The Effect of the Science, Technology, and Society (STS) Approach Supplemented with the Think-Pair-Share Technique on Grade 6 Students' Competency in Evaluating and Designing Scientific Inquiry Related to the Separation of Substances

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Received: November 02, 2024 **Revised:** November 17, 2024 **Accepted:** November 20, 2024

Abstract

The purposes of this research were to study and compare Grade 6 students' competency in evaluating and designing scientific enquiry for substance separation before and after learning through Science, Technology and Society (STS) approach supplemented with Think-Pair-Share technique. The participants comprised six Grade 6 students enrolled in the first semester of the 2024 academic year at a small-sized primary school under the Udon Thani Primary Educational Service Area Office 1. The participants were selected through purposive sampling. This study employed a one-group pretest-posttest research design. The instruments used in this research were: 5 lesson plans, and 20 test items addressing 4-typed questions scientifically through: 1) Identifying the question explored in a given scientific study; 2) Distinguishing questions that are possible to investigate scientifically; 3) proposing a way of exploring a given question scientifically; 4) evaluating ways of exploring a given question scientifically. The data were analyzed using descriptive statistics, including means, standard deviations, percentages, and frequencies. The findings of the study showed the students' competency of evaluating and designing scientific enquiry after learning ($\overline{x}$ = 27.67, S.D. = 8.64) was higher than before learning ($\overline{x}$ = 20.83, S.D. = 5.60) by the overall and all four components. In addition, students tended to have positive development in evaluating and designing scientific inquiry processes from the first to the fifth lessons.

Keywords: Science, Technology and Society (STS) Approach; Think–Pair–Share technique; Competency of evaluating and designing scientific enquiry

Background and importance of the problem

Over the past two decades since the world goes into the 21st century, there have been many changes due to the driving force of 3 main trends including: 1) Globalization turns us into one society and makes international communication and traveling easier. 2) Rapid technological development causes many technological innovations and 3) the trend of capital supremacy, money plays a vital role in every aspect of life in the modern world. These three main trends are creating an economic and social phenomenon in today's world called VUCA World (Rangabtook, 2020). Education system needs to adapt to a fast-changing world. Therefore, educational management itself must be responsive to the students' needs (Ngaoboonmar, 2021). The role of teachers in the VUCA world must be to act as teaching facilitator to help students prepare themselves for living in the present era (Inchai, 2022). Teachers today needed to develop student skills rather than memorising facts for equal living and learning (Nuangchalerm, 2015).

Students need to learn how to construct their own understanding through experiences. Learning managements should have students to interact with the world around them and continually adapt previous ideas to accommodate new information Piaget (1964). In addition, a student's cognitive development and learning ability can be guided and mediated by their social interactions. The promotion of social interaction plays an important role in the development of student cognition. Vygotsky (1971) believed that cognitive development is influenced by cultural and social factors. He stated that cognitive development is a socially process in which students acquire cultural values, beliefs, and problem-solving strategies through collaborative dialogues with more knowledgeable members of society. Knowledge and understanding of science and technology are important tools for preparing our young people to be able to living in today's world. The goal of science education is to provide every student with scientific literacy, which includes competency in evaluating and designing scientific inquiry processes. People in today's society must have the ability to identify issues, distinguish issues that can be examined using scientific processes, or propose methods for surveying and investigating using scientific methods (IPST., 2017).

Based on documentation review, it was found that learning management according to the concept of Science, Technology and Society (STS) is an alternative teaching and learning approach in the context of the impact of science and technology on everyday life. The goal of STS approach emphasis on science education in real life situation. It aims to develop students to have knowledge and understanding about science and technology to be able to make decisions about current problems and issues and take actual actions as a result of those decisions as a citizen with social responsibility (Yutakom, 1999). STS approach is seen as teaching and learning organization that give students with the opportunity to

compare science, technology and society with each other and to appreciate how science and technology contribute to the latest information construction (Yager, 1992). Many teachers use group work to enhance students' learning. A collaborative learning strategy called "Think – Pair – Share" (TPS) is instantaneously transformational structure that we can add to our classrooms. Students are instructed to think or write about an answer to the question before turning to a peer to discuss their responses. They share their partner's answers for the whole class to hear.

According to the results of the science literacy assessment from the Program for International Student Assessment (PISA) in 2022, it was found that the science literacy scores of Thai students decreased by 17 points, with a science score of 409 points due to learning management during the period COVID-19 epidemic crisis (Pisa Thailand., 2023, December 24). The findings were also consistent with the observation of science learning management in small schools under the Udonthani Primary Educational Service Area Office 1 that students were unable to identify the problems, unable to offer a method to investigate the problem, and unable to plan or design experiments. They seemed to lack of scientific process skills due to learning management in the past academic year as a lecture. Emphasizing the teacher as the center causes students to lack participation in learning activities and be unable to create knowledge on their own.

Based on reviewing, the researchers were interested in implementing STS approach supplemented with think – pair – share technique to promote grade 6 students' competency of evaluating and designing scientific enquiry competency about separation of substances.

Research objectives

To study and compare Grade 6 students' competency in evaluating and designing scientific inquiry before and after learning through the STS approach, supplemented with the Think-Pair-Share technique.

Research Methodology

1. Population and target groups

This study was conducted in a small school under the Udonthani Primary Educational Service Area Office 1. The population consisted of 42 grade 6 students from three small primary schools during the first semester of the 2024 academic year.

2. Research tools

2.1 Five lesson plans based on the Science, Technology, and Society (STS) approach, supplemented with the Think-Pair-Share technique, were developed for Grade 6 students on the topic of separating substances. Each lesson plan was implemented over a

duration of three hours, resulting in a total experimental time of 15 hours. The learning management process consists of 5 steps according to Carin (1997) learning management model: 1) Search step supplemented with the TPS techniques, 2) Problem solving step (Solve) supplemented with the TPS techniques, 3) Knowledge creation step (Create), 4) Experience exchange step (Share), and 5) Act step supplemented with the TPS techniques technique of Lyman (1981). Five lessons include 1) the problem of garbage on Wai Kru Day, 2) Rice grain processes, 3) Household herbal water 4) Turbidity and Water, and 5) Turning water into salt. The lesson plans were checked validate quality by 3 experts using means of a 5-point Likert scale ranging from strongly agree to strongly disagree. The average rating in the all components of five lessons were between 4.96 - 5.00 which means that this research tool quality was in high level.

2.2 The test for evaluating and designing scientific inquiry competency on the topic of separating substances consisted of four multiple-choice questions and open-ended questions. The tests were checked an index of item objective congruence (IOC) at 0.6 - 1.00 by 3 experts. During the pilot testing, the assessments were administered to 12 Grade 6 students who had previously studied the topic of separating substances. Whitney and Sabers (1970) formula was used to analyze the difficulty and discrimination indices of the open-ended questions while a Cronbach's Alpha was used to measure internal consistency or reliability of a test. The test difficulty, discrimination and reliability were 0.25 – 0.67, 0.25 – 0.83 and 0.90, respectively.

3. Data Collection

3.1 Before the intervention, the tests were administering to the target group students.

3.2 During the intervention, at the end of each learning plan, students' observations were reported.

3.3 After the intervention, the tests were again administering to the target group students.

4. Data analysis

4.1 Student's pre-test and post- tests were scored by 2 teachers using scoring according to PISA 2015 and 2018 criteria: all correct answer get 2 points; incomplete answer get 1 point; incorrect answer get 0 points.

4.2 Compare scores before and after learning through the STS approach supplemented with think – pair – share technique.

Research findings

1. Results of Grade 6 students' competency of evaluating and designing scientific enquiry competency before and after learning through the STS approach supplemented with think – pair – share technique as the following table 1.

Table 1. Comparison of assessment competencies and inquiry process design. Scientific knowledge before studying and after studying.

No.	Pre-test				Sum	Percentage	Post-test				Sum	Percentage
	B_1	B_2	B_3	B_4			B_1	B_2	B_3	B_4		
1	4	8	2	7	21	52.50	10	10	10	8	38	95.00
2	7	9	6	8	30	75.00	8	10	10	8	36	90.00
3	4	5	9	6	24	60.00	6	8	10	8	32	80.00
4	6	6	2	4	18	45.00	6	5	2	6	19	47.50
5	6	2	6	2	16	40.00	6	3	6	5	20	50.00
6	6	2	4	2	14	35.00	6	5	6	4	21	52.50
Average	**5.50**	**5.33**	**4.83**	**4.83**	**20.50**	**51.25**	**7.00**	**6.83**	**7.33**	**6.50**	**27.67**	**69.17**
S.D.	**1.22**	**2.94**	**2.71**	**2.56**	**5.86**		**1.67**	**2.93**	**3.27**	**1.76**	**8.64**	

From Table 1, it showed that the average scores after learning was higher than before learning by the overall and all four components.

2. Results of grade 6 students' competency of evaluating and designing scientific enquiry competency during learning through the STS approach supplemented with Think – Pair – Share technique.

From 5 learning steps, students were provided information on science and technology issues about the science topic in step. Then students work together to find problems from the given situation by selecting issues that can be investigated. For step 2, students exchange ideas to plan and design experiments, in which the researcher provides guidance for Lesson 1 – 3. However, for lesson 4 - 5, each pair of students will do it on their own as the following table 2.

Table 2 Examples of student answers in a rice grain process.

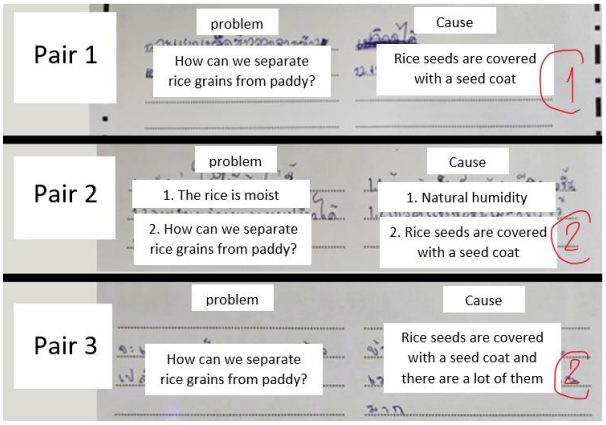
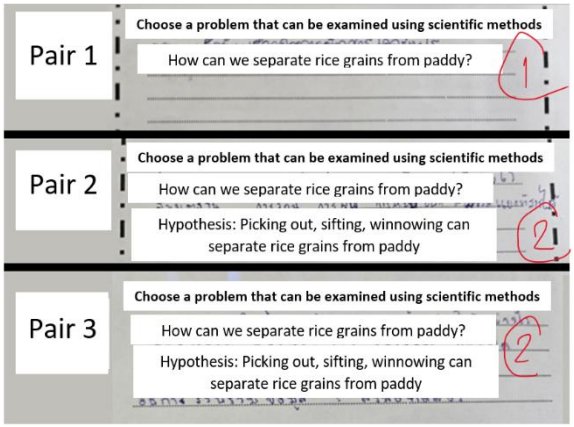
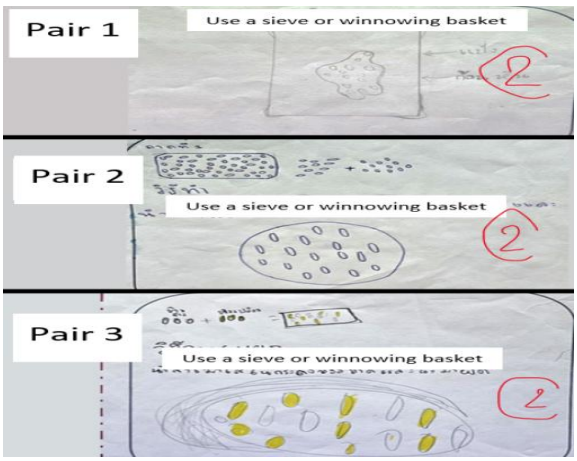
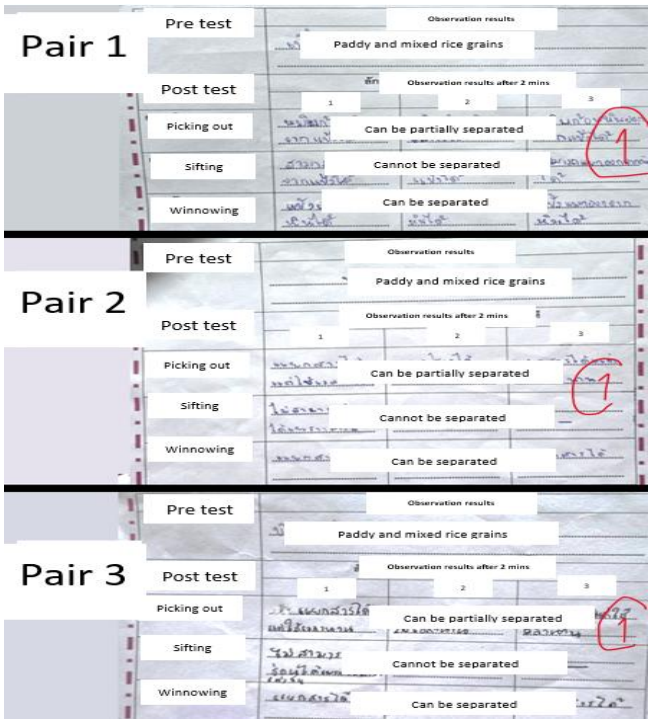
Competency level	Examples of student answers
B_1: Identification Issue	
B_2: choosing Issue	

Table 2 Examples of student answers in a rice grain processes (continued).

Competency level	Examples of student answers
B_3: experimental design	

B_4: action Check the Test	

Bases on results of grade 6 students' competency of evaluating and designing scientific enquiry competency during learning through the STS approach supplemented with think – pair – share technique, results show positive trends towards improvements in the competency from lesson 1 – 5, as shown in Figure 1.

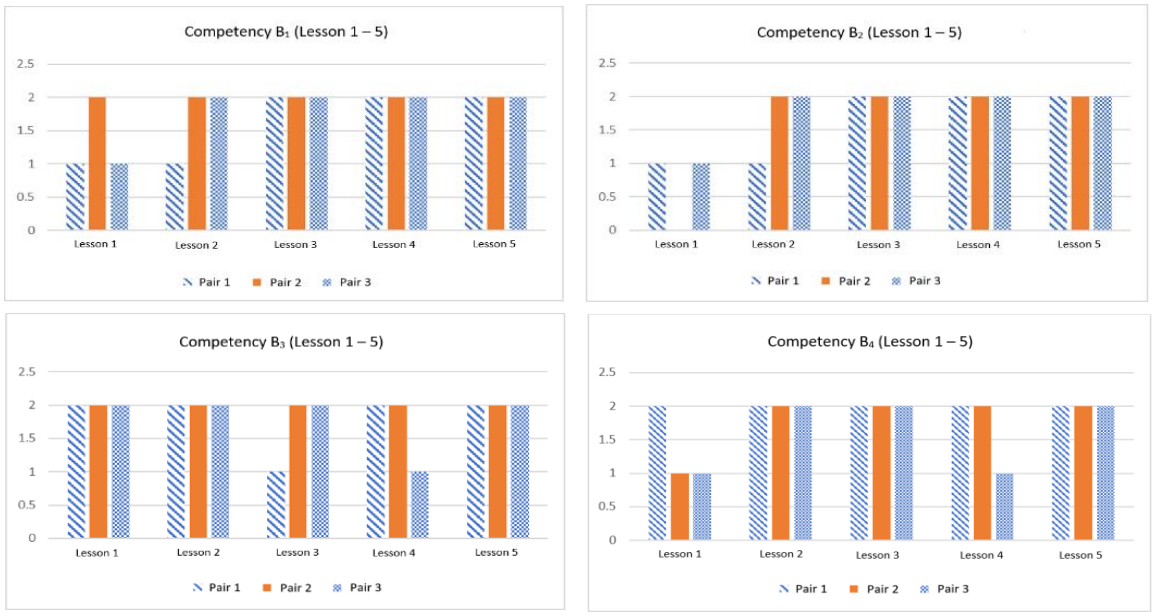


Figure 1: shows the development of B1 - B4 competency from lesson 1 – 5.

Discussion

Based on the findings, it was found that most students tend to develop competencies in evaluating and designing inquiry processes. The reasons may be as follows:

Firstly, students had actively participated through the learning process according to psychology. Students were initially stimulated and prepared by being presented with a community or societal situation or issue related to the content of the separation of substances. This enables students to connect classroom learning to their local, real-world situations. This has an impact on students to seek knowledge to answer their questions. So students can identify problems, cause of the problem, for selecting problems that can be investigated scientifically. Then students design a solution, check the reliability of the solution, such as how to test the hypothesis, what information to research. When the method of verification is selected, students design an experiment, and collect data and conclude the results. This learning process allows students to create knowledge by themselves according to the constructivism theory of Piaget (1964). In addition, when students share ideas with each other, giving students the opportunity to present their ideas to their classmates can promotes the development of new knowledge from social interactions which is consistent with the concept of social constructivism of Vygotsky (Vygotsky, 1971). Presenting knowledge to society, especially at the local where students live, is an opportunity for students to demonstrate their roles as citizens of the country. Researchers found that STS approach can student's understanding of science concept (Pilalom, 2020), and science problem-solving ability (Noythisong, 2021) student's representation of science concepts (Pertiwi, 2022).

Secondly, using think – pair – share technique and STS approach would encourage students to brainstorm together to analyze and identify problems from a given situation. It is for students to use their knowledge, ideas, and share their ideas with friends before presenting the answers to their classmates. Such actions could enhance students' communication skills and confidence and allow students to develop their knowledge from sharing information with friends. Moreover, it also promotes the presentation of scientific knowledge in society for meaningful learning, consistent with Vygotsky's social constructivist concept. Researchers found that using TPS technique could promote student's critical thinking ability (Ngaoboonmar, 2022), communication ability (Reunkampang, 2022), science conceptual understanding (Rehman, 2021).

Suggestions

1. It is suggested that teachers further integrate real-world contexts and practical examples related to the separation of substances into the STS framework. This would

encourage students to apply scientific concepts to real-life situations, thus enhancing their critical thinking and problem-solving abilities.

2. Teachers are encouraged to incorporate a variety of teaching tools, such as multimedia resources, interactive simulations, and hands-on experiments, to make the learning experience more engaging and to enhance students' ability to design and evaluate scientific inquiries.

3. Given the success of the Think-Pair-Share technique in promoting student interaction, further emphasis should be placed on collaborative learning. Teachers can create more opportunities for students to work together in small groups or pairs, which could foster peer-to-peer learning, deepen their understanding, and improve their inquiry skills.

4. It is recommended that the STS approach supplemented with Think-Pair-Share be extended to other science topics beyond the separation of substances. This could provide students with a broader scope to apply and refine their scientific inquiry skills across different scientific concepts.

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