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DEVELOPING SCIENTIFIC EXPLANATION OF GRADE 10 BIOLOGY STUDENTS THROUGH SOCIOBIOLOGICAL CASE-BASED LEARNING

(Research article)

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Abstract

This action research aims to develop the scientific explanation of grade 10 students using sociobiological case-based learning on the topic "immune system". The target group consisted of 21 students who are studying in biology course. The research instruments were: plan of instrument using sociobiological case-based learning, scientific explanation test, student behavior observation, semi-structure interviews, and student journal writing. The data were analyzed by percentage, mean, and standard deviation. The results showed in the first cycle, 18 students received an average scientific explanation score of 9.62 out of a total 12 points, representing 80.16%, and three students did not meet the good level criterion. In the second cycle, 21 students received an average scientific explanation score of 10.90 out of a total of 12 points, representing 90.87% of those who met the good criteria.

Keywords: action research, biology, students, scientific explanation, science education, sociobiological case-based learning

1. Introduction

The study of science in the 21st century is rapidly changing, which is reflected in the human quality of life. The challenges that humans face, including the development of a wide range of innovations based on scientific ideas (Organization for Economic Co-Operation and Development; OECD, 2016). Science is important in assisting humans in developing ways of thinking. Thought is causal and creative. It is capable of finding knowledge and solving problems in a systematic manner. A wide range of information and verifiable testimony can be used to make decisions. As a result, the study of science should be ongoing, with a focus on applying scientific knowledge to real-life situations or contexts (Nurse, 2016). in order to apply knowledge to make scientific decisions and to strengthen scientific knowledge for work in the knowledge-based economy (Autieri et al., 2016; Mirici & Uzel, 2019).

The primary structural framework of science education is scientific explanations (McNeill & Krajcik, 2008). It takes more than the ability to remember theories to describe scientific phenomena, but it also requires an understanding of how such knowledge is obtained and what level of trust scientific claims are made with (El Islami et al., 2018; Suhandi et al., 2018), considered a scientific quest that encourages students to be well versed in science (National Research Council, 1996). Scientific explanations are thus a practice that science teachers value and are used as a learning management goal, as they are important for basic science education as well as encouraging students to gain an understanding of science.

Understanding the nature of science and promoting scientific maneuvering (McNeill & Krajcik, 2008). Furthermore, students will understand how to define scientific questions, analyze and interpret data patterns, and associate information with theories to describe events or situations (Nawani et al., 2019). Furthermore, scientific explanations encourage students to communicate. Understand, think critically, and explain in relation to science and evidence (Nuangchalerm, 2017)

An investigation into the development of science learning, school focused on improving knowledge so that students could apply their knowledge in exams to gain an entry into higher education. Encourage students to apply their knowledge to solve problems or overcome obstacles when faced with situations or phenomena that arise correctly based on principles and reasons. It also focuses on teaching students how to apply their knowledge to describe situations or phenomena they encounter in everyday life. Observing the teaching of biology courses, however, students were found to be able to answer questions in terms of knowledge and good memory in the covid-19 pandemic situation.

The researchers conducted their exploration under the learning management theory concept that encourages students to develop scientific explanations. There are numerous learning options available. In chemistry, for example, socioscientific issues on the topic reaction rate (Mahanani, 2019), and in physics, context-based learning on the topic mechanical balance (Chumsaeng, 2017), and in biology courses on the unit endocrine system (Hongkerd, 2018). In addition, research by Illingworth et al. (2012) found that students develop the ability to scientific explanations when they study social issues. Teachers are linked to explanations that can be found in students' daily lives (McNeill & Krajcik, 2008; Nuangchalerm, 2009). Moreover, case-study teaching can develop students' ability to analyze, solve problems, make decisions, and reason (Barkley, 2010).

According to Suwono et al. (2017), case-based teaching in biology can help students develop high-level thinking skills. Students can accurately and rationally analyze problems by referring to biological information. Using real-life problems in teaching can lead to the discovery of scientific concepts and help encourage students to make biological connections in relation to social issues (Kloser, 2012). It gives rise to Sociobiological case-based learning, a teaching arrangement developed from problem-based learning management as a foundation and centered on the use of biological cases as a social issue. As a result of such problematic conditions and principles, the researchers were interested in developing scientific explanations of fourth-graders who were able to learn using biosocial cases as a base to meet good criteria.

This study is based on action research, which aims to solve specific problems of those who do the work in order to improve performance and work-in-progress quality and efficiency (Onsee & Nuangchalerm, 2019; Vuran, Çiğdemoğlu & Mirici 2020). The stages of operational research are as follows: plan, act, observe, and reflex. This research will be based on a method that will allow students to better manage their learning. The result can be use as instructional guideline engaging students in terms of scientific explanation and their learning promotion.

2. Method

2.1 Participants

Initially, the study participants were grade 10 students from one classroom in semester 2 of the academic year 2021 at one school from Mahasarakham province, Thailand. The preliminary scientific explanation test was used to screen students. According to the findings, twenty-one students did not meet the criteria for a good level of scientific explanation ability. As a result, the study's target group consisted of twenty-one students with scientific explanation ability scores lower than good.

2.2 Research instruments

The research instruments for this study included a sociobiological case-based learning lesson plan on the immune system, scientific explanation test, observation form, semi-structured interviews and student journal. Expert judgments accept reliable research instruments in action research. The majority of the validity and reliability were provided in the form of qualitative comments.

Lesson plan: Six lesson plans for sociobiological case-based learning received 12 hours of biology instruction. In cycle one, which lasted six hours, first, second, and third lesson plans were implemented. Cycle 2 lesson plans fourth fifth and sixth. Each lesson plan was corrected and reviewed by five experts to ensure its appropriateness. Then, as trust grows, improve lesson plans with expert guidance.

Scientific explanation test: Two items, open-ended questions are used at the end of each cycle, have students complete two tests with a rubric score adapted from McNeill & Krajcik (2008). The test consisted of 3 components: claim evidence and reasoning. The constructed test was checked and developed using the index of item objective congruence by five experts. Observation form: The observation of student behavior is structured, with the goal of identifying behaviors that indicate students' scientific explanations. This can be seen during learning activities. The instrument was built and checked by five experts. Then developed it before implementing it to the target students.

Semi- structured interviews: They interviewed the opinions of a group of students who did not meet the criteria set at the end of the learning activity in each cycle. The instrument was built and checked by five experts. Then developed it before implementing it to the target students

Student journal writing: It is a student journal that is written at the end of the cycle in order for students to reflect on it during the course. How did they get the answers, in which the researchers laid out the issues in the students' subjugations about scientific explanations in order for them to know how to think “How to study it in order to obtain answers identified as claim evidences and reasoning?”

2.3 Data collection

This research was action research employed by Kemmis & McTaggart (1988). Data collection consisted of 4 steps: plan, act, observe and reflect implemented in two cycles. More details can be described in the following (Figure 1).

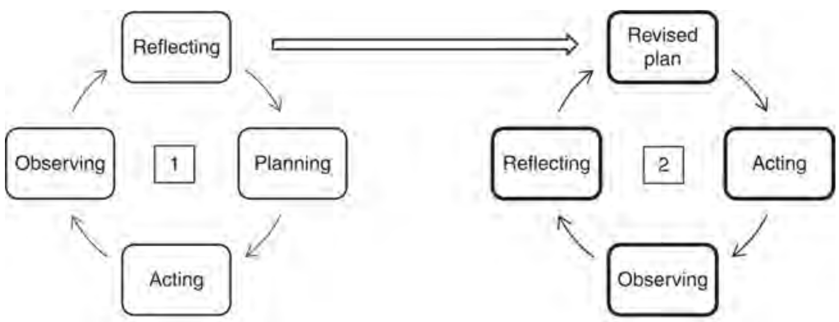

Figure 1. Steps of action research

Plan: Begin by surveying students' contexts and problems by observing the learning environment and their study behavior. The document is then analyzed, which is related to Scientific explanation and Sociobiological case-based learning. As a result, research tools were created and developed.

Act: After constructing and improving the research instruments, Cycles 1 were used lesson plans 1, 2, and 3. Cycle 2 were used lesson plans 4, 5, and 6 to implement them to the target students.

Observe: Behavior of the targeted group that indicate the ability to scientific explanations using. It structured behavioral observations. At the end of in cycle 1 and cycle 2, the researchers collected score data on the ability to scientific explanations of the targeted students. Using the scientific explanations test. It then collects data on the ability of students who do not meet certain criteria to provide scientific explanations using semi-structured interviews and student journals. It also collects data from post-learning logs generated during learning activities.

Reflect: Data from testing, observation, interviews, and student journals were analyzed. The findings were scrutinized in order to answer the study's purpose. The information and findings gleaned from observing and interviewing target students revealed issues with the teaching and learning process. The guidelines for solving problems are then discovered by researchers in the following cycle.

2.4 Data analysis

The researcher analyzed the data in this study based on the research objectives. Data were analyzed by comparing students' answers to the modified criteria from McNeill & Krajcik (2008), as shown in Table 1.

Table 1. Scientific explanation evaluation criteria adapted from McNeill and Krajcik (2008)

Component	Level		
	2	1	0
Claim	Provide the claim in full accordance with the situation.	Provide an incomplete claim to the situation, or provide an incomplete alternative answer.	Provide claims that are contradictory to the facts of the situation. or do not make a claim
Evidence	Provide consistent evidence to back up the entire claim.	Provide consistent evidence to back up incomplete claims or to provide other incomplete responses.	Provide evidence that contradicts the claim.
Reasoning	Provide consistent reasons by linking evidence and claims. utilizing all scientific principles	Provide consistent reasons by linking evidence and claims. utilizing insufficient scientific principles or specifying other insufficient answers	Provide reasons for inconsistencies in linking evidence and claims using scientific principles, or leave the reason unspecified.

The data were classified into three levels of ability to scientific explanations, as shown in Table 2, for each individual, which were good, moderate, and low. Furthermore, information obtained from the student interview form was used. To analyze, interpret, and summarize student behavior, use a student behavior observation form and a student journal. The results should then be reported in a descriptive manner.

Table 2. Interpretation criteria for scientific explanation

Score range (percentage of full score)	level
75-100	Good
50-74	Moderate
Lower than 50	Low

3. Result

A total of 34 students received a mean score of 7.71 on the scientific explanation. 13 students with good ability to scientific explanations accounted for 38.23 percent, followed by 14 students with moderate ability to scientific explanations, which accounted for 41.18 percent. 7 students with low ability accounted for 20.59 percent (Table 3). However, considering the scores derived from measuring the ability to scientific explanations against a given criterion, it was found that the student's ability to identify claims had a mean score of 3.18, representing 79.5 percent of the good level criteria, while a mean score of evidence and reasoning was 2.74 and 1.79, representing 68.50 and 44.75 percent, respectively. It was found that these two components did not meet the good level criteria. As a result, the researcher chose 21 students with moderate and low scores as the target group. To develop the target group of 21 students' ability to scientific explanations to a good level.

Table 3

Scientific explanations in the learning activities

Mean score	Score component				%	Interpret
	Claims (4)	Evidence (4)	Reasoning (4)	Total (12)		
Before	3.18	2.74	1.79	7.71	64.21	Moderate
Cycle 1	3.71	3.33	2.57	9.62	80.16	Good
Cycle 2	3.95	3.67	3.29	10.90	90.87	Good

Cycle 1, there were 18 students who passed the criteria, representing 85.71 percent, and 3 students who did not pass the criteria, representing 14.29 percent. The mean score total scientific explanation mean was 9.62, representing 80.16 percent. Consider the scores derived from measuring the ability to scientific explanations against a given criterion. The student's ability to identify claims and evidence had a mean score of 3.71 and 3.33 respectively, both components were at a good level, representing 92.75 percent and 83.25 percent, respectively, and a mean score reasoning was 2.57, representing 64.25 percent. It can be seen that the student's reasoning ability score is the lowest average. and has not passed the good level criteria.

Cycle 2, there were 21 students in the target group received a good level. When total scores were considered, students had an average score for the ability to scientific explanations of 10.90, representing 90.87 percent. Consider the scores derived from measuring the ability to scientific explanations against a given criterion. It was discovered that the student's ability to make claims had a mean score of 3.95, representing 98.75 percent, evidence received a mean score of 3.67, representing 91.75 percent, and reasoning received a mean score of 3.29, representing 79.75 percent. It shows that students passed the good level criteria.

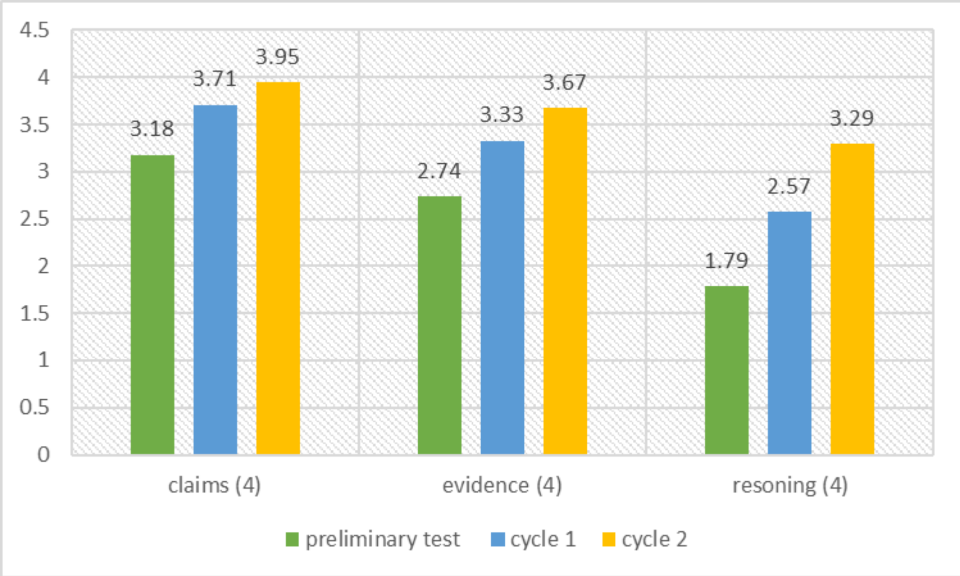

Figure 2. Mean score of scientific explanation in the study

Sociobiological case-based learning in cycles 1 and 2, students received points for each component of developing an incremental scientific explanation. In cycle 1, 18 students performed better on their ability to explain scientific concepts at the Good. In cycle 2, 21 students' ability to provide scientific explanations was rated as good level, that is the intended audience. As a result, when students are taught using Sociobiological case-based learning in each cycle, they have a greater ability to scientific explanations.

4. Discussion

According to the findings, students were capable of scientific explanations, with an average score of 9.62. When looking at the scores individually, 18 of the 21 students met the good criteria. This is because students in activities answer questions or make comments. There is an activity sheet available for students to use in order to practice scientific explanations. It also teaches students how to apply knowledge from theories, principles, and scientific explanations to situations that teachers define. This may be due to sociobiological case-based learning. It has focused on using biological cases as a social issue that can improve students' high levels of thinking skills. Students are able to analyze problems based on biological information accurately and rationally (Suwono et al., 2017).

As students learn through everyday problems, they discover scientific concepts and help encourage students to connect with biological knowledge (Kloser, 2012). However, there were 3 students who did not pass the good level criteria. But when observing the scores of the students who did not meet the criteria, these students had scores that were close to meeting the set criteria. However, the students who did not pass the criteria had some difficulty understanding the content. The students did not clearly identify the problem. Students are talking about sharing learning with their little friends, which affects the activities of the various stages of learning activities. Therefore, the researcher has taken the problems that arise in the first cycle and improved and developed them in the second cycle.

Cycle 2 The researchers improving and developing sociobiological case-based learning in Cycle 1, students' scores on their ability to create scientific explanations. The students had an average score of 10.90 points. Considering individual scores, it was found that 21 students passed the good level criteria out of the total number of students. This could be because the researcher designed a learning activity at the point where students identify problems. The researcher used the questions to encourage students to think critically about the situation. Furthermore, the researcher gives students the opportunity to share their knowledge. More comments from group members. This is supported by Sampson & Clark (2009); Woody (2015); Sulistina et al. (2021), provided students the opportunity to exchange knowledge, discuss, and express their opinions with their peers is a gift. As a result, students will be able to provide accurate scientific explanations. Not only cognitive abilities, but also scientific explanations, are employed.

However, communication skills are required, and the group should include members with diverse skills and knowledge in order to jointly create and validate scientific explanations. According to research, using sociobiological case-based learning as a foundation can help to develop scientific explanations. Students' scientific explanation scores have evolved in each cycle, and studies of qualitative data obtained by students have revealed that students' ongoing improvement is the result of sociobiological case-based learning, which involves students in activities by answering questions or making comments. There is an activity sheet available for students to use in order to practice scientific explanations. It also teaches students how to apply knowledge from theory, principles, and scientific explanations in situations that teachers define (Lillo & Aponte-Safe, 2019; Nuangchalerm, 2020).

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