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Developing the STS Unit of Heat Transfer to Provide Students' Perception of the Relationship between Science Technology Engineering and Mathematics

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ABSTRACT

STEM education is an approach to teaching and learning that integrates the content and skills of science, technology, engineering, and mathematics (STEM) in learning about heat through science technology and society (STS) approach. To help Thai students understand to relationship between science, technology, engineering, and mathematics (STEM). This paper will discuss how to develop Lesson plan of the transfer of heat through Yuenyong (2006) science, technology and society (STS). Where learning activities were provided based on 5 stages. These are included (1) identification of social issues, (2) identification of potential solutions, (3) need for knowledge, (4) decision-making, and (5) socialization stage. The learning activities could be as following: The first stage, we use video clip of 'The climate change of the Earth' and identify the impact of the temperature rise inside their homes. Second stage, will need to identification of potential solutions by design Cool House. By using background and other knowledge will be proposed for various alternative solutions. Next stage, students will gain additional knowledge from scientific experiments on heat transfer. So that students have the knowledge or findings used to design the cool house. Fourth stage, students design and decided for the best solution of design cool house based on their scientific knowledge and other. Finally, Students presented their cool house in front of the classroom. Classmates and teacher comments, ask questions and suggestions for improvements to the house cooling and contribute to the mutual exchange of ideas. This paper may lead to the development of science teaching through the integration of science, technology, engineering, and mathematics (STEM)

Introduction

Now a day new technology in fast development in science and technology that the way of living in society. Their fore science and technology study is every important to human resource. It also can cope in changing of twenty first century. In the meaning of education in every level would like students to improve in creativity and how to solve the problem with good judgment. It's also including improving development skill in communicating by use technology to pursuits the social skills. The education should intergrade in all the subject, so it can help solve the problem in and outside the classroom. Their fore students will see the usefulness of studying and they can adapt in the life style. And also the learning management should be according to twenty first century in many way of thinking as it call "STEM Education"

STEM Education is integration in four learning subject such as science, technology, engineer and mathematics Also, it's integration in context that involve with life style, so the learner see the important of the subject learning and put it in use in everyday life. It will help with knowledge so, learner will understand in thinking, improving analysis and creativity. All of that knowledge are knowledge of twenty first century, it will help in communication, how to be

leader and also how to take a criticism (Siripattrachai, 2013) for guide lines taught by STME Education such as:

Content Links from Science, Mathematics and Technology to Every Life.

All the learning process can be learning by nature and also can use in every life. So this is the first step of learning integration. The phenomenon and fabrication around us are not only way of learning. It can easy apply such as calculation of tissues areas. That's also connecting to the knowledge of materials science and manufacturing technologies by using engineering process problems and creative solutions.

Research of knowledge

To setting up the lesson plan by solving the problem or ask question and come up with selfexplanation. And get all the strong evidences that can be involved. Students can compare in all thinking and the learning process of STEM Education..

Learning base on project

Project is other way of learning, but project can integration in solving the problem. The strong point of STEM Education is the project and also open up the experience in self learning by define the problem, research, summary and communicated with research.

Creative work that can integrate from STME Education.

All the experience from creative work can build the creative thinking, design, making decision, and solve the problem. Specially the creative work that teacher teach in the classroom and open freely in thinking also creative project that integrated in science and mathematics.

Integrating technology of learning management that came from the knowledge of STME

The use of technology will motivate students in learning and apply learning in solving the problem and how to work as a team. Such as recoding and present the VDO, photo and other multimedia, to get the data analysis et.

Focus on the skills in twenty first century.

Activities that base on STME Education, will develop skill in twenty first century , for example: learning and innovation skills according to the framework that partnership in twenty first century skills will comprehensive in "four C" 1. Critical thinking 2. Communication, 3. Collaboration and 4. Creativity.

Acceptance and involvement from community

The learning of STME Education, teacher can take students out to community classroom. It's to research in the local nature, and also learning and report on the pollution or useful nature source. So community can learn and solve the local product problems and also students can be part and proud of the local product. (Lungkhapin, 2013)

The approach learning from seven guild line, such as: linking of science, mathematics and content to the real world. This research study uses the project to be base on producing the product and integrate the technology. So students can be apart and the knowledge from community to apply in physics learning though science, technology, engineering and mathematics.

The Learning concepts of science, technology, engineering and society (STS) (Yuenyong, 2006) bring social issue to community, local even world class to students to solve the problem and promote the learning of science. That is the heart of technology and can link to science to apply knowledge.

Science Technology and Society (STS) Approach of Science Learning

The STS Approach of instruction based on Yuenyong (2006) approach including 5 stages as follows:

Identification of social issues stage. This stage is designed to focus student attention and attitudes on learning about energy. The STS instruction has to begin in the realm of society. Instruction will be begun by posing issues related to scientific knowledge in society. These questions or problems of social issues need to be solved by citizens.

Identification of potential solutions stage. Students plan to solve the social problem related to raising scientific knowledge. This stage supports students to concern with the technological aspects for finding the possible solutions. Technological aspects are skills to support student decision making. Students need to think of what, why, and how ideas, design, systems, volition of application on scientific knowledge work for that social problems. Teaching strategies maybe used discussion among students' group, role-play, brain storming, searching information via internet, and discussion with expert (e.g. engineers or scientists).

Need for knowledge stage. This stage involves developing scientific knowledge. Social questions and technological knowledge create the need to know some science content. Scientific concept was formulated in many strategies to help students to understand the technology and social issues. The strategies, for examples, include reflection reading document provided by teacher, and lecture. To give feedback students' understanding about scientific concept, the short quiz will be taken after class of this stage.

Decisionmaking stage. This stage involves student in making a decision on how to use scientific knowledge and technology has solution of the social problem.

This aspect public rhetoric about energy related technological and societal issues becomes dominated by dichotomies like 'chances and problem', 'advantages and disadvantages', or uses and abuses'. Student will be given chance to learn to choose between alternatives and in a thoughtful way systematically comparing as many relevant pro's and con's as possible. Teaching strategies may be used discussion among students' group, role-play, and brainstorming.

Socialization stage. Students need to act as people who are a part of society by reporting their proposal for solving problem. Socialization process will allow students to validate their values and scientific concepts for solutions during their sharing in society. Student might exhibit their solution in public by produce a poster, social medias, a newspaper article or a plan, present science project, or any activities that give students chance to sharing and learning from those social activities. (Sengdala, 2014)

Technological process. The process of technology is the step of work that can build up and use full to solve the problem also need of human (ISPT, 2012) there are seven process such as:

Identify the problem. First step of technology is to control the problem and needs, it's also try to understand or analysis the problems. By the detailed of technology to control the problem or the need more clearly

Information gathering. Gather all the information from the credit sourced such as: books, journal, magazine and from the internet also brain storm in a group.

Selection. Choose the method and consideration to solve the problem that meet the demand and according to the problem as much as possible. The aspect is to be considered “pro and con”. So it can use it to save and make more progress.

Design and making. The design and preferment of thinking or imagination in the step that will help solve the problem. By using two and three dimension to plan, build and contribute the idea.

Testing. Testing is the way of proving of the project. It’s proving of the right or wrong work and knowledge, so we can see the defect of plan, what should be fixing. Students should record in the projects so it can improve later on.

Modification and improvement. Improvement is the test to know, if it should improve the project in which way. So it can fix the problem or go on with the project.

Assessment. The evaluation is the ways that prove of the project and solve the problem. So it can improve to get better results. Some of the activities might not be all seven step but some of the activities can switch step so student can learn how to use the step work.

Engineering Design Process

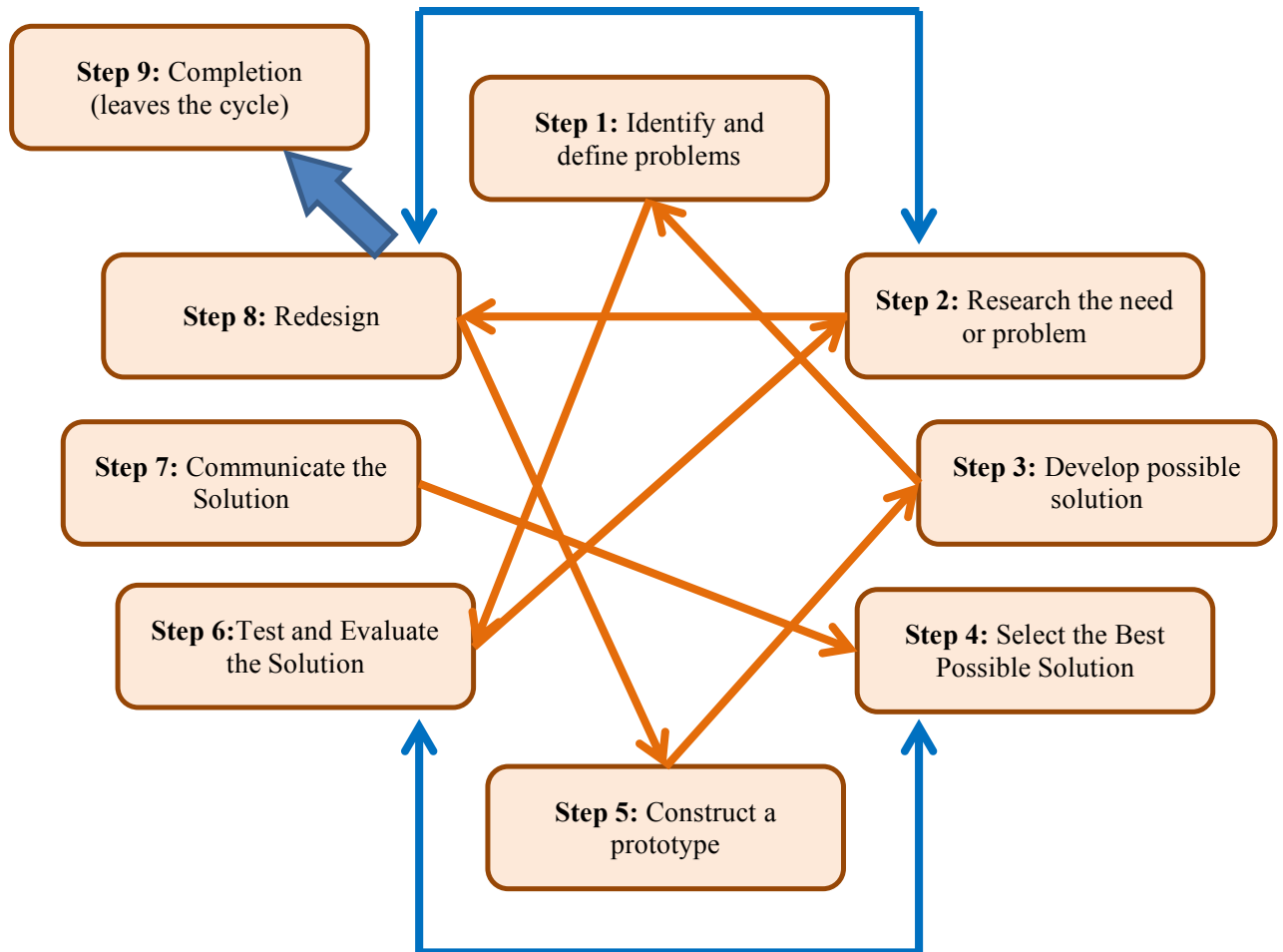


Figure 1: Engineering Design Process

(Morgan Hynes, MerredithPortsmore, Emily Dare, ElissaMilto, Chris Rogers, David Hammer, and Adam Carberry, 2011)

Morgan Hynes, MerredithPortsmore, Emily Dare, ElissaMilto, Chris Rogers, David Hammer, and Adam Carberry explaining engineering design of high school students in nine steps as follows:

Identify and define problems: High school students are capable of identifying a need or problem in a given situation and should be provided the opportunity to do so. The goal should be for students to deal with ill-defined problems, identify the necessary constraints imposed on the problem, and acknowledge the clients 'desired specifications. Classroom challenges should emulate real-world engineering challenges as much as possible.

Research the need or problem: Once a problem has been identified, instead of rushing to solve the problem with the first solution that comes to mind, students must conduct some background research. Students should understand that there are many things to consider when solving an issue and recognize that they need to fully explore the challenge in order to be well-informed as to how to solve it. Such as, engineering challenges and associated curriculum must make the need for and benefit of research clear to the students.

Develop possible solution(s): Recording multiple ideas for the task takes into consideration the need for planning and teamwork. Students should be actively brainstorm in groups to help foster individual learning and creativity. Through this process, students work on their communication skills with others and grasp the understanding of tradeoffs while forming their ideas within the problem criteria and constraints. By using words, drawings, and prototypes. Students can explore and develop ideas with clearly defined specifications.

Select the Best Possible Solution(s): The ultimate purpose of design is eventually to create an end product that solves the problem in hand. At high school level, students need to be able to justify and reason their own solution to pursue. This requires that a best possible solution be selected for the individual or group project. What may seem the best for one person may not always be the best for another person. This supports the notion that a perfect solution is rarely available to practicing engineers. This step necessitates that students will be able to back-up their ideas with proper consideration of evidence and issues that were discovered through problem definition and research. This also assures that students use their knowledge of math and science to make informed decisions, constantly assessing each one along the way.

Construct a prototype: The prototype is a presentation or model (physical, virtual, or mathematical) of the final solution. Iterative prototyping until it's acceptable product, it reached the component key of this stage. It's allowing students to physically construct a model of the solution. It is important to allow students to fail and learn from those failures as they iterate on their solution. It is not always important that the prototype perform like the intended final solution. Instead, it should demonstrate some functionality or look of the proposed final solution.

Test and Evaluate the Solution(s): Students must create fair tests based on the constraints and requirements of the problem to judge whether or not their prototype is successful. High school students are capable of developing their own experimental tests to evaluate their solutions. Determining appropriate testing procedures may cause students to reengage in the research step. As they determine what methods and tools will help determine how well their prototypes meet the requirements. At this juncture, students have the ability to recognize that a finished prototype does not necessarily mean a finished product.

Communicate the Solution(s): Part of engineering is sharing your ideas and findings with others for feedback and marketing purposes. By the time students reach high school, they will be capable of documenting their solution through written documents, presentations, and constructions. The ability to organize information for understanding and clarity is necessary to present ideas to others (i.e. teammates, teachers, and clients). These presentations should include specifications, performances, issues, limitations, and constraints. By giving an oral presentation, students will communicate their solutions in a language and style, that can be understandable by a target audience, which could be their classroom, the entire school, or actual practicing engineers. These presentations require that students accurately and completely document information pertaining to their solution.

Redesign: High school students level are able to troubleshoot their problems. Each decision they may aim to improve the prototype until a final product has been produced to meet all of the requirements and criteria, as well as passing all of the tests and evaluations.

Completion (leaves the cycle): The very last step of the EDP results in the determination that a final product has been achieved. This product is not simply the result of passing a set of predefined tests, but it's based on whether or not students believe they have sufficiently optimized their product to the selected constraints. In this step, students

make a decision that they have sufficiently met the design requirements and ready to implement their prototype as a final product.

Developing STS transfer of heat unit

The development planning in topic of transfer of heat unit by science, technology and society (STS) (Yuenyong, 2006) such as

1. The goal of vision base on indications and information of lesson plan in science. The topic of transfer of heat unit of eleven grade students.
2. Build up the lesson plan in knowledge of science, technology and society (STS by using STS approach (Yuenyong, 2006)) in five steps such as:

First step: Identification of social issues stage. : Society problem on this step student will realize the problem in society that come from science, technology. Students should be appreciating that they are part of the problem solving. Teacher can present students the problem and let them solve it and do research.

Second step: Identification of potential solutions stage. : Students are notice the problems that come from science and technology. Students have to plan to solve the problem. They have to get all the knowledge that students have. Also students should do more research that can support the answer.


Third step: Need for knowledge stage. : Students should do research and study in science that concerned the problem. So it can help to solve the problem.


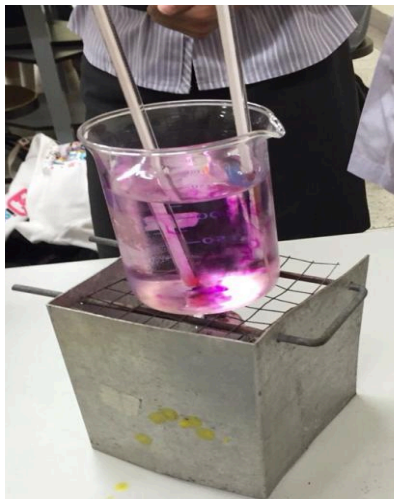
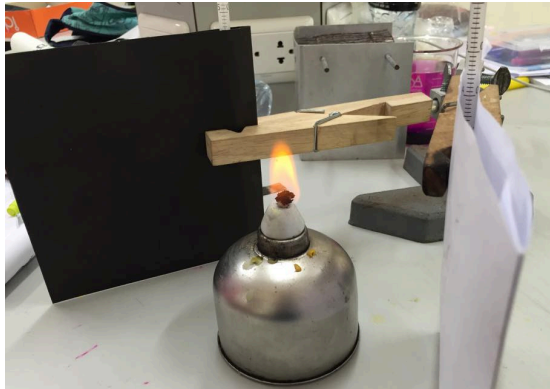
Forth step: Decision-making stage. : At this step students need to make decision on how to solve the problem after the research. Students have to see which is the best solution and is that solution good or bad for Thailand.

Fifth step: Socialization stage. : Social process would help students in review their solving problem concepts. Students might present the project though exhibition or project campaign and the comment from the viewer.

3. Present to adviser to recheck on the thesis
4. Improved the unit plan as adviser recommend.
5. Improved by expert
6. Adjust as expert recommend.
7. Test the study plan by non-target group.
8. Improved the study plan for the best.
9. Use the improvement the study plan and use with the target group.

Table one: Lessonplan:transfer of heat by using science, technology and society (STS) (Yuenyong, 2006)

Stage	Activity
<p>1. Identification of social issues stage.</p>	<p>1. VDO about earth climate change https://www.youtube.com/watch?v=BjZcOi5IVJU</p>  <p>Figure 2 The climate change of the Earth.</p> <p>2. Problems It's getting hot and hotter everyday people are try to find the better way to make the house cooler. Students as an architect, how are you going to fix the problem?</p>
<p>2. Identification of potential solutions stage.</p>	<p>1. Identifying the climate change and how it's affects students live? 2. Students need to identify what cost the heat in the house? How to solve this problem and no affectto the earth's climate? 3. Students will design the cooler house by use all knowledge that students already have. Also students need to specify what students use to solve this problem and more research with the unknown knowledge.</p>
<p>3. Need for knowledge stage.</p>	<p>1. Identifying in potential solutions stage. 2. Teacher and students debate on the knowledge that students should know and don't know yet. 3. Students do the experiment transfer heat.</p>

Stage	Activity
	<p data-bbox="550 257 901 295">Experiment transfer heat</p>  <p data-bbox="758 716 1228 754">Figure3 Expolor the heat conduction</p>  <p data-bbox="758 1281 1228 1319">Figure 4 Expolor the heat convection</p>  <p data-bbox="774 1742 1204 1780">Figure 5 Expolor the heat radiated</p> <p data-bbox="598 1814 1252 1852">4. Teacher and students discuss on the expolorment.</p>
<p data-bbox="199 1926 454 2007">4. Decision-making stage.</p>	<p data-bbox="550 1926 1436 2007">1. Students design the cooler house by using all knowledge that they have and apply the house and present to the group</p>

Stage	Activity
	2. Students will choose the best house design and show how to design and explain it on the paper.
5. Socialization stage.	1. Students in each group present in front of the classroom. Students and teacher give out comment, asking question and recommend, so the group can improve the design 2. Students will use all the recommend and comment to improve and post up on the facebook.

The way of learning in Science, technology and society (STS) (Yuenyong, 2006) will let students present their own idea in Technological process and engineering design process. The process in each step such as

First step students will learn about heat by the concept of Science, technology and society (STS) is the identification of social issues stage. At this stage teacher will present to students by give them problem to let the student see the affect of the problem and how to solve the problem. The identify and define problems and research the need or problem of engineering design process.

Second step identification of potential solution stage. Students will plan and design on how to solve the problem and get all the information that set with identification of social issues stage. It should have all the information to cover all the problem about temperature that getting higher. So students can improve the way of solving the problem.

Third step need for knowledge stage from second step students should specify their knowledge and get more knowledge in Science that involve the problem so it can solve the transfer heat problem and conclude the experiment.

Identification of potential solutions stage and need for knowledge stage students should know how to transfer heat in science and calculation in mathematics and it will lead to engineering design process in second step that is research the need or problem.

Fourth step decision-making stage: at this stage students will should the way to solve the problem by student will see the reason of the problem solving and choose the best way. Students also see the work and presentation.

Decision-making stage student will have good knowledge on Science in transferring heat, knowledge about mathematic and technology(technological process). It's also can come up with engineering design process such as.

- Step three develop possible solution : student will design the cooler house by themselves and present to the group
- Step for: select the best possible solution, students in each group will choose the best possible house
- Step five: construct a prototype: each group will plan the house on the paper

Fifth step socialization state the way of society will let the students think and show how to solve the problem in a group and present it out. Teacher and classmate will ask the question, give comment and suggestion. So the present group will improve the work. Step of engineering design process as follows

Step six: test and evaluate the solution: students will evaluation the cooler house from comment and recommendation

Step seven: communicate the solution: students will present in front of the classroom

Step eight: Redesign: students will redesign the work from the comment and recommendation that will be completion.

The studying of Science, technology and society (STS) in subject of heat by learning how to solve the problem and see the problem. They need to design how to solve this problem, students will search the knowledge, see the problem and how to solve the problem.

Conclusion

Improving the study in Science, Technology and Society(STS) (Yuenyong, 2006) about Heat is the way of STEM Education. Students will integrated the knowledge in Science, Technology and Mathematic thru the cooler house project, so students will improve their study about heat that related in Science, Technology, Engineering and Mathematic. It can devised in to two groups : the first group will learn in knowledge of Science and Mathematics and other group will learn in knowledge of how to work and how to build in technology and engineering. Students can use of the knowledge of Science and Mathematics to solve the problem by pass the Technological Process and Engineering Design Process.

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