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Enhancing the Students' Problem-Solving Skills through Situation-Based Learning with the Six Thinking Hats Technique

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Abstract

Background: Problem-solving skills are essential in learning, particularly in addressing complex situations that require multi-perspective analysis. Many students face difficulties in systematic thinking, leading to ineffective problem-solving. Enhancing these skills is crucial for overcoming daily challenges.
Aims: This research aims to improve the problem-solving skills of Grade 11 students in Electrochemistry, targeting a minimum criterion of 70% proficiency through the integration of Situation-Based Learning and the Six Thinking Hats technique.
Methods: This study employed the action research in three cycles with 31 Grade 11 students from Sarakhampittayakhom School, Thailand. Research instruments included (1) lesson plans based on Situation-Based Learning and the Six Thinking Hats technique, (2) problem-solving skills tests, (3) observation sheets for problem-solving behaviors, and (4) student interview guides. Quantitative data were analyzed using averages and percentages, while qualitative data were evaluated through content analysis.
Results: The findings indicate a significant improvement in students' problem-solving skills over the three cycles. In the first cycle, 13 students (41.94%) achieved the 70% criterion, increasing to 20 students (64.52%) in the second cycle and lastly, 28 students (90.32%) in the third cycle. This progression highlights the effectiveness of the proposed technique in enhancing problem-solving skills by fostering independent thinking, exploring diverse perspectives, and evaluating solutions comprehensively.
Conclusion: Students receiving Situation-Based learning with the Six Thinking Hats technique show increased problem-solving skills. Therefore, this approach can significantly enhance the problem-solving skills of the target group.

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INTRODUCTION

In contemporary society, scientific learning plays a vital role in knowledge development and the cultivation of essential 21st-century skills. Effective science education enhances students' critical, logical, creative, and analytical thinking, with problem-solving at its core (García-Carmona, 2023; Gencer & Doğan, 2020). A conducive learning environment fosters engagement in the scientific process, enabling students to understand scientific concepts deeply and apply them effectively in real-life situations (Hestiana & Rosana, 2020). Developing systems thinking and problem-solving skills equips students to analyze information, make informed decisions, and address real-world challenges (Sattrapruek, 2017). Hands-on science activities provide a practical avenue for cultivating these skills. For instance, experiments such as investigating chemical reactions or simulating ecosystems allow students to hypothesize, test, and draw conclusions. These activities encourage critical analysis, predictions, and iterative improvements based on real-time outcomes, fostering robust problem-solving abilities (Wadtan et al., 2023). Such experiences not only enhance understanding of scientific principles but also prepare students for complex and dynamic problem-solving scenarios. Ultimately, promoting problem-solving abilities is an essential component of

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educational management. By engaging students in real-world learning and classroom-based problem-solving practices, educators can help develop intellectual capacities that form a lifelong foundation for personal and professional success.

A systematic understanding of problem-solving is essential to fully harness its benefits in science education. Problem-solving skills equip students with the skills to analyze situations, utilize knowledge, and apply critical thinking to gather, evaluate, and validate information for proposing effective solutions (Gündüz et al., 2016). Beyond basic understanding, this skill demands mastery of theories, principles, and processes that enable students to address challenges across diverse contexts effectively. Meunier & Hudon (2020) highlight a structured approach to problem-solving that enhances students' ability to address real-world challenges systematically. The process involves four sequential steps: (1) Statement of the Problem, (2) Defining the Problem, (3) Searching for and Formulating a Hypothesis, and (4) Verifying the Solution. These steps guide learners to develop solutions rooted in causation, analyze outcomes critically, and refine their strategies for future problem-solving scenarios. Teachers play a crucial role in fostering these abilities within the classroom. By designing and implementing targeted learning activities, educators can instill effective problem-solving strategies that are both practical and adaptable to real-life situations (Göktaş & Yazici, 2020; Iwuanyanwu, 2020; Koculu et al., 2022). This structured approach not only cultivates intellectual growth but also equips students with lifelong skills, enabling them to navigate complex challenges with confidence and adaptability.

A notable decline in students' problem-solving abilities in chemistry has posed a significant educational challenge, exacerbated by disruptions caused by the COVID-19 pandemic. These disruptions negatively impacted academic performance, particularly in tasks requiring advanced problem-solving skills, as students adjusted to remote or hybrid learning environments (Demir, 2022; UNESCO, 2021; OECD, 2020; Nold, 2017). At Sarakhampittayakom School, a report from the science department highlighted that the average chemistry score of students reached only 56.34%, significantly below the expected 70% benchmark—a target designed to reflect essential problem-solving proficiency for real-world applications (Sarakhampittayakhom School, 2022). This gap in performance reveals critical challenges in students' application of knowledge to practical problems. Students often struggle to identify key issues, define problems clearly, and develop appropriate solutions within various situational contexts. An assessment in 2023, utilizing a written problem-solving test based on a four-step framework (Weir, 1974), revealed that 31 students failed to meet the benchmark. This test, consisting of 12 items and a total score of 36, assessed students' ability to articulate problems, hypothesize solutions, and validate outcomes. Analysis of the results indicated that students below the threshold struggled with analyzing situational information and constructing systematic solutions (Woods, 1987; Kilpatrick et al., 2013). Additional observations shed light on underlying barriers. Some students resorted to copying answers without comprehending the problem-solving process, while others faced challenges applying their understanding to practical scenarios. These findings underscore the necessity of introducing instructional methods that bridge these gaps and foster a deeper understanding of problem-solving. Situation-Based Learning has demonstrated potential as an effective solution to these issues. This approach has been shown to stimulate student engagement and enhance logical reasoning and problem-solving skills (Nancha & Buaraphan, 2024; Ambarita et al., 2022; Utari et al., 2019; Ardagh et al., 2016). By immersing students in real-world scenarios, it fosters meaningful engagement, encourages practical application, and builds systematic thinking skills that enhance their problem-solving abilities.

Although various studies have highlighted the importance of problem-solving skills in science education, most of these studies have focused on conventional teaching approaches. Previous research, such as that conducted by Antonio & Prudente (2023), Choowong & Worapun (2021), Gómez & Suárez (2020), Ješková et al. (2022), Mat et al. (2023), Oktaviani et al. (2023), Siboro (2024), and Yonyubon et al. (2022), suggests that effective educational strategies, such as active learning and inquiry-based learning, can improve students' critical and analytical thinking skills. However, these approaches generally have not integrated innovative techniques such as the Six Thinking Hats in Situation-Based Learning, which have the potential to provide multidimensional perspectives and encourage systematic thinking among students. In addition, although several studies have shown that real-world problem-solving contexts can improve student engagement and understanding (Alfares, 2021; Morsy & Darweesh, 2020; Nur et al., 2020; Villarta et al., 2021), these studies seldom examine the effectiveness of combining innovative methods with practical approaches in science education.

Situation-based learning management integrates real-life scenarios into students' learning experiences, fosters critical thinking, and encourages independent decision-making in problem-solving (Khairati et al., 2021; Nancha & Buaraphan, 2024). Through this approach, students gain the essential knowledge and skills necessary for situation problem-solving through analytical thinking, fostering their ability to address daily and future challenges (Suhaebar & Isrokatun, 2019). This approach also helps students develop problem-solving skills and creative thinking through meaningful, contextually relevant learning experiences (Youn et al., 2025). Therefore, to develop problem-solving skills, it is necessary to encourage students to think comprehensively, enabling them to select the most effective problem-solving approaches (Simanjuntak et al., 2021). Each student encounters different situations, making it challenging for learners to directly apply their knowledge to real-world contexts. To develop students' problem-solving skills, they must be trained to think comprehensively and follow a step-by-step process to arrive at optimal solutions.

Enhancing problem-solving skills requires nurturing students' comprehensive and systematic thinking skills, enabling them to choose the best solutions to their problems (Khalid et al., 2020). The researcher believes that integrating the Six Thinking Hats technique with Situation-Based Learning will enhance multifaceted, well-rounded thinking and significantly contribute to developing students' problem-solving skills (De Bono, 1985). The Six Thinking Hats technique cultivates students' critical thinking skills and systematic problem-solving skills by considering strengths, weaknesses, intriguing aspects, and personal feelings from multiple perspectives (Akcay & Yager, 2010; Ayaz-Can & Semerci, 2007). This technique consists of six colors: white hat (facts), black hat (cautions), red hat (feeling), yellow hat (benefits), green hat (creative), and blue hat (process). By fostering clarity and structure in problem-solving, this method significantly improves students' higher-order thinking skills (Elmore, 2018). Despite the potential of combining Situation-Based Learning and the Six Thinking Hats technique, few studies have specifically examined their effects on improving the problem-solving skills of Grade 11 students in complex scientific contexts such as electrochemistry. Therefore, this research aims to enhance the problem-solving skills of Grade 11 students in electrochemistry by integrating these two methods, targeting a minimum proficiency level of 70% and equipping students with skills to address real-world scientific challenges more effectively.

METHOD

Research Design

This research adopted an action research design consisting of four steps: planning, action, observation, and reflection (Kemmis & McTaggart, 1988). The rationale for selecting this approach was to foster active student participation in learning, enhance their problem-solving abilities, and encourage them to express their opinions in the classroom. The study was conducted over three action cycles (Figure 1).

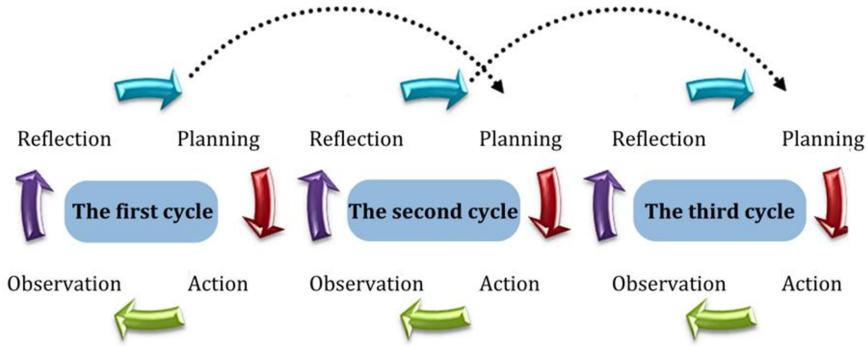

Figure 1. Research Framework: Methodology for Enhancing Students' Problem-Solving Skills

Participants

The target group consisted of 31 Grade 11 students at Sarakhampittayakhom School, Thailand. These students were selected based on their scores on problem-solving skills tests. The target group consisted of students who scored below 70%.

Research Instrument

Lesson Plan: The nine lesson plans involved situation-based learning with the Six Thinking Hats technique on electrochemistry for 14 hours. Each lesson plan consisted of five steps, as shown in Figure 2**.**

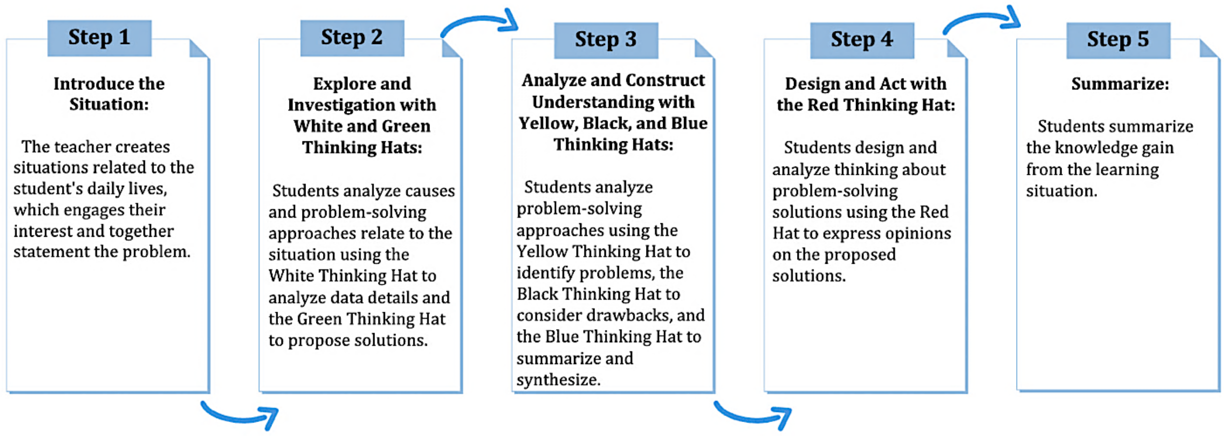

Figure 2. The Lesson Plan of the Situation-Based Learning with the Six Thinking Hats Technique

The researcher presented the lesson plans to experts to assess their suitability. The average quality of the lesson plan was 4.42-4.62.

***The problem-solving skills test*:** The problem-solving skills test comprised three sets of subjective tests, each containing three scenarios, with a total score of 36 points. It evaluated problem-solving skills through four steps: 1) Statement of the Problem, 2) Defining the Problem, 3) Searching for and Formulating a Hypothesis, and 4) Verifying the Solution. To ensure the validity of the test, the researchers consulted an expert to assess the consistency between the questions and the scenarios provided. The test achieved a consistency index of 1.00, indicating a high level of alignment between the questions and the situations used in the problem-solving skills test.

The problem-solving skills behavior observation form: The problem-solving skills behavior observation form evaluated four aspects: 1) Statement of the Problem, 2) Defining the Problem, 3) Searching for and Formulating a Hypothesis, and 4) Verifying the Solution. The researchers submitted the observation form to experts for evaluation to ensure consistency between observed behaviors and the steps of problem-solving skills. The consistency index ranged from 0.80 to 1.00, indicating that the observation form effectively aligned with the problem-solving process.

The student interviews: The interview focused on issues related to learning activities and problem-solving skills. The researchers submitted the student interview form to experts for evaluation to ensure consistency between the interview questions and the issues being addressed. The form achieved an average consistency index ranging from 0.80 to 1.00, indicating a high level of alignment between the questions and the points discussed during the interviews.

Data collection

The researchers conducted three consecutive action research cycles, following the concepts of Kemmis and McTaggart (1988). Each cycle comprised four steps in the PAOR cycle.

Planning: The researchers conducted a survey to identify issues faced by Grade 11 students and found that they lacked adequate problem-solving abilities. To address this issue, the researchers reviewed relevant documents and studies to plan and design effective learning activities. This process included determining the content for the activities, developing a learning management plan, and creating tools for data collection.

Action: The researchers implemented teaching activities according to their devised learning plan, which is shown in Table 1.

Table 1. The Scores of Problem-Solving Skills Test

Cycles	Learning Activities	Improvements/Changes
In the first cycle: The researchers executed the learning activity plan, incorporating Situation-Based learning with the Six Thinking Hats technique.	1) Redox reactions. 2) Balancing redox equations using oxidation numbers. 3) Balancing redox equations using half-reactions.	- Executed the learning activity plan incorporating Situation-Based Learning with the Six Thinking Hats technique. - Gathered data on the problem-solving skills of the target student group using a problem-solving skills test.
In the second cycle, the researchers executed the learning activity plan, incorporating Situation-Based learning with the Six Thinking Hats technique.	1) Galvanic cells. 2) Cell potential. 3) Electrochemical cells.	-The researchers analyzed the data obtained from the problem-solving skills test, behavior observation, and interviews, which developed more effective learning management by encouraging students to understand their group's problems and write problem analyses, emphasizing that there are no right or wrong answers. - Teachers promoted student collaboration in group activities by asking engaging questions to stimulate interest and guide the problem-solving approaches, prompting clear solutions that match given problems, and empowering students to collaboratively design more engaging problem-solving methods to increase interest.
The third cycle: The researchers executed the learning activity plan, incorporating Situation-Based learning with the Six Thinking Hats technique.	1) Corrosion protection. 2) Electroplating. 3) Electrolysis.	-Encouraging students to assist their peers in group activities, asking engaging questions, adjusting problem-solving time, and setting presentation deadlines to meet the specified schedule. - The teacher guided the steps of problem-solving skills, explaining how to choose solutions that align with the situation to help students achieve the proficiency benchmark in problem-solving skills.

Observation: The researchers observed student behavior during each cycle of the learning activities, using data collection tools such as problem-solving skills, behavior observation forms, and student interviews. After completing all the learning activity plans, students took a problem-solving skills test.

Reflection: The researchers analyzed observation data, which was used to refine and develop learning activity plans for the next action research cycle. This process was conducted over three consecutive cycles. Subsequently, the researchers discussed the results from all data collection, analyzed the data, and summarized the findings accordingly.

Data analysis

The researchers employed two complementary data analysis techniques to ensure a comprehensive evaluation of the findings. First, content analysis was utilized to examine qualitative data gathered from problem-solving behavior observation forms and student interviews. This approach allowed the researchers to identify patterns, categorize behaviors, and synthesize the research findings into meaningful insights. Second, basic statistical methods, including mean and percentage, were applied to analyze quantitative data obtained from the problem-solving skills test. These statistical techniques provided an objective measure of students' performance and enabled the researchers to evaluate improvements in problem-solving skills across the intervention cycles.

RESULTS AND DISCUSSION

Results

This study was conducted to enhance problem-solving skills in chemistry through Situation-Based Learning combined with the Six Thinking Hats technique for Grade 11 students. The passing criterion was set at 70%, with a target group of 31 students. The researchers summarized the number of students who met or did not meet the 70% problem-solving threshold in each cycle, as shown in Figure 3.

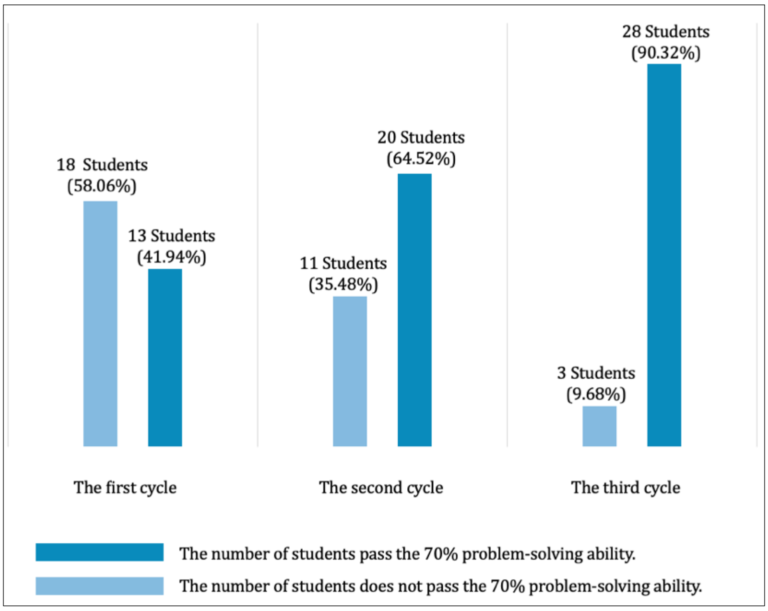

Figure 3. The Number of Students who Passed or Did Not Pass the 70% Problem-Solving Skills after Participating in Situation-Based learning with the Six Thinking Hats Technique

From Figure 3, the results show that the number of students achieving scores above 70% increased across the three cycles: 13 students (41.94%) in the first cycle, 20 students (64.52%) in the second cycle, and 28 students (90.32%) in the third cycle. Detailed scores for the problem-solving skills test, categorized into four components—1) Statement of the Problem, 2) Defining the Problem,

3) Searching for and Formulating a Hypothesis, and 4) Verifying the Solution—are presented in Table 2.

Table 2. The Scores of Problem-Solving Skills Test

Students	1) Statement of the Problem.			2) Defining the Problem.			3) Searching for and Formulating a Hypothesis.			4) Verifying the Solution.		
	The first cycle (9 points)	The second cycle (9 points)	The third cycle (9 points)	The first cycle (9 points)	The second cycle (9 points)	The third cycle (9 points)	The first cycle (9 points)	The second cycle (9 points)	The third cycle (9 points)	The first cycle (9 points)	The second cycle (9 points)	The third cycle (9 points)
1	8	7	8	8	6	6	9	7	6	8	6	6
2	6	7	9	4	5	9	3	6	9	3	6	8
3	4	5	8	3	5	6	3	7	6	3	6	7
4	7	7	7	7	7	7	0	8	7	3	9	9
5	7	7	9	7	7	8	8	8	9	6	7	9
6	5	7	8	3	7	7	2	5	7	2	5	7
7	9	7	8	9	7	7	9	7	7	8	8	6
8	5	9	9	4	8	8	3	4	5	3	6	6
9	7	7	6	9	8	7	7	6	5	9	7	8
10	9	9	8	8	8	8	6	7	7	3	4	4
11	9	9	9	8	7	8	9	6	8	9	7	8
12	4	7	9	6	6	6	2	6	6	0	6	9
13	5	7	7	5	7	7	3	6	6	2	6	7
14	4	6	8	3	5	7	2	4	7	2	5	6
15	7	8	9	7	8	8	7	8	8	6	8	8
16	7	4	9	3	6	6	4	6	6	4	5	6
17	5	7	7	5	9	8	5	8	8	0	7	7
18	6	6	6	4	7	7	4	9	7	3	7	7
19	4	7	8	5	7	7	5	6	8	0	6	7
20	7	7	8	3	7	6	2	5	6	2	5	8
21	9	7	7	9	8	8	9	7	6	8	5	5
22	8	8	7	7	7	7	6	7	7	5	7	6
23	6	6	8	7	8	6	7	7	7	7	7	5
24	4	9	8	4	8	7	4	8	7	4	6	5
25	7	7	8	5	5	6	3	4	7	3	4	8
26	8	9	7	8	9	8	7	8	6	6	8	6
27	7	8	8	8	8	7	6	8	7	5	7	6
28	8	8	9	8	8	8	6	7	7	5	6	7
$\bar{X}$	6.50	7.21	7.93	5.96	7.07	7.14	5.04	6.61	6.86	4.29	6.32	6.82

Table 2 shows that problem-solving skills improved consistently across the three cycles. In the first cycle, the highest average score was 6.50 in "Statement of the Problem," while the lowest was 4.29 in "Verifying the Solution." These averages increased in the second cycle to 7.21 and 6.32, respectively. By the third cycle, the scores improved further, reaching 7.93 for "Statement of the Problem" and 6.82 for "Verifying the Solution," reflecting steady progress in all components. A graph illustrating the percentage of these average scores for problem-solving skills is presented in Figure 4.

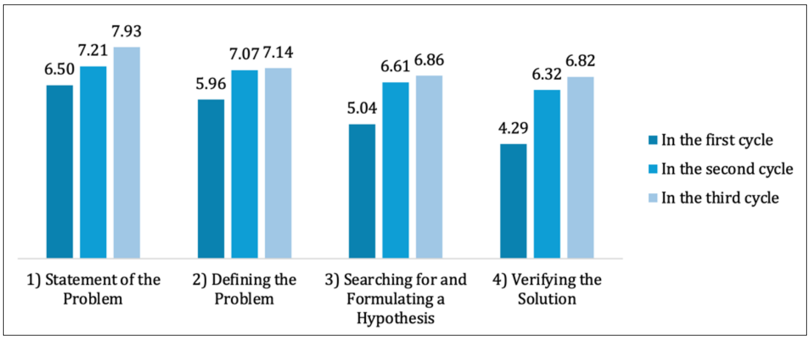

Figure 4. The Percentage of the Average Scores for Problem-Solving Skills

Figure 4 shows that the average percentage of scores for problem-solving skills increased in each component, with the average score in the "Statement of the Problem" being the highest.

Cycle-by-Cycle Analysis

Cycle 1:

During the first cycle, the researchers identified several issues through interviews and observations:

1. The students could state the problem but have difficulty accurately explaining the origins of these problems. The examples of students' responses revealed the following: "...I could make a statement of the problem by reading the problem situation provided by the teacher..." (Student No. 26, January 31, 2024: Interview) "I couldn't state the problem and explain it because I was confused and did not fully understand the situation in detail." (Student No. 21, January 31, 2024: Interview).
2. The students could not accurately analyze the causes of problems from the given situations. The examples of students' responses revealed the following: "I was not sure if I analyzed the situation correctly because I did not fully understand the situation and the assigned problem." (Student No. 2, January 31, 2024: Interview). "I could write down the information, but I was not sure if it aligned with what the situation specified because I did not understand the reasons behind it." (Student No. 20, January 31, 2024: Interview).
3. The students were unable to suggest searching for and formulating a hypothesis for problems in the situations due to uncertainty about where to start and a lack of understanding in expressing their presentation methods. The examples of students' responses revealed the following: "I did not know which problem-solving method to choose and how to use it correctly." (Student No. 2, February 5, 2024: Interview) "I did not know how to write down the problem-solving method or where to start." (Student No. 4, February 5, 2024: Interview).
4. The students could not verify the solution accurately due to mismatched solutions, resulting in incorrect analysis. The examples of students' responses revealed the following: "I was unsure how to analyze the responses from the scenario and how to ensure the assigned problem-solving method matched the given problem accurately." (Student No. 15, January 31, 2024: Interview) "I struggled to analyze the responses from the scenario and found that the assigned problem-solving method did not align with the given problem." (Student No. 20, January 31, 2024: Interview).
5. The students typically enjoyed group work with friends. Still, some may not contribute, as seen in sample responses: "I think it was an enjoyable learning approach as we collaborated on group activities with friends." (Student No. 25, February 5, 2024: Interview). "I was confused about the teaching method because the teacher presented situations for us to solve without clear instructions." (Student No. 27, January 31, 2024: Interview).
6. The students enjoyed group work with friends, but some may not contribute. The examples of students' responses revealed the following: "I was adjusting to the need to think

independently, which was time-consuming." (Student No. 30, January 31, 2024: Interview). "My friends did help with group work or offer opinions, leaving me to do everything by myself." (Student No. 27, January 31, 2024: Interview).

Interviews revealed that most students could make a statement of the problem, but some struggled to define the problem and search for and formulate a hypothesis. These issues might be due to students not researching independently and some resorting to copying peers, leading to mismatched solutions. Students' lack of interest, reluctance to participate, and failure to express opinions collectively contribute to most students' inability to analyze outcomes accurately and clearly.

The researchers analyzed data from problem-solving skills tests, observed problem-solving behavior, and conducted student interviews during the first cycle. It was found that some student groups could not closely identify the problem with situations, and most did not collectively analyze and address group problems. Teachers should encourage students to help each other with group activities and use questions to stimulate problem analysis without the fear of being wrong. Some students were not attentive to other groups' presentations and were disruptive. Most students could not verify the solution. Teachers should make presentations more engaging and use questions to help students connect the problem situations with the necessary knowledge.

Cycle 2:

In the second cycle, interviews and observations revealed improvements:

1. The students could state the problem and start grasping situations, possibly due to a growing understanding and experience in problem-solving. The examples of students' responses revealed the following: "I stated the problem by looking at the situation because it explained the problem information in the situation." (Student No. 22, February 12, 2024: Interview). "I stated the problem by comprehending the situation." (Student No. 20, February 12, 2024: Interview).
2. Some students could precisely analyze and pinpoint the reasons behind problem-based situations. The examples of students' responses revealed the following: " I understood that I needed to determine how to define the problem and then analyze its cause" (Student No. 22, February 12, 2024: Interview). "I analyzed the problems based on the situation after reading the statement of the problem." (Student No. 15, February 12, 2024: Interview).
3. Some students effectively formulated hypotheses by identifying problem causes, aiding in their understanding and solution selection. The examples of students' responses revealed the following: "I adhered to the statement of the problem, which involved defining the problem and problem-solving guidelines, and then identifying suitable solutions." (Student No. 7, February 14, 2024: Interview) "I evaluated the advantages and disadvantages of each problem-solving guideline and selected the most fitting one for the situation." (Student No. 4, February 14, 2024: Interview).
4. Some students could not analyze and verify the solution due to a low understanding of the result of the analysis. Some students copied their peers, which hindered their problem analysis. The examples of students' responses reveal the following: "I was unsure if my analysis of the problem-solving guidelines intended to address the given problem was accurate." (Student No. 8, February 12, 2024: Interview). "I was uncertain about the type of analysis to conduct because I was confused about the problem-solving guideline." (Student No. 15, February 12, 2024: Interview).

The interviews showed that most students could formulate problems more aligned with the situation and analyze and grasp the main issues. They collaborated to analyze and find solutions, engaging in more discussion and analytical thinking (Saadati & Reyes, 2019). The students also started expressing themselves more confidently by asking and talking more freely. This approach assessed students to develop systematic problem-solving skills. The students began by exploring different search methods and formulating a hypothesis as they became adept at finding solutions. However, they struggled to verify the solution accurately due to fear of differing from their peers, resulting in unclear conclusions for most students.

The researchers analyzed data from problem-solving skills tests, observed problem-solving behavior, and conducted interviews during the second cycle to guide the development of learning activities for the third cycle. It was found that some students did not participate in group activities with their peers. The teacher stimulated the engagement of students by actively approaching those who seldom participate in groups, and their level of problem-solving skills was still at a moderate level. The teacher guided the process of problem-solving skills logically, and students' presentations of problem-solving methods did not consistently match the specified problems (Widyastuti, 2021). The teacher advised on presenting problem-solving methods, emphasizing alignment with the given situation and problem.

Cycle 3:

By the third cycle, significant improvements were observed:

1. The students could state the problem from the situation and explain the issues. The examples of students' responses revealed the following: "...I could make a statement of the problem by reading situations and analyzing problems..." (Student No. 28, February 28, 2024: Interview) "...I could make a statement of the problem from the situation although I did not know if it was right or not..." (Student No. 13, February 28, 2024: Interview).
2. The students could define the problem by understanding the situation and identifying the available information. The examples of students' responses revealed the following: "...I was defining the problem and seeking what information the situation gave us by using the white hat to see what the problems gave us..." (Student No. 23, February 21, 2024: Interview) "...I analyzed by talking and exchanging opinions with my friends in the group..." (Student No. 15, February 21, 2024: Interview).
3. The students developed comprehension of the situation through the statement of the problem and defining the problem of the provided information to devise solutions. The examples of students' responses revealed the following: "I needed to identify the problem from the situation, understand its cause, gather relevant information, and outline the correct solution." (Student No. 28, February 21, 2024: Interview)"...I chose based on the consistency and solved problems correctly according in line with the problem situation..." (Student No. 6, February 21, 2024: Interview).
4. The students could verify the solution because they understood both the process and the group's problem-formulating methods, enabling effective evaluation. The examples of students' responses revealed the following: "...I analyzed the results from writing the solution and saw if the solution was appropriate for the given situation..." (Student No. 28, February 21, 2024: Interview) "...I analyzed the solution according to the defining the problem." (Student No. 17, February 21, 2024: Interview).
5. Students enjoyed group activities and problem-solving based on situations, exploring diverse approaches to find accurate solutions. The examples of students' responses revealed the following: "I enjoyed learning activities because they were fun and involved problem-solving skills step, which helped me think more thoroughly." (Student No. 18, February 28, 2024: Interview). "I felt that the learning activities were great. I analyzed situations, but sometimes I did not understand them well enough to analyze them properly because I got confused." (Student No. 14, February 28, 2024: Interview).

The interviews revealed that the students made efforts to problem identification and brainstorm collaboratively within their groups, allowing them to address problem identification. They exchanged ideas, demonstrated methods for finding answers, and accurately verified the solution (Diani et al., 2023). Some students did not participate in problem identification, which resulted in difficulties summarizing important details or comprehending the problems that needed to be fixed.

In the third cycle, the student interviews, behavior observation form, and problem-solving skills test were examined for information. The students improved their problem-solving skills in all four areas and achieved higher scores. This finding indicated that the students became adept at problem-solving based on situations and demonstrated strong problem-solving skills. They analyzed problems from situations, researched appropriate solutions, and accurately verified the solution.

Discussion

This study aimed to enhance Grade 11 students' problem-solving skills in Electrochemistry through Situation-Based Learning and the Six Thinking Hats technique, targeting a passing criterion of 70%. The findings demonstrate a consistent improvement across three cycles, highlighting the effectiveness of this integrated approach in fostering critical thinking and systematic problem-solving.

In the first cycle, 13 students surpassed the 70% problem-solving skills threshold, showing initial progress in their ability to identify and address problems. This improvement can be attributed to the hands-on nature of Situation-Based Learning, which encouraged students to actively engage with the learning material and think independently. The approach helped students restructure their understanding of problems by applying prior knowledge, aligning with Bruner's (1971) theory that problem-solving involves adapting past experiences to address current challenges. Despite these gains, some students struggled to define problems clearly and verify solutions accurately, indicating the need for more guided support. These findings suggest that initial exposure to structured, real-world scenarios can create a foundation for further development in problem-solving abilities.

In the second cycle, 20 students exceeded the 70% threshold, reflecting significant growth in their comprehension and analysis of problems. Immersing students in real-world problem situations allowed them to practice critical and analytical thinking (Ala et al., 2024; Yang, 2022), while the Six Thinking Hats technique guided them to evaluate problems systematically from multiple perspectives. This combination aligns with research by Cojorn and Sonsupap (2024) and Pongsue & Cojorn (2022), who emphasized that context-driven learning enhances students' ability to analyze and solve problems. Additionally, collaborative group activities promoted discussion and shared problem-solving strategies, fostering deeper engagement among students (Aithal and Kumar, 2017). However, some students still faced challenges in verifying solutions, highlighting the importance of iterative learning cycles to refine these skills.

By the third cycle, 28 students achieved scores above the 70% threshold, indicating substantial improvement across all components of problem-solving skills. Students demonstrated increased confidence in identifying, analyzing, and solving problems collaboratively, showcasing the effectiveness of the integrated approach. These findings are consistent with studies by Sari & Arliani (2023), Diani et al. (2023), and Mulia et al. (2021), which showed that Situation-Based Learning enhances problem-solving and collaborative skills. The Six Thinking Hats technique further supported students in organizing their thoughts and systematically evaluating solutions, enabling more accurate and reliable outcomes (Abdelkader et al., 2021). The success observed in this cycle underscores the potential of combining structured techniques with real-world contexts to develop advanced problem-solving capabilities.

Overall, the study highlights the transformative potential of integrating Situation-Based Learning with the Six Thinking Hats technique in fostering problem-solving skills. This approach not only encourages critical thinking and systematic analysis but also promotes collaboration and active engagement, preparing students to tackle real-world challenges (Hasanah et al., 2021; Kılıçaslan, 2018). The iterative nature of the action research process allowed students to refine their skills through repeated practice and feedback, as noted by Weir (1974). However, persistent challenges in verifying solutions indicate a need for more targeted interventions, such as additional teacher guidance or peer support mechanisms. These findings contribute to the growing body of evidence supporting innovative instructional strategies that bridge theoretical knowledge with practical application, offering valuable insights for future research and educational practices.

Implications of the Research Findings

The findings of this study have significant implications for educational practices, particularly in the field of science education and the development of problem-solving skills. The integration of Situation-Based Learning with the Six Thinking Hats technique provides a comprehensive framework that supports students in developing critical thinking, analytical skills, and the ability to address complex problems systematically. These implications are detailed as follows:

1. **Implications for Classroom Instruction**

   The research highlights the importance of incorporating real-world scenarios into learning activities. Situation-based learning fosters an engaging environment where students can connect theoretical knowledge to practical applications. This approach encourages independent thinking and allows students to explore diverse perspectives when solving problems. Educators can adopt this model to design lessons that emphasize real-world relevance, ensuring students are equipped with transferable skills for future challenges.

   The Six Thinking Hats technique further complements this process by providing a structured method for analyzing problems from multiple perspectives. Teachers are encouraged to integrate this technique to guide students in systematically evaluating problems and proposing solutions. This can lead to more interactive and reflective classroom discussions, enhancing student engagement and collaborative learning.

2. **Implications for Curriculum Development**

   The study underscores the need for curricula that prioritize problem-solving and critical thinking as core competencies. The demonstrated success of Situation-Based Learning suggests that incorporating similar models into the curriculum can bridge the gap between theoretical understanding and practical application. Curriculum developers should consider integrating structured problem-solving frameworks, such as the Six Thinking Hats, into science education to cultivate these essential skills.

   Moreover, the iterative nature of the learning process in this study highlights the value of repeated practice and feedback. Designing curricula that allow for multiple cycles of learning and improvement can better support students in mastering complex concepts over time.

3. **Implications for Teacher Training**

   The findings reveal that the success of this integrated approach relies heavily on effective teacher facilitation. Teachers play a crucial role in designing engaging activities, guiding discussions, and ensuring active student participation. Training programs for teachers should include modules on implementing Situation-Based Learning and the Six Thinking Hats technique. These programs should emphasize strategies for fostering collaboration, managing group dynamics, and addressing challenges in verifying solutions.

Additionally, teachers should be trained to provide clear instructions and guidelines for each step of the problem-solving process. This can help minimize student confusion and ensure that all learners are actively engaged and contributing to group activities.

4. **Implications for Future Research**

The study opens new avenues for exploring the long-term impact of integrating Situation-Based Learning and the Six Thinking Hats technique across different subjects and educational levels. Future research could examine how these methods influence other cognitive and affective skills, such as creativity, decision-making, and resilience.

Additionally, further studies could investigate the scalability of this approach in larger, more diverse classrooms or online learning environments. This would provide valuable insights into its adaptability and effectiveness in varying educational contexts.

By applying the insights from this research, educators, curriculum developers, and policymakers can create learning environments that better prepare students to navigate the complexities of the modern world. The integration of structured, context-driven learning strategies promises to enhance not only problem-solving abilities but also broader competencies essential for lifelong learning.

Limitations of the Study

While this study provides significant insights into enhancing problem-solving abilities through Situation-Based Learning combined with the Six Thinking Hats technique, several limitations should be acknowledged to provide a comprehensive understanding of the findings. First, the research involved a relatively small sample size of 31 Grade 11 students from a single school, which may limit the generalizability of the results. The context-specific nature of the study means that the findings might not fully apply to larger or more diverse populations. Expanding the scope of the study to include participants from various educational and cultural backgrounds would enhance its applicability.

Additionally, the focus of this study was limited to Electrochemistry, a specific subject within science education. While the results demonstrate the effectiveness of the approach in this context, its potential applicability to other subjects or interdisciplinary areas remains unexplored. Future research could investigate how this method performs across a wider range of academic disciplines to determine its broader educational impact. The study also assessed the immediate effects of the learning techniques over three cycles but did not explore the long-term retention or sustainability of the skills acquired. Without longitudinal analysis, it is difficult to determine whether the observed improvements in problem-solving skills are lasting. Further studies could examine how well students retain and apply these skills over extended periods.

A key element of the study's success was the role of teacher facilitation, as the implementation of the Six Thinking Hats and Situation-Based Learning techniques required significant guidance. Variations in teacher effectiveness may have influenced the outcomes, highlighting the need for standardized instructional frameworks that can be consistently applied across different educational settings. Furthermore, while the study highlighted improvements in students' problem-solving abilities, challenges persisted in the verification of solutions. This indicates a potential gap in the instructional design, suggesting that further refinement of activities focusing on this aspect of problem-solving is necessary. Another notable issue was student engagement in group activities. Although collaboration was encouraged, some students were fewer active participants, which may have limited their learning experience. Addressing individual differences in motivation and participation would further enhance the effectiveness of this approach. These limitations underline the importance of future research in addressing these challenges. Expanding the scope of the study, incorporating longitudinal analysis, and refining instructional strategies will help validate and strengthen the findings of this research.

CONCLUSION

This research aimed to enhance the problem-solving skills of Grade 11 students through Situation-Based Learning combined with the Six Thinking Hats technique. The findings indicate that 28 students achieved proficiency levels exceeding 70% in problem-solving skills by the end of the study. This improvement reflects the effectiveness of the integrated approach, which emphasizes independent learning, the exploration of diverse perspectives, and structured problem-solving activities. Students demonstrated notable progress in their ability to analyze situations, evaluate problem-solving methods, and articulate their solutions. The activities fostered critical and analytical thinking, enabling students to approach problems systematically. This highlights the value of situational learning in boosting engagement and enhancing analytical and problem-solving skills. To further improve the learning activities, the researcher implemented refinements, including setting clearer timelines, emphasizing solution proposal and evaluation, increasing discussions on chosen solutions, and ensuring full participation from all students during group activities. These adjustments enabled most students to effectively state problems from situations, demonstrate analytical ability, articulate problem-solving methods, and verify solutions with accuracy. Based on these findings, future enhancements should focus on optimizing the timing and preparation of learning activities to align more effectively with the objectives of the lessons. Educators are advised to provide detailed explanations of each step to prevent confusion and offer clear guidelines for conducting activities. These measures can further enhance the effectiveness of the learning process and support students in developing robust problem-solving abilities.

AUTHOR CONTRIBUTIONS STATEMENT

Suriwan Wongsa Contributed to the study's conception and design performed data collection and analysis and drafted the manuscript. She was also responsible for developing the Situation-Based Learning activities and integrating the Six Thinking Hats technique into the instructional framework. Kanyarat Cojorn Provided critical revisions and suggestions for the study design and manuscript. She supervised the research process, validated the data analysis, and contributed to the interpretation of findings and the preparation of recommendations for future educational practices.

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