



The Effect of the Jigsaw Type Cooperative Learning Model on Students' Conceptual Understanding of Collisions Material

Lalu Azikri Amrullah^{1*}, Mahrus¹, Gunawan², Kosim², Audy Sintia Anugraheni³, Erika Lestari⁴

¹Master of Science Education, University of Mataram, Mataram, Indonesia;

²Physic Education Study Program, Faculty of Teacher Training and Science, Mataram University, Mataram, Indonesia;

³Telecommunications Engineering, Telkom University, Jakarta, Indonesia;

⁴Department of Business Management Marketing, Soai University, Osaka, Japan.

Article Info

Article History

Received: April 4, 2026

Revised: April 17, 2026

Accepted: April 28, 2026

Published: April 30, 2026

*Corresponding Author

Lalu Azikri Amrullah

University of Mataram, Indonesia

e-mail: azikrilalu2011@gmail.com

Abstract

Low understanding of physics concepts is often caused by learning models that do not facilitate active student interaction in the dissection of abstract phenomena. This study aims to analyze the effect of implementing the Jigsaw-type cooperative learning model on students' conceptual understanding of collision material at MA Nurul Iman. The method used was a quasi-experimental design with a Nonequivalent Control Group Design, involving the experimental class of 21 students and the control class of 20 students. The results of the data analysis using the Independent Samples T-Test showed a significance value of 0.000, indicating a significant difference in achievement between the two groups. The increase in conceptual understanding in the experimental class reached an N-gain score of 0.76 (High category), surpassing that of the control class, which achieved 0.56 (Medium category). The Jigsaw model is significantly more effective at improving students' cognitive quality than the conventional model, thanks to individual responsibility mechanisms and peer tutoring. These findings contribute to the development of active learning strategies in secondary schools. Recommendations for educators to integrate cooperative models to overcome visualization barriers in complex mechanical concepts.

Keywords: Collisions, cooperative model, jigsaw, understanding physics concepts.

DOI:

<https://doi.org/10.65622/ijeI.v2i1.244>



© 2025 The Authors. This article is licensed under a Creative Commons Attribution 5.0 International License

INTRODUCTION

The Jigsaw cooperative learning model is theoretically designed to improve conceptual understanding through positive interdependence and individual accountability (Gallardo et al., 2003). The Jigsaw model emphasizes personal responsibility, with each group member required to master their portion of the material (Kahar et al., 2020; Ramadhanti et al., 2025). This individual workload is then reinforced through a peer tutoring mechanism upon the individual's return to the original group (Zahara et al., 2025). This peer-to-peer knowledge dissemination process not only helps students who are struggling but also reinforces understanding for the students who are explaining (Indah & Hasanuddin, 2025; Slavin et al., 2003; Verawati et al., 2020). The structured social interaction in Jigsaw changes the way information is processed, from passive acceptance to active construction, so that research questions regarding the model's effectiveness in addressing low conceptual understanding can be answered through systematic collaborative activities (Marlina, 2025; Rukmini & Mafaza, 2022).

The effectiveness of the Jigsaw model in improving conceptual understanding is rooted in the theory of social development and task interdependence proposed by its originator, Elliot Aronson (Johnson et al., 1984). Aronson asserted that Jigsaw creates a learning environment in which each student is the "key holder" of information critical to their group's success, thereby triggering intrinsic motivation to thoroughly understand the material (Aronson, 2021; Slavin, 1991). This aligns with Lev Vygotsky's (1978) social constructivist principle of the Zone of Proximal Development (ZPD), in which higher-level conceptual understanding is more readily achieved through interactions with peers who have slightly higher levels of understanding (Gallardo et al., 2003; Newman & Holzman, 2013). Various empirical studies consistently show that the Jigsaw structure, which emphasizes independent and collective mastery of the material, produces higher conceptual understanding scores than direct, teacher-centered learning models (Gillies & Ashman, 2003; Gultom & Bestari, 2025).

Low mastery of physics concepts at the secondary level remains a crucial issue in Indonesian education

Citation:

Amrullah, L. A., Mahrus, M., Gunawan, G., Kosim, K., Anugraheni, A. S., & Lestari, E. (2026). The effect of the jigsaw type cooperative learning model on students' conceptual understanding of collisions material. *Indonesian Journal of Educational Innovation*, 2(1), 36–41. <https://doi.org/10.65622/ijeI.v2i1.244>

(Safitri et al., 2020). Based on national assessment reports, students' average scientific literacy skills remain below the minimum standard, particularly in the mechanics domain, which requires abstract reasoning (Suparya et al., 2022). This condition is reflected in the research location, where initial observations indicated that fewer than 40% of students could explain the physical phenomena underlying the law of conservation of momentum. Group discussions are often hampered when the material is abstract and presented in only one mode of representation (text only) (Gunawan et al., 2025; Qothrunnada et al., 2025). Students in expert groups often struggle to explain physical phenomena to their peers due to a lack of visual media or diagrams to support their explanations (Amrullah et al., 2025). As a result, conceptual understanding is often procedural, relying on memorizing formulas rather than addressing their physical essence (Ayu et al., 2021). This gap indicates that the Jigsaw model requires additional support in the form of varied information representations to bridge the difficulties of visualizing complex physics concepts (Ardiansah, 2025).

The novelty (state-of-the-art) of this research lies in the Jigsaw model, which addresses the limitations of representation in conventional physics learning. Unlike previous studies such as those by Kahar et al. (2020), Prasetyo et al. (2025), Rukmini & Mafaza (2022), and many others, which generally only tested the effectiveness of Jigsaw independently, this study synergizes the collaborative power of Jigsaw with the use of various representation modes such as graphs, diagrams, and visual simulations during expert group discussions (Gunawan et al., 2025). This learning approach is designed to accommodate various learning styles and reduce students' cognitive load when processing abstract information (Naibaho & Wahyuni, 2024). Thus, this study aims to empirically test the influence of Jigsaw's social structure and the richness of learning information as a more comprehensive strategy in improving the quality of students' understanding of physics concepts.

MATERIALS AND METHODS

Time and Place

This research was conducted in the even semester of the 2025/2026 academic year, specifically between November and December 2025. The research location was MA Nurul Iman, located in West Nusa Tenggara Province. This location was selected based on population characteristics relevant to the research problem.

Research Design

The method used in this study is quantitative and quasi-experimental. The research design used is a Nonequivalent Control Group Design, in which the experimental and control groups are not selected randomly but are drawn from existing classes at the school (Nasrudin, 2019). This design selection was based on practical considerations in the field to avoid disrupting the structure of the learning groups that have been formed, in accordance with Sugiyono's (2023) view that quasi-experiments are very effective in educational research. However, the researchers are aware of the potential for selection bias from non-random assignment, which may affect internal validity. To mitigate this, an initial ability equivalence test was conducted through a pretest to ensure that both groups

were at a comparable starting point before the intervention was administered.

Population and Sample

The population in this study included all students of class XI IPA at MA Nurul Iman, who were divided into several parallel classes. The number of samples was 41 students, divided into two groups: class XI-A as the experimental class and class XI-B as the control class. The sampling technique was purposive sampling, namely, selecting the sample based on certain considerations, such as the equality of students' initial abilities and recommendations from physics teachers (Arikunto, 2019). The research variables were the Jigsaw-type cooperative learning model as the independent variable and students' conceptual understanding of the collision material as the dependent variable (Rasyid, 2022). Data collection was carried out by providing objective test instruments in the form of reasoned multiple-choice questions (two-tier multiple-choice), while the tools and materials used included the Lesson Implementation Plan (RPP), student worksheets, and validated test instruments.

Research Procedure

The research procedure followed the stages adapted from Gall et al. (2003), starting with a preparation phase that included instrument validation and obtaining research permits and informed consent from the school to ensure research ethics. In the implementation phase, the experimental class used the Jigsaw format with a strict time allocation: 15 minutes for forming home groups, 30 minutes for in-depth discussions in the Expert Group to dissect the collision sub-topic, and a 30-minute peer tutoring session upon returning to the home groups. This time allocation was crucial to prevent superficial discussions and ensure maximum concept retention. Meanwhile, the control class followed the conventional model with the same total duration. The entire series concluded with an evaluation phase through a posttest to measure conceptual understanding in both groups.

Data Analysis Techniques

Data analysis was conducted using descriptive and inferential statistics to prove the research hypothesis. Analysis prerequisite tests included a normality test using the Shapiro-Wilk method and a homogeneity of variance test using Levene's Test, conducted in SPSS. Hypothesis testing was conducted through an Independent Sample T-Test at a significance level of 5% ($\alpha=0.05$) to determine differences in conceptual understanding between groups (Balaka, 2022). In addition, the effectiveness of increasing conceptual understanding was measured using the Normalized Gain (N-gain) formula with score interpretation criteria according to Sugiyono (2023): $g > 0.7$ (high), $0.3 \leq g \leq 0.7$ (medium), and $g < 0.3$ (low) (Hake, 1998). All of these analysis procedures were supported by standard references to ensure the validity of the findings.

RESULTS AND DISCUSSION

Result

Concept Understanding Data Description

Data on conceptual understanding of momentum and impulse in physics were obtained from pretest and posttest scores for both sample classes. Descriptive analysis results showed that before the treatment, the experimental

class had an average pretest score of 35.00 (SD = 0.07), and the control class had 34.50 (SD = 0.15). This small difference in average scores indicates that both classes had relatively equal initial abilities.

After the treatment, conceptual understanding improved in both classes. However, the improvement in the experimental class, which implemented the Jigsaw cooperative model with a multi-representation approach, was significantly greater than that in the control class, which used the conventional model. This is evidenced by the experimental class's average posttest score of 84.76, compared with the control class's 71.50. The comparison of average conceptual understanding scores between the two classes is shown in Figure 1.

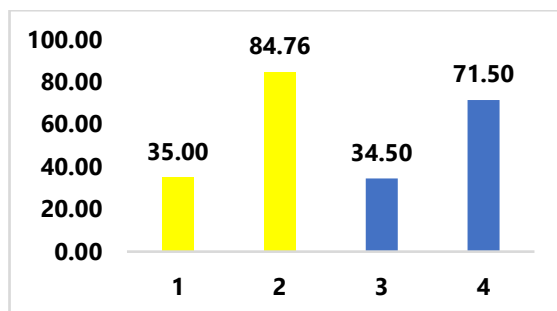


Figure 1. Comparison Graph of Average Pretest and Posttest Scores for Concept Understanding

The data show that the experimental class experienced greater improvement than the control class. This indicates that the Jigsaw model intervention made a greater positive contribution to strengthening students' cognitive construction of abstract physics concepts.

Analysis Prerequisite

Before testing the hypotheses, the research data were first assessed for prerequisites, including normality and homogeneity of variance.

1. Normality Test

The normality test assesses whether the distribution of conceptual understanding data is normal, a primary requirement for using parametric statistics. This test was conducted using the Shapiro-Wilk test, given that the number of research samples per group was less than 50 respondents (Julhadi et al., 2021). Based on the analysis results in Table 1, the significance values (Sig.) for the pretest and posttest data in the experimental class were 0.071 and 0.155, respectively (Sig. > 0.05). Meanwhile, in the control class, the significance values for the pretest and posttest were 0.145 and 0.233 (Sig. > 0.05). Based on these testing criteria, it can be concluded that all conceptual understanding data, both in the experimental and control groups, were normally distributed.

Table 1. Results of the Data Normality Test for Conceptual Understanding

Class	Data	Sig.	Description
Eksperimen	Pretest	0.071	Normal
Eksperimen	Posttest	0.155	Normal
Kontrol	Pretest	0.145	Normal
Kontrol	Posttest	0.233	Normal

2. Homogeneity Test

The homogeneity test was conducted using Levene's Test to ensure that the variances of the two groups were equal (homogeneous) (Sugiyono, 2023). Based on the data analysis in Table 2, the significance value (Sig.) for the conceptual understanding variable was 0.125. Because this value is greater than 0.05, the conceptual understanding data from the experimental and control classes have homogeneous variances. The fulfillment of the assumptions of normality and homogeneity provides a strong foundation for proceeding with the data analysis to the hypothesis-testing stage using parametric statistics, specifically the Independent Samples T-Test (Rasyid, 2022).

Table 2. Results of the Data Homogeneity Test for Conceptual Understanding

Variable	Sig.	Description
Conceptual Understanding	0.125	Homogen

Hypothesis Testing

Hypothesis testing was conducted to determine the effect of implementing the Jigsaw cooperative learning model on students' conceptual understanding of collisions. This testing was conducted by comparing posttest scores between the experimental and control classes using an Independent Sample T-Test (Maulida et al., 2024). The decision-making criteria were based on a significance value (Sig. 2-tailed) < 0.05 to reject H₀.

Based on the data analysis results in Table 3, the calculated t-value was 4.739, with a significance (Sig., 2-tailed) of 0.000. Since 0.000 < 0.05, according to the decision-making criteria, H₀ is rejected, and H_a is accepted. These findings empirically demonstrate a significant effect of implementing the Jigsaw cooperative learning model on students' understanding of physics concepts in grade 11 at MA Nurul Iman. This significant difference in achievement indicates that the Jigsaw model is more effective at improving conceptual understanding than conventional learning models in collisions.

Table 3 Results of Independent Sample T-Test Analysis

Variabel	t	df	Sig. (2-tailed)
Conceptual Understanding	4.739	39	0.000

Normalized Gain Test

The Normalized Gain (N-gain) score analysis was used to measure the treatment's effectiveness in improving students' conceptual understanding from pretest to posttest (Sugiyono, 2023). The analysis results showed that the experimental class using the Jigsaw model improved to the High category, while the control class using the conventional model improved to the Medium category. A comparison of the two models' effectiveness is shown in Table 4.

Table 4 N-gain Score

Group	Scor N-gain	Category
Eksperimen	0.76	High
Kontrol	0.56	Medium

Discussion

The findings of this study confirm that implementing the Jigsaw cooperative learning model significantly improved students' understanding of physics concepts related to collisions. This is evident from the results of the hypothesis test, which showed a significance value of 0.000, indicating a significant difference in achievement between the experimental and control classes. This phenomenon indicates that the social structure of the Jigsaw model creates a more effective learning ecosystem for analyzing complex physics material compared to conventional learning models, which tend to be passive.

The significant increase in understanding in the experimental class was substantially driven by the mechanisms of individual responsibility and positive interdependence within the group. In collisions, students often focus solely on memorizing the formula for the law of conservation of momentum without understanding the underlying physics, such as the distinct characteristics of perfectly elastic, partially elastic, and completely inelastic collisions. Through the Jigsaw model, these concepts are broken down into specific subtopics, which are discussed in depth during the "Expert Group" phase. This process facilitates stronger information encoding because students are required to thoroughly master the material so they can transfer that knowledge to their peers in their original groups.

Theoretically, the excellence of the experimental class stems from the intensive activities during the "Expert Group" phase. Consistent with research by Wirandini et al. (2024), at this stage, students not only understand the material independently but also assume responsibility for communicating it to their peers. The demand to become "teachers" for their peers (peer teaching) forces students to undergo profound cognitive reorganization. This aligns with findings that active learning is effective at increasing cognitive focus and engagement, ultimately resulting in better learning outcomes than simply listening to a one-way explanation from a teacher.

Furthermore, the Jigsaw model is a key instrument in bridging the abstract nature of physics through structured discussions. In this study, collision concepts involving the variables of velocity, mass, and coefficient of restitution were elaborated through more flexible interactions between students. This success is also supported by the efficient time management of the Jigsaw syntax, which allocates a greater portion of time to the discussion phase to maximize memory reinforcement and concept clarification. This proportional allocation of time prevents discussions from becoming superficial, resulting in a stronger and more lasting understanding.

The social interactions that develop during group discussions play a crucial role in building conceptual understanding. Jigsaw creates a learning environment in which each group member plays a vital role in the group's collective success (Prasetyo et al., 2025). Philosophically, this process aligns with social constructivism theory, which emphasizes that the meaning of knowledge is constructed through social negotiation (Ihsan & Artika, 2025). Therefore, the Jigsaw model is not simply a method for dividing tasks, but rather a strategy that encourages students' active involvement in constructing their own knowledge, thus minimizing the communication barriers

often encountered in conventional methods and deepening conceptual mastery.

Although this study shows significant results, several limitations warrant consideration. First, the use of a nonequivalent control group design (quasi-experimental) carries the risk of selection bias because subjects were not randomly selected, and uncontrolled external variables could influence the results. Second, the scope of this study remains limited to one school (MA Nurul Iman) with a relatively small sample size ($n=41$), so generalizing the results to a broader population requires caution. Furthermore, the focus of this study is limited to collision materials; the effectiveness of the Jigsaw model may yield different results when applied to physics materials with distinct cognitive characteristics. The final limitation concerns time management, as the Jigsaw syntax requires very strict time allocations to prevent expert group discussions from becoming superficial or rushed.

CONCLUSION

Based on the data analysis and discussion, it can be concluded that the implementation of the Jigsaw cooperative learning model significantly improved eleventh-grade students' understanding of physics concepts on collisions at MA Nurul Iman. This was demonstrated using an Independent Samples T-Test, which yielded a 2-tailed significance (Sig.) of 0.000, well below the significance level of 0.05. This superiority was further confirmed by the experimental class's N-gain score of 0.76, which falls into the High category, significantly surpassing the control class's score of 0.56, which falls into the Medium category. Intensive activities in the "Expert Group" phase and the peer tutoring mechanism proved effective in facilitating students' deeper understanding of abstract concepts, such as the law of conservation of momentum and the characteristics of various types of collisions. This improvement confirms that the collaborative synergy in the Jigsaw model is more effective at improving students' cognitive quality than conventional learning methods. Based on the findings of this study, it is recommended that physics teachers begin optimizing the use of cooperative learning models, particularly the Jigsaw model, in delivering material with high variable complexity to encourage students to be more actively involved in concept discovery. Future researchers are advised to expand the scope of their research to different physics materials or combine the Jigsaw model with other cognitive variables, such as critical thinking skills or student creativity. Furthermore, educators should carefully consider time management when assigning expert groups to ensure that all stages of the Jigsaw syntax can be implemented thoroughly and optimally within the limited class time.

ACKNOWLEDGEMENT

The author expresses his deepest appreciation and gratitude to Madrasah Aliyah (MA) Nurul Iman for granting permission, providing support, and providing facilities during the implementation of this research. He also extends his sincere appreciation to the Advisory Board of the Physics Education Study Program, University of Mataram, for their guidance, direction, and constructive

criticism in improving this scientific work. He also thanks all the students of class XI at MA Nurul Iman for their enthusiasm and cooperation during the data collection process. Finally, he extends his love and gratitude to his family and colleagues who have consistently provided moral support and motivation, enabling the successful completion of this scientific article.

AUTHOR'S CONTRIBUTION

Contribution Indicator	Author					
	1	2	3	4	5	6
Conceptualization	✓	✓	✓		✓	
Literature Review	✓		✓	✓		✓
Research Design / Methodology	✓	✓	✓	✓		
Instrument Development	✓	✓	✓			
Data Collection	✓					
Data Curation		✓	✓	✓		
Formal Analysis		✓	✓	✓	✓	✓
Data Interpretation	✓					
Writing – Original Draft	✓					
Writing – Review & Editing	✓	✓	✓	✓		
Visualization / Tables	✓				✓	✓
Supervision	✓	✓	✓	✓		

REFERENCES

- Amrullah, L. A., Muhajir, M. F., & Makhrus, M. (2025). Pengenalan E-LKPD Terintegrasi Pendekatan Multimodal: Strategi Praktis Pendorong Keterlibatan Peserta Didik SMAN 1 Mataram. *Indonesian Journal of Education and Community Services*, 5(2), 102–108. <https://journal.publication-center.com/index.php/ijecs/article/view/1909>
- Ardiansah, D. (2025). Analisis Strategi Multimodal: Navigasi Proses Interaksi Dalam Analisis Wacana Kelas. *Multidisciplinary Indonesian Center Journal (MICJO)*, 2(1), 775–786. <https://doi.org/https://doi.org/10.62567/micjo.v2i1.547>
- Aronson, E. (2021). The jigsaw classroom: A personal odyssey into a systemic national problem. In *Pioneering perspectives in cooperative learning* (pp. 146–164). Routledge.
- Ayu, I. G., Mammadova, I., & Masykuri, E. S. (2021). Cooperative Learning by Jigsaw to Improve Learning Outcomes for Eight-Grade-Students. *Scripta: English Department Journal*, 8(2), 45–54.
- Balaka, M. Y. (2022). *Buku Metodologi Penelitian Kuantitatif*. Penerbit Widina.
- Gallardo, T., Guerrero, L. A., Collazos, C., Pino, J. A., & Ochoa, S. (2003). Supporting JIGSAW-type collaborative learning. *36th Annual Hawaii International Conference on System Sciences*, 2003. Proceedings of The, 8-pp.
- Gillies, R., & Ashman, A. (2003). *Cooperative learning*. Taylor & Francis.
- Gultom, M., & Bestari, F. (2025). Meningkatkan Hasil Belajar PPKn pada Siswa Kelas V Melalui Model Pembelajaran Kooperatif Tipe Jigsaw. *Jurnal Pendidikan Dasar Dan Menengah*, 3(1), 40–53. <https://doi.org/https://doi.org/10.69743/edumedia.v3i1.20>
- Gunawan, G., Kosim, K., Zainuri, B. N. S., & Qothrunnada, Q. (2025). Multimodal Approaches in Science Teacher Education: An Integrative Review of Technologies, Representations, and Pedagogical Models. *Indonesian Journal of Teacher Education*, 6(1), 10–20. <https://journal.publication-center.com/index.php/ijte/article/view/1968>
- Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics*, 66(1), 64–74.
- Hasanah, Z., & Himami, A. S. (2021). Model pembelajaran kooperatif dalam menumbuhkan keaktifan belajar siswa. *Irsyaduna: Jurnal Studi Kemahasiswaan*, 1(1), 1–13. <https://jurnal.stituwjombang.ac.id/index.php/irsyaduna/article/view/236>
- Hildayanti, J., Kosim, K., & Gunawan, G. (2025). The Effect of Problem-Based Learning Supported by Interactive Media on Students' Physics Learning Outcomes. *Indonesian Journal of STEM Education*, 7(2), 90–98. <https://journal.publication-center.com/index.php/ijse/article/view/1866>
- Ihsan, M. B., & Artika, I. W. (2025). Integrasi mamangan adat Minangkabau dalam pembelajaran Bahasa Indonesia berbasis teori konstruktivisme sosial Vygotsky untuk pengembangan literasi kritis. *Journal of Social Humanities and Education*, 1(2), 212–220. <https://scriptaintelektual.com/scripta-humanika/article/view/400>
- Indah, I. S. R., & Hasanuddin, H. (2025). Analisis Bibliometrik Menggunakan Metode Kooperatif Tipe Jigsaw untuk Meningkatkan Kemampuan Komunikasi Matematis. *AL-AQSHA: Jurnal Pendidikan Islam*, 2(1), 11–24. <http://jurnal-staibalikipapan.my.id/index.php/al-aqsha/article/view/30>
- Johnson, D. W., Johnson, R. T., & Smith, K. A. (1984). *Cooperative learning*. Interaction Book Company New Brighton.
- Julhadi, Susilawati, D., Rosa, S., Adriani, P., Ganiem, L., & Fazilla, S. (2021). *Metodologi Penelitian Pendidikan* (N. Saputra, Ed.). Yayasan Penerbit Muhammad Zaini.
- Kahar, M. S., Anwar, Z., & Murpri, D. K. (2020). Pengaruh model pembelajaran kooperatif tipe jigsaw terhadap peningkatan hasil belajar. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, 9(2), 279–295. <https://doi.org/https://doi.org/10.24127/ajpm.v9i2.2704>
- Marlina, S. (2025). Pengaruh Model Pembelajaran Kooperatif Tipe Jigsaw terhadap Hasil Belajar IPA di Sekolah Dasar. *Jurnal Pendidikan Guru Sekolah Dasar Indonesia*, 1(1), 10–18. <https://pustakajurnal.web.id/index.php/jpgsdi/article/view/2>
- Naibaho, A. S., & Wahyuni, L. (2024). A Pembelajaran Teks Persuasi dengan Pendekatan Multimodal Berbasis Poster untuk Meningkatkan Kreativitas Siswa Kelas XI. *JIP-Jurnal Ilmiah Ilmu Pendidikan*, 7(4), 3587–3597.

- <https://doi.org/https://doi.org/10.54371/jiip.v7i4.3953>
- Nasrudin, J. (2019). *Metodologi Penelitian Pendidikan: Buku ajar praktis cara membuat penelitian*. Pantera Publishing.
- Newman, F., & Holzman, L. (2013). *Lev Vygotsky (classic edition): Revolutionary scientist*. Psychology Press.
- Prasetyo, S. W., Hanafi, Y., & Sagitha, F. D. (2025). Membangun minat belajar IPA siswa SMP melalui strategi pembelajaran kooperatif tipe Jigsaw. *Journal of Innovation and Teacher Professionalism*, 3(2), 383–390. <https://doi.org/https://doi.org/10.17977/um084v3i22025p383-390>
- Qothrunnada, Baiq Nabila Saufika Zainuri, Gunawan, & Kosim. (2025). Pengenalan Model PBL dengan Pendekatan Multimodal Untuk Meningkatkan Kemampuan Berpikir Kritis Dan Literasi Digital Siswa SMPN 1 Gerung. *Indonesian Journal of Education and Community Services*, 5(2), 67–74. <https://journal.publication-center.com/index.php/ijecs/article/view/1887>
- Ramadhanti, S. L., Konjin, H. C. T., Wadud, A. J., Nadlir, N., & Wakhidah, N. (2025). Model Pembelajaran Kooperatif Tipe Jigsaw dalam Pembelajaran IPA di Sekolah Dasar. *Journal of Instructional and Development Researches*, 5(2), 192–201. <https://journal.iel-education.org/index.php/JIDeR/article/view/452>
- Rasyid, F. (2022). *Metode Penelitian Kualitatif dan Kuantitatif Teori, Metode dan Praktek*. IAIN Kediri Press.
- Rukmini, H., & Mafaza, M. (2022). Meningkatkan Pemahaman Siswa dengan Menerapkan Model Kooperatif Tipe Jigsaw pada Pembelajaran Pelajaran Fisika. *Jurnal Ilmiah Pendidik Indonesia*, 1(1), 1–7. <https://doi.org/10.56916/jipi.v1i1.114>
- Safitri, I., Kaniawati, I., & Rusnayati, H. (2020). Penerapan Multirepresentasi Pada Pembelajaran Inkuiri Terbimbing Terhadap Penguasaan Konsep Dari Gaya Belajar. *Jurnal Pendidikan Fisika Dan Teknologi*, 6(2), 169–174. <https://doi.org/10.29303/jpft.v6i2.1870>
- Slavin, R. E. (1991). *Student team learning: A practical guide to cooperative learning*. ERIC.
- Slavin, R. E., Hurley, E. A., & Chamberlain, A. (2003). Cooperative learning and achievement: Theory and research. *Handbook of Psychology: Educational Psychology*, 7, 177–198.
- Sugiyono. (2023). *Metode Penelitian Kuantitatif Kualitatif dan R&D (edisi ke lima)*. ALFABETA.
- Suparya, I. K., Suastra, I. W., & Arnyana, I. B. P. (2022). Rendahnya literasi sains: faktor penyebab dan alternatif solusinya. *Jurnal Ilmiah Pendidikan Citra Bakti*, 9(1), 153–166.
- Ulfa, M., Wahyudi, W., Gunawan, G., & Gunada, I. W. (2024). The Effect of Project-Based Learning on Student Creativity in Physics Learning. *Indonesian Journal of STEM Education*, 6(2), 75–85. <https://journal.publication-center.com/index.php/ijse/article/view/1648>
- Verawati, N., Rahayu, S., & Detri, N. F. A. (2020). Efek Model Pembelajaran Kooperatif Tipe STAD dan Jigsaw Terhadap Penguasaan Konsep Fisika. *Jurnal Ilmu Sosial Dan Pendidikan*, 4(1), 321–326. <https://pdfs.semanticscholar.org/a91e/9e1d9e707820dcc44889ad686bad146d91f8.pdf>
- Wirandini, D. A. S., Nurhidayati, H., Sari, D. A. K., Segara, N. B., & Ningrawati, T. (2024). Penerapan Model Pembelajaran Kooperatif Tipe Jigsaw untuk Meningkatkan Kolaborasi Peserta Didik pada Mata Pelajaran IPS. *Entita: Jurnal Pendidikan Ilmu Pengetahuan Sosial Dan Ilmu-Ilmu Sosial*, 6(1), 87–104. <https://ejournal.iainmadura.ac.id/index.php/entita/article/view/13545>
- Zahara, D., Meisahruni, R. S., Purba, S. N., & Syahrial, S. (2025). Tinjauan Komprehensif Berbasis Literatur: Penerapan Metode Jigsaw Dalam Pembelajaran IPS Untuk Menumbuhkan Keaktifan Peserta Didik SD. *Jurnal Intelek Insan Cendikia*, 2(3), 4427–4441. <https://jicnusantara.com/index.php/jiic/article/view/2701>