogeneous.

An independent samples *t*-test was then conducted to determine whether there was a significant difference in the mean critical thinking scores between the experimental and control groups. As presented in Table 4, the results show that the calculated t value was greater than the critical t value ($3.544 > 1.99$), with a significance value of $0.001 < 0.05$. These findings indicate a statistically significant difference between the two groups, demonstrating that the reaction rate worksheet based on *Problem Based Learning* integrated with *Think–Pair–Share* was effective in enhancing students' critical thinking skills. This result is consistent with the findings of Temiyati and Nuryadi (2022), who reported that Problem Based Learning worksheets are effective in improving critical thinking skills. Similarly, Nuruttahirah and Suama (2023) found that the integration of *Problem Based Learning* with *Think–Pair–Share* contributes to the development of students' critical thinking skills and learning outcomes.

In terms of classical mastery, the experimental group achieved a completion rate of 80.56%, categorized as *complete*, while the control group reached only 44.44%, categorized as *moderately complete*. These results indicate that the developed worksheet was effective in training students' critical thinking skills. This finding aligns with Solikhah and Novita (2020), who stated that a worksheet can be considered effective if the classical mastery level reaches at least 75%.

The analysis of critical thinking components—namely problem identification, supporting sources, analysis, contradictory facts, personal assumptions, and conclusion drawing—based on students' test responses is presented in Table 5. The experimental group obtained an average score of 82.43%, classified as *very critical*, whereas the control group achieved an average score of 72.09%, classified as *critical*. Additionally, the observation results shown in Figure 2 indicate that the experimental group demonstrated higher critical thinking skills than the control group. These findings are in line with Imanah et al. (2023), who reported that *Problem Based Learning* encourages students to think critically when analyzing information, identifying problems, and solving real-world issues. Moreover, Apdolipah et al. (2023) emphasized that the implementation of *Think–Pair–Share* allows students to engage more freely in discussion and collaborative problem-solving, thereby enhancing their critical thinking capacity.

Finally, the applicability of the developed reaction rate worksheet based on *Problem Based Learning* integrated with *Think–Pair–Share* was evaluated through a student response questionnaire. The results showed a response rate of 85.81%, categorized as *very good*. This finding indicates that the worksheet effectively supports students' understanding of the material and increases their interest and engagement in learning. This result is supported by Fitriyah and Ghofur (2021), who reported similarly positive student responses to the use of worksheets, demonstrating their effectiveness in facilitating comprehension and enhancing students' learning motivation.

CONCLUSION

This study successfully developed a reaction rate worksheet based on *Problem Based Learning* integrated with *Think–Pair–Share* to train students' critical thinking skills. Based on the results of expert validation and readability testing, the developed worksheet was declared valid and suitable for instructional use. The effectiveness test results demonstrated that the worksheet significantly improved students' critical thinking skills, as evidenced by higher learning outcomes and classical mastery in the experimental group compared to the control group. In addition, students' responses indicated that the worksheet was highly applicable and well received, reflecting its ability to support understanding of reaction rate concepts and to enhance student engagement in the learning process. Therefore, the developed worksheet can be considered a valid, effective, and practical teaching material for fostering students' critical thinking skills in chemistry learning.

REFERENCES

Adella, T., & Darussyamsu, R. (2023). Analisis Model Pembelajaran Problem Based Learning Dipadu dengan Model Pembelajaran Think Pair Share Berbasis Lesson Study pada Materi Biologi SMA. Jurnal Pendidikan Biologi, 3(2), 13–21. http://rrkjurnal.ppj.unp.ac.id/index.php/RRKJURNAL

Apdolipah, Z., Yusnaidar, Y., Dewi, F., & Risdalina, R. (2023). Analisis Penerapan Model Pembelajaran Think Pair Share Dan Korelasinya Terhadap Kemampuan Berpikir Kritis Siswa. Journal of The Indonesian Society of Integrated Chemistry, 15(1), 37–47. https://doi.org/10.22437/jisic.v15i1.25413

Dita, L. A., & Syafriyani, D. (2022). Pengaruh Model Pembelajaran dan Minat Belajar Terhadap Hasil Belajar Siswa Pada Materi Laju Reaksi di SMA Negeri 1 Deli Tua. Jurnal Sekolah, 6(2), 186–192.

Fitra, D. K. (2022). Pembelajaran Berdiferensiasi dalam Perspektif Progresivisme pada Mata Pelajaran Ipa. Jurnal Filsafat Indonesia, 5, 250–258.

Fitriyah, I. M. N., & Ghofur, M. A. (2021). Pengembangan E-LKPD Berbasis Android Dengan Model Pembelajaran Problem Based Learning (PBL) Untuk Meningkatkan Berpikir Kritis Peserta Didik. Jurnal Ilmu Pendidikan , 3(5), 1957–1970. https://doi.org/10.31004/edukatif.v3i5.718

Herdiawan, H., Langitasari, I., & Solfarina, S. (2019). Penerapan PBL untuk Meningkatkan Keterampilan Berpikir Kreatif Siswa pada Konsep Koloid. Jurnal Kimia Dan Pendidikan, 4(1), 24. https://doi.org/10.30870/educhemia.v4i1.4867

Imanah, L. F., Yetmi, & Handayani, D. (2023). Upaya Peningkatan Keterampilan Berpikir Kritis dan Aktivitas Belajar Siswa SMA Pada Pembelajaran Abad-21 dengan Menerapkan Model Problem Based Learning (PBL). Jurnal Ilmiah Pendidikan Sains, 4(1), 66–74.

Indarta, Y., Jalinus, N., Waskito, W., Samala, A. D., Riyanda, A. R., & Adi, N. H. (2022). Relevansi Kurikulum Merdeka Belajar dengan Model Pembelajaran Abad 21 dalam Perkembangan Era Society 5.0. Jurnal Ilmu Pendidikan, 4(2), 3011–3024. https://doi.org/10.31004/edukatif.v4i2.2589

Kusyanti, R. N. T. (2022). Analisis Standarisasi Laboratorium Fisika dalam Mendukung Implementasi Kurikulum Merdeka di SMA Negeri 1 Tempel. Jurnal Karya Ilmiah Guru, 8(1), 40–47. https://doi.org/10.51169/ideguru.v8i1.404

Langitasari, I., & Rogayah, T. (2021). Problem-Based Learning (PBL) Pada Topik Struktur Atom: Keaktifan, Kreatifitas dan Prestasi Belajar Siswa. In Jurnal Inovasi Pendidikan Kimia (Vol. 15, Issue 2).

Nadhifa, E. R. (2024). Pengembangan Lembar Kerja Peserta Didik (LKPD) Kimia Berbasis Problem-Based Learning Sesuai Kurikulum Merdeka. Jurnal Riset Pembelajaran Kimia, 9, 49–55. https://journal.student.uny.ac.id/index.php/jrpk

Nuruttahirah, F., & Suama, W. (2023). The Effect Of The Integrated Think Pair Share Problem-Based Learning Model On Students' Cognitive Learning Outcomes Of Class X SMA. In JSRET (Journal of Scientific (Vol. 2, Issue 1).

Nuzhalifa, Y. U. (2021). Penerapan Model Pembelajaran Think-Pair-Share (TPS) berbasis Lesson Study sebagai Upaya untuk Meningkatkan Keterampilan Kolaborasi Mahasiswa. Jurnal Pendidikan Dan Pembelajaran Sains, 4(2623–0852), 48–57.

Pontoh, B., Santoso, I. R. S., & Rares, H. F. (2022). Pengaruh Model Pembelajaran Kooperatif Tipe Think Pair Share Terhadap Hasil Belajar Siswa Materi Asam-Basa Menggunakan Alat dan Bahan di Lingkungan Sekitar di Kelas XI MIA SMA Negeri 1 Tombatu. Journal Of Chemistry Education, 3(1), 17. https://doi.org/10.37033/ojce.v3i1.225

Redhana, W. (2019). Mengembangkan Keterampilan Abad Ke-21 dalam Pembelajaran Kimia. Jurnal Inovasi Pendidikan Kimia, 13, 2239–2253.

Simorangkir, M. (2024). Pengembangan e-LKPD Kimia Berbasis Problem Based Learning Pada Materi Laju Reaksi Sesuai Kurikulum Merdeka. In Jurnal Kependidikan (Vol. 13, Issue 2). https://jurnaldidaktika.org

Solikhah, S., & Novita, D. (2020). Kelayakan Lembar Kerja Peserta Didik (LKPD) Berorientasi Guided Discovery Untuk Melatih Keterampilan Berpikir Kritis Materi Ikatan Kimia Kelas X SMA. In UNESA Journal of Chemical Education (Vol. 9, Issue 2).

Suhari, A., Kurniawan, E., & Rahayu Ningsi, J. (2023). Pengembangan Lembar Kerja Peserta Didik (LKPD) Berbasis Problem Based Learning (PBL) Pada Materi Persamaan Reaksi Kimia Kelas X IPA SMAN 1 PANGEAN. Jurnal Online Mahasiswa Fakultas Tarbiyah Dan Keguruan.

Temiyati, & Nuryadi. (2022). Pengembangan LKPD Berbasis Problem Based Learning (PBL) untuk Meningkatkan Kemampuan Berpikir Kritis Peserta Didik. Jurnal Pendidikan Dan Konseling, 4.

Thiagarajan, S. (1974). Instructional Development for Training Teachers of Exceptional Children A Source Book. ERIC.