Srinakharinwirot Science Journal Vol. 37 No. 2 (2021) | 29-43

Research Article

Enhancing Scientific Literacy of Eighth Grade Students through the Learning Model Based on Project-Based Learning and Socio-Scientific Issues

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Received: 22 June 2021
Revised: 25 August 2021
Accepted: 26 August 2021

ABSTRACT

Scientific literacy is important because it helps people in making informed decisions, problem-solving in a social context related to daily life in terms of both scientific evidence and morally and ethically, in order to find the best possible solution. Therefore, the purpose of this study was to investigate the effects of the learning model based on project-based learning and socio-scientific issues on scientific literacy for eighth grade students. The samples were 40 eighth grade students in the second semester of the academic year 2020 in Bangkok and was acquired from a cluster sampling. The research design used in this study was one group pre-test post-test design; data were statistically analyzed by mean, standard deviation, percentage and t-test for dependent samples. The research instruments were 1) two lesson plans and 2) 30 questions with 10 situations scientific literacy tests. The results showed that 1) the scientific literacy mean score after the implementation was higher than those been before implementation at a statistical significance level of .05, 2) the overall level of scientific literacy changed from the low to the moderate levels. For the two sub scientific competencies, explaining phenomena scientifically and evaluating and designing scientific enquiry changed from the low to the moderate levels, 3) all students (100%) were previously in a low level of scientific literacy, but competency with a moderate or high level of evaluating and designing scientific enquiry accounts for more than 50% of total number of students and all PISA competencies exceed 50% of the total in overall after implementation.

Keywords: Scientific literacy, PISA competencies, Project-based learning, Socio-Scientific issues.

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Introduction

The development of the school-age population toward scientifically literate person plays an important role in 21^{st} century society. A scientifically literate person is a citizen who possesses characteristics related to the country's development, such as having knowledge that can assist in the solution of everyday challenges [1-2]; contributing in the making of better political decisions, helping in the improvement of economic returns, serving in the reduction of superstitions, enabling in the improvement of individual behavior, and facilitating in the creation of a more ethical world [3]; having knowledge of scientific principles that can lead to acceptance of different opinions, understanding of social practice, being able to express opinions, critically discuss, and make decisions on social issues [4], for instance, full participation in critical decisions in various fields such as health, natural resource and energy use, policy and environmental protection [1], understanding and supporting in decision-making about nature, the earth, and its changes that occur as a result of human activities [5], and a willingness to engage in science-related issues. Furthermore, by perceiving science as a reflective citizenship that has an opinion and contributes to current and future scientific issues, it aids in better democratic decision-making and encourages people to wisely pursue their democratic rights [6]. When all citizens are prepared to assess problems using the socio-scientific issues (SSI) and make informed decisions about personal and public concerns, democracy is hence powerful [2].

Since the reform of science education, scientific literacy has been widely recognized in Thailand's current era, as it has been the goal of science education management to satisfy society's needs. According to the literatures, documents, and reports involving participation in the international assessment of scientific knowledge achievements, which is accepted by many countries, the Thailand's science education policy is dictated by the assessment results from the Program for International Student Assessment (PISA) is coordinated by the Organization for Economic Cooperation and Development (OECD). PISA focuses on students' ability to apply science to real-life experiences in the future, as well as how youths who have completed compulsory education can become persons who are aware of issues, acquire information, know how to respond, and become a wise consumer. It's worth noting that compulsory education's youth are essentially defined as students aged 15 years 3 months up to 16 years 2 months at the time of assessment and must study for at least 6 years in a school that follows the system, regardless of whether it is a general education or technical school, public or private, domestic or international [7].

The PISA scientific literacy assessment is different from a test of subject-based knowledge in a school because it will emphasize on the students’ ability to apply knowledge and skills to their real life and work in the future at the individual, community, and global levels, rather than on subject content knowledge. The PISA assessment frameworks take into account the following aspects: 1) the scientific context refers to personal, social, and global conditions involving science and technology; 2) the body of knowledge is classified into two categories: (i) knowledge of science, i.e. knowledge of the natural world as it applies to real life, which is limited to four systems: physical systems (comprising chemistry and physics), living systems, Earth and space systems, and technology systems that are integrated into the first three systems, and (ii) process of science, i.e., knowledge in a method or process of acquiring scientific knowledge that can be applied in real life; 3) scientific competencies imply the application of scientific knowledge in three sub scientific competencies, i.e., explaining phenomena scientifically, evaluating and designing scientific enquiry, and interpreting data and evidence scientifically; 4) science attitude is defined as exhibiting an interest in science, supporting the quest of scientific knowledge, and taking responsibility for concerns such as natural resources and the environment [8].

From PISA 2000 to PISA 2018, Thai student has scientific literacy assessments revealed that average scores in PISA 2000 to 2006 assessments continued to decline, while average scores in PISA 2009 to PISA 2012 improved but remained below the OECD average, and then PISA 2015 has a lower average score. So far, according to the results of the PISA 2018 assessment, Thailand received an average score of 426 in science (OECD average 489), a 5 score gain over PISA 2015 but still below the OECD average. In Thailand, the Science Schools group and the University Demonstration Schools group above the OECD average, but the other school groups scored below average [9]. When considering the scientific competencies in three sub scientific competencies, namely explaining phenomena scientifically, evaluating and designing scientific enquiry, and interpreting data and evidence scientifically, reports found that the average scores of Thai students' scientific competencies in all three components were lower than the OECD average, and nearly half of students with scientific literacy levels below level 2 were classified as at-risk groups, indicating that they lacked basic competence to recall appropriate scientific knowledge for solving in real-life situations [9]. In particular, students from the general education school group, especially the Office of the Basic Education Commission (OBEC 1), scored significantly lower in PISA 2015. As the OECD considers being a predictor of a country's future economic competitiveness and development, it implied that students with a very low level of competency in using science to solve real-life problems are an important indicator of future citizens' ability to participate in society and the labor market. Approximately half of Thai students demonstrated lower-than-baseline scientific competencies, indicating the education system's weaknesses and perhaps even the country's worldwide economic competitiveness potential [10]. In addition, reports showed that 14% of students studying science desire to work in health sciences, but there are few students who want to work in science and engineering, notably there is minimal demand for work in information and communication technology. Because the demand for engineering work in Thailand has decreased significantly since PISA 2006, and other areas of science have also decreased marginally, this figure may indicate a downward trend in the nation's science and technology work in the future. As a result, it is critical to expedite the improvement of science learning quality in order to boost work related to science and technology, because a good academic record is a key motivational tool for future career choices [11].

As a result of the aforementioned problem, researcher is interested in investigating various forms of teaching and learning that promote scientific literacy. Researcher found that project-based learning can improve scientific literacy because it is a teaching and learning process that emphasizes the use of project activities in regular course teaching. The project is used as a tool for helping students in learning the main idea of the content's learning criteria [12-14], and also the development of 21st century skills with a focus on critical thinking and problem solving. With the project-based learning, students must utilize advanced thinking skills and learn to work as a team; students must employ advanced thinking skills and learn to work as a team to solve problems; everyone is part in the problem-solving process, which promotes analytical thinking through the use of scientific process skills. In accordance with the PISA assessment framework and scientific literacy definitions in terms of socio-scientific issues, the researcher has a proposal to develop a learning model that promotes scientific literacy and all three competencies. Based on our literature review into the concept of a social teaching and learning, researcher discovered that socio-scientific issues are appropriate and fits the additional requirements in the project-based learning. In other word, project-based learning neglects to emphasize the utilization of social issues to stimulate and encourage individual intellectual development in moral, ethics, and the recognition of science-society relationship. Socio-scientific issues is used not only as a context for science learning, but also as a well-defined teaching strategy for promoting knowledge and understanding of the connections between science, technology, society, and the environment, all of which are important components in the development of scientific literacy [15-16]. Therefore, researcher has developed the learning model based on project-based learning and socio-scientific issues for enhancing scientific literacy of eighth grade students.

Research methodology

Purpose of research

To investigate the effects of the learning model based on project-based learning and socio-scientific issues on scientific literacy for eighth grade students.

Scope of the study

Population of research

The population composed of 482 eighth grade students enrolled in the second semester of the academic year 2020 at a secondary school for general education under the OBEC 1, the Secondary Educational Service Area Office Bangkok 1, Bangkokyai, Bangkok.

Sample group of research

The sample group composed of eighth grade students enrolled in the second semester of the academic year 2020 at a secondary school for general education under the OBEC 1, the Secondary Educational Service Area Office Bangkok 1, Bangkokyai, Bangkok, and was acquired from a cluster sampling of 40 students from one classroom.

Variables of research

Independent variable was the learning model based on project-based learning and socio-scientific issues.

Dependent variable was the scientific literacy of eighth grade students which were 3 sub scientific competencies as 1) explaining phenomena scientifically, 2) evaluating and designing scientific enquiry and 3) interpreting data and evidence scientifically.

Step 1 Investigation of the problem condition and basic information from relevant documents and research

Our research design was followed a quantitative research and an experimental research. Researcher studied the problem condition and the basic information from related documents and research, such as determination of population and sample group, information about the Core Curriculum of Basic Education, B.E. 2551 (A.D. 2008), indicators and concepts in science subject (revision B.E. 2560), theory-, meaning-, and components of scientific literacy, and other concepts for enhancing scientific literacy. The obtained data was then used to analyze and construct the learning model based on project-based learning and socio-scientific issues for enhancing scientific literacy of eighth grade students. Regarding the report from PISA when considering the scientific competencies in three sub scientific competencies, explaining phenomena scientifically, evaluating and designing scientific enquiry, and interpreting data and evidence scientifically, the scientific literacy assessment from PISA 2000 to PISA 2018 revealed that Thai students still scored lower than the OECD average and nearly 50% of students with scientific literacy levels below level 2 were classified as at-risk groups, indicating that they lacked basic competence to recall appropriate scientific knowledge for solving real-life situations. Accordingly, researcher explored various forms of teaching and learning that promote scientific literacy. Researcher found that project-based learning could enhance scientific literacy due to a process of emphasizing the utilization of project activities in school course, resulting in a better understanding of the main idea of the content's learning criteria [12-14]. Moreover, it helped to develop the 21^{st} century skills with a focus on critical thinking and problem solving. With the project-based learning, students must utilize advanced thinking skills and learn to work as a team; students must employ advanced thinking skills and learn to work as a team to solve problems; everyone is part in the problem-solving process, which promotes analytical thinking through the use of scientific process skills. In accordance with the PISA assessment framework and scientific literacy definitions in terms of socio-scientific issues, researcher has a proposal to develop a learning model that promotes scientific literacy and all three competencies. Based on our literature review into the concept of a social teaching and learning, researcher discovered that socio-scientific issues are appropriate and fits the additional requirements in the project-based learning. In other word, project-based learning neglects to emphasize the utilization of social issues to stimulate and encourage individual intellectual development in moral, ethics, and the recognition of science-society relationship. Socio-scientific issues is used not only as a context for science learning, but also as a well-defined teaching strategy for promoting knowledge and understanding of the connections between science, technology, society, and the environment, all of which are important components in the development of scientific literacy [15-16]. Therefore, researcher has developed the learning model based on project-based learning and socio-scientific issues for enhancing scientific literacy of eighth grade students.

Step 2 Development of the learning model based on project-based learning and socio-scientific issues for enhancing scientific literacy of eighth grade students

To enhance eighth grade students' scientific literacy, researcher developed a conceptual framework for a learning model based on project-based learning and socio-scientific issues. Researcher began by analyzing the consistency of each step in the learning model, then studying the details and synthesizing the process, and finally developing a learning model. Researcher developed the learning model based on project-based learning and socio-scientific issues for enhancing scientific literacy of eighth grade students by 6 steps as following. Step 1: Introducing social issues. Step 2: Brainstorming for the solutions. Step 3: Designing the solutions. Step 4: Solving the problem. Step 5: Presenting to society. Step 6: Reflecting from society.

Step 3 Development of research tools

Researcher developed research tools as the following.

1. Lesson plan. It was in science course for eight grade students, content no. 3 Earth and Space Science, standard no. Sc 3.2, indicator no. M.2/4 - M.2/10 (Unit no. 7 Earth and its change from science textbook at eighth grade, volume 2 (Revised Edition 2017), NSTDA) that uses the learning model based on project-based learning and socio-scientific issues for enhancing scientific literacy for 2 plans, 24 periods (50 minutes each), and on the topics of 1) the problem of landslides and sinkholes and 2) the problem of coastal erosion.

2. Enhancing scientific literacy test. Researcher designed the scientific literacy test according to the PISA approach. It was 1) multiple-choice test items with four choices, 2) complex multiple-choice questions, and 3) short or long response answers. It composed of 30 items in which divided by the number of exams assessing students' scientific competencies in 3 sub scientific competencies as follows: 1) explaining phenomena scientifically for 15 items, 2) evaluating and designing scientific enquiry for 6 items and 3) interpreting data and evidence scientifically for 9 items.

Step 4 Experiment of the learning model with the experimental group

Researcher conducted a trial study as the following.

1. Conducting the trial study with students who are not the sample group.

2. Improving the trial results.

Step 5 Employment of the learning activities to the sample group and collection of data

At this stage, researcher developed a variety of learning resources, including media used for instruction in each plan, such as group activity sheets and audiovisual teaching aids materials, as well as group activity equipment, clip and VDO-related multi-media content. Subsequently, researcher planned to perform the experiment with a sample group of 40 students in eighth grade for 1 classroom as following (teaching 50% online and 50% onsite). The 1st week (3 periods), providing the pre-test of scientific literacy and explaining the details such as the study objectives, scope of content knowledge, measurement and assessment, learning through various learning activities, and assignments before studying for 2 hours. The 2nd – 4th weeks, conducting the learning activities by followed the first lesson plan: the problem of landslides and sinkholes for 3 weeks, 3 periods per week, totaling 9 periods (50 minutes for each period). The 5^{th} – 7^{th} weeks, conducting the learning activities by followed the second lesson plan: the problem of coastal erosion for 3 weeks, 3 periods per week, totaling 9 periods (50 minutes for each period). The 8^{th} weeks (3 periods), providing the post-test of scientific literacy. A total of 8 weeks, or 24 periods, were spent on the project (50 minutes for each period).

Data analysis

The result obtained from the implementation was quantitative data which composed of pre-test and post-test scores taken from the scientific literacy tests. The data were analyzed by using statistics, i.e. mean, standard deviation, percentage, and comparing the difference of pre-test and post-test scores using t-test for dependent samples. The test was analyzed using basic statistics, i.e. means, to compare the modified criteria based on the 6-level PISA Scientific Literacy Standards: [17].

level 1b with the minimum score of 12.5%,
level 1a with the minimum score of 25%,
level 2 with the minimum score of 37.5%,
level 3 with the minimum score of 50%,
level 4 with the minimum score of 62.5%,
level 5 with the minimum score of 75%,
level 6 with the minimum score of 87.5%

Next, the previously levels were categorized into the new level of competencies as following: [7].

low level with level 1b, 1 and 2,
moderate level with level 3 and 4,
high level with level 5 and 6

Following that, the scores of each competency level were analyzed for the students' scientific literacy according to the assessment criteria, i.e., the difference in the mean scores of scientific literacy before and after study was calculated with t-test for dependent samples. The .05 level was chosen as the statistical significance level for the hypothesis test that either students exhibit a moderate or high level of scientific literacy in three competencies and overall or the number of students with a level of scientific literacy at a moderate or high level in each competency and overall is 50% of the total of 40 students.

Results and Discussion

The researcher presented the results as the followings:

1. Scientific literacy mean scores of students who learned with the learning model based on project-based learning and socio-scientific issues, either before or after studying.

Table 1 A comparison of students' scientific literacy mean scores of students before and after with the learning model based on project-based learning and socio-scientific issues, either before or after learning.

Testing	N	Total score	$\bar{x}$	S.D.	t	p-value
Before learning	40	30	8.93	3.02	-10.28*	0.00
After learning	40	30	15.05	3.08		

*Significant at the .05 level.

Table 1 shows that the scientific literacy mean scores of students of pre-test and post-test were 8.93 (S.D.=3.02) and 15.05 (S.D.=3.08) respectively. The t-value of difference between those mean scores was -10.28 with p-value of 0.00. This meant that the students who learned with the learning model based on project-based learning and socio-scientific issues had the scientific literacy mean score after implementation was higher than those been before implementation at a statistical significance level of .05.

Table 2 A comparison of students' scientific literacy mean scores of students before and after in each sub scientific competency with the learning model based on project-based learning and socio-scientific issues, either before or after studying.

Scientific competency	Total score	Pre-test		Post-test		t	p-value
		$\bar{x}$	S.D.	$\bar{x}$	S.D.		
1. Explaining phenomena scientifically	15	4.83	1.91	7.73	1.93	-8.41*	0.00
2. Evaluating and designing scientific enquiry	6	1.75	0.95	3.05	0.90	-7.23*	0.00
3. Interpreting data and evidence scientifically	9	2.35	1.46	4.25	1.43	-7.24*	0.00

*Significant at the .05 level.

Table 2 shows that the scientific literacy mean scores of three sub scientific competency as followings; explaining phenomena scientifically score pre-test and post-test were 4.83 (S.D. = 1.91) and 7.73 (S.D. = 1.93) respectively, evaluating and designing scientific enquiry score pre-test and post-test were 1.75 (S.D. = 0.95) and 3.05 (S.D. = 0.90) respectively, interpreting data and evidence scientifically score pre-test and post-test were 2.35 (S.D. = 1.46) and 4.25 (S.D. = 1.43) respectively, This meant that the students who learned with the learning model based on project-based learning and socio-scientific issues had the scientific literacy mean score of three sub scientific competencies after implementation was higher than those been before implementation at a statistical significance level of .05.

2. Scientific literacy levels of students who learned with the learning model based on project-based learning and socio-scientific issues, either before or after studying

Table 3 A comparison of students' scientific literacy level of students before and after in each sub scientific competency and overall level of scientific literacy with the learning model based on project-based learning and socio-scientific issues, either before or after learning

Scientific competency	Total score	Pre-test				Post-test			
		$\bar{x}$	S.D.	Percentage	Level of scientific literacy	$\bar{x}$	S.D.	Percentage	Level of scientific literacy
1. Explaining phenomena scientifically	15	4.83	1.91	32.17	Low	7.73	1.93	51.50	Moderate
2. Evaluating and designing scientific enquiry	6	1.75	0.95	29.17	Low	3.05	0.90	50.83	Moderate
3. Interpreting data and evidence scientifically	9	2.35	1.46	26.11	Low	4.25	1.43	47.22	Low
Overall level of scientific literacy	30	8.93	3.02	29.75	Low	15.05	3.08	50.17	Moderate

Table 3 shows a comparison of students' scientific literacy level of students before and after learning in each sub scientific competency and overall level of scientific literacy of three sub scientific competencies as followings; explaining phenomena scientifically increased from low level (32.17%) to moderate level (51.50%), and also their evaluating and designing scientific enquiry increased from low level (29.17%) to moderate level (50.83%). In contrast to that, their competency in interpreting data and evidence scientifically remained steady with a low level of performance, but their percentage had increased from 26.11% to 47.44%. In addition, overall level of scientific literacy of three sub scientific competencies increased from low level (29.75%) to moderate level (50.17%).

3. Percentage of students classified according to their level of scientific literacy who learned with the learning model based on project-based learning and socio-scientific issues, either before or after learning.

Table 4 A comparison percentage of students classified according to their level of scientific literacy who learned with the learning model based on project-based learning and socio-scientific issues, either before or after learning.

Scientific competency	Level of scientific literacy	Pre-test		Post-test	
		Number of students	Percentage	Number of students	Percentage
1. Explaining phenomena scientifically	Low	37	92.50	21	52.50
	Moderate	3	07.50	19	47.50
	High	0	00.00	0	00.00
2. Evaluating and designing scientific enquiry	Low	33	82.50	15	37.50
	Moderate	7	17.50	25	62.50
	High	0	00.00	0	00.00
3. Interpreting data and evidence scientifically	Low	36	90.00	22	55.55
	Moderate	4	10.00	15	37.50
	High	0	00.00	3	07.50
Overall level of scientific literacy	Low	40	100.00	16	40.00
	Moderate	0	00.00	24	60.00
	High	0	00.00	0	00.00

Table 4 shows that after learning, the percentage of students with moderate or high level of scientific literacy increased in all of three sub scientific competencies and overall level of scientific literacy as followings; explaining phenomena scientifically level before and after learning were in the low level (92.50%) and moderate level (47.50%) respectively, evaluating and designing scientific enquiry level before and after learning were in the low level (82.50%) and moderate level (62.50%) respectively, interpreting data and evidence scientifically level before and after learning were in the low level (90.00%) and either moderate level (37.50%) or high level (7.50%) respectively, overall level of scientific literacy determined by the total of each student's scores in all of three sub scientific competencies before and after learning were in the low level (100%) and moderate level (60.00%) respectively.

Conclusions

Conclusions

1. After the implementation of learning model based on project-based learning and socio-scientific issues, the students had the scientific literacy mean score after implementation was higher than those been before implementation at a statistical significance level of .05, For the three sub scientific competencies, explaining phenomena scientifically, evaluating and designing scientific enquiry, and

interpreting data and evidence scientifically mean scores after implementation were higher than those been before implementation at a statistical significance level of .05

2. After implementation with the learning model based on project-based learning and socio-scientific issues, the level of scientific literacy of students in each sub scientific competency and overall level of scientific literacy of three sub scientific competencies changed as followings; explaining phenomena scientifically increased from low level to moderate level, and also their evaluating and designing scientific enquiry increased from low level to moderate level. In contrast to that, their competency in interpreting data and evidence scientifically remained steady with a low level of performance, but their percentage had increased. In addition, overall level of scientific literacy of three sub scientific competencies increased from low level to moderate level.

3. Before implementation, most of students (100%) were at a low level of scientific literacy. After studying, most of students (60%) were at a moderate level of scientific literacy, but only one competency with a level before and after studying were low level and moderate level respectively of evaluating and designing scientific enquiry accounts for more than 50% of total learners and all PISA competencies exceed 50% of the total in overall after implementation.

Discussion

1. As the results, the students had higher scientific literacy mean scores than before with significant difference at the .05 level in each sub scientific competency; explaining phenomena scientifically, evaluating and designing scientific enquiry and interpreting data and evidence scientifically. The findings demonstrated that the learning model based on project-based learning and socio-scientific issues was enhance students' scientific literacy because, this teaching aids in the enhancement of students' competency in explaining phenomena scientifically, implying the potential of scientific knowledge that can be applied to society. According to learning process, students practice the skill of searching from various learning sources to collect data, which promotes competency in interpreting data and evidence scientifically. In evaluating scientific data and evidence from a variety of sources (such as newspapers, the Internet, and journals) for enabling students to explore solutions to problems in a variety of ways. Furthermore, through the employment of our learning model, students have established a solution to the problem by working in groups to create products in a models, which will help in enhancing scientific literacy of competence in evaluating and designing scientific enquiry, in part to the capability to identify problems, distinguish which problems or questions can be examined through scientific methods, propose a method for exploring scientific problems, and evaluate such method for examining a given scientific problem. Students have also practiced, collected data, analyzed and interpreted it, and drawn conclusions, along with the group members' collaborative consideration of how the innovation or work developed can solve the problem to a great deal. Furthermore, students and teachers must discuss their findings, criticize, and listen to criticism, as well as learning in areas such as information efficiency, implementation process, quality of work, obstacles encountered, and whether or not solving societal problems is suitable. As mentioned above, it contributes to enhancing scientific literacy of competences in evaluating and designing scientific enquiry in terms of evaluating methods for examining scientific

problems, and also in interpreting data and evidence scientifically in terms of converting information from one form to another, analyzing and interpreting scientific data, and drawing conclusions. Our approach was in line with the findings of multiple studies conducted by Thomas [18], which demonstrated that project-based learning can promote scientific knowledge, science process skills, inquiry process, and the development of other learning abilities, such as life skills and social skills, i.e., collaborating with others, embracing others' perspectives, taking responsibility for oneself and the public, and honing communication skills. To this aim, project-based learning results in engaging students with a better understanding of content knowledge, improved learning skills, the ability to apply knowledge to practice, and the development of thinking skills, problem solving, creative thinking, and improved searching and information technology skills. In addition, our findings were also consistent with the findings of Notari, Baumgartner, and Herzog [19]; project-based learning increases learners' social skills and group work behavior, particularly by allowing students to practice working with others and exchanging knowledge, collaboration in working groups, self-learning, and socio-scientific issues. Thus, our learning model enables students to learn science from real-life situations while also promote skills that are essential for science learning, such as advanced analytical thinking, inquiry skills, scientific literacy, decision making, scientifically rational discussion, evaluating the value and reliability of information, and understanding of nature [20-21], especially in empowering students to think about scientific issues and make decisions, as well as reflection on the principles and morality of one's own life and the global society [16].

2. As the results, the overall level of scientific literacy changed from the low to the moderate levels. For the two sub scientific competencies, explaining phenomena scientifically and evaluating and designing scientific enquiry changed from the low to the moderate levels. In contrast to that, their competency in interpreting data and evidence scientifically remained steady with a low level of performance, but their percentage had increased. Our findings revealed that 47.22% of students' competency scores in this area remained at the same low level as before. However, if sub-levels based on PISA's 6 levels of scientific literacy are considered, the pre-test score is 26.11% and falls into level 1a (learners can only identify assumptions and make evidence supported by the given information), whereas the post-test score is 47.22% and falls into level 2 (learners can identify assumptions to explain everyday situations in a given science using evidence and rationale). As a result, students gain one level of competency in interpreting data and evidence scientifically. The result was supported by the result from Chuanpit Kanaphat to illustrate the effect of utilizing science learning model based on socio-critical and problem-oriented approach and science technology and society approach to promoting scientific literacy for lower secondary students [22]. Showed that students developed competencies in identifying scientific issues, scientific explanations of phenomena, social criticism, and awareness of the importance and impact of science and technology on personal and societal well-being tied to specific criteria; however, for the use of scientific evidence, students did not develop in accordance with the specific criteria because students are still unable to compare, classify, identify, interpret, draw conclusions, and provide data and evidence using complicated scientific knowledge according to the level 2 competency

(learners can use scientific knowledge and theory to compare, classify, identify, and provide data and evidence in everyday situations). This could be due to students' unfamiliarity with the new instructional model, needing additional time to become acquainted, or it could be due to students' lack of courage in expressing their opinions as they should and neglecting to note friends' comments. As a result, students were unable to distinguish between evidence-based and scientific theory-based data, as well as data based on other factors, or to evaluate scientific data and evidence from a variety of sources [23].

3. As the results, all students (100%) were previously in a low level of scientific literacy, but only one competency with a moderate or high level of evaluating and designing scientific enquiry accounts for more than 50% of total learners and all PISA competencies exceed 50% of the total in overall after implementation because this learning model, students have also practiced, collected data, analyzed and interpreted it, and drawn conclusions, along with the group members' collaborative consideration of how the innovation or work developed can solve the problem to a great deal. Furthermore, students and teachers must discuss their findings, criticize, and listen to criticism, as well as learning in areas such as information efficiency, implementation process, quality of work, obstacles encountered, and whether or not solving societal problems is suitable. As mentioned above, it contributes to enhancing scientific literacy of competences in evaluating and designing scientific enquiry in terms of evaluating methods for examining scientific problems [19]. For the two sub scientific competencies, explaining phenomena scientifically and interpreting data and evidence scientifically accounts for less than 50% of total learners, that shown some students were able to use content and knowledge to provide explanations in some given familiar life situations that required mostly a low level of cognitive demand. They were able to make a few inferences from different sources of data, in few contexts, and can describe simple causal relationships [24]. This could be due to students' unfamiliarity with the new instructional model, needing additional time to become acquainted, or it could be due to students' lack of courage in expressing their opinions as they should and neglecting to note friends' comments. As a result, students are unable to distinguish between evidence-based and scientific theory-based data, as well as data based on other factors, or to evaluate scientific data and evidence from a variety of sources [23].

It is hence that enhancing scientific literacy of eighth grade students through the learning model based on project-based learning and socio-scientific issues offers learners to seek knowledge, apply thinking processes, problem-solving skills, scientific process skills, inquiry skills, self-directed learning and practice [25-26], stimulate and develop moral and ethical intellectual growth, realize the interdependence of science, society and the environment, understand the nature, consider scientific issues and make decisions, and reflect on the principles and morality associated with one's own life and global society from real-life situations [20].

Acknowledgements

This study was conducted as part of a doctoral dissertation. Researcher would like to express our gratitude to my adviser, Asst. Prof. Dr. Theerapong Sangpradit, for his guidance and support.

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