Macrothink Institute™

Journal of Educational Issues
ISSN 2377-2263
2022, Vol. 8, No. 2

The Effects of 5E Inquiring-Based Learning Management on Grade 7 Students' Science Learning Achievement

Sumittra Yonyubon

Faculty of Education, Mahasarakham University, Thailand

E-mail: Sumittra61.ff@gmail.com

Jatuporn Khamsong

Faculty of Science and Health Technology, Kalasin University, Thailand

E-mail: Jatuporn.986@gmail.com

Wittaya Worapun (Corresponding author)

Faculty of Education, Mahasarakham University, Thailand

E-mail: Wittaya.wo@msu.ac.th

Received: July 17, 2022 Accepted: August 16, 2022 Published: August 25, 2022

doi:10.5296/jei.v8i2.20086 URL: https://doi.org/10.5296/jei.v8i2.20086

Abstract

The 5E teaching model is presented as an inquiring-based instructional method that benefits learners by letting them construct their knowledge of the class concepts from what they have learned or experienced. The sole purpose of the studies was to compare grade 7 students' learning achievement of science before and after learning in the learning management plan designed using the 5E inquiry-based learning. The study was conducted in a quasi-experimental design. The participants were 20 grade 7 students in Thailand. They were selected by a purposive random sampling method. The instruments included a 5E inquiring-based learning management plan and a pre-post learning achievement test. The data were analyzed by percentage, mean score, and standard deviation while the study hypothesis was tested using a paired-samples t-test. The results of the study indicate that the implementation of the 5E inquiry-based learning management plan benefits students'

knowledge of heat in a science class. The study provides pedagogical implications as it illustrated how a learning management plan designed in the 5E inquiry-based teaching model affected a science class. It also contributes to the research in the area as it extended the benefits of the teaching model in teaching concepts of science.

Keywords: 5E Inquiring-based Learning, Heat, Science Education

1. Introduction

In the globalized and competitive world of the 21st century, countries need to establish the knowledge of science for their citizens. It is, in fact, more important to the establishment of a society that supports scientific thinking. Therefore, it becomes a burden for educators to create a learning society that could let students in the country develop their science knowledge. At an individual level, students with a good knowledge of science can make rational decisions in daily life (Rosa et al., 2019), pursue various fields in higher education (Castellanos Castellanos & Rios-González, 2017), and become successful in professional life. Consequently, it becomes a priority for science education to develop both learners' scientific knowledge and thinking.

However, teaching science challenges stakeholders in an education setting. The complex nature of learning scientific subjects such as general science, chemistry, physics, biology, etc. can be a great challenge for school students. According to Anderman et al. (2012), challenges in teaching sciences relies on the requirements of adaptability, communication skills, non-routine problem-solving skills, self-development, and systems thinking. To clarify, learners are expected to be adaptive in learning sciences. Adapting to the ever-changing scientific scene requires several skills and mindsets. All of these provide distinct problems for the students learning science. Moreover, students need effective communicative skills in both written and oral modes to reveal the results of scientific investigation in class and in real life.

In addition, students need the development of metacognitive monitoring, self-regulation, and motivation to attend to the problem and persist in the face of challenges (Mayer, 1998). The world is full of unexpected events and problems; therefore, students are also expected to be equipped with skills that could deal with them. In addition, self-management skills and systematic thinking are also expected to occur in students' behaviors as outcomes of science classes. Considering these high expectations and limitations in teaching science in certain contexts, it is not a surprise that knowledge of science becomes a problem in educational settings (Jessani, 2015).

In Thailand, science is considered one of the most important subjects in the education plan for public schools across the country (The Ministry of Education, 2008). However, the subject also becomes a main concern in the educational setting. This could be evidenced by the results of high school students' quality tests both domestically and internationally. In detail, the result of the recent Ordinary National Educational Test (O-Net) shows that the average score of Thai students in science for the third educational level (grade 12) was only 32.68% (National Institution of Education Testing Service, 2019). Meanwhile, the average score of the students on science in the PISA test 2018 was 82 (S.D. = 426) which accounts for level 2 out of 6 of the competencies. Comparatively, the country was ranked 54th out of 78 countries taking the test that year (The OECD Programme for International Student Assessment, 2018). Therefore, it is a must to improve the quality of science education in the country.

The concept of heat is content that is included in science curricula around the globe. In Thailand, students learn the concept in the 7 grades. It is meant to illustrate how surroundings are explained by the knowledge of science and to let learners realize how they could apply science in daily life (The Ministry of Education, 2008). According to Science Learning Hub (2009), the knowledge of heat could be extended to other concepts of science such as moving particles, transferring heat energy, changing states by heat transfer, radiation, effects of heat, etc. However, the success of teaching science needs learners' understanding of concepts while allowing them to develop their thinking process using the demonstration of background knowledge and practical instances (Bazghandia & Hamrah, 2011). Therefore, teachers teaching the concepts of heat should make sure that they employ an instructional process that supports the elements.

The 5E teaching model is presented as an inquiring-based instructional method in a constructivist theory. According to Bybee (2006), the model benefits learners by letting them construct their knowledge of the class concepts from what they have learned or experienced. Teachers' role is to facilitate them throughout the learning circle and ensure their development using a systematic evaluation. There are 5 stages of the 5Es learning model including engaging, exploring, explaining, elaborating, and evaluating. The detail of each stage is given below.

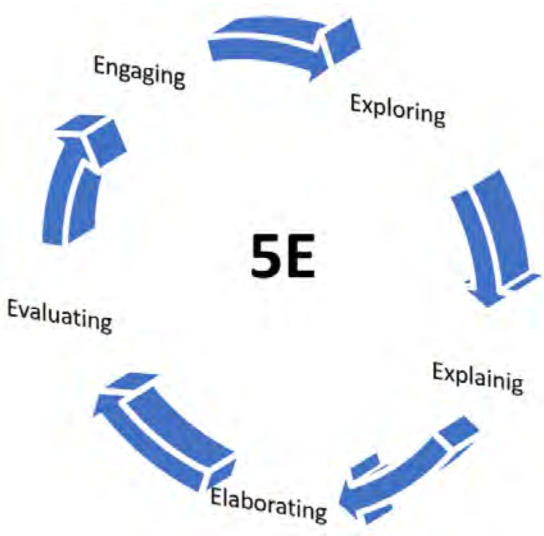

Figure 1. 5E instructional model

For each stage of the model, first, the teacher assesses students' prior knowledge and identifies knowledge gaps in the engaging stage. It's also important to pique students' interest in upcoming concepts. Students may be asked to ask opening questions or write what they know. This is when students learn the concept.

In the exploration phase, students learn through concrete experiences. They may be asked to follow the scientific method and make observations with peers. This phase is hands-on. In the explaining phase, teachers shift their role to the leader of the class. They help students synthesize new knowledge and ask questions.

For the Explaining phase to be effective, teachers should ask students to share what they learned during the phase before introducing technical information. Teachers use video, computer software, and other teaching material to aid comprehension.

The elaborating phase lets students apply what they've learned. This aids in comprehension. Teachers may assign students presentations or research to reinforce new skills. It solidifies students' knowledge before evaluation.

In the last phase, the 5E model allows formal and informal assessment. During this phase, teachers can ensure students' understanding of the core concepts using various kinds of evaluating tools such as self-assessment, peer-assessment, writing assignments, and exams.

Therefore, this model relies on students' logical and critical thinking. 5E is a model for instructional activities that encourages student engagement. The 5E instructional model uses a constructivist approach to raise students' concerns, help them develop lesson-related potential, and assess their abilities and understanding.

Moreover, the model has been proved to be beneficial in science classes in several studies (Ahmad et al., 2018; Bantaokul & Polyiem, 2022; Choowong & Worapun, 2021; Manzo et al., 2016; Ong et al., 2020; Sen & Oskay, 2017; Thangjai & Worapun, 2022). The results of the previous studies suggest that the 5E teaching model benefitted science classrooms in terms of developing students' knowledge of general science (Ahmed et al., 2018), world and changes (Bantaokul & Polyiem, 2022), light and image (Choowong & Worapun, 2021), and neuroscience and drug addiction (Manzo et al., 2016). It could be synthesized from the related studies that the 5E learning model can be beneficial for science education in several areas of knowledge and at different levels of education. Therefore, the method could be an alternative solution to solving science in the Thai context. The current study employed the 5E teaching model in a science class to improve students' learning achievement of heat. The sole purpose of the studies was to compare grade 7 students' learning achievement of science before and after learning in the learning management plan designed using the 5E inquiry-based learning.

2. Methodology

2.1 Research Design

The study was conducted in a quasi-experimental design. Therefore, it assigned only one group to the experiment. The participant's learning achievements on the topic of heat were assessed by a pre-post-test. A learning management plan designed in the 5E teaching model was employed as an independent variable. The purpose of the study was completed by a null hypothesis taking no difference between the participants' learning achievement before and after the implementation of the learning management plan.

2.2 Participants

The participants were 20 grade 7 students in Thailand. They were selected by a purposive random sampling method. The criteria were the convenience of data collection and students' previous performance in learning science, and students' experiences in science education. In detail, the participants were in a public school in Thailand. They passed through 12 science classes as stated in the core curriculum for basic education (Ministry of Education, 2008). The participants learned with one of the authors by the time data collection took place. They were treated considering the ethical issues for research in humans.

2.3 Research Instruments

2.3.1 Learning Management Plan

The learning management plan was designed using the principle of the 5E inquiring-based model (Bybee, 2015). It consisted of 8 lesson plans last a semester. The content of the learning management plan covered heat, temperature, thermal conduction, convection, radiation, melting point, enthalpy of fusion, and boiling point. An example of the learning process can be seen below. The plan was evaluated by 3 experts in education management and found to be at a high level of appropriateness ($\bar{x}$ = 4.32) before implementation.

Table 1. Learning process in the learning management plan

Phase	Learning activities-Topic: Thermal conduction
Engaging	- Teachers used the leading questions such as "Have you ever touched steam on the top of a boiling pot?", "How do you feel?", "Do you think how the heat is conducted?" - Students were separated into groups of 6-8.
Exploring	- Teachers gave a lecture and used learning material. - Students were assigned to do an experiment related to thermal conduction. - Students observed the experiment and made a report.
Explaining	- Students sent a representative to present their reports. - Teachers gave feedback and asked questions to ensure learners' learning.
Elaborating	- Teachers asked more questions related to the experiment to encourage further discussion.
Evaluating	Learning exercises were given. Students' knowledge of heat was individually assessed.

2.3.2 Pre-Post-Test

The learning achievement test was designed in a pre-post-test. The test consisted of 25 multiple-choice question items. The questions related to the knowledge of heat learned in class. The test shows .20-.60 difficulty, .46-.68 of discrimination, and .60-1.0 of validation. The test reliability was at 0.92.

2.4 Data Collection

The students took a pre-test at the beginning of the semester. The 5E inquiry-based learning management was employed throughout the semester. It took approximately 10 class hours to complete. Students took a post-test at the end of the data collection process.

2.5 Data Analysis

The data were analyzed by percentage, mean score, and standard deviation. The null hypothesis was tested using a paired-samples t-test.

3. Result

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

	Pre-test	**Post-test**	**t**	**p**
$\bar{x}$	10.1	17.35	12.54	0.00*
S.D.	3.02	3.11		

Note. *$P < 0.05$.

According to the table, it was found that the participant improve their science learning achievement of heat after learning with the 5E inquiry-based learning management plan. The result of the study rejects the null hypothesis as a paired-samples t-test indicates that the participant's average score on the post-test ($\bar{x}$ = 17.35, S.D. = 3.11) was significantly higher than the pre-test ($\bar{x}$ = 10.1, S.D. = 3.02), t = 12.54, p = 0.00. It could be interpreted that the 5E inquiry-based learning management plan positively affected students' knowledge and led to the improvement of science learning achievement in the concept of science.

4. Discussion

The results of the study indicate that the implementation of the 5E inquiry-based learning management plan benefits students' knowledge of heat in a science class. Therefore, the learning circles of engaging, exploring, explaining, elaborating, and evaluating could drive learners to construct their knowledge. The results of the study were consistent with the previous studies that also found the benefits of the teaching method in science classes (Ahmad et al., 2018; Bantaokul & Polyiem, 2022; Choowong & Worapun, 2021; Manzo et al., 2016; Ong et al., 2020; Sen & Oskay, 2017; Thangjai & Worapun, 2022). Therefore, it could be interpreted that the 5E inquiry-based learning is appropriate for science education in several settings including the Thai context as found in the current study.

Journal of Educational Issues
ISSN 2377-2263
2022, Vol. 8, No. 2

Moreover, the results of the study also extend the benefits of the 5E inquiry-based learning in the concepts of science. Apart from, General science (Ahmed et al., 2018), world and changes (Bantaokul & Polyiem, 2022), light and image (Choowong & Worapun, 2021), and neuroscience and drug addiction (Manzo et al., 2016), the current study also proves that the instructional method is also beneficial in teaching the concept of heat. Consequently, further studies could use the model in instructing other concepts of science.

In addition, the results of the study also confirm the benefits of inquiry-based learning in science education. According to Braund and Driver (2005), the teaching approach focuses on students' interests and encourages active learning by allowing them to conduct their investigations. Therefore, inquiry-based learning can be considered an effective approach for learning scientific concepts and understanding the nature of science, in which inquiry is key. In the current study, students conducted their experiment related to the concept of heat in active learning activities with teachers as facilitators, and it increased their learning achievement.

In addition, it can also be implied that the teaching method in the constructivist approach is an alternative solution to problems in science education. According to Driver et al. (1994), the constructivist approach views learning as a dynamic and social process, in which students actively construct meaning from their experiences in relation to their prior knowledge and the social setting. In the constructivist approach, learners do not come to science class with zero ideas about the world. Constructivists believe students shouldn't be passive recipients of teachers' knowledge and teachers shouldn't be classroom managers. Instead, teachers should encourage their learners to use world knowledge to deconceptualize concepts learn in classes (Fosnot, 1996). In the current study, learners were encouraged to construct the knowledge of heat via the learning circles of e engaging, exploring, explaining, elaborating, and evaluating. Eventually, they improved their understanding of the concept resulting in the development of their learning achievement.

5. Conclusion

The study was conducted to compare grade 7 students' learning achievement of science before and after learning in the learning management plan designed using the 5E inquiry-based learning. After the processes of a quasi-experimental study, the results of the study indicate that the implementation of the 5E inquiry-based learning management plan benefits students' knowledge of heat in a science class since the participants' learning achievement after the treatment was higher than in the pre-process. The study provides pedagogical implications as it illustrated how a learning management plan designed in the 5E inquiry-based teaching model affected a science class. Teachers can apply teaching processes exemplified in the study in their classes. However, it needs to be noted that the teaching method prioritizes learners' abilities to connect prior knowledge to the class concepts. Therefore, teachers adopting the teaching method should balance class leading between them and their pupils to ensure students' learning processes. Moreover, the study contributes to the research in the area as it extended the benefits of the teaching model in teaching concepts of science.

Acknowledgments

This research project was financially supported by Mahasarakham University.

References

Ahmad, N., Shaheen, N., & Gohar, S. (2018). 5E instructional model: Enhancing students academic achievement in the subject of general science at primary level. *Sir Syed Journal of Education & Social Research, 1*(1), 91-100.

Anderman, E. M., & Sinatra, G. M. (2012). The challenges of teaching and learning about science in the 21st century: Exploring the abilities and constraints of adolescent learners. Retrieved June 24, 2022, from https://sites.nationalacademies.org/cs/groups/dbassesite/documents/webpage/dbasse_072608.pdf

Bantaokul, P., & Polyiem, T. (2022). The use of integrated 5Es of inquiring-based learning and gamification to improve grade 8 student science learning achievement. *Journal of Educational Issues, 8*(1), 459-469. https://doi.org/10.5296/jei.v8i1.19802

Bazghandi, P., & Hamrah, S. Z. (2011). The principles of teaching science based on the ideas of Feyerabend regarding the nature of science and the manner of its expansion. *Procedia-Social and Behavioral Sciences, 29*, 969-975. https://doi.org/10.1016/j.sbspro.2011.11.330

Braund, M., & Driver, M. (2005). Pupils' perceptions of practical science in primary and secondary school: Implications for improving progression and continuity of learning. *Educational Research, 47*(1), 77-91. https://doi.org/10.1080/0013188042000337578

Bybee, R. W. (2009). The BSCS 5E instructional model and 21st-century skills. Retrieved June 24, 2022, from https://sites.nationalacademies.org/cs/groups/dbassesite/documents/webpage/dbasse_073327.pdf

Castellanos Castellanos, Y. A., & Rios-González, C. M. (2017). The importance of scientific research in higher education. *Medicina Universitaria, 19*(74), 19-20. https://doi.org/10.1016/j.rmu.2016.11.002

Choowong, K., & Worapun, W. (2021). The development of scientific reasoning ability on concept of light and image of grade 9 students by using inquiry-based learning 5e with prediction observation and explanation strategy. *Journal of Education and Learning, 10*(5), 152-159. https://doi.org/10.5539/jel.v10n5p152

Driver, R., Asoko, H., Leach, J., Mortimer, E., & Scott, P. (1994). Constructing scientific knowledge in the classroom. *Educational Researcher, 23*(7), 5-12. https://doi.org/10.3102/0013189X023007005

Fosnot, C. T. (1996). Constructivist: A psychological theory of learning. In C. T. Fosnot (Ed.), *Constructivisim: Theory, Perspective and Practice* (pp. 8-13). New York: Teacher College Press.

Jessani, S., I. (2015). Science education: Issues, approaches and challenges. *Journal of*

Education and Educational Development, *2*(1), 79-87. https://doi.org/10.22555/joeed.v2i1.51

Manzo, R. D., Whent, L., Liets, L., Torre, A. de la, & Gomez-Camacho, R. (2016). The impact of the 5E teaching model on changes in neuroscience, drug addiction, and research methods knowledge of science teachers attending California's ARISE Professional Development Workshops. *Journal of Education and Learning*, *5*(2), p109. https://doi.org/10.5539/jel.v5n2p109

Mayer, R. E. (1998). Cognitive, metacognitive, and motivational aspects of problem solving. *Instructional Science*, *26*(1), 49-63. https://doi.org/10.1023/A:1003088013286

National Institution of Education Testing Service. (2021). *2020 Ordinary National Educational Test (O-Net) Results*. Retrieved June 24, 2022, from http://www.niets.or.th/th

Ong, E. T., Govindasay, A., Salleh, S. M., Tajuddin, N. M., Rahman, N. A., & Borhan, M. T. (2018). 5E inquiry learning model: Its effect on science achievement among Malaysian year 5 Indian students. *International Journal of Academic Research in Business and Social Sciences*, *8*(12), 348-360. https://doi.org/10.6007/IJARBSS/v8-i12/5017

Rosa, F., O., Mundilarto, Wilujeng, I., & Sulistyani, A., M. (2019). Science in everyday life to build science literacy. *International Journal of Scientific & Technology Research*, *8*(12), 1148-1150.

Science Learning Hub. (2009). *Heat energy*. Retrieved June 24, 2022, from https://www.sciencelearn.org.nz/resources/750-heat-energy

Sen, S., & Oskay, O. O. (2016). The effects of 5e inquiry learning activities on achievement and attitude toward chemistry. *Journal of Education and Learning*, *6*(1), 1. https://doi.org/10.5539/jel.v6n1p1

Thangjai, N., & Worapun, W. (2022). Developing inquiry learning characteristics of grade 7 students using integrated 5e's of inquiry-based learning and game-based learning. *Journal of Educational Issues*, *8*(1), 137-150. https://doi.org/10.5296/jei.v8i1.19547

The Ministry of Education. (2008). *The basic education core curriculum*. Bangkok: The Ministry of Education.

The OECD Programme for International Student Assessment. (2018). *PISA 2018 insights and interpretations*. Retrieved September 1, 2021, from https://www.oecd.org/pisa/PISA%202018%20Insights%20and%20Interpretations%20FINAL%20PDF.pdf

Copyright Disclaimer