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Development of Grade 11 Students' the 21st Century Skills about Critical Thinking in Learning about Reproduction of Flowering Plants through Science Technology and Society (STS) Approach

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Abstract. This research aimed to enhance Grade 11 students' 21st century skills about critical thinking in learning about reproduction of flowering plants through Science Technology and Society (STS) Approach. Methodology regarded interpretive paradigm. The participants of this study were 45 Grade 11 students consisted of 29 females and 16 males (aging between 16-17 yours old) in a large sized urban public high school located in the northeastern of Thailand. The STS reproduction unit consisted of 5 lesson plans (7 hours) aligned with each stage of Yuenyong (2006) STS approach. Students' critical thinking abilities were interpreted via participant observations, students' worksheets, and informal interviews. The data analysis aimed to categorize students' abilities align with Nakmanurak (1994) structured framework of critical thinking. This structured framework comprising seven steps: 1) identifying the problem, 2) collecting information, 3) evaluating the credibility of information sources, 4) identifying relevant information, 5) formulating hypotheses, 6) drawing conclusions, and 7) evaluating the process and outcomes. Findings revealed that the majority of students held good ability of critical thinking. Even though students could share their ability thinking in the same ability, they had different levels of ability in each element.

Keywords: Science Technology and Society, Critical thinking, Reproduction

INTRODUCTION

Scientific literacy is a key focus for Thai citizens in order to help them and the nation or survive in a globally competitive economy. Scientific literacy related to student ability of applying scientific knowledge for solving issues in everyday life (Yuenyong and Narjaikaew, 2009). Critical thinking plays a vital role in science learning, enabling students to analyze information, evaluate evidence, and construct informed conclusions. This literature suggested that the integration of critical thinking in science education, examining theoretical perspectives, instructional strategies, and empirical research on fostering critical thinking skills in the context of science learning (Dam and Volman, 2004; Yuenyong, 2017; Zoller, 1993).

Education of Thailand should be modification because learners in the 21st century need to be developed learning skills to be able to live in society effectively. Then, student must cultivate the necessary skills to sustain life (Osman et al., 2009). In addition to promoting deep understanding of the content and supplement 21st century skills into all core subjects (Bellanca& Brandt, 2011). Many educators have believed the ability to learn is more important than specific knowledge that important skill is critical thinking (Kitroongrueng, 2010). Science education researchers have shown that students may be successful in performing such assignments provided they were exposed to teaching that included both critical thinking and required student practice (Zoller et al., 2002; Ten Dam and Volman, 2004). Due to, critical thinking is higher-order cognitive skills (HOCS) that require deep conceptual understanding (Zoller, 1993). In terms of working, people with the thinking skills and communication skills as well, it will lead to fast learner, can solve the problem, creativity and able to offer their opinion clearly. Thus, teaching should focus on the development of critical thinking (Bassham et al., 2005). Characteristics of instruction that are assumed to enhance critical thinking are promoting active learning, problem-based curriculum, stimulating interaction between students and learning based on real-life situations (Dam and Volman, 2004).

To construct the framework of critical thinking for educational research, we found that critical thinking was perceived in various definitions. However, it has some consensus. We can detect considerable commonality: Good critical thinking is reasonable, critical thinking involves a careful consideration of evidence; Critical thinking is oriented towards making a definite judgment; the ideal " critical thinker" thinks critically whenever it is appropriate; being a critical thinker involves knowledge, skills, attitudes, and dispositions.

According to the vague definition of critical thinking, some literatures suggested that we may consider beyond definitions to descriptions of critical thinking skills as well as attitudes and behavioral inclinations of a "critical thinker". Ennis (1987), Facione (1990), Fisher, and Scriven (1997) advanced the most developed theories of critical thinking's component skills. Ennis (1987) and Facione (1990) presented detailed descriptions of sub-skills. Despite variances, it has some fundamental critical thinking skills, such as clarifying meaning, analysing arguments, evaluating evidence, determining whether a conclusion follows, and drawing warranted conclusions. Additionally, some literatures developed conceptions of the dispositional and attitudinal components of a critical thinker (Ennis, 2016; Facione, 1990) . The dispositional and attitudinal characteristics of a critical thinker shared common views such as open-minded, fair-minded, searching for evidence, trying to be well-informed, attentive to others' views and their reasons, proportioning belief to the evidence, and welling to consider alternatives and revise beliefs.

As a cognitive skill, Ennis (1987) offered a thorough framework for evaluating critical thinking in their seminal work. Their approach focuses on assessing both critical thinking dispositions and abilities, which include cognitive processes like inference, deduction, and analysis. The framework establishes explicit criteria and indicators for assessing critical thinking, allowing for a systematic evaluation of people's reasoning abilities. There are also differences about the role and importance of deduction in critical thinking, about the tolerance of imprecision, and about the relationship between critical thinking and the logical analysis of arguments. Nakmanurak (1994) suggested that critical thinking is a multifaceted skill essential for effective problem-solving and decision-making. This literature review examines research on analyzing students' critical thinking abilities through a structured framework comprising seven steps: identifying the problem, collecting information, evaluating the credibility of information sources, identifying relevant information, formulating hypotheses, drawing conclusions, and evaluating the process and outcomes.

Step 1: Identifying the Problem: Effective problem identification is foundational to critical thinking. Research suggests that students' ability to identify and define problems accurately correlates with their overall critical thinking skills. Studies have

explored various instructional approaches, such as problem-based learning and case studies, to enhance students' problem identification abilities and foster critical thinking.

Step 2: Collecting Information: Gathering relevant information is a crucial aspect of critical thinking. Research has investigated the strategies students employ to collect and organize information effectively, including search strategies, information literacy skills, and use of digital resources. Additionally, studies have examined the impact of inquiry-based learning and research projects on students' information-gathering skills and critical thinking competencies.

Step 3: Evaluating the Credibility of Information Sources: Assessing the credibility of information sources is essential for informed decision-making. Research has examined students' ability to evaluate the reliability, validity, and bias of sources, including print and digital resources. Educational interventions focusing on media literacy and source evaluation skills have been shown to improve students' critical evaluation of information sources.

Step 4: Identifying Relevant Information: Discerning relevant information from a plethora of data is a critical thinking skill. Studies have explored students' ability to identify and prioritize information based on its relevance to the problem or inquiry at hand. Instructional strategies emphasizing concept mapping, graphic organizers, and concept-based learning have been found to support students in identifying and synthesizing relevant information effectively.

Step 5: Formulating Hypotheses: The formulation of hypotheses involves generating plausible explanations or predictions based on available evidence. Research has investigated students' proficiency in generating hypotheses, testing assumptions, and refining their thinking through iterative reasoning processes. Inquiry-based learning approaches, scientific inquiry tasks, and argumentation activities have been utilized to develop students' hypothesis-formulation skills and enhance critical thinking.

Step 6: Drawing Conclusions: Drawing logical conclusions based on evidence is a hallmark of critical thinking. Studies have examined students' ability to synthesize information, analyze patterns, and draw reasoned conclusions from data. Educational interventions focusing on structured reasoning tasks, argument mapping, and reflective writing have been shown to facilitate students' ability to draw informed conclusions and support their reasoning with evidence.

Step 7: Evaluating the Process and Outcomes: Reflection and evaluation are integral components of the critical thinking process. Research has explored strategies for promoting metacognitive awareness and self-assessment skills in students. Methods such as peer review, self-assessment rubrics, and reflective journals have been utilized to encourage students to evaluate their thinking process, monitor their progress, and identify areas for improvement in critical thinking skills.

Critical thinking is essential in science education because it allows students to gain scientific literacy and actively participate in the inquiry process. Theoretical frameworks, instructional tactics, assessment methodologies, and empirical studies all help us understand how to promote critical thinking in science education. By tackling obstacles and embracing creative techniques, educators may continue to improve students' critical thinking abilities and prepare them for active involvement in a scientifically literate society (Wongsila and Yuenyong, 2019; Yuenyong, 2013).

Several theoretical frameworks support the introduction of critical thinking into science education. The cognitive constructivist perspective stresses students' active participation in sense-making activities, which promotes inquiry-based learning and critical thinking. Social constructivism emphasizes the collaborative nature of knowledge formation, encouraging students to engage in discourse and arguments to improve their critical thinking skills. STS pedagogy frameworks emphasize the integration of real-world problems to promote critical thinking and ethical reasoning in science education (Attapan and Yuenyong, 2019; Suparee and Yuenyong, 2019; Yuenyong, 2006; Yuenyong, 2017).

Science technology and society approach begins with the society issues; learner must be aware of the social problems and find out the cause of problem. Then, students are finding a suitable ways for solving problems that using Prior Knowledge to develop ideas of the students. In addition, students collaborate with group members as well as the exchange of knowledge. Teachers should prepare issues that are related to science and sophisticated issues. As students will use the knowledge of many fields for find the answer (Yingchana, 2011). The goal of STS approach, enhance the scientific knowledge, enhance motivation to learning science and technology, Provides learners with critical thinking, creatively solve problems and make decisions based on credible information (Aikenhead, 1994). In this study, we use STS approach framework of Yuenyong (2006) consists of 5 stages: 1) identification of social issues 2) identification of potential solutions 3) need for knowledge 4) decision-making and 5) socialization stage that focuses on student's center. STS approach of Yuenyong (2006) has been used in the teaching of science subjects including physics, chemistry and biology. Many researchers have brought this method for teaching various subjects in biology such as genetics and DNA technology, genetics and biotechnology, biodiversity, homeostasis, etc. A results showed that higher achievement and development in various skills such as scientific literacy, decision making, analytical thinking, problem solving ability, understanding of the nature of science and aware of the social problems. (Aryowong, 2011; Phonhan, 2011; Ruksapukdee, 2012; Thipruetree, 2012; Waisalong 2012). This suggested that STS approach can promote critical thinking because critical thinking can be using efficacy solving problem (Hudgings and Edelman, 1988).

The STS approach is appropriate for teaching biology since biology is relevant to daily living. However, biology is difficult to master due to the nature of scientific teaching methods (Lazarewitz and Penso, 1992). They're interested in learning how to decline. Due to activities that do not align with the students' interests, a large amount of content, and a lack of opportunities to comment (Osborne and Collins 2001; Zeidan 2010). Furthermore, students believe that the subject is irrelevant or unrelated to everyday life, which leads to misconceptions (Griffthes, 2003). Students have misconceptions about fundamental principles such as pollination, plant reproduction, photosynthesis, plant physiology, and plant hormones. (Hershey, 2005). As a result, the purpose of this study was to investigate students' critical thinking abilities on the reproduction of blooming plants using Yuenyong (2006) STS approach. Regarding on Nakmanurak (1994), analyzing students' critical thinking through a structured framework comprising seven steps provides a comprehensive lens for understanding and assessing their cognitive processes. Research in this area underscores the importance of scaffolding instruction, providing authentic problem-solving tasks, and fostering metacognitive awareness to enhance students' critical thinking skills across diverse contexts.

METHODOLOGY

This research was a qualitative study focused on interpretive paradigm for study about grade 11 students' critical thinking while learning about the reproduction of flowering plants through Yuenyong (2006) Science Technology and Society approach, during the second semester of 2015 years, Banphai School. The study would emphasize on the importance of the students' critical thinking behaviour, expression during participating in learning activities, reflecting in their worksheet and writing diary for reflecting. Then data were interpreted and summarize.

Participants

The participants of this study were 45 eleventh – grade students consisted of 29 females and 16 males (aging between 16-17 yours old) in a large sized urban public high school located in the northeastern of Thailand. All of them never learned about plant reproduction.

The intervention of STS unit of reproduction of flowering plants

The unit consisted of 5 lesson plans (7 hours) aligned with each stage of Yuenyong (2006) STS approach.

The 1st lesson plan lasted one hour. The activities aligned into the stage of identification of social issues and stage of identification of potential solutions. The social issue was the farmer as newbies learning to grow pumpkins. The story of farmers as newbies learning to grow pumpkins was discussed in classroom. This story may engage students to identify the problems about growing pumpkins. And students raised the questions related to the issues in order to propose the possible solutions and what they need to learn about growing and selling pumpkins. Then, the issue of need for knowledge of reproduction of the plants was raised.

The 2nd lesson plan lasted two hours. The activities aligned with the stage of need for knowledge. First, activity of think pair share of "Why are the pumpkin flowers blooming in large numbers but there are few fruits?" was provided. Then, students did an experiment of studying the structure of different types of flowers, and experiment of classification of flower characteristics according to various criteria. Then, the activities for the stage of need for knowledge were further provided for two hours of the 3rd lesson plan. These activities included studying the characteristics and components of stamens and pistils, watching a video on fertilization of flowering plants, studying pollination and germination of pollen tubes, and summary of factors affecting pollination.

The 4th lesson plan lasted one hour to be provided aligning with the decision-making stage. The learning activities included listing of applying knowledge of science and other sciences for designing solutions to problems in the following issues: how to select the feasibility of that method, the cost of the solution to increase pumpkin yield, and methods that must increase both productivity and income for agriculture. And then, the activities of evaluating the benefits and disadvantages of each option were provided.

The 5th lesson plan lasted one hour to be provided aligned with the socialization stage. The learning activities included creating and sharing clip video of growing pumpkins to get good yields, and reporting the lesson learned from comments and reflection on the clip video.

Data collection and analysis

Students' critical thinking abilities were clarified during students' learning in the STS unit of reproduction of flowering plants. Students' critical thinking abilities were interpreted via participant observations, students' worksheets, and informal interviews. The data analysis aimed to categorize students' abilities align with Nakmanurak (1994) structured framework of critical thinking. This structured framework comprising seven steps: 1) identifying the problem, 2) collecting information, 3) evaluating the credibility of information sources, 4) identifying relevant information, 5) formulating hypotheses, 6) drawing conclusions, and 7) evaluating the process and outcomes. Students' critical thinking abilities, then, will be illustrated through score rubric as shown in Table 1. According to the table 1, the students' critical thinking will be categorized into very good ability when at least 3 elements fall into very good level, to be categorized good ability when 2 elements fall into very good level, and to be categorized poor ability when only one element fall into very good level or none.

Table 1: Rubric of students' critical thinking abilities regarding on Nakmanurak (1994) structured framework

Elements of critical thinking abilities	Levels of ability		
	Very good (3)	Good (2)	Poor (1)
Identify the Problem (IP)	Students' ability to identify and define problems accurately correlates the issues. And students have various approaches for the issues.	Students' ability to identify and define problems accurately correlates the issues.	Students identify the problem but did not relate to the issues.
Collecting Information (CI)	Students employ to collect and organize information effectively, including apply prior knowledge, search strategies, information literacy skills, and use of digital resources. Those collecting information support their problem solving.	Students employ to collect effectively, including apply prior knowledge, search strategies, information literacy skills, and use of digital resources.	Students employ prior knowledge for collect information.
Evaluating the Credibility of Information Sources (ECS)	Students assess the credibility of information sources is essential for informed decision-making. And students evaluate the reliability, validity, and bias of sources, including print and digital resources.	Students assess the credibility of information sources is essential for informed decision-making.	Students could find some information sources, however, it is not essential for informed decision-making
Identifying Relevant Information (RI)	Students identify and synthesize relevant information effectively by using concept mapping, graphic organizers, and so on. Then, students prioritize information based on its relevance to the problem or inquiry at hand.	Students identify and synthesize relevant information effectively by using concept mapping, graphic organizers, and so on.	Students identify relevant information but they did not provide clearly supporting.
Formulating Hypotheses (H)	Students generate hypotheses, testing assumptions, and refining their thinking through iterative reasoning processes (e.g. scientific inquiry tasks, argumentation activities, and so on).	Students generate hypotheses, and testing assumptions; but they did not refine their thinking based on available evidences.	Students provide some claims without direction of testing.
Drawing Conclusions (DC)	Students synthesize information, analyze patterns, and draw reasoned conclusions from data to inform pros and cons, use or abuse, advantage or disadvantage. And, their conclusion could be tracked reasoning with evidences; for example, they show structured reasoning, argument mapping, reflective writing, and so on.	Students synthesize information, analyze patterns, and draw reasoned conclusions from data to inform the orientation of decision making.	Students provide some claims without providing reasoning based on evidences.
Evaluating the Process and Outcomes (E)	Students evaluate the process and outcomes to confirm conclusion. And they apply methods (e.g. peer review, self-assessment rubric, reflective journals, and so on) to evaluate and improve their thinking.	Students evaluate the process and outcomes to confirm conclusion.	Students could not provide some information to confirm the conclusion.

FINDINGS

The findings present the highlight overview of students' thinking abilities and how the STS unit of reproduction of flowering plants foster students' critical thinking abilities.

Overview of students' thinking abilities

Students' critical thinking abilities were interpreted via participant observations, students' worksheets, and informal interviews during their studied in the STS unit of reproduction of flowering plants. Regarding on the table 1, students' critical thinking abilities could be categorized as the table 2.

Table 2: Categories of students' critical thinking abilities regarding on Nakmanurak (1994) structured framework

Students' critical thinking ability	Category	Number of students
Very good	Very good ability category 1	1
	Very good ability category 2	3
Good	Good ability category 1	6
	Good ability category 2	7
	Good ability category 3	12
	Good ability category 4	9
Poor	Poor ability category 1	4
	Poor ability category 2	3
	Total	45

According to the table 2, majority of students held good ability of critical thinking. Even though students could share their ability thinking in the same ability, they had different levels of ability in each element. These could be seen as the radar web for each category as below figure.

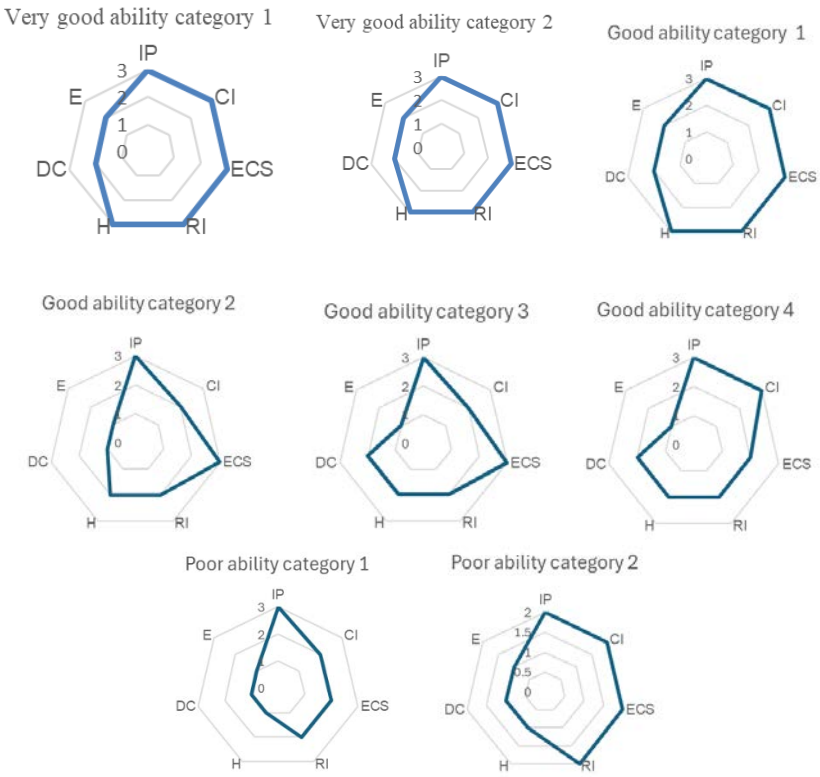

Figure 1: Categories of students' critical thinking abilities

STS unit of reproduction of flowering plants foster students' critical thinking abilities

Students' critical thinking abilities were clarified during students' learning in the STS unit of reproduction of flowing plants.

This research is qualitative research focusing on interpreting from word or passage of students that indicate to critical thinking. Student learning on reproduction of flowering plants by using STS approach in framework of Yuenyong (2006) that focuses on linking with everyday scientific that teacher teachers presented the problems in society of students or the situations that arise surrounding the students. There are 5 stages; each stage of STS teacher encourages students by question to promote thinking skills. The results from worksheets diary and observation in a classroom shown as follows.

First of all, identification of social issues stage began with situation about after the out of harvest season, farmer turned to plant pumpkin which it use less water and it spend less time harvest about three mouths.

When preparing to plant until pumpkin flower bloom but it found fewer products, thus didn't meet the expected targets. So farmers have slight profit which compared to the money invested. A situation is used to encourage students to resolve a problem. Because students are in the agricultural community. First of all, students need to identify of problems and the cause of trouble, for solving problems effectively. This activity will encourage students' critical thinking.

Stage 1 identification of social issues stage that students read the situation, they must say the main problem. Most students can identify issues correctly and to the point.

> "Pumpkins have many flowers but it lack fruit, As a result, it isn't followed in in target." (Watchaphol)
> "There are a lot of flowers, but pumpkins are less fruit." (Kanungnit)
> "Pumpkin has a little fruit." (Chomphoonuch)

Stage 2 identification of potential solutions stage, this stage student looking for a solution for help farmers to increase productivity. Then, member of each group brainstorm to consider the various issues that will be the only one of issues. After that, a representative of each group to present their group's opinion and tell the reasons solution was selected. Each group investigates information to help answer and assessment impart feasibility of the approach. Each groups brainstorm ideas that they should look for more information to encourage approach that are more credibility. This stage, student demonstrated the ability to think critically in terms of hypothesis. Students can use prior Knowledge to propose the ways for resolve the issue. It was found that they can propose interesting ideas and there is Reliable information which indicates that students can apply prior knowledge to find the answer. These are the following examples.

> "Human brings pollen to fertilize the female." (Kornkanok)
> "staminate flower are tapped into pistillate flower, using insects for pollination." (Wararat)
> "Farmers should plant more pumpkins and we don't use pesticides for keep insects to pollinate." (Chonlada)

Stage 3 Need for knowledge stage; Students learn biological content about reproductive flowering plants that consists of the structure of the flower, creating reproductive cells of flowering plants, Pollination and double fertilization. After learning about scientific knowledge, students will be check their knowledge gained from the activity in classroom and to study by them that there is enough information to solve the problem. According to analysis, form the answer question in activity found students shown behaviour about critical thinking 3 stages include; collecting information, credibility of sources of information, identify information.

Collecting information: students are learned in the classroom or inquiry from a variety of sources, they must choose content to solving problems that knowledge must be relevant to the issues. Form students' answers that it shown students have collecting information ability. In addition, there is knowledge from the activities in the classroom; there is another source such as books, website, from parents or village philosophers. Shows that students are interested, and students have ability to inquiry of knowledge. For example:

> "The structure of flowers consists of 4 parts; petal, sepal, stamen and pistil. Pumpkins flower are imperfect flowers which had affected difficult pollination, pollination of flowers in nature, fertilization of flowering plants. Pollen and egg were fertilized which called double fertilization. Finally, the flowers become fruit." (Kittipan)
>
> "Pumpkin is a biennial plant, solitary flower, monoecious. Insects are good pollinators. Some plants hormones can bring transformed male flowers to the female flowers. Pollination is the stamen fall on the stigma that It is important Plant breeding, if don't have pollination it doesn't have fruit." (Samita)
>
> "Pumpkin flowers are monoecious, stamen and pistil are each flower. Creating reproductive cells of flowering plants, male is sperms and female is egg cell which combination it will develop as a fruit. Insect water wind and rain are pollinators. Human can help plant breeding too." (Sirimanee)

Credibility of sources of information: The analysis is based on the knowledge that students have to solving problem. Students must identify credible information which must be able to tell sources of information. Found that students can determine the reliability of the data such as Get knowledge from teacher book, observing the laboratory and their experience. For example, as follows students' answers:

> "Content about structure of flower consist of 4 parts, data is reliable because it is derived from books and teachers." (KingKeaw)
>
> "Content about Pumpkin flowers aremonoecious which making difficult to breeding, information is reliable because of observation on activities in the classroom and teacher consultation and read a book." (Yodsaadee)
>
> "Some hormones can be transformed male flowers to the female flowers; there is credibility because I ask my parent who used this method that it can actually flowers gender." (Samita)

Identify information: Knowledge' students have already been mentioned above. They must able to identify the type of data such as fact, data from previous experience or opinion.Because, the students have realized that before decision solving problem, they requires enough knowledge and accurate. Students are able to solve the problem. The example illustrating student ability to identify information is given below:

> "Content about pumpkin flowers are monoecious which is fact. Due to the flowers of pumpkin is always monoecious." (Issariyaporn)
>
> "Plants must fertilize before it develops into a fruit. As well as the fertilization of human. But, plant occurs double fertilization that hybridization between sperm and egg and sperm and polar nuclei. It is the theory because has been studied until to publish a book." (Ratchaneekorn)

This stage, from students' answers is showed that when students learn about the reproduction of flowering plants. Students can conclude the cause of the problem more clearly. Due to, they are adopting knowledge about structure and type of flower to be the cause of the problem correctly such as farmers have been less producing because the nature of a pumpkin flower is imperfect flower which led to chance of pollinators difficult.

Stage 4 Decision-making stage, this stage is very important because students are applying the knowledge from need for knowledge stage and various sources, for analysis and conclusions in order to finding appropriate solutions and finding better ways of increasing productivity. In this stage, students expressed behavior of critical thinking 2

stages include; hypothesis and conclusion.Student are offered a solution, it appears that they are propose the ways more than two alternative, indicating most students know the cause of the problem which is caused by the morphology of the pumpkin flowers that lead to hard-pollination. Students are presented a rather solution direct cause. Students are using their skills to hypothesize the cause of the problem and selection of the data is used appropriately that they are offered a variety of possible solutions, explanation principle and explanation about good point and limitation of solution. Using scientific knowledge, expenses concerns, environmental concerns and concerns for producer and consumer safety etc. Moreover, students apply their knowledge for used to solve problems rationally. For example, content of plant hormones, agricultural knowledge and knowledge gained from the experience of the students. This activity promotes students to have analytical thinking about hypothesis and conclusion as explained in the following:

> "Important factors in pollination are insects that occur in nature. So, I want to raise bees around plot of field to pollinator's flowers. In order to have thoroughly insects and there are more chances of pollination, and income from the sale of honey. But, I Not sure bees can pollinate them 100%." (Praewa)
> "Important of insects are pollination. Therefore, I need to lure the insects to swarming the flowers. When insects like sucking nectar which brings hake's blue boy syrup mix with water that spraying to pumpkin at morning time to lure insects." (Kittisak)
> "Campaign to reduce the use of pesticides in the community because that will destroy insect that pollinators. Although, our garden isn't use it. But, other garden are used, it can reduce insects. The member. So, the campaign is a good approach, sustainability and safety of consumers. However, this way may take a long time." (Waraporn)
> "I would use plant hormones. I learned that auxin hormone which changes from male to female. This hormone is sold in the market because I've seen parents bring infuse longan, it Increase ovary when there are many ovary that the fruit has increased. But, It may be that fewer male flowers." (Boonsiri)

After students have presented various ways for solving problem. Student had to choose just one approach that is most appropriate. At this stage, students will illustrate the conclude ability which the consideration of the advantages and disadvantages of solution. There is an example described in the following.

> "Reducing use of pesticides for increase insects to pollination. Although, this way to destroy increasingly pumpkin. But it will be good for the environment and farmers, to increase pollination better." (Kittipan)
> "I chose to feed insects that it are bees and reduce usage of pesticides, because both have strong point that insects is a good pollinators which aren't pests, so it don't bite stem of pumpkins. It also helps increase income from sales of honey and honeycomb made beeswax. (Praewa)"
> "I want to hire worker for pollination because pollination will likely be the inevitable result. Although I pay hire workers, but the pumpkins have set well. As, pollen moves on the stigma." (Winutcha)
> "Applied perfume to lure insects because we don't have to hire a mixed that the use of natural resources to benefit." (Yodsawadee)

Stage 5 Socialization stages, in this stage, each member of the group to propose their solutions and discussion for choose the one suitable approach to offer to the community. The students in each group must choose a person and presentation methods to present. While each group discussions, they to apply their knowledge or recommendations from discussion, for consider possible solutions of their own. The results showed that the students had to evaluate their own conclusions that some people continue to do the same. But some people have been modified after discussion. For example, that the following words.

> "The consultant our group, I think that would combine two approaches which take plants hormone to transform sexual of pumpkin flower and beekeeping near the planation to use bees pollinate it." (Samita)

> "I still use the same approach which is people are the main pollinators and I will reduce the use of pesticides, with a negative effect on health." (Salit)
> "Using fabric softeners may affect to the pumpkin flowers is withered. I may use syrup instead of fabric softeners." (Prissana)

This stage, group of students transfer their knowledge to the community. The students choose the way of presentation, location, and person to present by themselves.

Conclusions

This research led Science technology and society approach used to teach biology, this approach is appropriate. Because biology related organisms which is located around the students. Thus, the issues happened for stimulating students' interest. From interpretation that students apply the knowledge and previous experience to answer the problem correctly. The students learned about the contents of the structure of the flower. They answered the question correctly about the cause of problem. Students apply knowledge from the classroom activities for designed to find solutions that there are rationale. The analysis illuminates that the process of critical thinking. STS approach can encourage students' critical thinking at each stage. As follows: First stage, this stage promotes in identify problem of students. Next, identification of potential solutions stage promotes students' hypothesis ability. Need for knowledge stage promotes critical thinking 3 processes; collecting information, credibility of sources of information and identify information that 3 processes used in step 4 is decision-making stage. This stage encouraging to students showed conclusion and evaluation behavior. Finally, the socialization stage encourages students' evaluation ability. Nowadays, in addition to promoting scientific knowledge. Teachers need to encourage thinking skills for students to apply in daily life effectively and they learn about lifestyle in their local communities. In order to provide students, see that science are important to subsistence.

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