Effects of The EIMA Learning Management on Scientific Explanation Ability, Reasoning and Thinking Ability and Science Learning Achievement of Grade 9 Students

Kanyarat Promsorn*, Wilailak Langka & Ittipaat Suwatanpornkool

Faculty of Education, Srinakharinwirot University, Bangkok 10110, Thailand

Article info

Article history:
Received : 10 April 2018
Revised : 15 May 2018
Accepted : 1 June 2018

Keywords:
EIMA Learning Management, Scientific Explanation Ability, Reasoning and Thinking Ability, Science Learning Achievement, Teamwork

Abstract

The purposes of this research were to compare scientific explanation ability, reasoning thinking, and scientific achievement before, after and the follow-up periods in atoms and the periodic table of Grade 9 students using the EIMA instruction model. In addition, qualitative data, teamwork ability were observed each period. The study groups were Grade 9 students who were studying basic science during the first semester of the 2017 academic year. They were from Triamudomsuksa Suwinthawong School in Bangkok. One classroom was selected by Two-Stage sampling. The implementation time was ten periods of fifty minutes. This research was a quasi-experimental study. The research instruments included the EIMA instruction model, lesson plans about atoms and knowledge of the periodic table in scientific explanation making test, ability of reasoning and thinking test, a science achievement test and teamwork observation form. The data were analyzed using Mutivariate Analysis of Variance (MANOVA, with repeated measures). Moreover, content analysis was used for qualitative data.

The research findings were as follows 1) Students who received EIMA instruction had the ability to make scientific explanations, ability in reasoning and scientific achievement regarding atoms and the periodic table as shown in the post-test and follow-up were higher than the pre-test at a .05 level of significance. 2) From teamwork observation, students with EIMA students clearly perceiving the importance of planning and the division of duties in a group. The students volunteered to work on the strength in order to help the group and had more awareness to help each other. The students cooperated to solve problems by asking different questions, and to find answers from books, and through the network and the ability to have evidence to support their answers.

Introduction

Science plays an important role in today's society and in the future because science relevant is to everyone, both in everyday life and careers as well as technology, tools and appliances. The products that are used to facilitate human life are the result of scientific knowledge combined with creativity that human have developed and
researched to solve problem systemically. Science is also a culture of the modern world which is knowledge-based society. Therefore, everyone should have scientific literacy (scientific literacy for all) in order to have a better understanding of nature and human technology. One of the important elements to strengthen science literacy is education for preparing people for scientific and technology society (The Ministry of Education Thailand, 2008).

Thailand aims to develop 5 learners’ key competencies consisting of communication capability, thinking capability, problem solving capability, capability in applying life skills and capability in technological application (The Ministry of Education Thailand, 2008). According to the results of Ordinary National Educational Test (O-NET) in Science subject of Grade 9 in 2016, students had an average score of 34.99% which was low. The average scores of the General Aptitude Test (GAT) 2/2015, 1/2016 and 2/2016 were 147.72 115.66 and153.81 and the average scores of the Professional Aptitude Test (PAT2) 2/2015, 1/2016 and 2/2016 were 72.00 76.18 and 79.49 from 300 point which were less than 50%. In addition, according to the results of the assessment of academic ability in science under the Programme for International Student Assessment (PISA) which assess the scientific performance consisting of the abilities to identify scientific issues, explain phenomena scientifically and use scientific evidence, found an average score in PISA 2009 test was 425 (The Institute for the Promotion of Teaching Science and Technology :IPST, 2009) and 444 for PISA 2012 test which were lower than an average score of the Organization for Economic Co-operation and Development (OECD). It was also found that 34% of Thai students had scientific knowledge lower than the standard of the Institute for the Promotion of Teaching Science and Technology (The Institute for the Promotion of Teaching Science and Technology: IPST, 2012).

Based on these reports, it shows that the science learning of Thai students has not been successful. The scientific knowledge assessment does not pass the 50% criterion and the learning management method needs to be improved. This reflects the problem of prior learning management that emphasized on a memory model teaching rather than process skills. Therefore, the solution is to organize the appropriate learning process as the learning process is an important factor that helps develop the intellect and thinking process of students by encouraging students to learn science with an emphasis on linking knowledge to process, have skills in researching and creating knowledge using an inquiry process and solving various problems. This process allows students to participate in every step of learning and organizing practical activities. For science learning management to help students achieve knowledge by themselves, students must think of new ideas and transform data from assumptions and make decisions based on prior knowledge and discover the principles by themselves. Schwarz and Gwekwerere (2007) applied EIMA learning management from Bybee’s 5E instructional model (2016) which is the student-centered learning process. This allows students to practice their skills and scientific process in order to achieve knowledge and solve problem by themselves by creating a model for explanation. EIMA learning management consists of 4 steps: 1) Engage 2) Investigate 3) Model and 4) Apply. EIMA learning management has similarities and differences with 5E instructional model that is used as the instructional method at present. The differences are EIMA learning management has a step to create a model for explanation (Model). This is a step that students use the data from investigation and create a model for the scientific explanation. Studying the key competencies in students’ thinking in different aspects will help promote both reasoning and thinking ability and choosing situations and directly affects students. This allows students to become aware of the importance of thinking (Siriphet, 2017)

From the current problems in instructional management, it shows that most students lack the ability to create scientific explanation and reasoning and thinking ability. EIMA learning management is suitable for developing the ability to create scientific explanation and reasoning and thinking ability of the junior high students. This is in order to find the suitable instruction model for a learning management that will develop better results in students ability to create scientific explanation and reasoning and thinking ability competency. This will be the guideline for developing the effective science teaching and learning management.

Objectives

1. To compare the ability to create scientific explanation, reasoning and thinking ability, and science learning achievement of Grade 9 students that was taught by using EIMA learning management before learning, after learning and during the monitoring.
2. To investigate the teamwork of Grade 9 students that were taught by using EIMA learning management

Conceptual Framework

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Dependent Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>EIMA Learning Management</td>
<td>1. Scientific Explanation Ability</td>
</tr>
<tr>
<td></td>
<td>2. Reasoning and Thinking Ability</td>
</tr>
<tr>
<td></td>
<td>3. Science Learning Achievement</td>
</tr>
<tr>
<td></td>
<td>4. Teamwork</td>
</tr>
</tbody>
</table>

![Figure 1 Conceptual Framework](image)

Research Methodology

1. Population and Samples
   1.1 Population
   The population of this study was Grade 9 students, 1st semester of an academic year 2017 under the Secondary Educational Service Area Office 2, all 5 schools in Benjaburapha secondary school consortium which consisted of Triamudomsuksanomklao School, Debsirinromklao School, Rattanakosin Somphodladkrabang School, Nawaminthrachinuthit Triamudomsuksanomklao School and Triamudomsuksa Suwinthawong School in total of 1,472 students.
   1.2 Sample
   The sample used in this study was a class of Grade 9 students of Triamudomsuksa Suwinthawong School, Nong Chok District, Bangkok under the Secondary Educational Service Area Office 2 which was obtained by using two-stage sampling. The sampling process was as follows 1) determine the population which was Grade 9 students in all 5 school in Benjaburapha secondary school consortium which consisted of Triamudomsuksanomklao School, Debsirinromklao School, Rattanakosin Somphodladkrabang School, Nawaminthrachinuthit Triamudomsuksanomklao School and Triamudomsuksa Suwinthawong School. 2) Sampling by using school as sampling unit which resulted in Triamudomsuksa Suwinthawong School, 3) After we obtained the school, a class of Grade 9 students of Triamudomsuksa Suwinthawong School was then sampled.
   1.3 Content used in this study
   The content used in this study was W20205 Atom and Periodic Table which was the additional subject of Grade 9 level according to the Basic Education Core Curriculum B.E. 2551 (A.D. 2008), 1st unit Atom and Periodic Table.

1.4 Duration
   This research was performed in the 1st semester of an academic year 2017 for 5 weeks in total of 10 periods, 50 minutes per period. Pre-test and Post-test was 5 weeks apart and Post-test and the Follow Up was 2 weeks apart.

1.5 Definition of Terms
   EIMA learning management means the use of inquiry, searching and investigating process in Substances and Properties of Substances of the 1st unit Atom and Periodic Table subject. The details of each step were as follows:
   1.5.1 Engage refers to introducing students in the topic in order to identify problems by using a variety of activities to get students interested and committed in finding answer. This is in order to proceed into the topic to be studied and further into the investigation.
   1.5.2 Investigate refers to helping students to investigate the topic, make assumptions from problems then investigate and collect data through observation, experimentation and study from various sources.
   1.5.3 Model refers to helping students to create model for the scientific explanation. In this step the data from the investigation is used to create the model to provide scientific explanation.
   1.5.4 Apply refers to asking students to apply those explanation to new situations.

2. Research tools
   2.1 5 EIMA instructional frameworks. The appropriateness of all instructional frameworks were evaluated by the experts in the aspects of the components of the instructional framework, learning objectives, contents, learning activities, learning materials, measurement and evaluation which found that the scores of all aspects were between 20 - 25 from 25 point. The instructional framework was therefore most appropriate.
   2.2 Scientific explanation ability test. This test was the written test consisting of 5 questions in which students answered questions in each situation by using the scientific explanation. This test consisted of 3 components which included 1) claim, 2) evidence and 3) reasoning with the IOC of between 0.60 - 1.00, difficulty (p) of 0.37 - 0.48 and discrimination (r) of 0.20 - 0.50.
   2.3 Reasoning and thinking ability test. This test was a multiple choice test (consisting of 4 choices)
Effects of The EIMA Learning Management on Scientific Explanation Ability, Reasoning and Thinking Ability and Science Learning Achievement of Grade 9 Students

Promsorn et al.

in total of 20 items with the IOC of 0.60 - 1.00, difficulty (p) of 0.23 - 0.64 and discrimination (r) of 0.24 - 0.64.

2.4 Achievement test on Atom and Periodic Table. This test was a multiple choice test (consisting of 4 choices) in total of 20 items with the IOC of 0.60 - 1.00, difficulty (p) of 0.48 - 0.70 and discrimination (r) of 0.20 - 0.40.

2.5 Teamwork observation. This observation required the recording of the overall atmosphere of teamwork to evaluate the behaviour in 5 aspects such as defining objectives and allocating work; awareness of roles; good interaction, complementing and helping each other; keeping the atmosphere and adjusting to each other; and open communication, consultation and troubleshooting. The IOC of this test was between 0.80 - 1.00 with the correlation coefficient of teamwork behaviour of students between 0.67 - 0.72.

3. Data collection

The quasi-experimental design was used in this study with two-phase embedded design: experimental model by quantitative dominant (Buason, 2013). The sample was taught by using EIMA instructional framework. The data collection was performed in the pre-test, post-test and follow-up period with the steps as follows:

1. Pre-test, The pre-test was performed by using the 5-item scientific explanation ability test, 20-item reasoning and thinking ability test and 20-item achievement test on Atom and Periodic Table.

2. EIMA learning management was used in teaching students according to 5 learning plans for 5 weeks, 10 periods, 50 minutes per period. During the learning process, the teamwork behaviour was recorded by the researcher and assistants.

3. Post-test, The post-test was performed by using 5-item scientific explanation test, 20-item reasoning and thinking ability test and 20-item achievement test on Atom and Periodic Table in 2 weeks interval.

4. Follow Up, The follow up was performed by using 5-item scientific explanation test, 20-item reasoning and thinking ability test and 20-item achievement test on Atom and Periodic Table. The results of the observation of students’ teamwork were discussed together with the results of EIMA instructional framework.

4. Data analysis

4.1 Comparative analysis of scientific explanation ability, reasoning and thinking ability, and science learning achievement on Atom and Periodic Table was performed by using MANOVA with repeated measures.

4.2 Internal analysis within a group to compare the results of pre-test, post-test and follow up in each group by using MANOVA with repeated measures.

4.3 Study the observation of teamwork behaviour of students that were taught by using EIMA instructional framework. Two assistants helped in observing teamwork of students and the observations and notes were used as qualitative data to complement in the interpretation, drawing conclusions and discussion.

Results

1. The analysis results of scientific explanation ability, reasoning and thinking ability, and learning achievement on Atomic and Periodic Table of Grade 9 students who were taught by using EIMA learning management which were analysed by using MONOVA with repeated measures are shown in Table 1.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Multivariate Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>scientific explanation ability</td>
<td>Λ (Wilks’ lambda) = .026</td>
</tr>
<tr>
<td>reasoning and thinking ability</td>
<td>F-statistic = 136.720*</td>
</tr>
<tr>
<td>science learning achievement</td>
<td>p-value = .001</td>
</tr>
</tbody>
</table>

Table 1 summarizes the analysis results of scientific explanation ability, reasoning and thinking ability, and learning achievement on Atomic and Periodic Table of Grade 9 students who were taught by using EIMA instructional framework. Considering the multivariate test, it was found that the average scores of pre-test, post-test and follow up of students who were taught by using EIMA learning management were statistically significant at the 0.05 level (Λ = .026, Multivariate F-statistic = 136.720, p-value = .001 < .01) agreeing with the hypothesis.

Pairwise Comparison of the results of scientific explanation ability, reasoning and thinking ability, and learning achievement on Atomic and Periodic Table showed that all pairs were statistically significant at the 0.05 level.
From the average scores of pre-test, post-test and follow up in Table 2 it was found that after students were taught by using EIMA instructional framework, the score on scientific explanation ability test were higher with the growth score of 79.32%.

<table>
<thead>
<tr>
<th>scientific explanation ability</th>
<th>pre-test (20 points)</th>
<th>post-test (20 points)</th>
<th>follow up (20 points)</th>
</tr>
</thead>
<tbody>
<tr>
<td>average (\overline{X})</td>
<td>10.85</td>
<td>19.65</td>
<td>23.04</td>
</tr>
<tr>
<td>standard deviation (S)</td>
<td>2.51</td>
<td>2.25</td>
<td>1.90</td>
</tr>
</tbody>
</table>

Greenhouse-Geisser F-statistic = 721.180* p-value = .000

From the average scores of pre-test, post-test and follow up in Table 3 it was found that after students were taught by using EIMA instructional framework, the score on reasoning and thinking ability test were higher with the growth score of 54.64%.

<table>
<thead>
<tr>
<th>reasoning and thinking ability</th>
<th>pre-test (20 points)</th>
<th>post-test (20 points)</th>
<th>follow up (20 points)</th>
</tr>
</thead>
<tbody>
<tr>
<td>average (\overline{X})</td>
<td>8.91</td>
<td>13.34</td>
<td>14.97</td>
</tr>
<tr>
<td>standard deviation (S)</td>
<td>1.91</td>
<td>1.68</td>
<td>1.38</td>
</tr>
</tbody>
</table>

Greenhouse-Geisser F-statistic = 294.928* p-value = .000

From the average scores of pre-test, post-test and follow up in Table 4 it was found that after students were taught by using EIMA instructional framework, the score on Atomic and Periodic Table learning achievement test were higher with the growth score of 57.15%.

<table>
<thead>
<tr>
<th>science learning achievement</th>
<th>pre-test (20 points)</th>
<th>post-test (20 points)</th>
<th>follow up (20 points)</th>
</tr>
</thead>
<tbody>
<tr>
<td>average (\overline{X})</td>
<td>5.53</td>
<td>12.12</td>
<td>13.80</td>
</tr>
<tr>
<td>standard deviation (S)</td>
<td>1.46</td>
<td>1.73</td>
<td>1.70</td>
</tr>
</tbody>
</table>

Greenhouse-Geisser F-statistic = 294.928* p-value = .000

Effects of The EIMA Learning Management on Scientific Explanation Ability, Reasoning and Thinking Ability and Science Learning Achievement of Grade 9 Students

Promsorn et al.
2.5 Troubleshooting, the researcher and assistants commented on the observation records of teamwork behavior in the similar way that being open to criticism and encouraging friends were still not obvious in Plan 1. The assistants had to walk around the classroom and encourage students to express their ideas. Some students used impolite words to refer to themselves, the assistants therefore warned them to use polite words when asking for cooperation without sarcasm. From Plan 1 to Plan 5 it was found that students worked together to solve problems and answer questions from other groups. They worked together to find the answers from books and Internet network. They also found the evidence to support their answers. For the language, it was found that students did not use impolite words because both researcher and assistants walked around and inspected during group activities.

**Discussion**

1. The study of the effects of EIMA learning management on scientific explanation ability showed that the students who were taught by using EIMA learning management had higher scientific explanation ability in the follow up and post-test than in pre-test with the statistical significance at 0.05 level. The score increased by 54.64% which is consistent with the hypothesis. This was also consistent with Schwarz and Gwekwerere (2007) who used this instructional framework with Grade 7 students in science class and found that after students were taught by using the instructional framework students had higher explanation ability. In addition, McNeill and Krajcik (2007) who studied the scientific explanation, the characteristics and evaluation of learning management for Grade 7 students found that the learning management using 4 learning management approaches which consisted of 1) creating the model to explain scientific knowledge, 2) creating sentences and reasons to explain scientific knowledge, 3) definition of scientific explanation and 4) linking the scientific explanation to everyday life allowed students to learn from scientific explanation. This shows that EIMA learning management is a qualitative instructional framework that can be used in developing the scientific explanation ability of students because it has the following instructional activities:

1. Teacher developed students interest in a variety of activities to stimulate curiosity, enthusiastic and had imagination. This was in order to make it easier to identify problems and answers. Students reviewed their prior experiences to guess the answer of the question by using facts or evidences related to the answer. This made students curious to learn new things and contribute to scientific explanation.

2. Students performed the investigation by planning, searching information and scientific knowledge and used the findings to identify claims. Then the data was classified, analysed, commented and predicted to comply with the empirical evidence and reasoning that is consistent with the experiment and investigation. This allowed students to organize their ideas and develop scientific knowledge and create explanation.

3. Students could create scientific explanation by creating self-knowledge from doing activities, searching for sources of information, scrutinizing data in order to find the relationship between knowledge, evidence and fact. After that the correct scientific explanations were created as well as a variety of works from activities under the guidance of teachers and experts. The feedback contributed to knowledge dispute that led to the conclusions of the situation to be explained. This resulted in correction and repetition of work in order to develop better work and understanding which is consistent with the study of Berland and Reiser (2009) who found that students used evidence to understand the phenomenon, had social relationships by interacting in class and designed the strategies for scientific practice related to explanations and arguments. Student could create the scientific explanation in all aspect. They could also present and explain a model at a higher level. It could be observed that the creation of new knowledge related to creation of model. Therefore, this contributed to the better scientific explanation ability of students.

4. Students could apply knowledge by themselves by linking the relationship between empirical evidence and reasoning through the investigation process in order to draw the conclusions. This process developed the scientific explanation ability for students.

However, in this study it was found that each step of creating scientific explanation by creating a model was still unclear. This might be because the content used to create the model had different difficulty degrees. Creating a model that can clearly demonstrate the working process took time and was very complex. The experience of students were also required as found in the study by McNeill and Krajcik (2007).

2. The effects of EIMA learning management on logical thinking ability. It was found that students who
Effects of The EIMA Learning Management on Scientific Explanation Ability, Reasoning and Thinking Ability and Science Learning Achievement of Grade 9 Students

Promsorn et al.

were taught by using EIMA learning management had higher reasoning and thinking ability in the follow up and post-test than in pre-test at the significant level of 0.05 which increased by 54.64% and is consistent with the hypothesis. This was also consistent with the study by Ates and Cataloglu (2007) who studied the effects of reasoning and thinking ability of students on the understanding of concept and problem-solving skills in basic mechanics. They found that the average scores on problem solving skills test by MBI were significantly different among students who used concrete evidence in reasoning and adhered to evidence. However, there were no significant differences between pre-test and post-test average scores of the test of concept understanding measured by the FCI of all groups of students. The results showed that EIMA learning management was the learning activities that Schwarz and Gwekwere (2007) had developed in order to practice logical thinking skills which were inserted in all 4 steps for organizing activities as follows:

Step 1 Engage. In this step, students practiced logical thinking in identifying the initial agreement which was students could identify problems to be learned or understand problems.

Step 2 Investigate. Students practiced logical thinking in many aspects such as identifying the initial agreement in which students could work together in planning, identifying problems, considering the reliability of the sources of information and observations, data collection and interpreting or scrutinizing data. Deductive reasoning ability refers to the ability of students to summarize the results of activities or experiments. Inductive reasoning ability refers to the ability of students to consider data and situations by observing people and decide which facts support, object or not related to the predicted conclusions.

Step 3 Model. Students practiced inductive reasoning by working together in activities, experiments and creating a model to create the scientific explanation and draw the conclusions or by studying inserted knowledge then summarized into knowledge and a model.

Step 4 Apply. In this step students practiced logical thinking in interpretation in which they had to understand the situations and questions from teachers and deductive reasoning, generalization and argument evaluation that might be used to explain the situations, answers or used in reasoning to find solutions.

The results showed that learning by using EIMA learning management was the teaching method that encouraged students to seek knowledge and discover the facts by themselves by using the scientific process as a tool. In seeking knowledge, students had the opportunity to think and practice and help the student in learning and finding answers by themselves which resulted in enduring knowledge and knowledge transfer. In other words, students could memorize for a long time and apply knowledge in new situations. Students did not learn by memorization which allowed students to develop their thinking skills. This was consistent with the Institute of Promotion of Teaching Science and Technology (2005) indicating that EIMA learning management that Schwarz and Gwekwere (2007) developed from the inquiry method is the learning process that combines thinking process and skills to solve problems or find answers which develops students to understand and can apply the knowledge in various situations.

3. The study of the effects of EIMA learning management on Atom and Periodic Table learning achievement shows that students who were taught by using EIMA learning management had higher scores on the follow up and post-test than pre-test with the statistically significance at 0.05 level which increased by 57.15%. This was consistent with the hypothesis and indicated that EIMA learning management could improve knowledge, understanding and skills of students. This might be because in EIMA learning management students had to work together in activities, express their opinions and create their own model. These stimulated and challenged students to find answers. Students could do activities without boredom. Thinking and practicing with the repeated process made students develop knowledge and memory which could be applied automatically without memorizing. This was consistent with the constructivist learning theory of Vygotsky which was based on constructivism theory with the key concept that learners create knowledge by interacting with other people in society while they participate in activities or works. This theory also provided a guideline for the instructional management which focuses on relationships. The results of this study is consistent with the study by Juykrayang (2010) who studied the effects of EIMA learning management on the concept on atmosphere and scientific explanation ability of junior high school students and found that this instructional framework resulted in enduring understanding and better science learning achievement.

4. The effects of EIMA learning management on students’ teamwork behaviour. From the observation
records, it was found that students who were taught by using EIMA learning management had better teamwork behaviour which could be clearly observed in Plan 2, 3, 4 and 5. This was consistent with the constructivist learning theory of Vygotsky which was based on constructivism theory with the key concept that learners create knowledge by interacting with other people in society while they participate in activities or works. This theory also provided a guideline for the instructional management which focuses on relationships. It was also found that students who were taught by using EIMA learning management and had high level of leadership took on the role of leader, led members in planning and participate in the coordination of the group. Although the group members changed in each activity, these students also showed good teamwork skills, especially planning skills, mainlining atmosphere and communication for solving problem. This was consistent with the study by Anuworrachai (2010) which found many behaviours in group activities such as having courage to express their ideas, open for opinions, planning to divide up the work within group and showing openness and perseverance.

Observing the teamwork atmosphere and emotional expression of group members it was found that although overall students could work together without much conflict, however sometimes the behaviours that reflected the negative emotion were still found. For example, in Plan 2 students used impolite words and sarcasm with classmates and the other members had to change the topic and then returned to work and brainstorm again. This showed that emotional control of the classmates who changed the situations by controlling their emotions, did not interact with inappropriate behaviours and solved problems by explaining the reasons for working with team members. This could solve the emotional dissatisfaction of the team members who used sarcasm. In Plan 1, some students opposed the ideas of team members with inappropriate words, but other team members did not pay attention. Some students also showed disinterest in working together by reading books or were absent-minded. However, after Plan 1 it could be observed that students tried to solve these problems and worked together more which were the appropriate behaviours and consistent with the emotional management aimed at solving problems rather than avoiding problems.

**Suggestions**

1. After students were taught by using EIMA instructional framework, in addition to working as a team, the leadership of each student could be observed. Therefore, the leadership skills and assertiveness of students should be studied in order to develop potential of students as much as possible.

2. The effects of EIMA learning management on other skills such as analytical thinking, critical thinking and creative thinking should be studied because this instructional framework focused on thinking in different aspects.

3. More time should be spent for learning management because most students have different thinking basis and working process. Therefore, it takes a lot of time to manage learning and the existing schedule is not enough. Students may need to spend time outside the classroom to create the relevant model and makes it easier to create scientific explanation.

**References**


