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The Effect of Collaborative Problem Solving Learning Model on Students' Collaboration Skills in Chemistry Learning

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Abstract
The low collaboration skills of students are due to the less-than-optimal role of the teacher in fostering interpersonal skills and cooperation in the classroom. Selecting an appropriate learning model is key to effectively enhancing students' collaboration skills. Therefore, the Collaborative Problem Solving (CPS) learning model optimizes students' collaboration skills. This study aims to determine the effect of the Collaborative Problem Solving (CPS) model on students' collaboration skills in elements, compounds, and mixtures. The approach employed is a quasi-experimental design utilizing a non-equivalent control group format. All 8th-grade junior high school students in Samarinda for the 2023/2024 academic year served as the population in this study. Class VIII A was assigned as the experimental group, whereas Class VIII B was the control group. The sample was selected using purposive sampling based on the subject teacher's considerations, including classroom participation, group collaboration, and peer interaction. The instrument used was a collaboration skills questionnaire consisting of 25 statement items, utilizing a 5-point Likert scale. Data collection was also carried out using an observation sheet developed based on the indicators of collaboration skills. The data were analyzed descriptively after being collected through observations and collaboration skill questionnaires. The findings indicated that the experimental group achieved a higher average score than the control group, indicating that the CPS model syntax positively improved students' collaboration skills.

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INTRODUCTION

The advancement of globalization and technological progress demands an educational approach that is relevant to the needs of the 21st century. One of the essential competencies that must be developed is collaboration skills, alongside critical thinking, creativity, and communication. However, students' collaboration skills in Indonesia are still relatively low, ranking 12th globally (Maielfi & Wahyuni, 2020). This condition is attributed to the lack of teachers' attention to the development of students' interpersonal skills. In practice, teachers tend to focus more on content mastery rather than fostering a learning process that involves collaboration. Observational results from the School Field Introduction Program revealed that many students were passive, hesitant to express their opinions, and merely followed their group members' views during discussions.

Collaboration skills are defined as a reciprocal learning process that involves the exchange of perspectives, information, and collective efforts to achieve a common goal (Marisda & Handayani, 2020). According to Pratiwi et al. (2020), the indicators of collaboration skills include: (1) working effectively in groups, (2) adapting to fellow group members, (3) sharing responsibility for collaborative tasks, (4) engaging in group decision-making through discussion, and (5) maintaining effective communication within the group.

The Collaborative Problem Solving (CPS) learning model is an approach that integrates collaborative learning with problem-solving. This model emphasizes interaction among group members in systematically solving problems through the following stages: *share perspective*, *define the issue*, *identify the interest*, *generate options*, *evaluate options*, dan *reach agreement* (Wibawa et al., 2019). Through this sequence, students are encouraged to actively think, engage in discussions, respect others' opinions, and collaboratively construct solutions (Fitriyani et al., 2020; Harisandi et al., 2020). CPS is believed to foster a learning process that is not only meaningful but also effective in cultivating students' collaborative attitudes.

This study introduces an innovation through the implementation of the CPS model specifically in chemistry learning, particularly on the topic of elements, compounds, and mixtures at the junior high school level. This topic is considered abstract and often poses a challenge for students (Eymur & Geban, 2017). Most previous studies have been limited to the use of CPS in mathematics or general science learning (Arta, 2018). Therefore, this study offers a novel approach to enhancing students' collaboration skills through more specific science content (Surya et al., 2022). In addition to addressing practical needs in the field, this study also opens up opportunities for the development of CPS in other concept-based science topics.

The implementation of the CPS model offers a structured solution to the low level of students' collaboration skills through systematic stages. The CPS model encourages students to engage in active interaction, learn to respect one another, and take responsibility within their groups, serving as a relevant alternative for 21st-century learning, this study specifically aims to analyze the effect of the CPS model on students' collaboration skills in learning about elements, compounds, and mixtures

METHOD

Research Design

The quasi-experimental design used was a non-equivalent control group design, involving the division of two classes into experimental and control groups. Both groups will undergo an initial observation (pretest), the treatment, and a final observation (posttest) (Maciejewski, 2020).

Research Sample

The research was conducted at a junior high school in Samarinda during the even semester of the 2023/2024 academic year. The sample was selected using purposive sampling based on specific characteristics and predetermined criteria (Andrade, 2021). The sample included students from classes VIII A and VIII B, with each class consisting of 30 students.

Data Collection Techniques

The instrument used was a collaboration skills questionnaire consisting of 25 statement items, utilizing a 5-point Likert scale. Data collection was also carried out using an observation sheet developed based on the indicators of collaboration skills (Julius, 2018). The CPS model treatment was implemented during the second meeting in the experimental class. The CPS stages applied included: (1) share perspective, (2) define the issue, (3) identify the interest, (4) generate options, (5) evaluate options, and (6) reach agreement. These stages were carried out progressively in a single meeting focused on the topic of elements, compounds, and mixtures.

Data Analysis Techniques

The data were examined through descriptive statistical methods to explain the findings, while hypothesis testing was conducted using the Mann-Whitney U test. The scores from the

observation sheets were processed using the formula and table adapted by Nurpratiwi in (Herlindo et al., 2024) presented below:

$$\text{Score} = \frac{\text{Total Score Obtained}}{\text{/Maximum Possible Score}} \times 100\%$$

Table 1. Student Activity Categories

Percentage	Category
$80 < N \leq 100$	Very Good
$60 < N \leq 80$	Good
$40 < N \leq 60$	Fair
$20 < N \leq 40$	Poor
$0 < N \leq 20$	Very Poor

The processing of questionnaire data is done using the following formula:

$$\text{Score} = \frac{\text{Self-Assessment Score+Peer-Assessment Scoreor peer assesment}}{2}$$

Table 2. Student Response Categories

Percentage	Category
$80 < N \leq 100$	Very Good
$60 < N \leq 80$	Good
$40 < N \leq 60$	Fair
$20 < N \leq 40$	Poor
$0 < N \leq 20$	Very Poor

RESULTS AND DISCUSSION

The research took place at a junior high school in Samarinda through two meetings in two different classes. This study aims to analyze the influence of utilizing CPS on students' collaboration skills. The measurement of collaboration skills was conducted through observation sheets and collaboration questionnaires. The first meeting assessed the initial condition of students in both classes without any treatment. Only the experimental class implemented CPS in the second meeting, while the control class applied the cooperative learning model. The findings before and after the implementation of CPS for the experimental group and cooperative learning for the control group resulted in the following outcomes, as shown in the table below:

Table 3. Average Pretest and Posttest Scores of Students' Collaboration Skills

Class	N	Average Pretest Score	Average Posttest Score
Experimen	30	51.53	85.17
Control	30	53.97	77.83

Based on Table 3, the average pretest scores between the two groups are 51.53 and 53.97, respectively. Therefore, there is no significant difference in collaboration skills between the two classes. Meanwhile, the average posttest results show that the experimental class scored 85.17, while the control class scored 77.83.

Table 4. Results of the Non-Parametric Test

	Sig. Value
Mann-Whitney	118,000
Asym.Sig.(2-tailed)	0,000

As shown in Table 4, the Asymp. Sig. (2-tailed) value is recorded as 0.000, which is below 0.05. Therefore, the difference in students' collaboration skills is evident between the two classes.

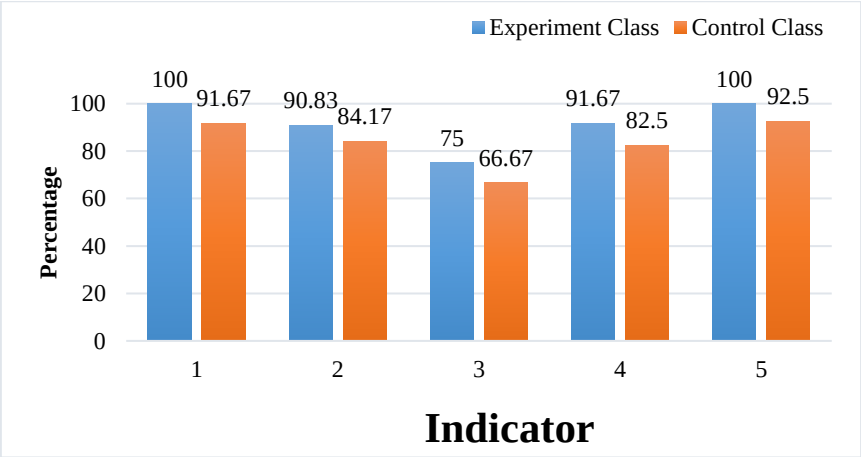

Figure 1. Collaboration Skills Observation Scores

Description:
1 = Effective group collaboration
2 = Adapting to group members
3 = Shared responsibility for collaborative tasks
4 = Deliberation in decision-making
5 = Communication within the group

Figure 1 presents the findings from observing all collaboration skills indicators in assessing the experimental and control classes. Both are categorized as very good, except for the third indicator, which falls under the good category.

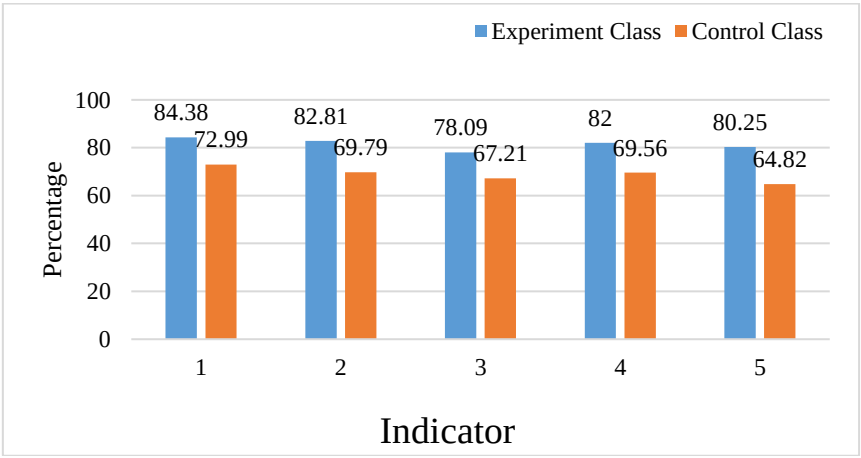

Figure 2. Collaboration Skills Questionnaire Scores

Description:
1 = Effective group collaboration
2 = Adapting to group members
3 = Shared responsibility for collaborative tasks
4 = Deliberation in decision-making
5 = Communication within the group

Figure 2 presents the findings concerning the collaboration skills questionnaire in the experimental class using the CPS learning model. The results indicate that nearly all analyzed indicators fall into the *outstand*ing category, except for the third indicator, which is categorized as *good*. Meanwhile, the control class, which applied the cooperative learning model, showed that all the analyzed indicators fall into the *good* category.

The analysis results show a noticeable difference after students were taught using the CPS learning model. The scores for each collaboration skill indicator show an improvement in the

experimental class compared to the collaborative performance of students in the control class. In line with the study by Hendarwati et al. (2021), the improvement in collaboration skills in learning is influenced by the characteristics of the instructional model used, which aligns with the skills required.

The first observed indicator, effective group collaboration, encourages students to be more actively involved in their groups and work together to solve problems (Pendit et al., 2024). Based on the score outcomes, there is a difference in the experimental class compared to the collaboration skills scores in the control class. This is due to the "generate options" step in the CPS learning model syntax, which guides students to collaboratively develop options or solutions to a given problem (Astuti, 2020). The cooperative learning model generally still encourages students to work in groups; however, the collaboration process in the control class tended to be unstructured (Malan, 2021). Firman et al. (2023) stated that high levels of students' skills in effective group collaboration occur when group members learn to respect different perspectives and use them as a reference point in problem-solving.

The second observed indicator, adapting to fellow group members, aims to help students adjust within the group while working with others. Kurniayati et al. (2025) stated that students can adapt when they ask questions, express their opinions, and work together to complete the assigned tasks. This difference is due to the "define the issue" stage in the CPS learning model, where group members are guided to collaboratively identify the problem or task that needs to be solved, receive feedback from others, and address the issue (Saeed & Ramdane, 2022). In the control class, the model used did not sufficiently encourage students to consciously identify problems collectively or to adapt effectively during the group problem-solving process (Xin et al., 2023). The high level of students' skills in adapting to fellow group members is influenced by how group members can appreciate the diversity of opinions and solutions proposed by others (Firman et al., 2023).

The third observed indicator, which is shared responsibility for collaborative tasks, aims to train students in taking responsibility for completing group work. Based on the score outcomes, there is a difference in the experimental class compared to the collaboration skills scores in the control class. This situation arises from implementing the CPS learning model's "identify the interest" stage. Group members are guided to actively gather the necessary information to design options or solutions for a problem (Astuti, 2020). Cooperative learning allows for task distribution however, it does not emphasize the importance of identifying roles and interests, resulting in an uneven development of students' sense of responsibility in the control class (Gillies, 2016). In line with the findings of Pramasanti et al. (2020), responsibility can be fulfilled by dividing tasks, collaborating on assignments, and assisting peers. Individual responsibility within the group fosters a sense of care among its members.

The ability to deliberate in decision-making is the fourth indicator that was observed. This indicator aims to train students to accept group decisions and appreciate the contributions of others. According to Junita & Wardani (2020), this indicator encourages students to participate actively, making the discussions more enjoyable. Based on the score outcomes, there is a difference in the experimental class compared to the collaboration skills scores in the control class. This stems from the "evaluate options and reach agreement" stage in the CPS approach, which emphasizes the importance of group members being involved in evaluating available options to reach a consensus, with students at the center of the learning activity and the teacher acting as a facilitator (Aeni et al., 2024). Cooperative learning places less emphasis on evaluating decisions made within groups through in-depth consideration. As a result, students' deliberation skills in the control class have not developed optimally (Thakral, 2017).

The fifth indicator in this learning process is communication skills within the group, which aim to train students to accept feedback and consider others' opinions. Based on the score outcomes,

there is a difference in the experimental class compared to the collaboration skills scores in the control class. This is due to the "share perspective" stage, which encourages group members to share their views and knowledge about the problem that must be solved. The improvement in the control class was not as significant as in the experimental class due to the absence of stages such as *sharing perspectives*, which specifically encourage students to express their opinions and systematically listen to others' viewpoints (Rose, 2018). Communication skills are evident when students discuss using language that is easy to understand, whether with their group members or during a presentation in front of the class (Erviani et al., 2022). Communication among students in learning is essential. Communication is effective when opinions are conveyed clearly, leading to positive feedback (Firman et al., 2023).

A learning model is considered impactful when the results of the experimental class and control class differ significantly (Anggraeni et al., 2024). The average posttest score shows that the experimental class using the CPS model scored 85.17, while the control class applying the cooperative model obtained a score of 77.83. In addition, the Mann-Whitney test result of 0.000 indicates a significant effect caused by the applied learning model. Overall, the research findings indicate that the implementation of the Collaborative Problem Solving model has a positive impact on students' collaboration skills. All indicators of collaboration skills showed significant improvement in the experimental class. However, the control class that employed cooperative learning also showed improvement, although at a lower level (Cubero et al., 2018).

This aligns with the findings of Safitri et al. (2024), indicating that collaboration skills can develop naturally through ongoing interaction in the learning process, However, the implementation of the CPS model accelerates and strengthens this development. In other words, the systematic CPS syntax facilitates students' active engagement in every stage of the learning process, ensuring that the development of collaboration skills occurs comprehensively rather than partially (Mohammed et al., 2022). Therefore, the learning process becomes more meaningful and less monotonous (Patimah et al., 2022). Based on the results obtained, the CPS learning model applied to the topic of elements, compounds, and mixtures is considered a valuable instructional approach for enhancing students' collaboration skills. This comparison of results reinforces the finding that the CPS model is more effective than conventional approaches in developing students' collaborative skills.

CONCLUSION

The implementation of the Collaborative Problem Solving (CPS) model in teaching elements, compounds, and mixtures has been proven to significantly enhance students' collaboration skills. All collaboration indicators showed significant improvement in the experimental class compared to the control class, thanks to the CPS syntax that promotes active interaction and shared responsibility. The impact of this study demonstrates that CPS can create a more participatory learning environment that is relevant to the needs of the 21st century. The novelty of this research lies in the specific application of the CPS model in junior high school chemistry instruction, an area that has been rarely explored in previous studies.

RECOMMENDATIONS

Based on the research conducted, future researchers are encouraged to implement the CPS model to enhance students' collaboration skills in other areas of chemistry and examine its effect on collaboration skills across different sample groups.

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