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Using the 5Es Model on Inquiry-Based Learning to Develop Grade 6 Student Science Learning

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Abstract

This study aimed to investigate the effect of the 5Es model on grade 6 students' learning achievement and satisfaction with this teaching approach. The study included 37 grade 6 students from a public school in Thailand, who were selected using purposive sampling based on their educational path and learning conditions. The research instruments included a learning management plan based on the 5Es model of inquiry-based learning, a learning achievement test, and a semi-structured interview. Data analysis involved the use of mean scores, standard deviations, percentages, and paired samples t-tests, and the interview data were analyzed using thematic analysis. The results of the study showed that the participants' science learning achievement improved on the concept of rocks and fossils after

implementing a learning management plan based on the 5Es model, and this approach also led to an increase in participants' learning satisfaction.

Keywords: Inquiry-based learning, Learning achievement, Learning satisfaction

1. Introduction

Learning achievement in science is an important qualification for school-level educational contexts. According to Phye (2011), learning achievement is a significant measure of a student's performance and comprehension of a subject, and it is frequently used to evaluate the efficacy of a student's education and to indicate areas in which the student may want further to support or challenge. Science learning achievement would benefit students as it ensures that they develop a range of important academic skills and knowledge that could support their future studies and careers such as thinking skills, literacy in scientific concepts and principles, mathematical skills, communication and collaboration, and technological literacy (Holbrook, 2010). However, it should be noted that learning achievement is not intelligence or talent. A student with high intelligence or natural skill in a subject can nevertheless fail if they do not put in the necessary effort or receive enough support and training. Therefore, proper instruction and learning experience are still needed in the developing processes of students' learning achievement (Reiss, 2005).

Rocks and Fossils is a topic that could aid primary school children in comprehending the relationship between science and the natural world. With learning achievement of the concept, students can learn about the history of the Earth and how it has changed over time. Moreover, the topic is suitable for their ages. Many students find rocks and fossils to be fascinating and learning about them can be a joyful and engaging way for students to learn about science and the natural world (Jankulovska, 2020). In addition, rocks and minerals are used in many everyday products, such as concrete, glass, and jewelry. By learning about rocks and minerals, students can gain a better understanding of how these materials are used and why they are important. Lastly, learning the concept of rocks and fossils support the development of scientific skills as it requires students to use scientific skills such as observation, measurement, and data analysis. By engaging in these activities, students can develop and strengthen their scientific skills (Moutinho & Almeida, 2016).

However, since the issue contains complex learning processes appropriate for the students' ages, it is possible that the students would struggle to understand it. First, rocks and fossils incorporate a variety of scientific principles, including the rock cycle, the production of fossils, and the classification of rocks. These principles may be difficult for students to grasp, especially if they are unfamiliar with the subject (Kortz & Murray, 2009). In addition, understanding scientific concepts is only a portion of the difficulty. It may also be challenging for students to relate these concepts to real-world scenarios and to answer questions about them. In addition, the study of rocks and fossils frequently necessitates that students conduct observations and collect data about the studied materials. This can be difficult for pupils who are not accustomed to making exact observations or arranging data (Borgerding & Raven, 2018). Lastly, learning processes entail the utilization of scientific tools and technologies, such as microscopes, spectrometers, and geologic maps. It may be difficult for students to use

these tools appropriately and successfully. This also involves insufficiency of the equipment in certain educational contexts. Therefore, teaching approaches should be meticulously crafted to meet the needs of pupils, taking individual characteristics and educational situations into account.

Consequently, developing learning achievement of rocks and fossils requires an instructional approach that helps students learn the scientific principles by making the connection between the knowledge and real-world problem through hands-on activities. In this case, inquiry-based learning (IBL) could be a potential instructional approach for students in grade 6. According to Caswell and LaBrie (2017), IBL is a method of instruction that places an emphasis on student-centered, hands-on research and investigation of various ideas and concepts. It is predicated on the idea that students are more likely to comprehend and remember information if they are actively engaged in the learning process, as opposed to simply being presented with information to memorize. Similarly, Coffman (2017) suggested that inquiry-based learning stresses the learner's role in creating their own understanding and knowledge. It involves asking questions, obtaining and evaluating information, and constructing understanding. IBL is generally considered an extension of constructivism since it emphasizes the learner's involvement in developing their own understanding and knowledge through research and study (Tamim & Grant, 2013).

Duran and Dökme (2016) differentiated the learning processes of inquiry-based learning and traditional teacher-centered teaching. According to the authors, the role of the teacher is one contrast between inquiry-based learning and typical teacher-centered instruction. In conventional education, the teacher is the major source of knowledge and is responsible for imparting this information to the students. In contrast, the role of the teacher in inquiry-based learning is that of a facilitator, assisting students in developing their own understanding and guiding them through the inquiry process. The emphasis on problem-solving and critical thinking is another distinction. Rather than just memorizing facts and following a set of prescribed actions, inquiry-based learning encourages students to think critically and solve problems using their own ideas and techniques. Traditional teacher-centered instruction, on the other hand, may place greater emphasis on memorization and adherence to predetermined processes.

One example of an IBL activity is open-ended inquiry, where students are given a topic or problem to explore and are allowed to come up with their own questions and ideas for investigation. Another example is project-based learning, where students work on a long-term project that requires them to research, plan, and execute a solution to a real-world problem. Other IBL activities include problem-based learning, design thinking, field trips, experiential learning, and simulation and role-playing. These activities are designed to engage learners actively in the learning process and encourage them to construct their own understanding and knowledge through hands-on exploration and investigation (Coffman, 2017).

5Es is presented as one of the models in inquiry-based learning that allows students to actively explore and discover scientific concepts and principles. According to Bybee (2009), students draw upon their preexisting knowledge and actively engage in the learning process

through the posing of questions, participation in hands-on experiences, and conduct of exploratory and formal investigations. Through these experiences, students develop their own explanations for scientific phenomena and utilize literacy skills to represent and re-represent their developing understanding. The 5E model not only fosters the acquisition of science inquiry skills but also promotes an understanding of the nature of science (Rodriguez et al., 2019). The model consists of 5 learning circles including Engage, Explore, Explain, Elaborate, and Evaluate. The detail of each circle can be seen below.

Table 1. 5Es model of inquiry-based learning

Learning Circles	**Purposes**	**Activities**
Engage	To grab the students' attention and get them interested in the topic being studied	- Asking questions - Presenting a problem or challenge - Providing an engaging activity or demonstration
Explore	To actively explore the topic through hands-on activities, experiments, or other interactive methods	- Hands-on activities - Experiment - Observation
Explain	To share their observations and explain their understanding of the scientific concept or principle being studied	- Explanation - Class discussion
Elaborate	To apply their understanding of the scientific concept to new situations	- Self-Study - Project
Evaluate	To ensure students' learning achievement of the concepts being instructed	- Test - Behavioral assessment

Moreover, the 5Es model has been recognized as a beneficial tool in science education as evidenced by the results of previous studies (*e.g.*, Açışl et al., 2021; Bantaokul & Polyiem, 2022; Iscan & Seyhan, 2021; Khan et al., 2020; Ong et al., 2020; Ong et al., 2021). For example, Açışl et al. (2021) conducted a study to assess the effectiveness of student-guiding materials on student achievement in the "Movement and Force" unit, using the 5E learning model. The study used a quasi-experimental research design with 60 students, divided into an experimental group and a control group. The control group students were given experiment booklets prepared according to the 5E learning model. It was found that there was a significant difference in favor of the experimental group who learned with the 5E model.

Ong et al. (2021) compared the effectiveness of the 5E Inquiry Learning Model with the traditional teacher-centered method on students' science achievement in the subject of

electricity. The study used a quasi-experimental pretest-posttest control group research design with a total of 65 students from two Year 5 classes in Malaysia. The results showed a significant difference in the posttest means between the two groups for both low and average-achieving students, indicating the effectiveness of the 5E Inquiry Learning Model in improving students' science achievement.

The study by Khan et al. (2020) determined the effectiveness of the 5E Learning Cycle Model (LCM) on students' learning in physics at the secondary school level in Pakistan. The study used an experimental research design with a sample of 80 physics students from grade 9 at a school in the Haripur district. The students were divided into experimental and control groups of 40 students each, and the experimental group was taught using the LCM while the control group was taught using the Traditional Teaching Method (TTM). The results showed that the students taught using the LCM were more effective learners in physics compared to those taught using the TTM.

Therefore, the 5Es model has the potential in developing students' learning achievement of the rocks and fossils concept. Moreover, it has been proven to be beneficial in science classrooms. The current attempts to use the principle of the model in designing a learning management plan and employ it to solve problems in learning the concept in a science class of grade 6 students. The objectives of the study were 1) to investigate the effect of the 5Es model on grade 6 students learning achievement and 2) to investigate students' satisfaction with the 5Es model.

2. Methodology

2.1 Research Design

The present study was designed as a quasi-experimental study to examine the effectiveness of the 5Es model on grade 6 students' learning achievement of science regarding rocks and fossils. In this study, the researchers used a variety of statistical techniques to control for potential confounds and ensure the validity of the results. By using a quasi-experimental design, the researchers were able to carefully examine the impact of the intervention on the outcome of interest, providing valuable insights into the effectiveness of the intervention in question.

2.2 Participants

The present study included 37 grade 6 students from a public school in Thailand as participants. These students were selected using a purposive sampling method based on their educational path and learning conditions. Specifically, the participants had completed the basic science education curriculum provided by the Ministry of Education, and none of them were enrolled in science-intensive programs or studying abroad. Additionally, none of the participants had any reported learning difficulties. All participants were informed about their participation in the study and the researchers ensured that their confidential information was kept secure in accordance with ethical guidelines for human research.

2.3 Instruments

2.3.1 Learning Management Plan

The learning management plan was designed using the framework of the 5E model of inquiry-based learning. Therefore, in each lesson plan, the activities were designed to let students actively explore and discover scientific concepts and principles. The 5Es circles of Engagement, Exploration, Explanation, Elaboration, and Evaluation were employed as a sequence order of learning. The learning management plan consists of 5 lesson plans on the topics of 1) Granite, 2) Sedimentary Rock, 3) Metamorphic Rock, 4) Rock Circle, and 5) Fossil. It takes 8 class hours to complete the learning management plan. The learning management plan was evaluated by 3 experts and professional teachers in total before being implemented.

2.3.2 Learning Achievement Test

The learning achievement test used in this study consisted of 20 multiple-choice questions related to the comprehension of rocks and fossil context. The test was designed to have a maximum score of 20 points. The content validity of the test was established, and the Index of Item Objective Congruence (IOC) was found to be between 0.67 and 1.00. The difficulty and discrimination of the test were found to be between 0.42 and 0.49, and 0.48 and 0.57, respectively. The reliability of the test was determined to be 0.865.

2.3.3 Interview Form

In this study, a semi-structured interview was used as a primary data collection method. 6 participants were randomly selected based on and contacted to schedule a convenient time for the interview. The interview consisted of 5 questions regarding how students passed through learning activities. The Index of Item Objective Congruence (IOC) indicates the content validity of each question at 0.67 and 1.00. The interviews were recorded and transcribed for further analysis.

2.4 Data Analysis

The statistics used in data analysis include mean score, standard deviation, percentage, and paired samples t-test. The interview data were analyzed using the method of thematic analysis.

3. Results

3.1 The Effect of the 5Es Model on Grade 6 Students Learning Achievement

Table 2. The comparison between students' learning achievement before and after the treatment

Test	n	$\bar{x}$	S.D.	t	Sig.
Pre-test	37	9.22	0.98	16.74	.000*
Post-test	37	15.97	0.99		

Note. P < 0.05*.

The results of the study indicate that there was a difference between the students' pre and post-test mean scores. A paired samples t-test indicates that participants' average score on science learning achievement in the pretest ($\bar{x}$ = 9.22, S.D. = 0.98) was significantly different from the posttest ($\bar{x}$ = 15.97, S.D. = 0.99), t = 16.74, p = 0.00. Considering that the posttest score was higher than the pretest, we interpret the results of the study that the learning management plan designed using the framework of the 5Es model positively affected the development of participants' learning achievement in the concepts of rocks and fossils.

3.2 Students' Satisfaction with the 5Es Model

The transcribed interview can be grouped into themes below.

The first theme focuses on their contentment with various educational activities. Participants in the interviews stated that they had a pleasant experience learning about the management strategy. For instance, they had the impression that they were being directed to learn on their own when the lesson first started. In addition to that, they reported feeling satisfied with the hands-on activities that gave them the opportunity to observe rocks in a variety of forms. They are also interested in pursuing additional research on fossils because of the connection that such research has to the study of dinosaurs, which is another subject that piques their curiosity.

The second common thread is the level of contentment that students have with the function of the teacher. The interviewees stated that they liked the way teachers acted in class because students were given the opportunity to learn on their own, share their ideas in a class discussion, and clarify their understanding of the concept later after teachers provided an explanation of the concept of rock and fossil. For example, an interviewee replied:

"*I like watching documentary about Dinosaur, and I am happy that I had a chance to use the knowledge in school.*"

They had the impression that their teachers did not abandon them to learn on their own but rather were present to lead them through the educational process.

During the interview, the participants mentioned that they enjoyed learning new material in a classroom setting because it allowed for interactive and engaging instruction from a knowledgeable teacher. For example, when asked how the class material make them learn, an interviewee replied:

"*It is really good and exciting to see what fossil looks like. Before, I am not interested in stone around me, but now I look at pebbles differently.*"

Therefore, the use of teaching instruments and visual aids, such as rocks and pictures of fossils, helped the participants to better understand and visualize the geological processes involved in the formation of rocks and fossils. The structured and interactive nature of a classroom setting made the learning experience enjoyable and rewarding for the participants.

4. Discussion

The results of the study can be summarized that there was an improvement in the participant's science learning achievement on the concept of rocks and fossils after implementing a learning management plan of the 5Es model in inquiry-based learning. Moreover, it could lead to the learning satisfaction of participants. The results of the study could be discussed below.

First, it could be claimed that the 5Es model as a framework in the inquiry-based teaching approach positively affected students' learning achievement of force and motion. The result of the study adds evidence to support the benefits of the model in science education, and it is consistent with previous studies (*e.g.*, Açışl et al., 2021; Bantaokul & Polyiem, 2022; Iscan & Seyhan, 2021; Khan et al., 2020; Ong et al., 2020; Ong et al., 2021) that discovered similar results. Inquiry-based learning is a teaching approach that emphasizes student-driven investigation and problem-solving, with the goal of fostering a deeper understanding of the material being studied (Caswell & LaBrie, 2017). In this study, students learned about rocks and fossils through the design and conduct of their own experiments, the collection of data, and the drawing of conclusions based on their observations. They were also encouraged to actively engage with the material and to develop a deeper understanding of the underlying principles. Furthermore, they were encouraged to make connections between the material being studied and real-world situations, to facilitate a more meaningful and relevant learning experience. By conducting their own experiments, students were able to see firsthand how the principles of force and motion applied in different contexts, further enhancing their understanding of the material.

Findings from this study suggest that participants were satisfied with the inquiry-based learning approach used to teach them about rocks and fossils. One potential reason for this could be that inquiry-based learning allows students to take an active role in their own education, rather than simply being told information or asked to memorize facts. By encouraging students to explore and investigate concepts on their own, inquiry-based learning can foster a sense of ownership and responsibility for their own learning, which can be highly motivating. The results of the study went in line with the previous studies that also found learning satisfaction in implementing the 5Es model (*e.g.*, Bantaokul & Polyiem, 2022).

Inquiry-based learning also promotes critical thinking and problem-solving skills, as students are encouraged to engage with the material, think critically about it, and make connections to real-world situations. This contrasts with traditional teacher-centered teaching approaches, in which students may feel more passive and are simply told information or asked to remember facts. By actively engaging in inquiry-based activities, students can develop these important skills and apply them to a variety of different situations.

5. Conclusion

In the current study, we examined the impact of the 5Es model on grade 6 students' learning achievement and satisfaction with the teaching approach. The study included 37 grade 6 students from a public school in Thailand, who were selected using purposive sampling based on their educational path and learning conditions. The research instruments included a learning management plan based on the 5Es model of inquiry-based learning, a learning achievement test, and a semi-structured interview. The results of the study showed that the participants' science learning achievement improved on the concept of rocks and fossils after implementing a learning management plan based on the 5Es model, and this approach also led to an increase in participants' learning satisfaction.

These results can be implicated in both pedagogical and academic contexts. First, the findings of this study can be used to inform the development of science education curricula and teaching methods at the grade 6 level. Educators can consider incorporating elements of the 5Es model into their own teaching practices to engage students and promote a deeper understanding of the material

In addition, these results may also be useful for educators at other grade levels who are interested in incorporating inquiry-based learning into their classrooms. The findings of this study suggest that inquiry-based approaches, such as the 5Es model, may be effective for engaging students and promoting learning achievement.

Further research could be conducted to replicate the study in different contexts and with different populations to see if the results hold up and can be generalized to other settings. Moreover, studies could be conducted to compare the effectiveness of the 5Es model with other inquiry-based teaching approaches or with more traditional teacher-centered approaches to gain a deeper understanding of the most effective methods for teaching science concepts. Additionally, it would be interesting to extend the research to higher grade levels and explore the effectiveness of the 5Es model with older students.

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