

Effectiveness of reciprocal teaching in enhancing creative thinking skills in physics education: a study at SMK SMTI Bandar Lampung

Welly Anggraini, Sri Latifah, Puput Chuswatun H Chan

Physics Education Department, Universitas Islam Negeri Raden Intan Lampung, Indonesia

Email: wellyanggraini@radenintan.ac.id

Abstract

This study investigates the effectiveness of the Reciprocal Teaching model in enhancing students' creative thinking skills in physics education at SMK SMTI Bandar Lampung. A quasi-experimental design involving 60 tenth-grade students was employed, using pre- and post-tests to assess four creative thinking indicators: fluency, flexibility, originality, and elaboration. Observations of the model's implementation were conducted across four sessions using a validated rubric. The experimental group demonstrated a significant improvement, with average scores increasing from 60 to 78. Statistical analysis confirmed the model's effectiveness ($t(58) = 5.58, p < 0.05$). These results suggest that Reciprocal Teaching promotes not only conceptual understanding but also creativity in physics learning. Given the study's limited scope, further research is recommended to explore long-term effects and broader applications. The findings contribute to the growing evidence supporting interactive, student-centred instruction in STEM education. This study extends prior work by explicitly linking Reciprocal Teaching to four key indicators of creativity in a vocational high school context.

Keywords: Creative thinking skills, Interactive learning, Reciprocal teaching

Article submitted 2025-01-14. Revision uploaded 2025-09-14.

Accepted for publication 2025-09-26.

Available online on 2025-10-31.

<https://doi.org/10.12928/jrkpf.v12i2.1242>

© 2025 by the authors of this article.

This is an open-access article under the [CC-BY-NC](#) license.



I. Introduction

Education plays a fundamental role in shaping students' cognitive and problem-solving abilities, which are essential for their future careers and personal development [1]. One of the key objectives of modern education is to equip students with higher-order thinking skills, particularly creative thinking, which allows them to approach problems from various perspectives and develop innovative solutions [2],[3]. However, conventional teaching methods often focus on rote memorisation rather than fostering active learning and critical engagement, leading to a gap in students' creative capacities [4],[5].

Reciprocal teaching is an instructional approach designed to address this gap by incorporating interactive learning strategies that encourage students to take an active role in their learning process [6]. This model integrates structured dialogue, collaborative discussions, and student-led inquiry, all of which enhance comprehension, metacognition, and creativity [7],[8]. In physics education, where conceptual understanding and problem-solving are essential, Reciprocal Teaching can provide a more engaging and effective learning experience [9].

Recent studies have confirmed the potential of reciprocal teaching to foster higher-order thinking and creativity. For example, Hidayah et al. [10] found that the application of the reciprocal teaching learning model significantly improved students' higher-order thinking skills and science process skills. Meanwhile, Putra et

al. [11] reported that applying the reciprocal teaching method in a sociology class increased student creativity from 36% to 80% in the "good" category and improved learning outcomes. These findings align with global educational trends emphasising creativity as a key competency for the 21st century [12].

Despite the recognised importance of creative thinking, many students struggle with developing these skills, particularly in physics learning [13]. A 2021 survey by the Ministry of Education and Culture reported that 62% of Indonesian students felt their learning experiences lacked stimulation and failed to foster creativity [14]. At the same time, prior research confirms Reciprocal Teaching's potential to improve comprehension and metacognitive skills [15]. Its specific impact on four creativity indicators –fluency, flexibility, originality, and elaboration– remains underexplored, especially in vocational high school settings in Indonesia.

Moreover, recent comparative studies in Southeast Asia highlight the need for culturally relevant strategies to foster creativity in STEM education [16]. Emerging work suggests that integrating Reciprocal Teaching with digital platforms may further enhance creative thinking outcomes in vocational contexts [17]. This study addresses these gaps by investigating the effectiveness of Reciprocal Teaching in enhancing creative thinking skills among tenth-grade students at SMK SMTI Bandar Lampung. Unlike previous works that primarily focused on comprehension or general higher-order thinking skills, this research directly examines creativity indicators within a vocational physics context, offering fresh insights for STEM education. The findings are expected to contribute both theoretically –to the discourse on interactive teaching models and creativity– and practically, by informing instructional strategies for physics educators in similar contexts.

II. Methods

This study employed a quasi-experimental design with a Nonequivalent Control Group [18]. The research was conducted at SMK SMTI Bandar Lampung, involving 60 tenth-grade students from class X APL. The sampling technique applied was purposive sampling, with Class X APL 1 as the experimental group and Class X APL 3 as the control group [19]. Before data collection, ethical approval was obtained from the Research Ethics Committee of Universitas Islam Negeri Raden Intan Lampung, and official permission was secured from SMK SMTI Bandar Lampung. Participation was voluntary, and informed consent was obtained from students and their guardians.

Preparation Phase: Identifying learning needs, developing test and observation instruments, and assessing the validity and reliability of the instruments [20]. The instrument validation involved expert reviews by three physics education specialists, followed by a pilot test with 20 students from a different class. Content validity was confirmed through a Content Validity Index (CVI) of 0.89. Reliability testing using Cronbach's Alpha yielded a value of 0.82, indicating high internal consistency.

Implementation Phase: The experimental group received instruction using the Reciprocal Teaching model for four weeks, while the control group followed conventional methods [21]. The four-week duration was chosen to align with the school's physics curriculum schedule and to ensure coverage of the targeted topics without disrupting other instructional plans.

Data Analysis Phase: Normality and homogeneity tests were performed as prerequisite tests before conducting a t-test to compare the experimental and control groups [22]. N-Gain scores were calculated to assess the magnitude of improvement, and Cohen's d was used to determine effect size. Statistical analyses were conducted using SPSS v26.

The research instruments included essay-based tests assessing creative thinking indicators (fluency, flexibility, originality, and elaboration), as well as structured observation sheets measuring student engagement [23]. Observations were conducted by a trained observer using a validated rubric. To minimise subjectivity, two independent raters scored a subset of responses, yielding an inter-rater reliability coefficient of 0.84. A standardised scoring system ensured consistency across the four observation sessions. Data analysis involved N-Gain calculations, t-tests, and effect size analysis to determine the significance of the findings [24].

III. Results and discussion

The purpose of this section is to present and analyse the findings obtained from the study. The results are examined based on statistical analyses and their alignment with previous research. Additionally, the discussion elaborates on the implications of these findings in the context of creative thinking skill development in physics education. The study revealed that the Reciprocal Teaching model significantly enhanced students' creative

thinking abilities. The comparative analysis of pre-test and post-test scores showed an improvement in creative thinking indicators.

Table 1. Results of Pre-Test and Post-Test

Class	Mean Pre-test	Mean Post-test	Mean Gain	% Gain	N-Gain	<i>t</i> (df)	<i>P</i>	Cohen's <i>d</i>
X APL 1 (Experimental)	60	78	18	30.0%	0.45	—	—	—
X APL 3 (Control)	61	65	4	6.6%	0.10	—	—	—
Between-group						$t(58) = 5.58$	$p < 0.001$	$d = 0.85$

The Reciprocal Teaching model substantially enhanced students' creative thinking skills. The experimental group's mean score improved from 60 on the pre-test to 78 on the post-test, reflecting a 30% relative gain and an N-Gain value of 0.45 (medium level). In contrast, the control group showed only a modest increase (61 → 65; N-Gain = 0.10). An independent-samples *t*-test on the gain scores confirmed the difference between groups was statistically significant ($t(58) = 5.58$, $p < 0.001$) with a large effect size (Cohen's $d = 0.85$). These results demonstrate that Reciprocal Teaching is markedly more effective than conventional instruction [25] in fostering creative thinking.

Observation data revealed that 85% of students actively participated in group discussions and 90% successfully explained physics concepts [26]. This high level of engagement suggests that Reciprocal Teaching promotes not only cognitive gains but also active participation and self-expression, two factors strongly linked to creative thinking development.

These findings are consistent with those of Mafarja et al. [27], who reported improvements in students' creative problem-solving abilities through the use of Reciprocal Teaching in science classes. Similarly, Yulianti et al. [28] observed gains in metacognition and creativity in vocational physics contexts. At the global level, these results support OECD [29] emphasis on creativity as a crucial 21st-century competency.

The gains observed can be attributed to the model's structure—summarising, questioning, clarifying, and predicting—which compels students to articulate and refine their understanding collaboratively [30]. Such dialogic learning fosters fluency and flexibility in idea generation, while opportunities to clarify and predict enhance originality and elaboration. These mechanisms align with social constructivist theory, emphasising that knowledge is co-constructed through peer interaction and guided facilitation.

While the overall impact was positive, certain challenges emerged. Some students initially hesitated to participate in peer-led discussions due to unfamiliarity with collaborative learning. This reflects findings by Teacher Implementation of Cooperative Learning in Indonesia: A Multiple Case Study by Karmina et al. [16], who note that cultural norms and teacher-centred traditions in Southeast Asian contexts can inhibit the adoption of collaborative strategies. Teacher readiness was also crucial, effective implementation required training to manage group dynamics, scaffold questioning, and encourage equitable participation.

This study's four-week duration and single-school context limit the generalizability of the findings. Future research should explore longer-term impacts, multiple institutions, and integration with digital platforms, as suggested by Yu et al. [17]. Indicator-level analyses (fluency, flexibility, originality, and elaboration) would provide deeper insights into which creative-thinking components benefit most from reciprocal teaching.

These findings indicate that Reciprocal Teaching can be a powerful tool for vocational physics education, enhancing both creative thinking and conceptual mastery. By adopting structured dialogue and collaborative strategies, teachers can foster a classroom environment conducive to innovation and problem-solving, key skills for 21st-century STEM fields.

The findings of this study further emphasise that Reciprocal Teaching fosters not only creative thinking but also student autonomy in learning. This model enables students to take greater control of their learning processes, leading to improved problem-solving skills and deeper conceptual understanding. Furthermore, it aligns with the constructivist paradigm, which suggests that learning is most effective when students actively construct knowledge rather than passively receive information.

Reciprocal teaching has demonstrated advantages over other models, such as Problem-Based Learning (PBL) and Inquiry-Based Learning (IBL). While PBL focuses on real-world problem-solving and IBL emphasises student-driven investigations, Reciprocal Teaching provides a structured yet interactive framework

that balances guided instruction with student collaboration. The four-step approach, summarising, questioning, clarifying, and predicting, zensures systematic engagement and fosters both critical and creative thinking.

Despite its effectiveness, challenges include the need for well-trained educators to facilitate meaningful discussions and ensure participation [31]. Students accustomed to passive learning may initially struggle with interactive methods, requiring scaffolding and gradual adaptation [32].

Internationally, the shift toward student-centred learning aligns with global education trends. Countries such as Finland and Singapore have successfully implemented collaborative learning models, highlighting the relevance of Reciprocal Teaching worldwide [33], [34]. Future research should explore long-term effects across age groups and digital environments. Integrating technology, such as AI-assisted discussions or online collaborative platforms, could improve the scalability and accessibility of Reciprocal Teaching in the 21st-century [35].

IV. Conclusions

This study demonstrates that the Reciprocal Teaching model significantly enhances students' creative thinking skills and conceptual understanding in vocational physics education. The experimental group achieved a 30% relative gain and a medium N-Gain value of 0.45, with statistically significant differences confirmed by t-test analysis ($t(58) = 5.58$, $p < 0.001$, Cohen's $d = 0.85$). Observation data also showed high levels of student engagement (85% active participation; 90% successful concept explanations), confirming that dialogic, peer-led discussions promote active participation, self-expression, and student autonomy.

The findings add to existing literature by highlighting the effectiveness of Reciprocal Teaching within vocational physics, a context underexplored in previous studies. They also emphasise the model's advantage over other interactive strategies such as Problem-Based Learning (PBL) and Inquiry-Based Learning (IBL), offering a structured yet collaborative framework for fostering creativity. While the results are promising, the study's four-week duration and single-school sample limit generalizability. Future research should examine longer interventions, broader school contexts, and integration with digital learning platforms to evaluate scalability and long-term impact. Overall, Reciprocal Teaching represents a powerful instructional approach for cultivating 21st-century competencies, particularly creative thinking and problem-solving, in STEM education. Its adaptability across disciplines and alignment with global trends toward student-centred, collaborative learning make it a viable strategy for modernising physics instruction and preparing learners for innovation-driven futures.

Acknowledgements

The authors would like to express their gratitude to SMK SMTI Bandar Lampung for their support and cooperation in conducting this research. Special thanks are extended to the students and teachers who participated in the study and contributed valuable insights. The authors also acknowledge the funding and guidance provided by Universitas Islam Negeri Raden Intan Lampung, which made this research possible.

References

- [1] S. Ainsworth, "DeFT: A conceptual framework for considering learning with multiple representations," *Learn. Instr.*, vol. 16, no. 3, pp. 183–198, Jun. 2006, doi: [10.1016/j.learninstruc.2006.03.001](https://doi.org/10.1016/j.learninstruc.2006.03.001).
- [2] E. Juliangkary, I. N. Suparta, I. M. Ardana, and G. A. Mahayukti, "Development of Learning Models to Enhance Students' Creative Thinking: A Systematic Literature Review," *PPSDP Int. J. Educ.*, vol. 3, no. 2, pp. 488–503, Nov. 2024, doi: [10.59175/pijed.v3i2.333](https://doi.org/10.59175/pijed.v3i2.333).
- [3] F. Al Mamun, "Fostering Creativity and Critical Thinking in the Classroom: Strategies for 21st-century Education," *Int. J. Multidiscip. Res.*, vol. 6, no. 4, pp. 1–12, Jul. 2024, doi: [10.36948/ijfmr.2024.v06i04.23563](https://doi.org/10.36948/ijfmr.2024.v06i04.23563).
- [4] N. Amirova, "Traditional vs. Non-Traditional Teaching in Secondary Education: A Comparative Analysis," *Porta Universorum*, vol. 1, no. 3, pp. 101–109, May 2025, doi: [10.69760/portuni.010309](https://doi.org/10.69760/portuni.010309).
- [5] C. Burgos-Videla, M. Parada-Ulloa, and J. Martínez-Díaz, "Critical thinking in the classroom: the historical method and historical discourse as tools for teaching social studies," *Front. Sociol.*, vol. 10, pp. 1–15, Apr. 2025, doi: [10.3389/fsoc.2025.1526437](https://doi.org/10.3389/fsoc.2025.1526437).
- [6] J. S. Bruner, *The Process of Education*. Harvard University Press, 2009. doi: [10.2307/j.ctvk12qst](https://doi.org/10.2307/j.ctvk12qst).
- [7] H. Alrø and O. Skovsmose, "Dialogic learning in collaborative investigation," *NOMAD Nord. Stud. Math. Educ.*, vol. 9, no. 2, Nov. 2024, doi: [10.7146/nomad.v9i2.147119](https://doi.org/10.7146/nomad.v9i2.147119).
- [8] A. de Araujo, P. M. Papadopoulos, S. McKenney, and T. de Jong, "A learning analytics-based collaborative

- conversational agent to foster productive dialogue in inquiry learning,” *J. Comput. Assist. Learn.*, vol. 40, no. 6, pp. 2700–2714, Dec. 2024, doi: [10.1111/jcal.13007](https://doi.org/10.1111/jcal.13007).
- [9] N. Mafarja, M. M. Mohamad, and H. Zulnaidi, “Effect of Cooperative Learning With Internet Reciprocal Teaching Strategy on Attitude Toward Learning STEM Literacy,” *Sage Open*, vol. 14, no. 3, Jul. 2024, doi: [10.1177/21582440241280899](https://doi.org/10.1177/21582440241280899).
- [10] R. Hidayah, S. Latifah, H. Komikesari, and I. Yusuf, “Reciprocal Teaching Learning: Is it Effective to Improve Students’ Higher Order Thinking Skills and Scientific Process Skills?,” *Indones. J. Sci. Math. Educ.*, vol. 4, no. 1, pp. 69–77, Mar. 2021, doi: [10.24042/ijsme.v4i1.8675](https://doi.org/10.24042/ijsme.v4i1.8675).
- [11] S. C. Putra, N. Made, N. Suryanti, I. Malik, and H. Wadi, “The Implementation of the Reciprocal Teaching Method to Improve Students’ Creativity and Learning Outcomes in Sociology Subject of Class XII IPS 4 at SMAN,” *Reflect. J.*, vol. 5, no. 1, pp. 1–10, 2025, [Online]. Available: https://journal-center.litpam.com/index.php/RJ/article/view/2671?_cf_chl_tk=UGoyruO8ag6gs_ms1LoavA8dm1jbZH.2PLh3yoHb8U0-1761809860-1.0.1.1-ySbaxQLtI_O6Sgn06jWF.AVSw8xamxPrSG3Q00ji9X4
- [12] B. Thornhill-Miller *et al.*, “Creativity, Critical Thinking, Communication, and Collaboration: Assessment, Certification, and Promotion of 21st Century Skills for the Future of Work and Education,” *J. Intell.*, vol. 11, no. 3, p. 54, Mar. 2023, doi: [10.3390/jintelligence11030054](https://doi.org/10.3390/jintelligence11030054).
- [13] J. R. Batlolona and M. Diantoro, “Mental Models and Creative Thinking Skills in Students’ Physics Learning,” *Creat. Stud.*, vol. 16, no. 2, pp. 433–447, Jun. 2023, doi: [10.3846/cs.2023.14743](https://doi.org/10.3846/cs.2023.14743).
- [14] J. Hattie, *Visible Learning*. Routledge, 2008. doi: [10.4324/9780203887332](https://doi.org/10.4324/9780203887332).
- [15] C. E. Hmelo-Silver, “Problem-Based Learning: What and How Do Students Learn?,” *Educ. Psychol. Rev.*, vol. 16, no. 3, pp. 235–266, Sep. 2004, doi: [10.1023/B:EDPR.0000034022.16470.f3](https://doi.org/10.1023/B:EDPR.0000034022.16470.f3).
- [16] S. Karmina, B. Dyson, P. Watson, and R. Philpot, “Teacher Implementation of Cooperative Learning in Indonesia: A Multiple Case Study,” *Educ. Sci.*, vol. 11, no. 5, p. 218, May 2021, doi: [10.3390/educsci11050218](https://doi.org/10.3390/educsci11050218).
- [17] X. Yu, T.-Y. Wang, and T. Yuizono, “Creativity development through questioning activity in second language education,” *Front. Educ.*, vol. 8, pp. 1–11, Aug. 2023, doi: [10.3389/feduc.2023.1178655](https://doi.org/10.3389/feduc.2023.1178655).
- [18] J. L. Cooper, “Cooperative Learning and Critical Thinking,” *Teach. Psychol.*, vol. 22, no. 1, pp. 7–9, Feb. 1995, doi: [10.1207/s15328023top2201_2](https://doi.org/10.1207/s15328023top2201_2).
- [19] A. M. A. Alabbasi, S. H. Paek, D. Kim, and B. Cramond, “What do educators need to know about the Torrance Tests of Creative Thinking: A comprehensive review,” *Front. Psychol.*, vol. 13, Oct. 2022, doi: [10.3389/fpsyg.2022.1000385](https://doi.org/10.3389/fpsyg.2022.1000385).
- [20] Zafrullah, Ersya Mayola, Rizki Tika Ayuni, and Cheequitha Adhelia, “Development of Instruments for Learning Independence for High School Students: Construct Validity and Reliability,” *Begin. J. Teach. Educ. Manag.*, vol. 1, no. 2, pp. 91–103, Nov. 2023, doi: [10.61166/bgn.v1i2.40](https://doi.org/10.61166/bgn.v1i2.40).
- [21] A. D. Afifa, S. Andayani, and J. Ahmad, “Pengaruh Model Pembelajaran Reciprocal Teaching Berbantu Media Visual Terhadap Hasil Belajar,” *EMTEKA J. Pendidik. Mat.*, vol. 5, no. 1, pp. 207–216, Mar. 2024, doi: [10.24127/emteka.v5i1.2592](https://doi.org/10.24127/emteka.v5i1.2592).
- [22] R. E. Mayer, “The Past, Present, and Future of the Cognitive Theory of Multimedia Learning,” *Educ. Psychol. Rev.*, vol. 36, no. 1, p. 8, Mar. 2024, doi: [10.1007/s10648-023-09842-1](https://doi.org/10.1007/s10648-023-09842-1).
- [23] Y. I. Tanjung, T. Wulandari, F. Festiyed, Y. Yermadesi, and Y. Ahda, “Development Analysis of Creative Thinking Test Instruments on Natural Science Materials,” *J. Pendidik. Fis.*, vol. 12, no. 1, p. 22, Jun. 2023, doi: [10.24114/jpf.v12i1.43340](https://doi.org/10.24114/jpf.v12i1.43340).
- [24] A. S. Palinscar and A. L. Brown, “Reciprocal Teaching of Comprehension-Fostering and Comprehension-Monitoring Activities,” *Cogn. Instr.*, vol. 1, no. 2, pp. 117–175, Mar. 1984, doi: [10.1207/s1532690xci0102_1](https://doi.org/10.1207/s1532690xci0102_1).
- [25] Y. H. Jang and S. H. Kim, “Inconsistencies in the MRI Evaluation of Rotator Cuff Atrophy After Surgical Repair,” *J. Shoulder Elb. Surg.*, vol. 30, no. 7, pp. 414–416, Jul. 2021, doi: [10.1016/j.jse.2021.03.004](https://doi.org/10.1016/j.jse.2021.03.004).
- [26] B. Bungum, M. V. Bøe, and E. K. Henriksen, “Quantum talk: How small-group discussions may enhance students’ understanding in quantum physics,” *Sci. Educ.*, vol. 102, no. 4, pp. 856–877, Jul. 2018, doi: [10.1002/sce.21447](https://doi.org/10.1002/sce.21447).
- [27] N. Mafarja, H. Zulnaidi, and H. Mohd. Fadzil, “Using Reciprocal Teaching Strategy to Improve Physics Students’ Critical Thinking Ability,” *Eurasia J. Math. Sci. Technol. Educ.*, vol. 18, no. 1, p. 2069, Jan. 2022, doi: [10.29333/ejmste/11506](https://doi.org/10.29333/ejmste/11506).
- [28] Rosi Yulianti, Asmar Yulastri, Ambiyar, and M. Giatman, “Meta-Analysis in Measuring the Effectiveness of Problem-Based Learning Models in Vocational Education,” *Indones. J. Comput. Sci.*, vol. 12, no. 6, Dec. 2023, doi: [10.33022/ijcs.v12i6.3570](https://doi.org/10.33022/ijcs.v12i6.3570).
- [29] OECD, *Future of Education and Skills 2030: Creativity and Critical Thinking Framework*. Paris: OECD Publishing, 2022.
- [30] T. Z. Oo, A. Magyar, and A. Habók, “Effectiveness of the reflection-based reciprocal teaching approach for reading comprehension achievement in upper secondary school in Myanmar,” *Asia Pacific Educ. Rev.*, vol. 22, no. 4, pp. 675–698, Dec. 2021, doi: [10.1007/s12564-021-09707-8](https://doi.org/10.1007/s12564-021-09707-8).
- [31] M. Barak and Y. J. Dori, “Enhancing Higher Order Thinking Skills Among Inservice Science Teachers Via

- Embedded Assessment,” *J. Sci. Teacher Educ.*, vol. 20, no. 5, pp. 459–474, Oct. 2009, doi: [10.1007/s10972-009-9141-z](https://doi.org/10.1007/s10972-009-9141-z).
- [32] J. Zwiers and M. Crawford, *Academic Conversations*. New York: Routledge, 2023. doi: [10.4324/9781032680514](https://doi.org/10.4324/9781032680514).
- [33] B. Paju, A. Kajamaa, R. Pirttimaa, and E. Kontu, “Collaboration for Inclusive Practices: Teaching Staff Perspectives from Finland,” *Scand. J. Educ. Res.*, vol. 66, no. 3, pp. 427–440, Apr. 2022, doi: [10.1080/00313831.2020.1869087](https://doi.org/10.1080/00313831.2020.1869087).
- [34] D. Nguyen and D. Ng, “Teacher collaboration for change: sharing, improving, and spreading,” *Prof. Dev. Educ.*, vol. 46, no. 4, pp. 638–651, Aug. 2020, doi: [10.1080/19415257.2020.1787206](https://doi.org/10.1080/19415257.2020.1787206).
- [35] E. Wenger, “Communities of Practice and Social Learning Systems,” *Organisation*, vol. 7, no. 2, pp. 225–246, May 2000, doi: [10.1177/135050840072002](https://doi.org/10.1177/135050840072002).