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The Effectiveness of Inquiry-Based Learning to Improve the Analytical Thinking Skills of Sixth-Grade Elementary School Students

Wipaporn Sasanti
Department of General Science, Faculty of Education and Educational Innovation, Kalasin University, Thailand, *wipaporn.sa@ksu.ac.th*

Chulida Hemtasin
Department of General Science, Faculty of Education and Educational Innovation, Kalasin University, Thailand, *chulida.he@ksu.ac.th*

Tawan Thongsuk
Department of General Science, Faculty of Education and Educational Innovation, Kalasin University, Thailand, *tawan.th@ksu.ac.th*

This analysis dissects a piece of information into its parts and determines how they interact in constructing a concept. This study focuses on enhancing the analytical thinking skills of grade 6 students in science and technology courses by implementing inquiry-based learning management. The aim is to meet the minimum requirement of 70 percent and assess student satisfaction with the approach. This work follows a classroom action research approach involving planning, action, observation, and reflection steps. The target group comprises 25 grade 6 students studying in the first semester of the 2022 academic year at an elementary school in Northeast Thailand, selected through purposive sampling. The research tools include six 5E inquiry-based learning plans, an analytical thinking skills test, and a satisfaction questionnaire. Data collection involves implementing the learning plan in two operational cycles, conducting analytical thinking tests, and administering satisfaction questionnaires. The collected data are analyzed to determine achievement levels and satisfaction ratings. The statistics used are mean, standard deviation, and percentage. The findings from the first operational cycle indicate that 76.0% of students did not meet the evaluation criteria. After the second operational cycle, the mean score improved, and all students met the assessment criteria of 70.0%. Overall, the inquiry-based learning approach has the potential to enhance analytical thinking skills, and student satisfaction levels were generally positive. These findings highlight the importance of incorporating effective learning management strategies, such as analytical thinking, to improve students' higher-order thinking skills.

Keywords: analytical thinking, classroom action research, elementary school, 5E instructional model

INTRODUCTION

Analytical thinking, also called critical thinking, encompasses the capacity to critically analyze and evaluate new and high-quality ideas (Suarniati et al., 2018). It falls within the cognitive domain of learning according to Bloom's theory (Amelia et al., 2016; Giani et al., 2015; Yuliandini et al., 2019). Analytical thinking involves the process of breaking down information into smaller components, identifying relationships between each part and other factors, and considering the overall structure (Montaku et al., 2012; Astriani et al., 2017). The ability to differentiate, organize, and attribute is integral to the analysis process (Astriani et al., 2017). Art-in (2012) defines analytical thinking as a

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competency that entails identifying and classifying various aspects, such as objects, stories, or events while discerning the relationships between them. Anwar and Mumthas (2014) further characterize analytical thinking skills as a mental process employed to determine solutions to problems. Differentiating, organizing, and attributing are three indicators of analytical thinking skills (Ad'hiya and Laksono, 2018; Farizi et al., 2023; Heliawati et al., 2021; Wirdiyatusyifa et al., 2021). Differentiating involves distinguishing relevant or essential parts of presented material from irrelevant or unimportant ones. Organizing focuses on determining how elements fit or function within a structure. Attributing entails identifying the point of view, bias, values, or intent underlying the presented material (Ramirez and Ganaden, 2008; Wijaya et al., 2023). These indicators provide a comprehensive framework for assessing and developing analytical thinking skills, enabling individuals to effectively analyze and evaluate information in various contexts.

Analytical thinking skills have emerged as essential competencies in the 21st century (Prawita et al., 2019), playing a crucial role in human development across social, technological, and educational domains (Ramadani et al., 2021). Strong analytical thinking skills are vital, as they enable individuals to effectively navigate complex problem-solving situations and adapt to the demands of a rapidly evolving world (Ad'hiya and Laksono, 2018). Analytical thinkers possess the ability to investigate and outline the details of a situation, allowing them to think critically and intelligently when faced with challenges (Belecina and Ocampo, 2018; Ricco et al., 2020). Conversely, individuals lacking analytical thinking skills may encounter challenges that hinder their personal and professional growth. Recognizing the significance of analytical thinking skills, the Programme for International Student Assessment (PISA) incorporated their measurement into assessments of international students' knowledge (OECD, 2018). PISA aims to evaluate students' abilities to apply their knowledge and skills in real-world contexts, including their capacity for analytical thinking. Thailand, among other countries, participates in the PISA examination. However, recent results indicate concerns about Thailand's performance. According to the 2018 PISA results, out of the 79 participating countries, Thailand ranked 66th globally, 20th in the region, and 4th in science among ASEAN countries (OECD, 2018). Additionally, Thailand scored only 426 points in analytical thinking skills, indicating room for improvement in this crucial area. These findings raise important questions about the state of analytical thinking skills among Thai students and the factors contributing to the observed challenges.

To gain deeper insights, it is crucial to examine the localized studies that were conducted within our dataset. For instance, a recent investigation conducted at a public elementary school in Northeastern Thailand focused on assessing the analytical thinking skills of sixth-grade students. The findings revealed that 76% of the students did not meet the required 70% threshold for analytical thinking skills. This local study underscores the pressing need to address and enhance the analytical thinking abilities of Thai students during the early stages of their education.

In support of this notion, Khansuk et al. (2020) emphasize that Thai students lack the necessary analytical capabilities to effectively engage with scientific data. Addressing the challenges faced by Thailand in fostering and nurturing analytical solid thinking skills requires a multifaceted approach encompassing curriculum design, pedagogical practices, teacher training, and assessment methodologies (Ad'hiya and Laksono, 2018; Santhitiwanich et al., 2018). By addressing these interconnected factors, Thailand can work toward empowering its students with the analytical thinking skills required for successful science learning and development.

According to Teemuangsai and Meesook (2017), the instructional approaches employed in 90 secondary schools located in Northeastern Thailand, involving a total of 2,430 students ranging from grades 7 to 12, were predominantly traditional. The students who participated in the study desired a shift in the teaching methodology, aiming to make the lessons more captivating, less monotonous, and more connected to real-life situations. Appropriate learning management strategies tailored to the school context are crucial to improving proficiency in higher-order thinking skills such as analytical thinking.

Active learning management, mainly through approaches such as problem-based learning (PBL), project-based learning (PjBL), and inquiry-based learning, has received significant attention for its effectiveness in fostering analytical thinking skills (Kwinram et al., 2022; Rubio and Garcia Conesa, 2022; Thaiposri and Wannapiroon, 2015). Research has demonstrated that PBL models positively impact students' critical thinking and analytical abilities (Birgili, 2015; Hallinger and Lu, 2011; McCrum, 2017; Zabit, 2010). Additionally, inquiry-based learning activities have been found to promote cognitive and analytical thinking skills, as well as enhance students' overall satisfaction with the learning process (Nuangchalerm and Chaiyasuk, 2009). Moreover, Ramadani et al. (2021) explore using inquiry-based models and tools specifically designed to enhance analytical thinking skills. Qomariya et al. (2018) assert that implementing an inquiry-based learning model can effectively improve students' analytical thinking skills. Furthermore, Prawita et al. (2019) examine the effectiveness of a Generative Learning-based approach in improving analytical thinking skills among students with both high and low reading motivation.

Inquiry-based learning is an educational approach rooted in constructivism, emphasizing students' active involvement in exploring and acquiring knowledge during the learning process (Ramadani et al., 2021). The concept of inquiry involves a structured learning process that encompasses formulating questions and hypotheses, designing procedures to address these inquiries, collecting data through experiments or observations, drawing conclusions, and effectively communicating these findings (National Research Council, 2011). Within inquiry-based learning, students engage in thinking processes and activities that foster the development of independent and in-depth thinking skills, curiosity, and a positive attitude toward learning (Franklin, 2015). This approach empowers students to actively seek and investigate knowledge, instilling confidence in their abilities (Kusdiastuti et al., 2016). By employing inquiry-based learning, students are encouraged to explore and comprehend the natural world independently, opening avenues for personal growth and understanding (Nuangchalerm and Chaiyasuk, 2009). Various types of inquiry-based learning exist, including confirmation inquiry, structured inquiry, guided inquiry, and open inquiry. In this research, the utilization of these inquiry types was not employed since the study primarily concentrated on the phases of the 5E instructional model without categorizing the various activities according to specific inquiry types.

The 5Es in the learning cycle represent the sequential stages of engagement, exploration, explanation, elaboration, and evaluation (Kwinram et al., 2022). During the engagement phase, students connect their prior knowledge and develop an interest in the topic. In the exploration phase, students engage with learning resources, conduct investigations, and document their activities. The explanation phase involves analyzing data gathered during exploration, constructing knowledge, and presenting the findings to peers. In the elaboration phase, students relate their newly constructed knowledge to real-life contexts and engage in discussions with classmates. The students engage by activating prior knowledge and developing interest. They explore through studying resources, planning, and recording activities. They elaborate by analyzing data, constructing knowledge, integrating it into daily life, and sharing ideas with classmates. The final phase, evaluation, entails assessing students' comprehension and application of scientific concepts through various forms of formative assessment (Sukji et al., 2018).

Considering the problem of students' analytical thinking skills falling below the required level, it is essential to develop these skills based on applied learning management. This issue forms the basis of this research, aimed at achieving two goals:

Aim of the study

1. To enhance the analytical thinking skills of grade 6 students in science and technology courses by implementing inquiry-based learning management, with the objective of meeting the 70 percent requirement.

2. To assess the level of satisfaction among grade 6 students with the inquiry-based learning approach.

METHOD

Research Methodology

This research follows the classroom action research approach proposed by Kemmis and McTaggart (2014), which involves four distinct steps and consists of two spirals. The steps are outlined below:

Step 1: Plan

In this step, the research team examines the school context, collaborates with a mentor, and identifies issues related to analytical thinking among 6th-grade students. This information guides the development of a learning management plan and serves as a basis for addressing the research problem. Research tools, including an inquiry-based learning management plan, an analytical thinking test, and a satisfaction questionnaire, are created and refined based on expert feedback. Once the tools are finalized, they are prepared for data collection.

Step 2: Action

During this step, the research team implements the improved learning management plan developed in Step 1. The teaching and learning activities are divided into two operational cycles. In the first cycle, learning management plans 1-3 are used for inquiry-based learning, and in the second cycle, learning management plans 4-6 are employed.

Step 3: Observe

During the observation step, the researcher closely monitors the target group's behavior during teaching and learning activities. At the end of each operational cycle, the target group is assessed through analytical thinking tests. Additionally, interviews are conducted with the students to gather their feedback on the learning management method. The insights gained from these interviews contribute to improving teaching methods in subsequent cycles.

Step 4: Reflect

After completing each instructional cycle, the researcher collects data by administering analytical thinking tests and analyzing the obtained data. The observations and interview data are also analyzed to gain a comprehensive understanding. The insights gathered from these analyses are used to enhance the practice cycle and guide further development in subsequent cycles.

By following these four steps, the research team ensures a systematic and iterative process, addressing the research problem effectively and continuously improving the inquiry-based learning approach for enhancing analytical thinking skills among 6th-grade students (Figure 1).

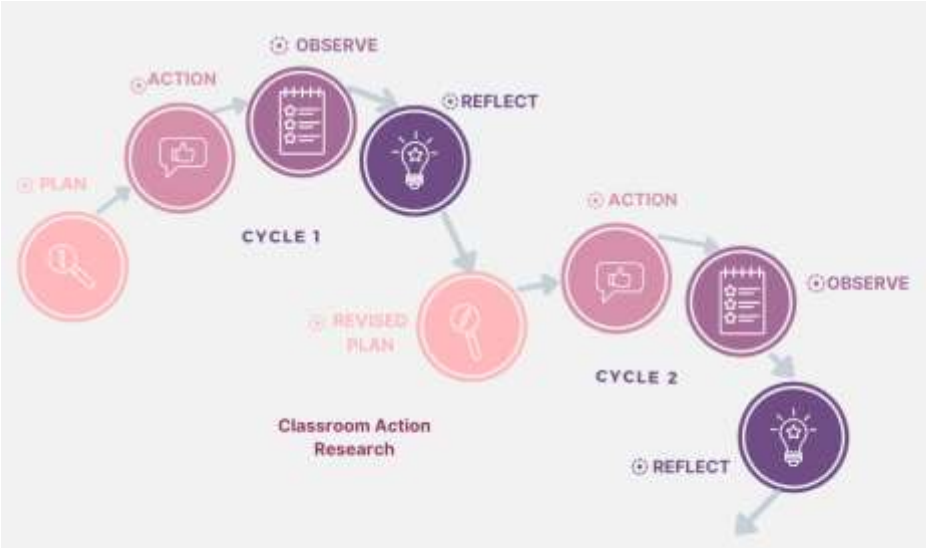

Figure 1
Kemmis and McTaggart classroom action research model (Kemmis and McTaggart, 2014)

Participants

The target group for this study consists of 25 students in grade 6 who are currently enrolled in the first semester of the 2022 academic year. The participants were selected based on purposive sampling, specifically from students in the classroom where the researcher is teaching. These students were identified based on their analytical thinking scores, which fall below the minimum requirement of 70 percent (Pre-test reports of students' assessments conducted by researchers).

Research tools

The tools utilized in this experiment encompassed the following:

1) A 5-step inquiry-based learning plan on the separation of mixtures was created, which consisted of 5 individual plans:

a) Classifying mixtures for two hours;

b) Separating mixtures for two hours;

c) Separating solids from solids for two hours;

d) Separating insoluble substances for two hours;

e) Separating magnetic substances from mixtures for two hours;

f) Separating substances in everyday life for three hours.

The total duration of the learning management activities amounted to 13 hours, with each lesson lasting 60 minutes. Expert suitability assessment and evaluation resulted in an average suitability rating of 4.56, with an item objective congruence (IOC) index ranging from 0.80 to 1.00.

2) An analytical thinking skills test focusing on Unit 2: the separation of mixtures in the sixth-grade curriculum. This test comprised multiple-choice questions with 4 options, totaling 30 items focused on differentiating, organizing, and attributing. The test demonstrated an IOC index ranging from 0.60

to 1.00. The discrimination index (R) was between 0.20 and 0.80, and its reliability (KR20) was 0.74, with difficulty (P) ranging from 0.55 to 0.625.

3) A satisfaction questionnaire was administered to assess the participants' satisfaction with the inquiry-based learning management plan. The questionnaire adopted a rating scale format with 5 levels, following the Likert scale, with the IOC ranging from 0.67 to 1.00.

Data collection

The researcher collected data by using a test, as follows:

1) Learning activities on the separation of mixtures were organized during the first operational cycle, spanning three learning management plans. The duration of this cycle was two weeks, with a total of six periods, each lasting sixty minutes. The learning activities were conducted using an inquiry-based learning approach.

2) A 30-item analytical thinking test was administered to the sample group. The data collected from the test were analyzed to determine the mean score and quality level. The second operational cycle included students who did not meet the predefined criteria.

3) In the second operational cycle, additional learning activities on the separation of mixtures were organized, following the prescribed learning management plan, which included three plans. This cycle extended over three weeks, with sixty-minute periods for each plan. The inquiry-based learning approach was again employed during these activities.

4) After completing the second operational cycle, the target students underwent an assessment comprising a 30-item analytical thinking test. They were also required to complete a satisfaction questionnaire. The collected data were then analyzed to determine the average score and quality level. Statistical analysis was performed using the obtained scores to report the research findings.

Data analysis

The collected data in this study were analyzed based on the studied variables using the following procedures:

1) The data from the learning achievement test administered after each operational cycle were analyzed. The scores were used to calculate the mean, standard deviation, and percentage. If a student's score fell below 70 percent, it indicated that they did not meet the passing criteria. Conversely, scores equal to or above 70 percent were deemed satisfactory.

2) The researcher conducted an analysis of student satisfaction after completing both operational cycles. The mean and standard deviation of the satisfaction ratings were calculated and compared against predetermined objective criteria. The satisfaction questionnaire employed a rating scale with five levels aligned with the Likert scale. The interpretation of the satisfaction questionnaire results was based on specific criteria.

FINDINGS

The results of developing analytical thinking skills in the essential science subject of separating mixtures for grade 6 elementary school students through inquiry-based learning management are shown in Figure 2.

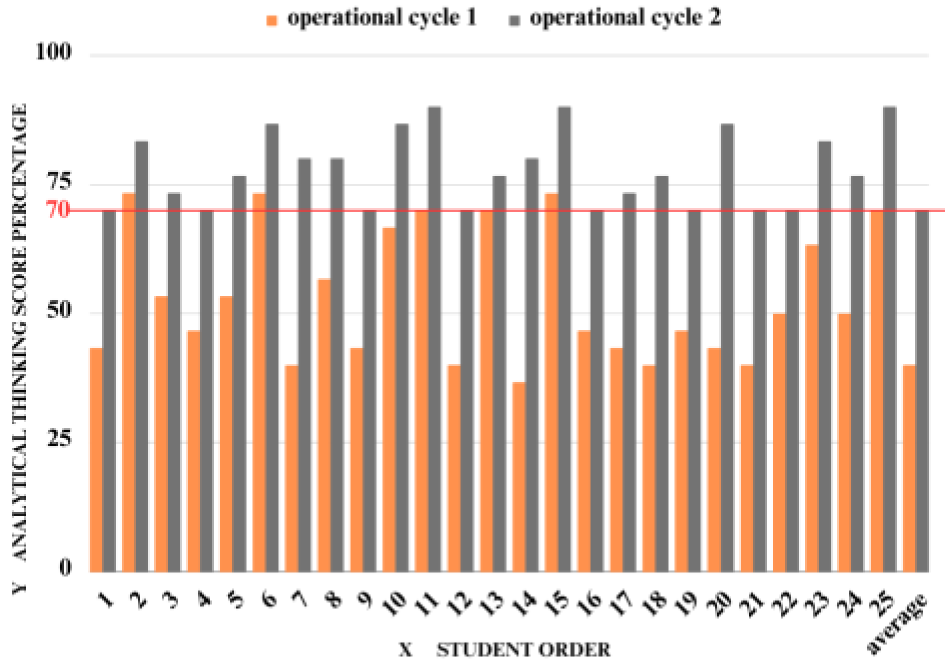

Figure 2
Analytical thinking test results in operational cycles 1 and 2

In the first operational cycle, students engaged in inquiry-based learning, resulting in a total mean score of 16.00 with a standard deviation of 3.81, representing 53.3%. Out of the students, 6 (24.0%) met the evaluation criteria, while 19 students (76.0%) did not pass the requirement (Figure 2).

During the second operational cycle, students continued their learning journey through inquiry-based learning management, achieving a total mean score of 23.40 with a standard deviation of 2.20, representing 78.0%. All students successfully met the assessment criteria of 70.0% (Figure 2).

Additionally, the satisfaction of grade 6 students after implementing inquiry-based learning management was assessed and is presented in Table 1. The table provides the average ratings, standard deviations, and satisfaction levels for various aspects of the learning experience.

Table 1
Satisfaction of grade 6 students

List	Average	Standard deviation	Level of satisfaction
1. Students participate fully in activities.	4.64	0.62	Most satisfied
2. Students are satisfied with studying from various sources of knowledge.	4.56	0.80	Most satisfied
3. Students build knowledge and self-understanding.	4.56	0.64	Most satisfied
4. Students develop problem-solving thinking, leading to problem-solving.	4.56	0.75	Most satisfied
5. Students gain knowledge from learning activities.	4.72	0.53	Most satisfied
6. Teachers have exciting ways to integrate methods into lessons.	4.56	0.70	Most satisfied
7. The teacher allows students to express their opinions.	4.64	0.74	Most satisfied
8. Activities in the lesson are easy to understand and follow.	4.60	0.75	Most satisfied
9. Fun and exciting learning activities.	4.72	0.53	Most satisfied
10. Teachers have exciting and novel teaching materials.	4.56	0.80	Most satisfied
Average	4.61	0.69	Most satisfied

The data in Table 1 show that the grade 6 students expressed high levels of satisfaction in multiple areas. They fully participated in activities, were satisfied with studying from various sources of knowledge, and built knowledge and self-understanding. Moreover, they developed problem-solving thinking and gained knowledge from learning activities. The teachers' exciting and engaging instructional methods contributed to the student's satisfaction, as did their encouragement of student expression and use of clear and understandable activities. Overall, the average satisfaction rating for all aspects was 4.61, with a standard deviation of 0.69, indicating high satisfaction among the students.

DISCUSSION

Implementing classroom action research in this study involved four distinct steps and consisted of two spirals. Each spiral focused on different operational cycles, intending to enhance analytical thinking skills among grade 6 students in science and technology courses using the 5E instructional model.

Spiral One: Engaging Students in Inquiry-Based Learning

Students were exposed to inquiry-based learning management using the 5E model during the first operational cycle. The aim was to develop their analytical thinking skills in the essential science subject of separating solids from solids.

Learners typically possess some prior knowledge and understanding of a subject, although this knowledge may vary in accuracy or correctness. As teachers, this presents an opportunity to assess what learners already know about the subject (Owolade et al., 2022). The extent of prior knowledge can influence how effectively students retain information and comprehend new concepts (Wade and Kidd, 2019; Umanath and Marsh, 2014; Chen et al., 2014). Analytical thinking allows learners to integrate new information with their existing knowledge, thereby expanding their understanding (Areesophonpichet, 2014).

Teachers utilize games as an initial step to generate interest and gauge prior knowledge. The questions for the game are created using information from the associated lesson. Game activities, such as sorting the particle size of a substance within an allotted time, are used to evaluate the learners' prior knowledge. These games serve as a means of reviewing the learners' existing knowledge and stimulating their interest.

The second step involves assigning a research problem to the students, focusing on "methods for separating mixtures in the case of solids from solids." As students search for solutions to the problem, they evaluate their prior learning, identify the necessary materials, and develop a strategy for application (Chan, 2011). Concurrently, teachers introduce and exemplify experimental methods for separating mixtures to guide the students' research. Encouraging students to search for and discover ways to design mixture separations fosters their ability to think critically, organize information, and make connections.

Promoting analytical thinking continues in the third step, where each group of learners engages in a separation experiment activity and records their experimental results. At this stage, the sorting and organizing aspects are taught, and students choose hypotheses that correspond to formulating the problem that has been put forward, including the task of assembling statements made up of a number of temporary variables (Annisa et al., 2016). The students employ reasoning to make conclusions from the evidence they have gathered. Subsequently, they either provide justifications for their conclusions or revise their existing ones based on their findings (Zhang et al., 2015). Through verbal or written communication, the students share their findings with their peers, facilitating collaboration and enhancing their analytical thinking skills (Yıldız-Feyzioğlu and Demirci, 2021).

In Step 4, the students are tasked with creating a booklet that explores various separation methods based on the properties of different substances. The teacher deliberately assigns a mixture separation task without indicating the specific ingredients, thereby promoting the sorting and organizing aspects of analytical thinking. Furthermore, data analysis activities are incorporated to teach students how to organize and attribute information. When analyzing data, it is essential to distinguish relevant information from the research findings, establish connections between different data points, and draw conclusions from the study (Ramadani et al., 2021).

The evaluation stage serves two purposes: determining whether the lesson has successfully achieved the learning objectives and identifying misconceptions among the learners. The teacher assesses the students' analytical thinking skills and the knowledge acquired through discussions, summarizes the learning outcomes, and evaluates the quality of the booklets. After completing the 5E lesson in the first operational spiral, the teacher assesses the analytical thinking of the learners.

The results of the analytical thinking test conducted during this cycle revealed a mean score of 16.00 with a standard deviation of 3.81, representing 53.3% of the requirement. A significant number of students (76.0%) did not meet the 70% requirement. These findings align with the research conducted by Teemuangsai and Meesook (2017), which emphasizes the need for a shift in teaching methodologies. Their study highlights the importance of making lessons more captivating, less monotonous, and more connected to real-life situations. Traditional instructional approaches previously utilized in the schools of Northeastern Thailand may not have adequately developed students' analytical thinking skills.

Based on the assessment findings mentioned above, the researcher conducted interviews to identify the obstacles students faced during the study's first operational cycle. The interviews revealed that a majority of students struggled with remembering their prior knowledge and encountered difficulties in connecting their existing knowledge with new information. Additionally, there was a lack of collective thinking observed after the third stage of the study. Evidently, students relied heavily on memorizing the principles of substance separation based on specific case studies. Consequently, when confronted with new problems, they encountered challenges in applying their knowledge effectively. Furthermore, during peer discussions without the guidance of teachers, the students exhibited uncertainty in determining the accuracy or validity of the results they obtained. This obstacle highlights the need for scaffolding and guidance to foster critical thinking skills and develop a deeper understanding of the subject matter.

These findings underscore the importance of addressing these specific obstacles to enhance students' learning experiences and improve their analytical thinking abilities. By implementing instructional strategies that encourage meaningful connections between prior and new knowledge, promoting critical thinking in problem-solving, and providing guidance during collaborative discussions, educators can help students overcome these challenges and achieve better learning outcomes.

Spiral Two: Advancing Analytical Thinking Skills

The second operational cycle encompassed implementing the 5E inquiry-based learning approach, with specific adjustments made for the learning activities. Mind mapping is an instructional strategy that stimulates both hemispheres of the brain and facilitates visual thinking, as proposed by Buzan (2002). Mind mapping offers a holistic representation of a subject while capturing its details. This technique enhances creative and innovative thinking, promotes knowledge retention, and facilitates effective and systematic knowledge management and analysis. Consequently, in Step 2, the teacher modified the activities to allow the students to conduct further research and create a mind map illustrating the strategies employed to acquire prior knowledge related to separating mixtures.

In Step 3, the teacher provided guidance and facilitated collaborative discussions within the classroom, aligning with the suggestions of Bybee et al. (2006). During the explanation phase, the teacher offered explanations to deepen students' understanding and promptly addressed any misconceptions. Subsequently, the students collaboratively summarized their findings. In Step 4, the teacher further adapted the activity by prompting students to apply examples from everyday life to create problems for separating mixtures. As indicated by Şaşmaz-Ören et al. (2010), this approach allows students to establish connections between theoretical concepts and real-life challenges, empowering them to generate potential solutions to these issues. Finally, during the conclusion stage, students were instructed to create a mind map summarizing their conceptual knowledge. Indeed, students' learning outcomes depend on their conceptual comprehension (Sastrika et al., 2013).

Throughout this cycle, the analytical thinking test scores significantly improved, with a mean score of 23.40 and a standard deviation of 2.20, representing a success rate of 78.0%. Importantly, all students met the assessment criteria of 70.0%. These results demonstrate the effectiveness of inquiry-based learning facilitated by the 5E model in enhancing students' analytical thinking skills. This finding aligns with previous research highlighting the positive impact of inquiry-based learning on critical thinking and analytical abilities (Birgili, 2015; Hallinger and Lu, 2011; McCrum, 2017). The 5E model provided a structured framework that promoted active learning, exploration, and independent thinking, leading to notable improvements in analytical thinking skills.

The satisfaction survey conducted on the grade 6 students further supported the effectiveness of the inquiry-based learning approach. The results indicated high levels of satisfaction with various aspects, including active participation in activities, satisfaction with studying from various sources of knowledge, and developing problem-solving thinking. These findings are consistent with studies that have shown the positive impact of inquiry-based learning on student engagement, knowledge acquisition, and satisfaction (Nuangchalerm and Chaiyasuk, 2009; Qomariya et al., 2018). Using engaging instructional methods, encouraging student expression, and providing clear and understandable activities contributed to the students' overall satisfaction. These findings align with research emphasizing the importance of teacher involvement, student engagement, and stimulating learning environments in enhancing student satisfaction (Rubio and Garcia Conesa, 2022; Thaiposri and Wannapiroon, 2015).

Overall, implementing inquiry-based learning management, guided by the 5E model, successfully enhanced the analytical thinking skills of grade 6 students. This approach not only improved their academic performance but also fostered their engagement, satisfaction, and overall learning experience. The positive outcomes observed in this study align with the existing literature supporting the effectiveness of inquiry-based learning in promoting critical thinking, problem-solving skills, and student satisfaction (Ramadani et al., 2021; Zabit, 2010).

CONCLUSION

This classroom action research study aimed to enhance the analytical thinking skills of grade 6 students in science and technology courses by implementing the 5E instructional model. The study also assessed students' satisfaction with the inquiry-based learning approach. The first spiral focused on engaging students in inquiry-based learning, targeting different aspects of analytical thinking at each step. Games were used to assess prior knowledge and generate interest, encouraging differentiation. Subsequent steps involved research, separation experiments, and data analysis, fostering skills in organizing information and making connections. Collaborative discussions further developed the students' analytical thinking abilities by attributing meaning to findings. The results of the analytical thinking test revealed that a significant number of students did not meet the required threshold, indicating challenges in connecting existing knowledge, misremembered prior knowledge, and a lack of collective thinking. These findings emphasized the need for instructional strategies promoting meaningful connections, critical thinking, and guidance during discussions. Adjustments were made in the second spiral, including mind mapping and additional collaborative discussions. Mind mapping facilitated the differentiation and organization of knowledge, while teacher-guided explanations and corrections enhanced attributing skills. Applying real-life examples to create problems promoted critical thinking and connections between theoretical concepts and challenges. The results of the analytical thinking test in the second cycle showed significant improvement, with all students meeting the assessment criteria. The satisfaction survey demonstrated high levels of student satisfaction. These positive outcomes affirm the effectiveness of inquiry-based learning facilitated by the 5E model in enhancing students' analytical thinking skills, as evidenced by improvements in differentiating, organizing, and attributing information. Overall, the study highlights the significance of inquiry-based learning and the role of the 5E model in promoting critical thinking, problem-solving, and student engagement.

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APPEMDIX

Analytical Thinking Skills Test

Instructions: 1. The test consists of 30 questions worth 30 points.

2. Students should choose the correct answer, which is only one choice.

1. Which method is used to separate substances in the salt-making process?

a. Precipitation

b. Evaporation

c. Filtration

d. Precipitation

2. Which substance does not have the property of evaporation?

a. Salt

b. Sodium bicarbonate

c. Sugar

d. All of the above

3. What can be used to aid in the precipitation of substances?

a. Clear lime water

b. Orange juice

c. Orange peel

d. Sand sugar

4. Which method should be used to separate charcoal from salt?

a. Decantation

b. Filtration

c. Magnetic attraction

d. Evaporation

5. Which method should be used to separate solids with different weights?

a. Filtration

b. Dry evaporation

c. Decantation

d. Pick up

6. Which principle should be used by students to separate pebbles from sand?

a. Making it precipitate

b. Using a sieve

c. Filtration

d. Shaking it

7. Which mixed substance is suitable for separating materials?

a. Water and oil

b. Water and salt

c. Water and marbles

d. Water and sugar

8. All of the following mixed substances use evaporation except which one?

a. Sodium bicarbonate and curry powder

b. Sodium bicarbonate and sand sugar

c. Iodine powder and ethanol

d. Charcoal and charcoal powder

9. Which solute cannot be separated by dry evaporation?

a. Ammonia solution

b. Copper sulfate solution

c. Sodium chloride solution

d. Molasses

10. If a student receives a mixture of charcoal and salt, how should they separate them? (Arrange in order)

a. Precipitation, dissolution, and evaporation

b. Dissolution, filtration, and evaporation

c. Filtration, dissolution, and evaporation

d. Dissolution, evaporation, and filtration

11. Which statement about distillation is incorrect?

a. Relies on the property of substances: boiling point

b. Substances with low boiling points are separated first

c. Separating substances by density

d. When a substance changes state into vapor

12. Which method is used to separate crude oil in the petroleum industry?

a. Relies on density

b. Extraction with a solvent

c. Sequential distillation

d. Evaporation

13. Which substance can be evaporated?

a. Iodine powder

b. Curry powder

c. Napthalene

d. All of the above

14. Which of the following is an advantage of fractional distillation?

a. Separating substances with small amounts mixed in

b. Can separate substances with very close boiling points

c. Cost-effective

d. Can separate substances with different boiling and melting points

15. Which statement is incorrect about precipitation?

a. Relies on different dissolution principles

b. Substances that dissolve less precipitate first

c. One substance in the mixture does not dissolve in the solvent

d. Precipitation results in pure substances

16. In the chromatography method, a substance that can move a long distance during separation will have which characteristic?

1. Good absorption capacity 2. Poor absorption capacity

3. Good solubility 4. Poor solubility

a. 1,3

b. 1,4

c. 2,3

d. 2,4

17. If substances are closely related, what should be done?

a. Change the solvent

b. Increase the length of the absorbent

c. Both a and b

d. None of the above

18. Which of the following pairs of substance separation is correct?

a. Canal water - sedimentation

b. Salt production - evaporation

c. Ink dye - precipitation

d. All of the above

19. How can a mixture between charcoal powder and iron filings be separated?

a. Filtration

b. Using a magnet

c. Precipitation

d. Decantation

20. When should distillation be used to separate a mixed substance?

a. Clay water

b. Water and oil

c. Salt and pepper

d. Flour and sugar

21. If you want to separate oil from the surface of a kaffir lime, what method should be used?

a. Ordinary distillation

b. Filtration

c. Precipitation

d. Steam distillation

22. Which characteristic should a substance have to be separated in the order of distillation?

a. Solid mixed with liquid

b. Must separate volatile oil

c. Have multiple components

d. Have similar boiling points

23. What method is used to separate a single substance?

a. Distillation

b. Filtration

c. Picking out

d. Using a magnet

24. When is precipitation suitable for separating substances?

a. Saturated solution

b. Dilute solution

c. Large quantity of solution

d. Concentrated solution

25. When a solute is separated from a concentrated solution as the temperature decreases, what type of separation is it?

a. Distillation

b. Steam distillation

c. Precipitation

d. Chromatography

26. What should be considered when selecting a method to separate mixed substances?

a. State of the substance

b. Boiling and melting points of the substance

c. Texture of the substance

d. Solubility in water

27. Which method is most suitable for separating a substance that does not dissolve in water from a liquid?

a. Distillation

b. Filtration

c. Precipitation

d. Extraction

28. If you want to separate seeds from salted vegetables, which method should be used?

a. Distillation

b. Filtration

c. Using a spoon to separate

d. Precipitation

29. Which methods can be used to separate a single substance completely?

a. Filtration and extraction

b. Chromatography and distillation

c. Precipitation and using a magnet

d. Evaporation and extraction with a solvent

30. Filtration is a method of separating substances based on the difference in which property?

a. Weight of the substance

b. Color of the substance

c. Size of the particles

d. Boiling point of the substance