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Analysis of the learning model implementation learning cycle 5e in science learning

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ABSTRACT

Science learning at the junior high school level plays an important role in developing students' science process skills as the foundation of scientific literacy. However, classroom practices still tend to emphasize content mastery rather than learning processes and systematic skill development. This study aimed to analyze the implementation of the 5E Learning Cycle model in acid–base learning, focusing on the development of students' science process skills at each learning stage. This research employed a descriptive qualitative approach involving Grade VII students. Data were collected through classroom observations, documentation of student activities, and analysis of science process skills that emerged during learning, and were analyzed thematically. The results indicate that the 5E Learning Cycle supports student-centered learning and facilitates the gradual development of science process skills. The Engagement stage builds students' cognitive readiness and motivation. Exploration becomes the main phase for developing basic process skills through experimental activities. Explanation and Elaboration support data interpretation, communication, and application of concepts, while Evaluation functions as a reflection on students' understanding and learning processes. The study concludes that the 5E Learning Cycle can be effectively implemented in authentic classroom contexts with limited resources and provides both theoretical and practical contributions to process-oriented science learning.

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INTRODUCTION

Science education at the junior high school level plays a fundamental role in developing students' scientific literacy, scientific reasoning, and inquiry skills (Wiriani & Ardana, 2022). Science learning is not solely oriented toward mastering concepts but also toward developing science process skills, which include the ability to observe, formulate questions, design investigations, analyze data, communicate findings, and apply concepts in real-life contexts (Solihin, Mailayfaiza, et al., 2025). From a modern science education perspective, the quality of learning is determined not only by learning outcomes but also by the quality of the learning process experienced by students (Solihin & Dedah, 2022). However, various studies indicate that science learning practices in schools remain dominated by a teacher-centered, knowledge-transmission approach (Yatimah et al., 2019). Learning tends to emphasize the delivery of material and curriculum completion, whereas students' opportunities to engage in authentic scientific processes are relatively limited (Rigianti & Utomo, 2022). This condition has implications for students' low mastery of science process skills and underdevelopment of critical thinking skills, particularly at the junior high school level, which should be a transitional phase toward more abstract and analytical science learning (Kurniawati, 2018).

In response to these challenges, constructivist paradigms and inquiry-based learning have gained increasing attention in science education(Jumiati & Martini, 2021). This approach emphasizes that students actively construct knowledge through direct learning experiences and social interactions (Solihin, et al., 2025). Learning models that facilitate active student engagement in scientific inquiry are considered more effective at fostering meaningful conceptual understanding and sustainable scientific skills(Ichwanah & Nurita, 2018). One widely recommended constructivist learning model is the 5E Learning Cycle, which comprises the stages of Engagement, Exploration, Explanation, Elaboration, and Evaluation. This model is designed to systematically organize students' learning experiences, from activating prior knowledge to reflecting on and evaluating conceptual understanding(Jais & Samrin, 2020). Several studies have reported that the 5E Learning Cycle is efficacious in improving student conceptual understanding and engagement in science learning. However, studies of the 5E Learning Cycle still exhibit limitations in their research focus(Jais & Samrin, 2020). Most previous studies have assessed the model's effectiveness by measuring improvements in learning outcomes or by comparing pretest and posttest scores (Turan, 2021). This approach is not fully able to explain how the learning process occurs and how science process skills develop gradually at each phase of the 5E Learning Cycle. Furthermore, research examining the 5E Learning Cycle is generally conducted under relatively ideal learning conditions, with a controlled student population and adequate laboratory facilities (Fujiyanti et al., 2018). Studies on the implementation of this model in real-world classroom contexts with limited resources, limited learning time, and large student populations are still relatively rare. However, this context represents the science learning conditions commonly found in many junior high schools, particularly in Indonesia(Liana, 2020).

This situation is also reflected in science learning at SMP Negeri 2 Rawamerta, Karawang Regency. This school faces challenges such as limited tools and materials for practical work, limited time allocated to learning, and a relatively large number of students per class. This situation requires teachers to implement a learning model that is not only theoretically sound but also adaptable to and realistic in classroom conditions. Therefore, the implementation of the 5E Learning Cycle at SMPN 2 Rawamerta is a relevant context for in-depth study. Furthermore, the material on acids and bases was chosen because it has both conceptual and contextual characteristics, enabling students to relate scientific concepts to everyday phenomena. This material also requires student involvement in experimental activities and data analysis, which is highly relevant to assessing the development of science process skills through inquiry-based learning.

Based on a review of prior research and empirical evidence from schools, a research gap is identified likes research of Garcia I Grau et al. (2021);Ong et al., (2021), and (Sari & Rahmi, 2024). First, there is still limited research that analyzes the 5E Learning Cycle using a process-based approach (process-oriented analysis), particularly in examining the emergence of science process skills at each stage of learning. Second, studies on the implementation of the 5E Learning

Cycle in real classrooms with limited resources and large class sizes remain minimal. Third, research that explicitly links the stages of the 5E Learning Cycle, science process skills, and the context of science learning at the junior high school level is still rare. Therefore, this study aims to fill this gap by analyzing the implementation of the 5E Learning Cycle model in science instruction in grade VII at SMP Negeri 2 Rawamerta, with a focus on the development of science process skills at each stage of learning. By adopting a process-based perspective and a real classroom context, this study is expected to provide theoretical contributions to enrich studies on inquiry-based science learning and practical contributions for teachers in designing science learning that is adaptive, meaningful, and relevant to school conditions.

RESEARCH METHODS

Research Design

This study employed a qualitative descriptive research design aimed at obtaining a comprehensive understanding of the implementation of the 5E Learning Cycle model in science learning. This approach allows researchers to explore learning activities, interactions, and classroom dynamics in their natural setting without manipulating variables. The focus of the study was not to test hypotheses, but to describe systematically how each stage of the 5E model was carried out and how students' science process skills emerged during learning. Through this design, researchers were able to capture detailed information regarding teacher strategies, student engagement, and contextual factors influencing learning. Therefore, the qualitative descriptive approach was considered appropriate for analyzing process-oriented science learning.

Population and Samples

The population of this study included all Grade VII 160 students and 3 science teachers at SMP Negeri 2 Rawamerta, Karawang Regency, in the Academic Year 2025/2026. From this population, the research sample was determined using purposive sampling techniques. One science teacher and 40 students from class VII-B were selected because this class had implemented the 5E Learning Cycle model in science learning. The selected class consisted of 22 male students and 18 female students. This sampling strategy ensured that the participants were relevant and capable of providing rich data related to the research focus.

Instruments

Several instruments were used to collect comprehensive and credible data. Observation sheets were developed to record the implementation of each stage of the 5E Learning Cycle, including teacher activities and students' science process skills during learning. Semi-structured interview guides were prepared to explore teachers' and students' perceptions, experiences, and challenges related to the learning model.

Procedures

The research procedures were carried out in several systematic stages. The preparation stage involved coordinating with the school, identifying participants, and developing research instruments based on the objectives of the study. The implementation stage was conducted by observing science learning activities that applied the 5E Learning Cycle model in the classroom. During the data collection stage, researchers conducted classroom observations, gathered documentation, and carried out semi-structured interviews with the teacher and selected students. The final stage involved member checking and triangulation to verify the credibility and accuracy of the collected data before analysis.

Data Analysis

Data analysis was conducted using the Miles and Huberman interactive model, consisting of data collection, data reduction, data display, and conclusion drawing and verification. Data reduction involved selecting, focusing, and simplifying raw data obtained from observations, interviews, and documentation. The reduced data were then organized and presented in descriptive narratives and tables to facilitate interpretation. The final step involved concluding by identifying patterns and relationships between the 5E learning stages and the development of science process skills. To ensure data trustworthiness, source triangulation, technique triangulation, and member checking were applied throughout the analysis process.

RESULTS

This research was conducted in class VII at SMPN 2 Rawamerta to determine the implementation of each stage of the 5E Learning Cycle model in science learning on Acids and Bases. Data were collected through learning implementation observation sheets and semi-structured interviews with teachers and students. Observations were conducted during the learning process, and interviews were conducted after the learning process to obtain in-depth information on perceptions, responses, and obstacles to implementing the 5E Learning Cycle model. The results of the data analysis are as follows:

Table 1. Implementation of the 5E Learning Cycle Model Stages

No	Stage 5E	Maximum Score	Score Obtained	Percentage (%)	Category
1	Engagement	4	4	100	Very good
2	Exploration	4	4	100	Very good
3	Explanation	4	4	100	Very good
4	Elaboration	4	3	75	Good
5	Evaluation	4	3	75	Good
Rate-rate		4	3,6	90	Very good

Based on the results of observations of the implementation of learning presented in Table 1, the 5E Learning Cycle model has been implemented effectively in science learning in class VII at SMPN 2 Rawamerta. All learning stages, namely Engagement, Exploration, Explanation, Elaboration, and Evaluation, can be implemented according to the planned syntax. The Engagement, Exploration, and Explanation stages achieved a maximum score, with an implementation percentage of 100%, indicating that the teacher successfully aroused students' curiosity, facilitated exploration activities, and effectively guided the explanation of concepts. Meanwhile, the Elaboration and Evaluation stages achieved 75%, placing in the good category, indicating that although implementation was effective, there were still limitations, particularly in time management and in more in-depth activities. Overall, the model's average implementation was 90%, placing it in the outstanding category, indicating that the teacher has consistently understood and implemented the 5E Learning Cycle model.

Next, the results of observations of students' science process skills are presented in Table 2. The implementation of the 5E Learning Cycle model is able to elicit various scientific skills at each stage of learning. In the Engagement stage, most students demonstrated the skills of observation and questioning, with percentages above 85%, indicating initial involvement in the phenomena under study. In the Exploration stage, the skills of designing experiments, classifying, and analyzing data were demonstrated by 82.5%-90% of students, indicating that students were actively engaged in practicum activities and the process of concept discovery. The skills of communicating and interpreting data in the Explanation stage, and of applying concepts in the Elaboration stage, also performed well. However, the percentage was relatively lower than in the exploration stage. This shows that the 5E Learning Cycle model provides ample opportunities for students to experience the scientific process directly and gradually.

Table 2. Science Process Skills that Emerge During Learning

Stage 5E	Science Process Skills Indicators	Number of Students (n=40)	Percentage (%)
Engagement	Observing phenomena	38	95
	Ask a question	34	85
Exploration	Designing an experiment	36	90
	Classifying the results	35	87,5
	Analyzing data	33	82,5
Explanation	Communicating results	32	80
	Interpreting data	31	77,5
Elaboration	Applying the concept	30	75
Evaluation	Conclude	29	72,5

Based on Table 2, the application of the 5E Learning Cycle model revealed various science process skills among students at each stage of learning. At the Engagement stage, most students demonstrated observation and questioning skills, with percentages above 85%, indicating initial involvement with the phenomena under study. At the Exploration stage, the skills of designing experiments, classifying, and analyzing data were demonstrated by 82.5%-90% of students, indicating that students were actively engaged in practicum activities and in the process of concept discovery. The skills of communicating and interpreting data at the Explanation stage, as well as applying concepts at the Elaboration stage and concluding at the Evaluation stage, also performed well. However, the percentage was relatively low, indicating that some students still require guidance during the processing and reflection stages of learning outcomes.

Table 3. Summary of Teacher Perceptions on the Implementation of the 5E Model

Aspects Analyzed	Findings	Category
Understanding the 5E concept	Teachers understand all stages	Very good
Compliance with the science material	Very suitable	Very good
Student response	Enthusiastic & active	Good
Main obstacles	Time & practical tools	Enough
Impact on student understanding	Understanding increases	Good

Based on Table 3, the interview results indicated that science teachers had a strong understanding of the concepts and stages of the 5E Learning Cycle model. Teachers assessed that this model was well-suited to the characteristics of science materials, particularly acid-base materials, which emphasized experimental activities and direct observation. Teachers also reported that student responses during learning were generally positive, characterized by increased enthusiasm and activity. However, teachers identified obstacles, including limited time and practical tools, that required adaptive classroom management and learning strategies to implement each stage of the model optimally.

Table 4. Student Responses to the 5E Learning Cycle

Response Aspect	Number of Students	Percentage (%)	Category
Interesting learning	36	90	Very good
More active learning	34	85	Very good
Easier to understand the material	33	82,5	Good
Experiencing technical difficulties	14	35	Low
Want to reuse the model	35	87,5	Very good

Based on Table 4, student responses to the implementation of the 5E Learning Cycle model showed a very positive trend. As many as 90% of students reported that learning felt more interesting, and 85% reported feeling more active during the learning process. In addition, 82.5% of students stated that the material on acids and bases became easier to understand through experimental activities and group discussions. However, 35% of students reported experiencing technical difficulties, particularly related to limited laboratory equipment and the recording of experimental results. These findings indicate that, in general, the 5E Learning Cycle model was well received by students, but still requires support from facilities and more optimal learning management.

Table 5. Supporting and Inhibiting Factors in the Implementation of the 5E Learning Cycle

Factor	Indicator	Frequency of Appearance	Category
Supporters	Student enthusiasm	High	Strong
	Material suitability	High	Strong
	Teacher competency	High	Strong
Inhibitor	Time constraints	Currently	Enough
	Tool limitations	Currently	Enough
	Differences in student abilities	Low	Low

Based on Table 5**,** the main supporting factors for implementing the 5E Learning Cycle model include high student enthusiasm, the suitability of the model stages to the characteristics of science materials, and teacher competence in managing learning. These factors are in the strong category and play an important role in the success of learning implementation. On the other hand, inhibiting factors include limited learning time and insufficient practicum resources, as well as differences in students' abilities, particularly among low-performing students. Despite several obstacles, the dominant supporting factors enable the continued effective and meaningful implementation of the 5E Learning Cycle model in the classroom.

DISCUSSION

This discussion analyzes the implementation of the 5E Learning Cycle model in science instruction on acids and bases and its implications for the development of students' science process skills (Garcia I Grau et al., 2021). The analysis examined the relationships among learning stages, student activities, and the achievement of science process skills in a real junior high school classroom(Sotáková & Ganajová, 2023). The study's results indicate that implementing the 5E Learning Cycle can foster more student-centered learning than conventional instruction. Students not only act as recipients of information but are actively involved in observing phenomena, formulating questions, conducting explorations, and communicating findings (Mahbubah et al., 2024). This finding is consistent with the view of Fauzi & Mustadi, (2019), who emphasized that the 5E Learning Cycle is designed to activate students' cognitive roles through systematic, continuous learning stages. At the Engagement stage, students demonstrated increased curiosity about the concepts of acids and bases by drawing on contextual phenomena from everyday life(Jumaa & Ismail, 2023). Activating prior knowledge is crucial for building students' cognitive readiness before entering the exploration stage. This is consistent with the findings of Liana, (2020), who stated that early student involvement can increase focus and motivation to learn, thereby facilitating subsequent concept construction. Level Exploration is a crucial phase in the development of science process skills. Students engage in direct observation, measurement, and data recording through simple experimental activities (Turan, 2021). This involvement encourages the development of skills in observing, classifying, and interpreting data. This finding aligns with research by Wiriani & Ardana, (2022), which showed that exploration-based learning significantly improves students' science process skills compared to an expository approach. In a real-world classroom context with limited resources, exploration can still take place effectively through the design of meaningful yet straightforward experimental activities (Jumiati & Martini, 2021). This demonstrates that the development of science process skills does not always depend on the completeness of the laboratory, but instead on the teacher's pedagogical strategies in facilitating learning. (Cahyani et al., 2021). This finding supports the research of (Tode et al., 2021)), which emphasized that the quality of the practicum experience is more important than the complexity of the equipment used. Level Explanation provides space for students to construct conceptual understanding through discussions and presentations of their exploration results. In this phase, students begin to relate empirical data to the scientific concepts of acids and bases. The teacher acts as a facilitator, helping to correct misconceptions without dominating the learning process. This pattern aligns with the constructivist view articulated by Garcia, I., Grau, et al. (2021), which posits that conceptual understanding is formed through social interaction and reflection on learning experiences.

Next, at the Elaboration stage, students demonstrate the ability to apply the concepts of acids and bases to new situations, both through problem solving and the analysis of contextual phenomena. This stage contributes to the strengthening of higher-order thinking skills, particularly in connecting concepts to everyday contexts. This finding is in line with research by Aditia et al. (2018). This states that concept elaboration strengthens knowledge transfer and increases the resilience of students' understanding. Evaluation not only serves as a tool for measuring learning outcomes but also as a means of reflecting on the learning process. Students are involved in evaluating their own understanding and work processes, thus encouraging the development of metacognitive awareness. This supports Gunawan et al., (2018). Findings that evaluation in the 5E Learning Cycle plays a crucial role in improving students' reflective skills and conceptual understanding. Overall, students' science process skills develop gradually and are integrated throughout each phase of the 5E Learning Cycle. Basic skills, such as observing and measuring, emerge predominantly during the exploration phase, whereas integrated skills, such as interpreting data and communicating results, develop during the explanation and elaboration phases. This developmental pattern aligns with the science process skills framework proposed by (Jumiati & Martini, 2021)

The findings of this study reinforce prior studies indicating that the 5E Learning Cycle is effective in developing science process skills. However, this study makes an additional contribution by demonstrating that this effectiveness can also be achieved in real classroom settings with limited resources and a relatively large number of students. Thus, these findings broaden the context for applying the 5E Learning Cycle, which has previously been studied primarily under ideal conditions. In the context of science learning in junior high schools, the development of science process skills is crucial, as students are in a transition phase toward more abstract forms of science learning (Garcia I Grau et al., 2021). The 5E Learning Cycle provides a learning structure that helps students build understanding gradually and systematically. These findings align with Saproni et al., (2026), who found that the learning cycle-based model is effective for early adolescent students. In terms of the teacher's role, implementing the 5E Learning Cycle requires a shift from information provider to learning facilitator. Teachers need to design activities that encourage exploration and discussion, and provide constructive feedback. This role change aligns with the findings of Ahluwalia & Puji, (2021), who emphasized that the success of inquiry-based learning is highly dependent on the teacher's pedagogical competence.

This study also shows that active student engagement during learning contributes to increased motivation to learn. Students show greater enthusiasm when allowed to experiment and discuss. This finding supports the research of (Ahluwalia & Puji, 2021). This states that active learning can increase student motivation and engagement in science learning. However, implementing the 5E Learning Cycle is not without challenges. Time management is an aspect that requires attention, especially in classes with large numbers of students. However, this challenge can be overcome through careful lesson planning and the selection of activities appropriate to the class context. This aligns with Setiyawati et al., (2023)recommendation regarding the flexibility of implementing the 5E model. From a curriculum perspective, the 5E Learning Cycle aligns with the Independent Curriculum's emphasis on student-centered learning and competency development. This model enables integration between concept mastery and 21st-century skill development. These findings align with a 2019 OECD study that emphasized the importance of process-based learning in science education.

The important contribution of this study lies in its process-based analysis, which provides a detailed overview of how science process skills develop at each stage of learning. This approach complements previous research that focused solely on learning outcomes. Thus, this study provides a more comprehensive perspective on the effectiveness of the 5E Learning Cycle. The practical implication of this study is that the 5E Learning Cycle can serve as an alternative science learning model that is adaptable to school conditions with limited resources. Teachers can modify learning activities without compromising the essence of the model's stages. This strengthens the study's relevance to educational practice in junior high schools. Theoretically, the findings of this study strengthen the constructivist foundation in science learning by demonstrating that a structured learning process can facilitate the systematic development of science process skills. These findings align with the constructivist learning theories proposed by Piaget and Vygotsky, particularly regarding the role of experience and social interaction in learning.

CONCLUSION

Based on the research results and discussion, it can be concluded that applying the 5E Learning Cycle model to science learning on acids and bases can facilitate a student-centered learning process and encourage the gradual, integrated development of science process skills. Each stage of the 5E Learning Cycle makes a specific contribution to the emergence and development of science process skills, from basic to integrated skills. Level *Engagement* plays a role in building students' cognitive readiness and learning motivation through activating prior knowledge and presenting contextual phenomena. *Exploration* is the primary phase in the development of basic science process skills, particularly the skills of observation, measurement, and data collection through experimental activities. Next, the Explanation and Elaboration stage facilitates students in constructing and applying scientific concepts based on exploration results, thereby enabling the development of skills in interpreting data, communicating findings, and linking concepts to everyday contexts. This study also shows that the 5E Learning Cycle can be implemented effectively in a real-world classroom context with limited learning resources and a relatively large student population. These findings confirm that the success of inquiry-based learning is not solely determined by the availability of facilities, but rather by the quality of the learning design and the teacher's role as a facilitator of the learning process. Theoretically, this study strengthens the constructivist perspective in science education by emphasizing the importance of process-based analysis in evaluating the effectiveness of learning models. Unlike previous research that focused more on learning outcomes, this study contributes to a richer understanding of how science process skills develop at each stage of the 5E Learning Cycle. In practice, the results of this study suggest that the 5E Learning Cycle can serve as an alternative, adaptive, and relevant science learning model for junior high school teachers, particularly in situations with limited resources. With proper planning, this model has the potential to improve the quality of the learning process and support the sustainable development of students' scientific competencies.

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