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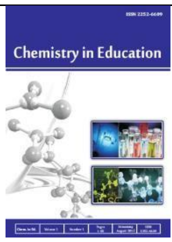

The Effect of the Six Thinking Hats Strategy on Student Grouping to Improve Problem-Solving Skills and Concept Mastery in Reaction Rate Material

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ABSTRAK

Penelitian ini bertujuan untuk menganalisis pengaruh strategi Six Thinking Hats terhadap peningkatan keterampilan pemecahan masalah dan pemahaman konsep siswa pada materi laju reaksi. Metode penelitian yang digunakan adalah kuasi-eksperimen dengan desain non-equivalent control group. Instrumen penelitian meliputi tes penguasaan konsep (pretest dan posttest), lembar kerja peserta didik (LKPD), serta angket respons siswa. Data dianalisis menggunakan uji Mann-Whitney U, uji Friedman, korelasi Rank Spearman, serta perhitungan effect size. Hasil penelitian menunjukkan bahwa penerapan strategi Six Thinking Hats memberikan pengaruh yang signifikan terhadap peningkatan kemampuan pemecahan masalah dan pemahaman konsep siswa. Hal ini ditunjukkan oleh hasil uji Mann-Whitney U pada setiap LKPD ($p < 0.05$) serta nilai effect size yang berada pada kategori besar hingga sangat besar (Cohen's d = 1,15; 1,48; 0,56; dan 2,99). Uji Friedman juga menunjukkan adanya perbedaan kinerja yang signifikan antar-LKPD pada kelas eksperimen maupun kelas kontrol ($p = 0{,}000$). Pada aspek pemahaman konsep, ditemukan perbedaan yang signifikan ($p = 0{,}000$), dengan peningkatan nilai Cohen's d dari 0,65 (sedang) menjadi 2,08 (besar). Namun demikian, hasil uji korelasi Rank Spearman menunjukkan bahwa tidak terdapat hubungan yang signifikan antara pemahaman konsep dan kemampuan pemecahan masalah. Temuan ini mengindikasikan bahwa konteks penilaian individu dan kolaboratif memberikan pengaruh yang berbeda terhadap capaian belajar siswa.

ABSTRACT

This study aims to analyze the effect of the Six Thinking Hats strategy on enhancing students' problem-solving skills and conceptual understanding in the topic of reaction rates. The research employed a quasi-experimental method using a non-equivalent control group design. Instruments included concept mastery tests (pretest and posttest), student worksheets (LKPD), and student response questionnaires. Data were analyzed using the Mann-Whitney U test, the Friedman test, Spearman's Rank correlation, and effect size calculations. The results showed that the implementation of the Six Thinking Hats strategy had a significant impact on the improvement of students' problem-solving abilities and conceptual understanding, as indicated by the Mann-Whitney U test results for each LKPD ($p < 0.05$) and large to very large effect sizes (Cohen's d = 1.15; 1.48; 0.56; and 2.99). The Friedman test revealed statistically significant differences in performance across LKPDs in both the experimental and control classes ($p = 0.000$). In terms of conceptual understanding, a significant difference was observed ($p = 0.000$), with an increase in Cohen's d from 0.65 (moderate) to 2.08 (large). However, the Spearman Rank correlation test indicated no significant relationship between conceptual understanding and problem-solving ability, suggesting that individual and collaborative assessment contexts influence student outcomes differently.

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INTRODUCTION

Education holds a strategic role in preparing a generation that excels not only in academic achievement but also in critical thinking and independent problem-solving. According to Law No. 20 of 2003, education is defined as a conscious and deliberate effort to create a learning process that enables students to actively develop their full potential (Permendikbud, 2016). In alignment with this principle, the Merdeka Curriculum has been introduced as a response to the need for a more flexible, adaptive, and meaningful educational approach, with a strong emphasis on the mastery of 21st-century skills, including problem-solving abilities (Siahaan et al., 2017). In the context of rapid social transformation and technological advancement, it is essential for students to be equipped with the ability to analyze problems, process relevant information, and develop solutions grounded in conceptual understanding (Surya, 2023).

Problem-solving is strongly associated with conceptual understanding, as both play a complementary role in the process of scientific thinking. Students with a solid grasp of concepts are more likely to develop appropriate and effective problem-solving strategies (Winarsih & Nisa, 2024). Conceptual mastery serves as a fundamental basis for continuously improving students' learning quality (Ihsan et al., 2019). However, in reality, chemistry education in schools is still largely dominated by conventional approaches. As a result, complex topics such as reaction rates are often perceived as difficult, as they require abstract reasoning and mathematical skills (Ristiyani & Bahriah, 2016). This leads to a lack of student interest and difficulty in connecting conceptual knowledge with real-world phenomena (Wiratma & Subagia, 2015). In fact, the primary aim of chemistry education is to help students explain everyday events scientifically and solve problems based on conceptual understanding (Demircioğlu & Çağatay, 2013).

Problem-Based Learning (PBL) is an instructional model that effectively enhances students' thinking skills by using contextual problem-solving as the foundation for learning (Aiyesi & Annisa, 2023). However, observations and interviews conducted at SMA Negeri 9 Semarang revealed that its implementation remains suboptimal. Students were often confused, lacked understanding of the problems, and were unmotivated to participate actively, primarily due to the absence of a a structured thinking framework, resulting in ineffective group work. To address this issue, the Six Thinking Hats strategy, which divides the thinking process into six distinct perspectives: facts (white), feelings (red), risks (black), benefits (yellow), creativity (green), and process control (blue) can be utilized as a complementary tool within the PBL approach (De Bono, 1999; Asfuri, 2019). Integrating this strategy into student group organization aims to clarify individual roles during discussion, broaden the exploration of diverse viewpoints, and improve both problem-solving skills and conceptual understanding, particularly in the topic of reaction rates. This integration is expected to promote a more active, relevant, and meaningful learning experience.

METHODS

This study employed a quantitative method with a quasi-experimental approach, using the Pretest-Posttest Only Control Group Design. The subjects were 11th-grade students at SMA Negeri 9 Semarang, specifically class XI.5 as the experimental group and class XI.6 as the control group, with 36 students in each class. The samples were selected using a combination of purposive sampling and cluster random sampling techniques. Data were collected through preliminary observation, tests (pretest and posttest), student worksheets (LKPD), response questionnaires, and documentation. Conceptual understanding was measured using a multiple-choice test consisting of 15 items covering cognitive levels C2 to C5 of Bloom's Taxonomy, administered before and after the treatment in both classes. Problem-solving skills were analyzed based on the results of four group worksheets developed according to Polya's problem-solving stages, covering the following topics: (1) collision theory and the concept of reaction rate, (2) factors affecting reaction rates, (3) reaction order and rate laws, and (4) the application of reaction rate concepts in daily life. As supporting data, a Likert-scale response questionnaire was used to assess students' perceptions of the implementation of the Six Thinking Hats strategy in the experimental class after the treatment, along with relevant documentation.

RESULT AND DISCUSSION

Result

Descriptive statistical analysis of the pretest and posttest scores is presented in Table 1.

Table 1. Descriptive Statistics of Pretest and Posttest Data

	N	Minimum	Maximum	Mean	Std. Deviation
Experimental Pretest	36	33	78	58,58	11,685
Control Pretest	36	33	71	51,19	10,985
Experimental Posttest	36	75	100	90,67	5,865
Control Posttest	36	60	88	75,17	8,729
Valid N (listwise)	36				

A more detailed analysis of the four LKPD results from both classes is shown in Table 2.

Table 2. Descriptive Statistics of LKPD Data

LKPD	Class	N	Minimum	Maximum	Mean	Std. Deviation
1	Experimental	36	70	85	77,50	4,629
	Control	36	60	82,5	70,42	7,380
2	Experimental	36	78	86	81,67	2,726
	Control	36	68	84	75,67	5,026
3	Experimental	36	70	85	76,25	5,018
	Control	36	65	82,5	73,33	5,412
4	Experimental	36	80	90	83,47	3,745
	Control	36	67,5	77,5	72,50	3,586

Results of the Effect Test of the Six Thinking Hats Strategy on Problem-Solving Skills

The effect of the Six Thinking Hats strategy implementation was analyzed using the Mann–Whitney U test with the assistance of IBM SPSS Statistics 30 software. The results are presented in Table 3.

Table 3. Results of the Mann–Whitney U Test on LKPD Scores

LKPD	Eksperimental (Rata-rata Rank)	Control (Rata-rata Rank)	p-value	Conclusion
1	47,00	26,00	0,000	Significantly different
2	49,50	23,50	0,000	Significantly different
3	41,50	31,50	0,038	Significantly different
4	54,50	18,50	0,000	Significantly different

The test results showed that the significance values for LKPD 1 to LKPD 4 were all less than 0.05, indicating a statistically significant difference between the experimental and control groups.

Results of the Effect of the Six Thinking Hats Strategy on Concept Mastery

The effect of the Six Thinking Hats strategy on students' conceptual understanding was analyzed through the results of the pretest and posttest. The Mann–Whitney U test was conducted using IBM SPSS Statistics 30 to analyze the pretest and posttest scores, and the results are presented in Table 4.

Table 4. Results of the Mann–Whitney U Test on Pretest and Posttest Scores

Data	Eksperimental (Rata-rata Rank)	Control (Rata-rata Rank)	p-value	Conclusion
Pretest	43,03	29,97	0,008	Significantly different
Posttest	51,97	21,03	0,000	Significantly different

Discussion

The pretest results indicated that the initial abilities of both classes were relatively comparable, although the experimental class performed slightly better. After the intervention, the experimental class showed a significant improvement in posttest scores, suggesting that the Six Thinking Hats strategy was effective in enhancing students' conceptual understanding of reaction rates. Furthermore, the average scores of the worksheets (LKPD) in the experimental class demonstrated a more consistent increase compared to the control class. This indicates that the systematic thinking approach fostered by the Six Thinking Hats strategy encouraged students to be more active and structured in solving problems. Students became more capable of identifying problems, designing and implementing solutions, and evaluating their outcomes.

Before conducting statistical analysis, prerequisite tests in the form of normality and homogeneity tests were carried out. The normality test using the Kolmogorov-Smirnov method showed that the pretest data for the experimental class (0.187) and the control class (0.052), as well as the posttest data for the experimental class (0.111) and the control class (0.148), all had significance values greater than 0.05, indicating that the data were normally distributed. Conversely, the worksheet (LKPD) scores were not normally distributed, as all significance values were less than 0.05. Based on these conditions, the overall statistical analysis in this study was conducted using non-parametric techniques (Mann-Whitney U test), as recommended by Field (2013) when the assumption of normality is violated. Homogeneity testing was conducted using Levene's test and applied only to the pretest and posttest data. The results indicated that the pretest data had homogeneous variance (significance = 0.681 > 0.05), while the posttest data did not share equal variance (significance = 0.013 < 0.05), indicating a difference in variance between the two groups.

The Effect of the Six Thinking Hats Strategy on Problem Solving

The effect of implementing the Six Thinking Hats strategy in problem-based learning on students' problem-solving abilities was analyzed using the Mann-Whitney U test. The test results showed that the significance values for LKPD 1 through LKPD 4 were all less than 0.05, indicating a significant difference between the experimental and control classes. These findings support Arends' (2012) view that problem-based learning is effective in fostering critical thinking skills and contextual problem-solving. The achievement data for the Student Worksheet (LKPD) scores in both classes are presented in Figure 1.

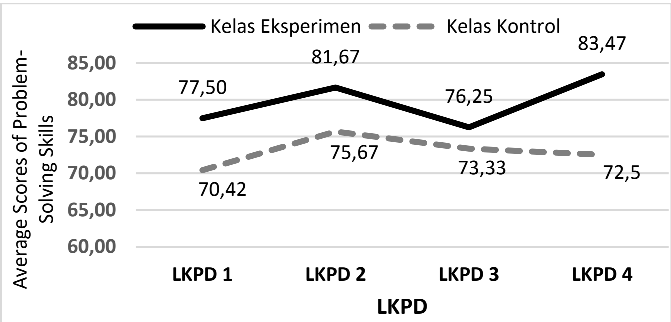

Figure 1. Graph of the Average Scores of Problem-Solving Skills

The experimental class showed a consistent increase in scores, from an average of 77.50 on Worksheet 1 (LKPD 1) to 81.60 on Worksheet 2, thanks to the implementation of the Six Thinking Hats strategy, which encouraged students to think in a structured manner. Although the score declined to 76.50 on Worksheet 3 due to challenges in quantitative material, an increase was observed again on Worksheet 4, reaching 83.47. This improvement was influenced by the relevance of the learning context and the exploration of multiple thinking perspectives. These results align with the views of De Bono (1999) and Rahmawati et al. (2022), who stated that real-world contexts and parallel thinking frameworks can enhance problem-solving skills.

Conversely, the average scores in the control class tended to fluctuate. The average score increased from 70.42 in Worksheet 1 to 75.67 in Worksheet 2, but then decreased to 73.33 in Worksheet 3 and

72.50 in Worksheet 4. This decline is associated with the more abstract nature of the material and the absence of a structured discussion framework, such as the one provided by the Six Thinking Hats strategy. Discussions in the control class followed only Polya's steps without specific thinking roles, resulting in less effective collaboration and higher dependence on dominant students. When working on more application-based worksheets like Worksheet 4, students in the control class tended to feel confused and struggled to explore the problems deeply. This reinforces the findings of Dori & Herscovitz (1999) and Zimmerman (2002), who stated that success in contextual problem solving is highly influenced by critical thinking facilitation, structured learning support, and directed self-regulation strategies.

Students' problem-solving skills in this study were analyzed based on four indicators adapted from Polya (Nurmawati et al., 2021). The discussion begins with the achievement of the understanding the problem skill, as illustrated in Figure 2.

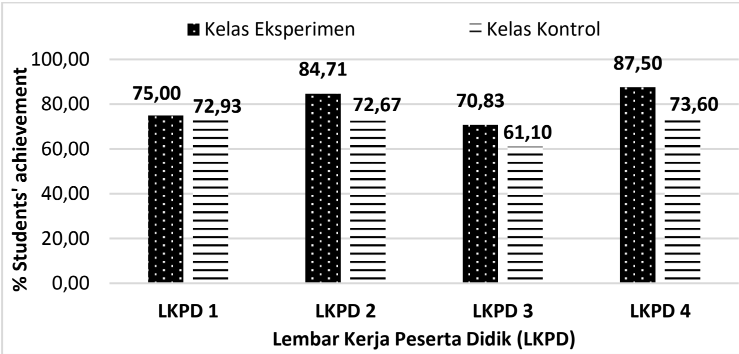

Figure 2. Percentage of Achievement in the "Understanding the Problem" Indicator

The analysis results in Figure 2 show a consistent difference in students' achievement in the "understanding the problem" skill between the experimental and control classes. In Worksheet 1 (LKPD 1), the experimental class achieved 75.00%, slightly higher than the control class (72.93%) due to the role of the white hat in helping students identify problems. The achievement increased significantly in Worksheet 2 (84.71% vs. 72.67%) with the support of the red hat, which encouraged emotional engagement. Although there was a decline in Worksheet 3 (70.83% vs. 61.10%) due to the complexity of mathematical aspects, the experimental class still outperformed the control. In Worksheet 4, the experimental class's achievement rose again (87.50% vs. 73.60%) as a result of problem contexts that were closely related to real-life situations. These results indicate that the integration of the white and red hats can strengthen students' understanding of problems in a comprehensive manner.

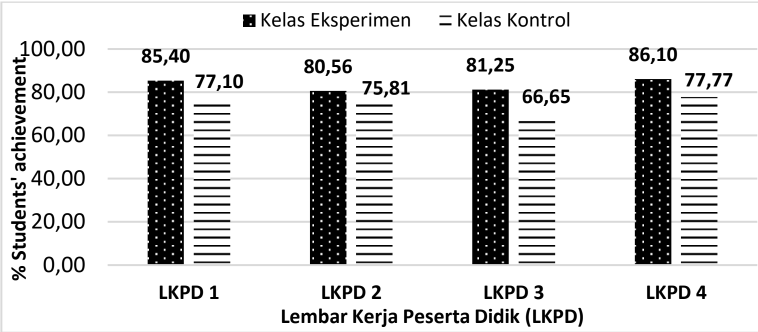

Figure 3. Percentage of Achievement in the "Planning Problem Solving" Skill

The graph in Figure 3 shows that students' achievement in the skill of planning problem solving in the experimental class was consistently higher than that of the control class across all worksheets. In Worksheet 1, the experimental class achieved 85.40%, compared to 77.10% in the control class. This reflects the role of the Six Thinking Hats strategy particularly the black and yellow hats in supporting the formulation of plans by considering both risks and benefits. This trend continued through Worksheet 4, with the experimental class reaching its highest achievement at 86.10%. In contrast, the control class experienced a decrease in Worksheet 3 (66.65%) and stagnation in Worksheet 4 (77.77%), indicating difficulties in designing solutions without the support of a structured thinking framework.

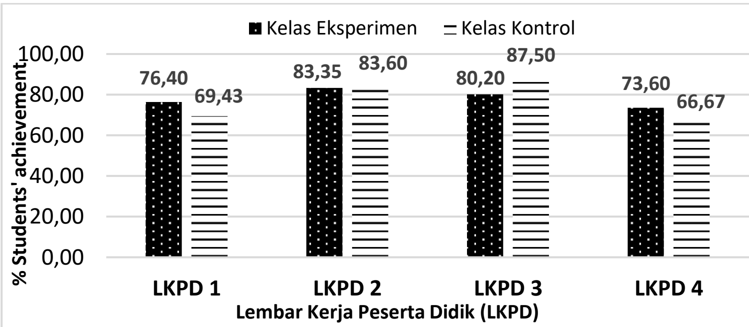

Figure 4. Percentage of Achievement on the Indicator "Implementing the Solution"

Based on Figure 4, the achievement on the "Implementing the Solution" indicator shows varied results. The experimental class outperformed in LKPD 1 and 4, while the control class scored higher in LKPD 2 and 3, especially in LKPD 3. This is presumed to be due to the control class being more accustomed to direct approaches, while the experimental class was still adapting to the structured thinking pattern. Nevertheless, in real-life contexts such as in LKPD 4, the Six Thinking Hats strategy appeared to be more effective in encouraging relevant solutions.

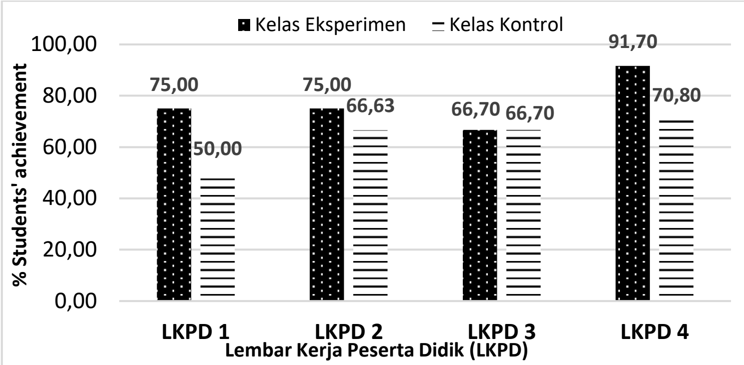

Figure 5. Percentage of Achievement on the 'Rechecking' Indicator

Based on Figure 5, the achievement on the "Reviewing the Solution" indicator shows that the experimental class consistently outperformed the control class across all LKPDs. For example, in LKPD 1, the experimental class reached 75.00%, while the control class only achieved 50.00%, and it peaked in LKPD 4 with 91.70% compared to 70.80%. This advantage reflects the effectiveness of the blue hat in helping students reflect, monitor, and improve their solutions in a structured manner. These findings are consistent with Chien (2020), who stated that the implementation of the Six Thinking Hats can enhance reflection and metacognitive awareness.

The Friedman test was also conducted to analyze differences in students' problem-solving achievement across each session (LKPD 1-4) within the same class (intragroup). The Friedman test revealed a significant difference in problem-solving achievement among the LKPDs in both the experimental and control classes (p = 0.000). In the experimental class, the highest achievements were found in LKPD 2 and 4, while the lowest was in LKPD 3, indicating that the Six Thinking Hats strategy had a gradual yet varied impact. In contrast, the control class showed inconsistent performance; although achievement peaked in LKPD 2, it declined in LKPD 4 due to the absence of a systematic thinking pattern.

In addition to the significance test, an effect size calculation was conducted to determine the magnitude of the impact of implementing the Six Thinking Hats strategy on problem-solving skills.

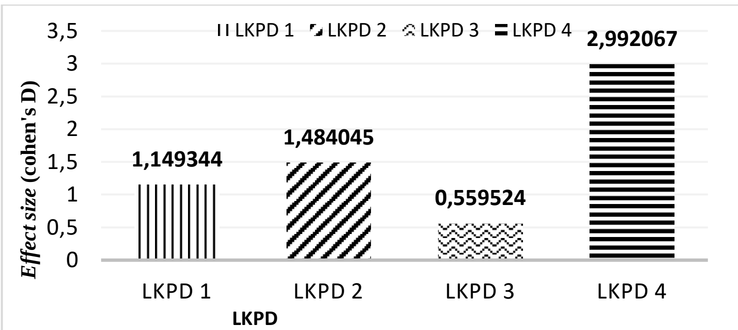

Figure 6. Effect Size (Cohen's d) for Each Worksheet (LKPD)

The effect size analysis using Cohen's d in Figure 6 shows that the Six Thinking Hats strategy had varying impacts on students' problem-solving skills. The effect size values for LKPD 1 and 2 were 1.149 and 1.484 respectively (large category), indicating a significant contribution from the start. The value decreased to 0.560 in LKPD 3 (medium category), possibly due to more complex material. However, effectiveness sharply increased in LKPD 4 with a value of 2.992 (very large category), indicating that this strategy strongly supports problem-solving at the end of the learning process.

The Effect of the Six Thinking Hats Strategy on Concept Mastery

The effect of the Six Thinking Hats strategy on students' concept mastery was analyzed through pretest and posttest results using the Mann-Whitney U test. The pretest results showed an average rank of 43.03 for the experimental class and 29.97 for the control class, with a significance value of 0.008, indicating a significant difference before the treatment. Although the initial conditions were not balanced, the analysis was continued as permitted by Fraenkel et al. (2012). The posttest results revealed a greater difference, with an average rank of 51.97 for the experimental class and 21.03 for the control class, and a significance value of 0.000. This shows that the Six Thinking Hats strategy significantly improved concept mastery. Students' concept mastery was further analyzed by comparing pretest and posttest scores in both the experimental and control classes. The pretest and posttest achievement data for both classes are presented in Figure 7.

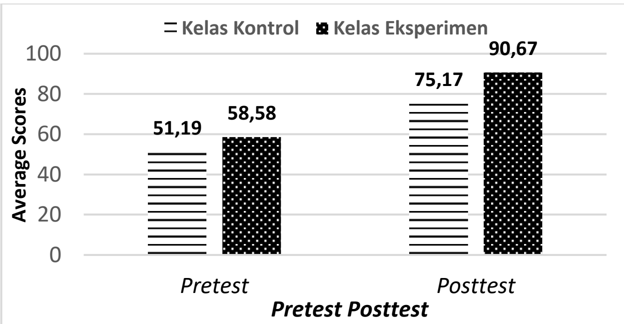

Figure 7. Concept Mastery Achievement in the Control and Experimental Classes

Based on Figure 7, the average pretest score of the experimental class increased from 58.58 to 90.67 on the posttest, while the control class increased from 51.19 to 75.17. The score improvement in the experimental class (32.09 points) was higher than in the control class (24.98 points), indicating that the implementation of the Six Thinking Hats strategy was more effective in improving concept mastery. The test used covered the aspects of understanding, applying, analyzing, and evaluating in accordance with the revised Bloom's Taxonomy (Anderson & Krathwohl, 2001).

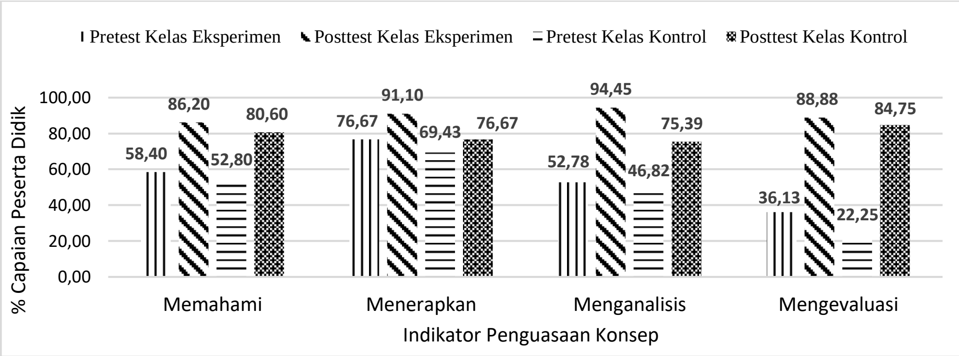

Figure 8. Percentage of Concept Mastery Indicator Achievement

Based on Figure 8, all concept mastery indicators showed improvement after the learning process, both in the experimental and control classes. In the experimental class, the analyzing indicator had the highest achievement in the posttest at 94.45%, while in the control class, the highest achievement was in the evaluating indicator at 84.75%. The Six Thinking Hats strategy implemented in the experimental class provided a clear structure for discussion through the division of thinking roles, such as the white hat (information), black hat (risks), yellow hat (benefits), green hat (new ideas), red hat (intuition), and blue hat (process control).

The improvement in the evaluating indicator was also significant: the experimental class increased by 52.75% (from 36.13% to 88.88%) and the control class by 62.50% (from 22.25% to 84.75%). This high achievement is related to evaluative judgement, which involves critically assessing the quality of information and solutions (Blackie et al., 2023). Although both classes used the Problem-Based Learning model, the structured thinking provided by the Six Thinking Hats strategy helped students evaluate more systematically.

For the understanding indicator, the experimental class's achievement increased by 27.80% to 86.20%, while the control class reached 80.60%. This improvement was influenced by the use of the white and red hats, which helped students examine information and construct meaning aligned with the theory of meaningful learning. For the applying indicator, the experimental class increased from 76.67% to 91.10%, while the control class rose from 69.43% to 76.67%. The white, blue, and green hats supported students in logically structuring their responses to calculation-based questions. Generally, the combination of problem-based learning and the Six Thinking Hats strategy was more effective in improving conceptual understanding.

To determine the strength of the learning strategy's effect on students' conceptual achievement, an effect size analysis was conducted using Cohen's d formula.

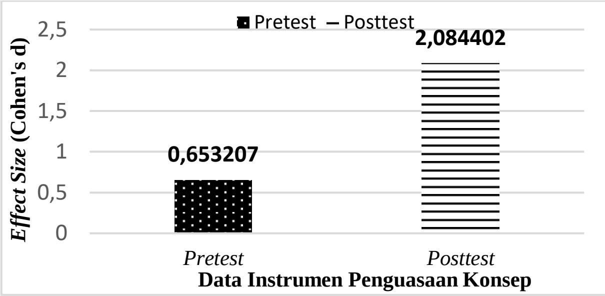

Figure 9. *Effect Size* (Cohen's d) *Pretest Posttest*

Based on Figure 9, the pretest effect size value of 0.65 (medium category) indicates that the initial conceptual understanding was relatively balanced. After the learning intervention, the posttest effect size increased to 2.08 (large category), indicating a strong influence of the Six Thinking Hats strategy in enhancing conceptual mastery. This method supports students in engaging in structured thinking from understanding to evaluating making the learning process more active and in-depth.

Students' Responses to the Learning Process in the Experimental Class

The questionnaire was administered to the experimental class to determine students' responses to the Six Thinking Hats strategy. The instrument used a 4-point Likert scale with 24 statements, covering aspects of problem-solving and conceptual understanding. Responses from 36 participants were categorized into four levels, as shown in Figure 10.

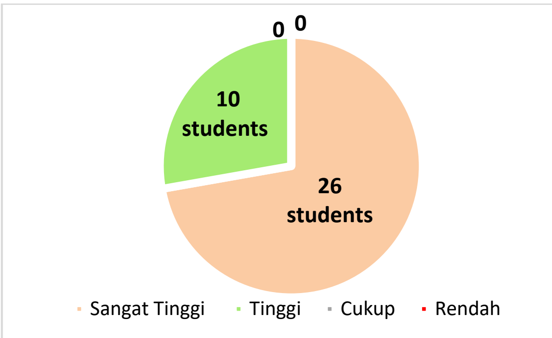

Figure 10. Distribution of Students' Problem-Solving Response Questionnaire

Based on the results in Figure 10, out of 36 respondents, 26 students (72.22%) showed a very high response and 10 students (27.78%) showed a high response. No respondents were found in the moderate or low categories. These results indicate that students gave very positive responses to the learning process, with a high level of engagement.

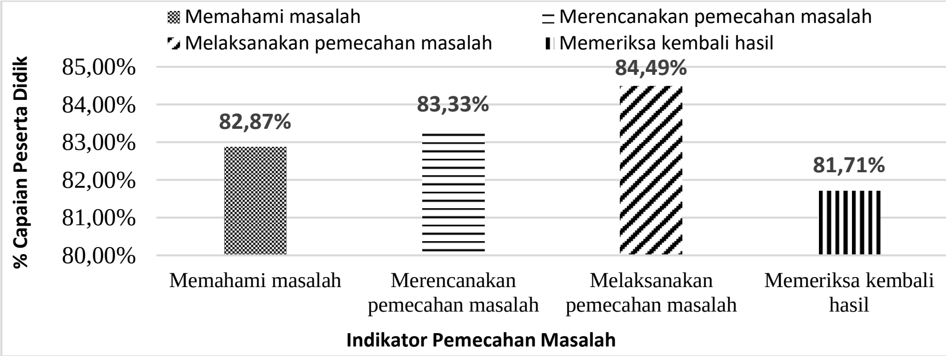

Figure 11. Results of the Questionnaire Analysis on Students' Responses to the Problem-Solving Indicators

Based on Figure 11, the indicator "implementing problem-solving" received the highest score of 84.49%, indicating the effective role of the green hat in fostering creativity. This was followed by the indicators " making plans" (83.33%), "understanding the problem" (82.87%), and "reviewing the results" (81.71%), each reflecting the contribution of the thinking hats in supporting the problem-solving process.

Students' responses regarding concept mastery were analyzed through a questionnaire consisting of 12 statements, covering four indicators based on Bloom's Taxonomy: understanding, applying, analyzing, and evaluating.

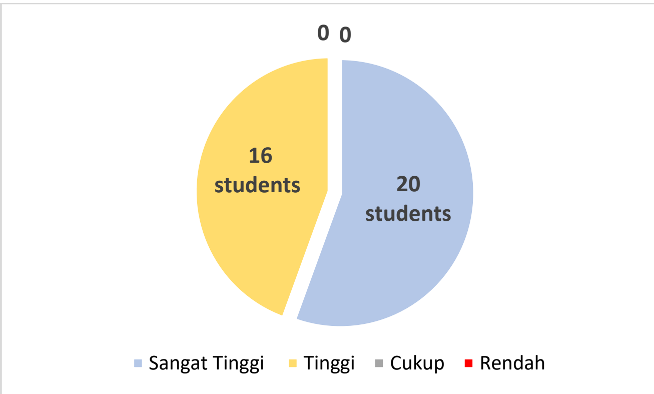

Figure 12. Distribution of Students' Concept Mastery Response Questionnaire

Based on the 36 respondents shown in Figure 12, 20 students were in the very high category and 16 students in the high category, with none falling into the moderate or low categories. This indicates that the Six Thinking Hats strategy is effective in supporting students' concept mastery and problem-solving skills.

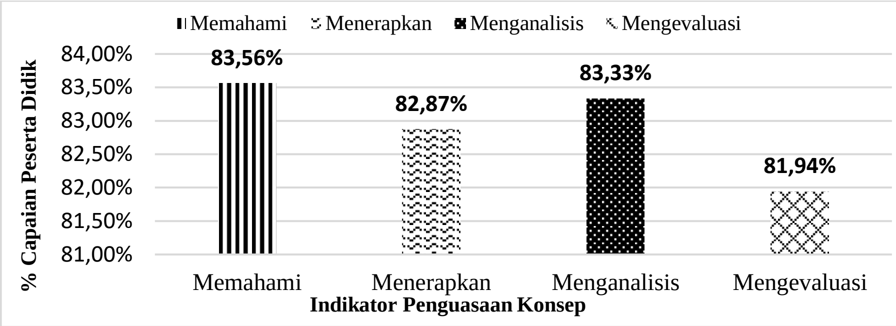

Figure 13. Results of the Questionnaire Analysis on Students' Responses to Concept Mastery Indicators

Based on the analysis of Figure 13, students' responses regarding their chemistry concept mastery after problem-based learning using the Six Thinking Hats strategy were classified as excellent across all Bloom's taxonomy indicators. The "understanding" indicator received the highest score (83.56%), thanks to the role of the White and Yellow Hats in building comprehension through factual information and positive perspectives. The "analyzing" (83.33%) and "applying" (82.87%) indicators reflected students' ability to break down and use concepts in real contexts, influenced by the roles of the Black, Green, and Red Hats. The "evaluating" indicator (81.94%) was also very good, although further reinforcement is needed for the Blue Hat's role in encouraging reflection. These findings align with Vygotsky's and Bruner's constructivist theories, which emphasize the importance of meaningful experiences and social interaction, thus proving that the Six Thinking Hats strategy is effective in enhancing concept mastery through collaborative and directed thinking.

Correlation Test Results between Concept Mastery and Problem-Solving Skills

The Spearman Rank correlation test was used because the data were not normally distributed, to examine the relationship between concept mastery and problem-solving skills in the experimental and control classes, using pretest and Worksheet 1 scores (initial), as well as posttest and Worksheet 4 scores (final). The results showed no significant relationship in either class, with correlation coefficients in the experimental class of 0.115 ($p = 0.504$) and 0.223 ($p = 0.190$), and in the control class of 0.147 ($p = 0.393$) and 0.269 ($p = 0.113$), as all p-values were greater than 0.05. This indicates that collaborative problem-solving results in the worksheets do not always align with concept mastery measured individually through tests. This may be due to differences in assessment context, where worksheets were completed collaboratively with assigned thinking roles, while tests were taken individually. As explained by Rafi & Pourdana (2023) and Brundage et al. (2023), collaborative thinking skills can develop through group discussions, but they do not always directly reflect individual cognitive mastery, since these two approaches assess different aspects of cognition.

CONCLUSION

The implementation of the Six Thinking Hats strategy has been proven to have a significant impact on improving both problem-solving skills and conceptual understanding. The Mann-Whitney U test results showed significant differences between the experimental and control classes for each LKPD ($p < 0.05$), reinforced by effect size values categorized as large to very large ($d = 1.15$; 1.48; 0.56; and 2.99), indicating a strong influence of this instructional strategy. The Friedman test in the experimental class also revealed significant differences in achievements from LKPD 1 to LKPD 4 ($p = 0.000$), with a more stable upward trend compared to the control class, which tended to be inconsistent. In terms of conceptual understanding, the experimental class showed a significant improvement from pretest to posttest ($p = 0.000$), with Cohen's d increasing from 0.65 (medium) to 2.08 (large). Meanwhile, the Spearman Rank correlation test results indicated no significant relationship between conceptual understanding and problem-solving ability, suggesting that achievements in collaborative and individual contexts follow different cognitive pathways.

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