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# The Effect of Cooperative Learning on Improving High School Students' Chemistry Learning Outcomes in Indonesia: *Systematic Literature Review*

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**Abstract: The Effect of Cooperative Learning on Improving High School Students' Chemistry Learning Outcomes in Indonesia.** Objectives: This study aims to analyze the implementation of the Cooperative Learning Model in chemistry instruction at high schools in Indonesia and its impact on student learning outcomes. Methods: This study was conducted using the Systematic Literature Review (SLR) method based on the PRISMA guidelines, with data sources from Google Scholar, SINTA, Garuda, and Scopus for the period 2015–2025. Of the 126 articles identified, 20 met the inclusion criteria for further analysis. Findings: The results indicate that cooperative learning has a positive impact on student learning outcomes. The STAD model is the most widely used model to demonstrate the highest improvement in learning outcomes based on the synthesis of several reviewed studies, followed by Jigsaw, TAI, Cooperative Script, Group Investigation (GI), and Course Review Horay (CRH). Conversely, the Rotating Trio Exchange model showed less consistent effectiveness. The trend in research publications also increased during the 2017–2025 period. The success of cooperative learning implementation is influenced by teachers' ability to manage groups, the availability of media, as well as student readiness and heterogeneity. Conclusion: Therefore, cooperative learning particularly the STAD and Jigsaw models has proven to be relevant and effective in improving the quality of chemistry instruction in high schools.

**Keywords:** Cooperative learning, learning outcomes, high school chemistry

***Abstrak: Pengaruh Pembelajaran Kooperatif terhadap Peningkatan Hasil Belajar Kimia Siswa Sekolah Menengah Atas di Indonesia.*** *Tujuan: Penelitian ini bertujuan untuk menganalisis penerapan Model Pembelajaran Kooperatif dalam pembelajaran kimia di sekolah menengah atas di Indonesia dan dampaknya terhadap hasil belajar siswa. Metode: Studi ini dilakukan menggunakan metode Systematic Literature Review (SLR) berdasarkan pedoman PRISMA dengan sumber data dari Google Scholar, SINTA, Garuda, dan Scopus untuk periode 2015–2025. Dari 126 artikel yang ditemukan, 20 artikel memenuhi kriteria inklusi untuk analisis lebih lanjut. Temuan: Hasil penelitian menunjukkan bahwa pembelajaran kooperatif memberikan dampak positif terhadap hasil belajar siswa. Model STAD merupakan model yang paling dominan digunakan untuk menunjukan peningkatan hasil belajar tertinggi berdasarkan sintesis beberapa studi yang direview, diikuti oleh Jigsaw, TAI, Cooperative Script, Group Investigation (GI), dan Course Review Horay (CRH). Sebaliknya, model Rotating Trio Exchange menunjukan efektivitas yang kurang konsisten. Tren publikasi penelitian juga meningkat pada periode 2017-2025. Keberhasilan implementasi pembelajaran kooperatif dipengaruhi oleh kemampuan guru dalam mengelola kelompok, ketersediaan median, serta kesiapan dan heterogenitas siswa. Kesimpulan: Oleh karena itu, pembelajaran kooperatif, terutama model STAD dan Jigsaw, telah terbukti relevan dan efektif dalam meningkatkan kualitas pembelajaran kimia di sekolah menengah atas.*

***Kata kunci:*** *Pembelajaran kooperatif, hasil belajar, kimia SMA*

## INTRODUCTION

Learning in the 21st century requires students to have critical thinking, communication, collaboration, and creativity skills, known as the four C skills. In the context of high school chemistry education, mastery of these skills is key for students to understand abstract concepts and apply them in everyday life. Therefore, the chemistry learning process needs to be directed not only at knowledge transfer, but also at developing higher-order thinking skills through interactive, student-centered learning strategies (Redhana, 2019).

This orientation is in line with recent educational research which emphasizes that student-centered and collaborative pedagogical approaches are essential for developing 21st century skills, particularly in science education that requires active engagement and problem-solving processes (Widiandari & Redhana, 2021).

One approach that is relevant to these demands is cooperative learning. This model emphasizes learning activities in small, heterogeneous groups, where students help each other and are responsible for achieving common learning goals. Through discussions, exchanging ideas, and expressing opinions, students not only gain a deeper understanding of concepts, but also develop social and communication skills. Research results show that Think Pair Share (TPS) and Student Teams Achievement Division (STAD) types of Cooperative Learning can increase motivation and science learning outcomes because students are more active and involved in the learning process (Mawar et al., 2019).

Similar findings have also been reported in chemistry education studies which show that collaborative and student-centered learning environments significantly improve students' critical thinking skills and conceptual understanding, particularly when students actively analyze and discuss learning problems together (Paraniti et al., 2025).

In chemistry education, the effectiveness of cooperative learning models has been demonstrated through improved conceptual understanding across various topics, including atomic structure. For example, the Team Assisted Individualization (TAI) and Numbered Heads Together (NHT) models have been shown to improve chemistry learning outcomes while fostering a sense of responsibility and cooperation within groups. Both models help students actively think, discuss, and explain the concepts they have learned, thereby strengthening their understanding of abstract material (Dewi et al., 2019).

One important effort in improving the quality of chemistry learning at the high school level is through the application of various innovative student-centered learning models, such as cooperative learning, which emphasizes cooperation and individual responsibility within groups. This model is believed to be able to foster student activity, social interaction, and critical thinking skills. In practice, the implementation of cooperative learning in high school chemistry classes still faces various obstacles. Teachers tend to stick to teacher-centered lecture methods, while students still show good readiness to learn in terms of physical, psychological, and cognitive aspects. This situation results in a less than optimal learning process and student learning outcomes that have not yet reached the expected criteria for mastery. (Ferdian et al., 2018).

However, although a number of individual studies have proven the effectiveness of cooperative learning in the context of science learning, to date there has been no systematic study summarizing empirical evidence related to its specific application in chemistry learning in Indonesian high schools. Most studies are still case studies with

limited scope or only highlight certain types of cooperative learning, without providing a comprehensive picture of its impact on chemistry learning outcomes. Therefore, this research takes the form of a Systematic Literature Review conducted to (1) analyze trends in the use of cooperative learning in high school chemistry learning in Indonesia; (2) determine the effectiveness of cooperative learning on chemistry learning outcomes; and (3) identify factors that influence the success of its implementation. Therefore, a clear research gap exists in the absence of a comprehensive and systematic synthesis of empirical evidence regarding the effectiveness, implementation trends, and influencing factors of Cooperative Learning in Indonesian high school chemistry education.

## METHOD

### Types of Research

This study uses a Systematic Literature Review (SLR) approach following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Page et al., 2021). This method was chosen because it provides a comprehensive synthesis of relevant research results in a systematic, transparent, and replicable manner (Snyder, 2019)

This method allows researchers to identify, evaluate, and interpret all previous studies to provide an overview of the effectiveness of Cooperative Learning on chemistry learning outcomes.

**Tabel 1.** Research Question

| No | Research Questions | The Analysis Sought |
|---|---|---|
| 1 | What is the trend in the application of the Cooperative Learning model in chemistry education in Indonesian high schools during the period 2015–2025? | Exploring variations of the CL model (STAD, Jigsaw, CRH, TAI, etc.) used in the context of high school chemistry. |
| 2 | To what extent is Cooperative Learning effective in improving high school students' chemistry learning outcomes? | Identifying the contribution of the model to students' cognitive learning outcomes |
| 3 | What factors influence the successful implementation of the Cooperative Learning model in high school chemistry education? | Analysing supporting variables such as media, teacher strategies, and student characteristics. |

### Research Procedure

The articles used in this SLR study were obtained from three digital libraries, namely Google Scholar, SINTA, Scopus and Garuda Kemdikbud, with publications ranging from 2015 to 2025. The keywords used in the search process were: “cooperative learning,” “cooperative learning in high school chemistry,” and “student learning outcomes in chemistry.”

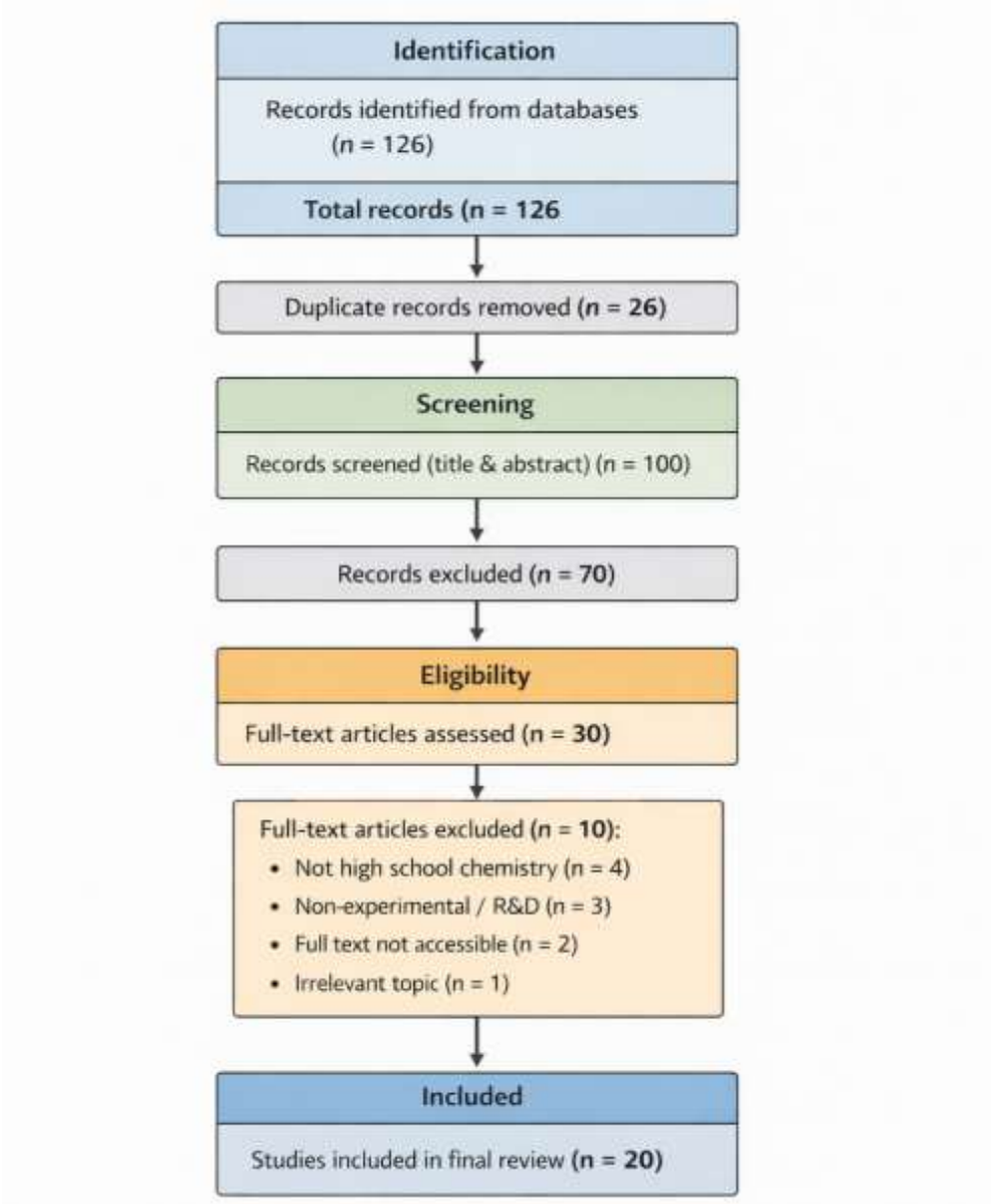


***Figure 1.*** *PRISMA Flow Diagram of article Selection Process*

The search process was conducted during September 2025 and produced a number of articles that were then selected based on inclusion and exclusion criteria as shown in Table 2.

**Tabel 2.** Inclusion and Exclusion Criteria

| Inclusion Criteria | Exclusion Criteria |
|---|---|
| The article discusses the application of the Cooperative Learning model in chemistry lessons in high school. | Duplicate articles or articles that cannot be accessed in full. |
| The study measured students' cognitive learning outcomes or supporting indicators (motivation, science process skills). | Research using development methods (R&D) or non-experimental/direct teaching |

| | |
|---|---|
| Articles published between 2015 and 2025. | The focus of the research is not on high school chemistry education. |
| Articles come from verified scientific journals, proceedings, or theses/dissertations. | Incomplete abstract or irrelevant topics. |
| Scopus indexed articles | Scopus unindexed articles |

## ■ RESULT AND DISCUSSION

Based on a review of 20 articles published between 2015 and 2025, the application of cooperative learning in chemistry education in Indonesian high schools shows a positive trend. This model has been proven to not only improve student learning outcomes in the cognitive domain, but also have an impact on affective and psychomotor aspects, such as motivation, interest, activity, and scientific process skills. To obt ain a more focused picture, the synthesis of research findings was grouped based on the type of cooperative learning model used.

The synthesis of findings in this study was conducted using a descriptive qualitative synthesis approach, in which the selected articles were categorized based on the type of cooperative learning model. The data were then compared and summarized using indicators such as improvement in test scores, percentage of classical mastery, and learning completeness reported in each study.

These percentages were obtained by referring to the reported improvement in students' scores, mastery learning percentages, and comparisons between experimental and control groups in each study, rather than from statistical meta-analysis calculations.

**Tabel 3.** Journal Analysis Results The Effect of Cooperative Learning Implementation on Improving Learning Outcomes

| Model Cooperative Learning | Number of articles | Chemistry Topics Covered | Key Findings |
|---|---|---|---|
| STAD | 7 | Hydrocarbons and Redox | Consistently improves learning outcomes and motivation; more effective when combined with media (worksheets and mind mapping). |
| Jigsaw | 3 | Solution equilibrium, Colloids, Periodic Table of Elements | Effective for abstract concept understanding; classical mastery >90%. |
| CRH (Course Review Horay) | 1 | General | Improves motivation and learning outcomes gradually. |
| Cooperative Script | 1 | General | Increases motivation (60– |

| | | | |
|---|---|---|---|
| | | | 75%) and mastery (68–88%). |
| GI (Group Investigation) | 1 | Chemical Bonding | Develops critical thinking skills. |
| Inquiry-Based Cooperative Learning | 1 | Chemical Bonding | Increases activity (38–81%) and learning outcomes (34–78%). |
| Time Token | 1 | Chemical Bonding | Improves participation and learning completion. |
| TAI (Team Assisted Individualization) | 1 | Chemical Equilibrium | Improves science process skills and cognitive outcomes (>80%). |
| Rotating Trio Exchange | 1 | General | No significant effect, depends on classroom conditions. |
| Other variations (Crossing Puzzle, STAD + media) | 3 | General | Puzzles increase participation but lower outcomes, STAD and media more effective than direct instruction. |

Table 3. shows that the Student Teams Achievement Division (STAD) and Jigsaw models are the most frequently used and demonstrate the most consistent effectiveness. The STAD model consistently improves learning outcomes and motivation because it combines structured group work, individual accountability, and group rewards, which encourage active participation and responsibility among students. This structure ensures that all students are actively involved in the learning process.

Meanwhile, the Jigsaw model is particularly effective in understanding abstract chemistry concepts because it requires students to become “experts” in specific subtopics and teach their peers. This process promotes deep learning, peer teaching, and cognitive engagement, which are essential in mastering complex and abstract chemistry materials such as equilibrium and colloids.

The trend graph for Cooperative Learning research in high school chemistry is shown more clearly in Figure 1.

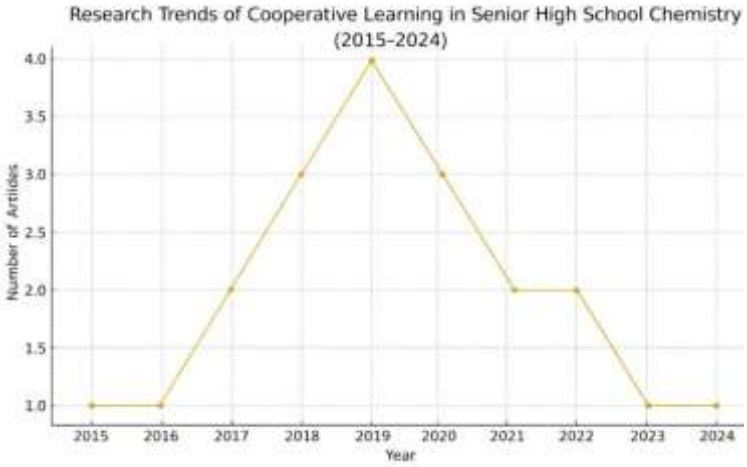


**Figure 2.** Trend Chart of Cooperative Learning Research in High School Chemistry

The trend of increasing use of cooperative learning in Indonesia became increasingly apparent in the period 2017–2019. This was marked by a growing number of classroom action research (CAR) and experiments that adopted this model to improve chemistry learning outcomes. The popularity of the STAD and Jigsaw models is influenced by their simple, flexible, and easy-to-implement steps in classrooms with large numbers of students. These findings are in line with the results of the studies summarized above, which show the effectiveness of both models in the context of chemistry learning in high schools.

The percentage of the effectiveness of Cooperative Learning on high school students' chemistry learning outcomes is presented in Figure 2.

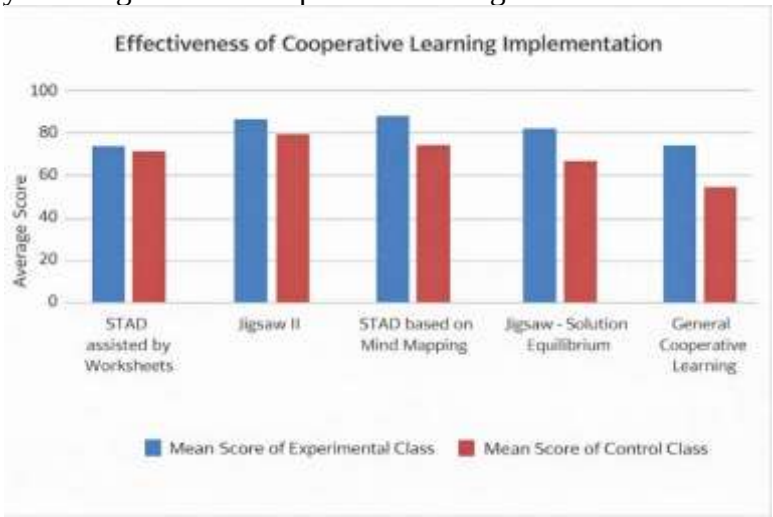


**Figure 1.** Effectiveness of Cooperative Learning Implementation

Figure 2 shows that the average score of the experimental class was higher than that of the control class across all Cooperative Learning models analysed. These findings indicate that the application of cooperative learning models, particularly the STAD and Jigsaw types, has a positive effect on improving students' chemistry learning outcomes. This result suggests that group-based learning environments are more effective than conventional instruction in enhancing students' conceptual understanding, active participation, and learning motivation.

These findings can be theoretically explained through the perspective of students' mental models in chemistry learning. Previous studies emphasize that learning difficulties often arise when students fail to connect macroscopic phenomena with sub microscopic explanations and symbolic representations. Suja et al. (2020) reported that students frequently rely on memorization and intuitive reasoning when learning chemistry, which leads to alternative or incomplete mental models. Their study demonstrated that instructional approaches that explicitly facilitate conceptual connections are effective in improving students' scientifically correct mental models (Suja et al., 2020).

Accordingly, the effectiveness of Cooperative Learning implementation in chemistry learning is not only determined by the model itself, but also by several supporting factors. First, teacher competence in managing the stages of cooperative learning plays a crucial role in determining learning success. Second, the availability of supporting learning media, including worksheets based on multiple representations, helps students understand abstract chemistry concepts more concretely. Third, student characteristics, particularly learning styles and communication skills, influence group interaction dynamics. Students with visual and kinaesthetic learning styles tend to adapt more easily to collaborative learning. In addition, balanced group composition between high- and low-ability students contributes significantly to effective cooperation. Overall, the success of Cooperative Learning implementation depends on the synergy between teacher roles, student readiness, and the use of learning media that align with the characteristics of chemistry content.

Overall, the results of this synthesis show that the success of cooperative learning in high school chemistry education depends heavily on the synergy between three main aspects, namely the role of teachers as facilitators, student readiness and characteristics, and the support of learning media that is appropriate for the characteristics of the material. With proper management, the cooperative learning model can not only improve chemistry learning outcomes, but also foster social and collaborative skills that are essential for students in the 21st century.

## ■ CONCLUSION

Based on the results of a SLR of 20 research articles published between 2015 and 2025, it can be concluded that the cooperative learning model has a positive impact on chemistry learning at the high school level in Indonesia. The STAD (Student Teams Achievement Division) model is the most widely used and proven effective in improving learning outcomes, motivation, and student interest. The Jigsaw model is also effective, especially in helping students understand abstract chemistry concepts and increasing classical mastery. Other models such as Course Review Horay (CRH), Cooperative Script, Team Assisted Individualization (TAI), and Group Investigation (GI) show positive contributions to student motivation, activity, critical thinking skills, and science process skills.

Although most studies show positive results, there are also models whose effectiveness is less consistent, such as Rotating Trio Exchange, which does not provide a significant difference in learning outcomes. This shows that the success of cooperative learning implementation depends not only on the model used but also on factors such as teacher strategies, classroom management, and student characteristics.

Thus, cooperative learning can be considered an effective strategy for improving the quality of chemistry learning in Indonesian high schools. Practically, teachers are encouraged to apply models such as STAD and Jigsaw by integrating appropriate learning

media and adapting them to student characteristics and chemistry topics. For future research, it is recommended to use more rigorous experimental designs with larger samples and to explore the integration of cooperative learning with other innovative approaches, such as project-based learning and digital technology.

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