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Developing STS Nuclear Energy Unit for Providing Students' Perception of the Relationship between Science Technology Engineering and Mathematics

Chonlada Sritaweekart, Tawee Sranamkham, Chokchai Yuenyong* Faculty of Education, Khon Kaen University, Thailand *Corresponding Author: ychok@kku.ac.th

ABSTRACT

STEM education suggested students to learn science with integration between Science, Technology, Engineering and Mathematics. To help students make sense of relationship all 4disciplines. This research aimed to developing STS approach Nuclear energy unit for providing students' perception of the relationship between science technology engineering and mathematics. The STS Nuclear Energy unit was developed based on Yuenyong (2006)'s STS approach. His approach consists of five stages including (1) identification of social issues, (2) identification of potential solutions, (3) need for knowledge, (4) decision-making, and (5) socialization stage. The paper will explain how the unit was developed and clarify how the unit provided activities for some aspects of the relationship between science technology engineering and mathematics. The paper may have implications for developing science teaching with STEM education.

Keywords: STEM, STS, Nuclear energy

Introduction

Education been change a lot and it also affect society life style. Education in twenty first century is the education that brings out the knowledge and ability, to open up the opportunity for students to develop self ability as much as they can. There are no limitation on time and place. It's also including the intelligence and ability to recognize on other issues. This can help students to analyze thinking in many other ways. In twenty first century education is aiming to learning innovation, life skills, information skill, media and technology that will help in many other subjects and the most important thing are science and technology. Most of the students are less interesting on science and technology. So government has guidelines for students to learn and gain the knowledge and improvement in the way of economy (Office of the National Economic and Social Development Board, 2006 cited in Ministry of Education, 2008). Also help promote the students in the important in life and how to improve the way of learning for Thai citizen for living (Ministry of Education, 2008). With participation of all sectors want citizen to have good quality, good moral, good ethics, subconscious and desirable values. According to the objective of basic education it's to get ready to conduct real life (IPST, 2013; Tupsai, Yuenyong, and Taylor, 2015; Yuenyong and Narjaikaew, 2009).

The Institute for the Promotion of Science and Technology (IPST) is seeing the important of education. So they are thinking of the new way by suitable to very living in the society and economy. As we know STEM Education by IPST. This program have been promoting in every grade levels. On this culture of learning it's aim to innovation on Science, Technology, Engineering and Mathematics. General knowledge on STEM is the composed concept and process skills. That can link to individual, social and world problem for students use the knowledge to solve the problem in real life. It's also

improving in thinking and researching for new idea. It will be benefits for working and life conduct, though the experience in activity by uses the base problem. It's also promoting students to improve in idea and the way of thinking, also how to solve the problem. Creative is the way of promoting STEM Education in Thailand (IPST, 2014).

However, society always think that science is the most difficult subject, most of students are try not to understand in the subject for example students love to do experiment but can't explain the conduct (Kaewkraisorn, 2011). The problem came from the learning that not support the reason and can't solve the problem. So science becomes the subject that not according to the real life (Yuenyong, 2006 cited in Soyjak, 2010), therefore we need to put science in to student life and make it easy to understand. And make the new generation to see that science is all around, such as power generation in nuclear power plant and the last step on the process will leave the radioactive waste, if we don't have the science knowledge. We can't protect and clan the radioactive waste. So the community around the power plant will have the substances toxic and also cause the sickness.

The IPST has enhanced science teachers to teach science through engineering process design with aiming to provide STEM education in Thailand. They expected that scientific inquiry and designing for problem solving through engineering process design may allow students to integrate science technology engineering and mathematic for designing. This program has been launch since early year 2014 (IPST, 2014). The STS approach is another teaching approach that suggested science learning through technological or engineering process design (Soijak, 2010). Therefore, the STS may provide student chance to learn science and creating some project, volition, solutions with integration among science technology engineering and mathematics.

The STS approach is the innovation of study through society focusing on relationship between science, technology and society. Students that are study in twenty first century can apply in solving the problems, research and the communicated in community and responsibility in society (Yuenyong and Narjaikaew, 2009). On this research using knowledge in science, technology and society base on Yuenyong (2006)'s there are five steps process such as: (1) identification of social issues, (2) identification of potential solutions, (3) need for knowledge, (4) decision-making, and (5) socialization stage. It's can be useful in many ways for student such as: problem solving, how to do self explanation (Chantaranima and Yuenyong, 2014) and also support students on the knowledge of technology as hands on and apply the knowledge. This activity is not only can use in the classroom. It can use along with other subject. Finally, hopefully from the activities are open students' opportunity, how to solve the problems and fulfill the human needs in technology though the project pass by STEM education.

Science Technology Engineering and Mathematics (STEM) education

STEM Education is the integration on Science, Technology, Engineering and Mathematic by apply in to everyday life. In the context that link between school, community, work place and complete with today economy (Tsupros, 2009 cited in Hays Blaine Lantz, 2009). It's a preparation for all students to get ready in society challenges by innovation and how to solve problems.

The Components of STEM

STEM is Science, Technology, Engineering and Mathematics; it's the abbreviation use extensively in the education field, but the meaning hasn't come clearly so on this research put together the meaning of all the abbreviation as follow:

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Science: Science seeks to develop an understanding of the natural world (John Williams, 2011) through observable and measurable phenomena within the universe. Scientists are often used as a tool for understand objectively to ever-changing, natural world in our live. The three general areas of science include: (1) Physical Science, (2) Life Science, and (3) Earth and Space (IPST, 2013).

Technology: Technology is an application of knowledge and to use various resources available for problem-solving, creative thinking, and design to meet human needs (Bunkheuang, 2009). Technological process consists of seven stages including (IPST, 2013): (1) Identify the problem (2) Information gathering (3) Selection (4) Design and making (5) Testing (6) Modification and improvement (7) Assessment.

Engineering: Engineering is science skill, profession of acquiring and applying scientific, economic, social, and practical knowledge in order to design. It's also maintain structures, machines, devices, systems, materials and processes (IPST, 2013).

The Engineering Design Process (EDP) is about organizing ideas to improve decision making in order to develop high quality solutions and/or products to problems. The main ideas in successful instruction of the EDP are: students are engineers; teachers need to listen to students; and classroom environments need to change to properly enable learning through the EDP. Figure 1 describes skills and abilities associated with engineering design for high school student consists of nine stages including: (1) The Identify need or problem (2) Research the need or problem (3) Develop possible solution(s) (4) Select the Best Possible Solution (5) Construct a prototype (6) Test and Evaluate the Solution(s) (7) Communicate the Solution(s) (8) Redesign (9) Completion decision.



Figure 1 Engineering Design Process (Hynes, M., Portsmore, M., Dare, E., Milto, E., Rogers, C., Hammer, D., & Carberry, A., 2011)

Throughout this process, students are constantly evaluating and testing their ideas, repeating steps as necessary and sometimes even restarting from the beginning. Occasionally the original idea will have some initial overlooked flaw or a different approach may become apparent through work on the challenge (Hynes, M., Portsmore, M., Dare, E., Milto, E., Rogers, C., Hammer, D., & Carberry, A., 2011).

Mathematics: Mathematics is not just counting but involves the essential elements. First, there is a Mathematical Thinking such as analogy, classification / sets, patterns, shape, and property. Second, the Language of Mathematics there is children will

be able communicate mathematical ideas or concept such as greater than, less than, etc. Third, Higher-Level Math Thinking there is activities for children's play or activities of daily life (Siripatrachai, 2013).

Science Learning and Activity based on STS Approach

STS approach helps to support teaching and learning relevant to society situation. The STS develops skills to use the processes of scientific and technological inquiry for information gathering, problem-solving, and decision-making; and to use values and ideas involved dealing with the interaction among science, technology, and society for local issues, plublic policies, and global problems (Bybee, 1985 cited in Yuenyong, 2006). The STS approach of instruction based on Yuenyong's (2006) including 5 stages as follows:

Identification of social issue stage. It's the issue on social in science and technology at this stage teacher will motivate students, to see the social issue and fine the answer on each question. So students be more interest and want to do research. At this point teacher will give the students, the local issue and the social high light, also offering the technology product and so-on.

Identification of potential solution stage. On this stage let students to check on their ability and solving social issue and also notice the social issue that came from science and technology. Students can pane and find the way to answer the problem by check self ability and also can do more research and fine the support to the answer.

Need for knowledge stage. At this stage students will learn science that help to solve the problem, so at this point teacher will set up the science class that emphasize to skill and science process, by the experiment and research for the best information.

Decision making stage. At this stage students will review all the knowledge and fix it out how to solve the problem. Students need get all the knowledge in science and technology to design how to solve the problem and if it can be use in community.

Socialization stage. Students will use the society thoughts to solve the problems by present or design the decision so students can exchange ideas. Students need to write a letter to the head of local community about issue in the society, also put up web board or role play exhibition about science and listen to the comment of the people (Soyjak, 2010).

Method of Developing STS Nuclear energy Unit

To develop learning and student are a main factor for learning process to enhance student's learning. Teacher act like a facilitator, stetting an environmental learning and preparing activity that support student too develop their efficiency, their ability and their interesting. The activities should support student for process of analyzing, hypothesis, creative thinking and self-study. They can get learning and discover new knowledge by themselves into long-life education.

Developing STS Nuclear energy Unit. The research design focus on students' concept of the relationship between Science Technology Engineering and Mathematics based on Science, Technology, and Society (STS) approach. Guidelines for creating and developing lesson plans as follows:

Study curriculum, there are principles, goal, structure, period, and content in the Basic of Education Core Curriculum 2008

Create a Lesson plan, guidelines for writing lesson plans: consider destination, sequence objectives, knowing time frame, create activities to meet objectives, check for understanding, and sample lesson plan format on concept of Science, Technology and Society (STS) by using the Yuenyong (2006) STS approach.

In the process of creating and developing lesson plans, researcher will present the experts for revision, improve lesson plan based on the recommendations of the experts, and implement lesson plan adjusted to the target group students

Lesson plan. Science Technology and Society leaning process. Students met the situation; identify the question or problem, to develop student's concept and skill. Students have to think about "How to solve the problem?" by using their concept and skill. Teacher is a facilitator and prepares appropriately learning environment (see Table 1).

Table 1

Lesson plan through Yuenyong (2006) Science Technology and Society (STS)

Stage	Acti	vity
1. Identification of social issues stage.	Students read the situation about Fukushima nuclear disaster It's a social issue, at this situation is a situation that the equipmer failure and radioactive emissions at Nuclear power plar "Fukushima daiichi" after earthquake and tsunami hit Japan i 2011. Teacher used Figure 2, Figure 3 and questions that below t motivate students.	
	Figure 2 The explosion of nuclear power plant	Figure 3 Staff is checking radiation after the
	Questions for students : 1. How it's happen? 2. What do think and if there is a nuclear power plant in Thailand? Please explain. 3. If you are an engineer how would you design a nuclear power plant in Thailand (please think of safety and environment) Teacher gives out the problem activity for student to solve and student need to build a nuclear power plant in Thailand by using the knowledge of science and nuclear power. Students need to think about safety and environment. Each group has to brain storm to do the research and how much	
2. Identification of potential solutions stage.	Each group has to brain storm to do the research and how much students know about it. Also what question need to be answer. Students need to give tentatively proposed the method to find the answer, how is effect society if Thailand got nuclear power plant.	
3. Need for knowledge stage.	Teacher will set up the activ explain. Students need to use all build a nuclear power plant.	ities for students to explore and the knowledge to application to

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Stage	Activity
	 First activity: Know the energy Objective: students can identify the different sources of power and energy. Step of activity Let students define the meaning of energy in many way Teacher and students discussion about different sources of power and energy such as chemical, energy, thermal power, mechanical energy, electric energy, radiant energy and nuclear power by give example of how to use each power and energy Introduce students to fuel and the resources of energy production such as how human body use food as fuel. Divine students in to group so students can research the energy sources such as oil, coal, wood nature gas, water, wind, solar energy, nuclear power et. Divine students in to two groups first group will renewable energy and other group is consumption. Students in each group will present the power source that they been research for, by drawing or post up picture up to each group.
	 Second Activity: Chain reaction in nuclear energy Objective: students can demonstrate the chain reaction in nuclear energy. Step for activity Teacher educated student in nuclear power and the fission of nuclear reactions is called nuclear fission. It will produce a lot of power and also atoms of uranium are widely used in the fission process. It can produce more power then coal. Demonstration on chain reaction. Students set up domino in straight line or curve line (show as Figure 4)
	Figure 4 Demonstration on chain reaction
	 Pushed the first domino in a row. Describe what happened (involve chain reaction). 3. Demonstration on how to control the chain reaction. Students set up domino close to each other but put on barrier or obstacle and ask students what happened, if domino hit

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Stage	Activity	
	the obstacle.	
	- Set up domino again after stop nuclear reaction but this	
	time put the block higher so the domino stop. Students need to	
	observe and debate on the relationship of the chain reaction, and	
	also how to control the chain reaction in nuclear power plan.	
	4. Student draw picture explain the nuclear in fission.	
	Third Activity: Nuclear Reactor Model	
	Objective: students can name all the part of nuclear reactor	
	Step of activity	
	1. Teacher educated about nuclear reactor then can make the	
	high heat and the heat came from fission. So it's made hot water	
	into stem to spin the turbines that link to electrical generator.	
	2. Students watching VDO about how does nuclear reactor	
	work and study the nuclear reactor. So it's the way how to build up	
	3 Students in each group research and simulated nuclear	
	reactor on paper also decorative. Put up on the wall and present to	
	the class.	
	Fourth activity: The pros and cons of the nuclear power plant	
	Objective: student can tell pro and cons in power plant.	
	Step of activity	
	1. Leacher and students analyze and give comment on	
	set up the power plant	
	2. Teacher open the opportunity to students on comment and	
	write report on pro and cons	
	3. Set up group to debate on nuclear power plant.	
	4. Student in each group present (roll play or picture) by	
	having variety of support, against it but with the neutrality.	
	Objective: the impact of the accident at nuclear power plant. Also	
	choose the place to build the power plant. Also	
	Step of activity	
	1. Students do research and present the affect of accident in the	
	nuclear power plant such as health problems et.	
	2. Set the students that agree on the same idea in a group so	
	they can comment, give their own idea and present to the class.	
	3. Student design community around the nuclear power plant	
	each sten	
	caen step.	
	Sixth activity: Class discussion	
	After the research and activities students need to use all the	
	knowledge to application to build a nuclear power plant as if an	
	engineer.	
	Teacher's question: What regardless of what principles, that	

Activity	
decision to build a nuclear power plant?	
Second, discussion:	
Teacher and students debate on:	
- Environment around the plant	
- Safety in the power plant	
- Effects from build the nuclear power plant	
All students' knowledge from step 1, 2 and 3 to review how	
student will build the nuclear power plant. What should student improve in step 2	
 Each group have to make decision on how to design the nuclear power plant (please think about environment and safety) Students' decision on design, students need to think is it possible to do and what are the advantages or disadvantages. Please explain Please draw your design and write your decision on the paper. 	
Social process would help the students to revise their concepts	
and solve the problem such as:	
- Each group brain storm, plan and divine all the work.	
Students need to plan outdoor activities and give out information	
and design about nuclear power plant for the hold school	
- In outdoor activity take place some of student in each group	
- After outdoor activity students need to write a report how you feel about the activity and feedback from people who watch VDO and people who attend outdoor activity.	

Discussion

The Yuenyong's (2006) STS nuclear energy unit was provided to engage students to inquiry of nuclear energy and designing for problem solving through engineering process design as highlighted in the Table 1. The Unit may provide students chance to learn nuclear energy and creating some project, volition, solutions with integration among science technology engineering and mathematics. Below is discussion how each stage of Yuenyong (2006) STS nuclear energy unit could provide students to find solutions through engineering design process and applying knowledge about science, technology, engineering and mathematics.

Step 1: Identification of social issues, each student group read the situation about nuclear bomb at Fukushima. It's a social issue that it is about the equipment failure and radioactive emissions at Nuclear power plant. There were several injured and died because they gain radioactivity. At this situation, students will discussion "how it's happen?, what do think and if there is a nuclear power plant in Thailand? Please explain, and if you are an engineer how would you design a nuclear power plant in Thailand (please think of safety and environment)", students were challenged. This situation was used to stimulate students to identify the problem, it has related to Step 1 of Engineering Design Process (EDP): Identify need or problem. The group discussions allow students to provided their

explanation where knowledge may integrate among science, technology, engineering and mathematics (STEM).

Step 2: Identification of potential solutions, students will need to answer the problem of planning by the student's knowledge of their existence and planned to seek additional knowledge that will encourage students to find out the answer. The outcome of the group students need to give tentatively proposed the method to find the answer, how is effect society if Thailand got nuclear power plant, relate with scientific knowledge.

Step 3: Need for knowledge, students will need to study the scientific knowledge related to the problem. This could be mentioned they engage in the EDP step 1 – identify need or problem. Then, they have chance to identify the mean to resolve that problem. This could be recognized as they do the EDP step 2. After the explore activities teacher provide question: What regardless of what principles, that decision to build a nuclear power plant? Then, students discussed the question in small groups before the conversation was opened to the whole class. After that teacher and students debate on: environment around the plant, safety in the power plant, and effects from build the nuclear power plant. Students used their science knowledge to think through the idea from activity, to application to build a nuclear power plant. This could be mentioned that students work as EDP step 2 - research the need or problem, scientific knowledge, and using student's Mathematical knowledge in activity.

Step 4: Decision-making, the end result of activities 1, 2, and 3 was that students made the connection their idea. What should student improve in EDP step 2 then decision-making on how to design the nuclear power plant (please think about environment and safety), students need to think is it possible to do then draw their design and write their decision on the paper. In this stage, relate with using these scientific knowledge and Technological process to solve problems, using these Higher-Level Math Thinking to design the nuclear power plant, and has relate with EDP step 3-5: develop possible solution(s), select the best possible solution, and construct a prototype.

Step 5: Socialization, to help the students to revise their concepts and solve the problem. Students in each group will explain and discuss with audience attending in outdoor activity to understand what those students designed and invented, how they did it, and what benefits it can provide?, recording VDO and post it up to Face book. Students recognized errors and suggestion in their thinking on recommendations of the other, to improve new concept for good outcome. In this stage, relate with EPD on step 6-7: test and evaluate the solution(s), communicate the solution(s), and redesign. In addition, it has related with use technology in the social media.

Conclusion

The paper proposed the opportunity of engaging students to scientific inquiry of Yuenyong (2006) STS nuclear energy unit through engineering design process (EPD). These activities may encourage students to problem solving to application their knowledge of science and mathematics, and also their skills and process of technology and engineering to help design and creation their work. This suggested how to teach science in order to give students chance to learn STEM.

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