Trend of environmental science project: A reflection of Thailand GLOBE student research competition

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Abstract. The Global Learning and Observations to Benefit the Environment (GLOBE) is an international science and education program that promote teaching and learning of science, enhance environmental literacy and awareness. The Institute for the Promotion of Teaching Science and Technology (IPST) acted as a country coordinator. IPST has implemented GLOBE throughout the country. One of the important approach is “GLOBE Student research competition (GLOBE SRC)”, this project aim to promote students to learn and share Earth System Science (ESS) research. The research focused on environmental science by using GLOBE measurement protocols. This study reflected outcome of the project such as the amount of ESS research, type of environmental science research and learning outcome of the project in 2009 - 2020. A total of 451 researches were analyzed in term of title and abstract. The result indicated that Survey research is 69%, Experimental research is 26%, and Invention research is 5%. The trend of the Experimental research increased and Invention research slightly increased in the last six years. The result indicated that this approach enabled students to improve their scientific inquiry, scientific thinking and scientific attitude. They received learning experiences that build 21st century competency to assist them in the future.

1. Introduction
The concept of environmental science learning through the integration of various science curriculums will encourage the learners to use three major skills namely: life and career skills, learning and innovation skills (critical thinking and problem solving, creativity, communication and collaboration) and information media and technology skills [1–3]. These skills are very important to ensure 21st century readiness for every student. The learning by using STEM education, which is an interdisciplinary learning approach that integrated four disciplines of science, technology, engineering, and mathematics, is the key to increase these skills and STEM fields. [4,5]. Project-based and problem-based learning are the approaches that teacher selects and apply to the science learning. These approaches are student-centered learning, which lead learners to explore the real-world problems. They will apply their scientific knowledge and ability to solve the problem [6,7]. When, teacher utilized Project-based and problem-based learning with real world situations or problems, these can lead to a transdisciplinary learning experience for students [8]. This learning approach would assist young citizen in learning to adapt to the global change.
GLOBE Program is an international science and education program that provides student-teacher-scientist-community working together to better understand, sustain, and improve Earth’s environment by using scientific inquiry approaches. The GLOBE program promote students to do scientific research on earth and environmental science, this philosophy foster the students to actively and meaningfully learn about the local and global environmental science education using existing technologies [9–11]. These approaches has enhanced learning and innovation skills for students. This Program has been adopted since September 30, 1999. The Institute for the Promotion of Teaching Science and Technology (IPST), Ministry of Education, has been appointed as the coordinating and implementing agency for the GLOBE Program in Thailand. IPST considers the GLOBE Program as an integral part of missions to improve the quality of school science mathematics and technology education of the country. Moreover, GLOBE Thailand, IPST has developed and implemented the Earth System Science (ESS) curriculum throughout the nation since 2009. The ESS curriculum apply project-based learning approach as a major concept. It works to bring together the research and knowledge from several disciplines of Earth Science to understand the cycles that connect the oceans, atmosphere, and land surfaces. This learning way contribute to scientific understanding of the earth as a system, and support students across the curriculum, focusing on student research in Earth System Science (ESS) [12]. Since 2009, the GLOBE Student Research Competition (GLOBE SRC) project has been conducted by IPST, Thailand. It’s a national environmental science project competition for students in Grade 4 - 12 levels. This project aim to promote school to do student-teacher-scientist collaboration research focusing on ESS. The students have learned and understood the earth system by doing real science in natural setting, generating research questions base on their own observation, seeking answers through experiment and inquiry, exploring with their own curiosity to understand the earth and critical environmental issues.

This study aim to reflect outcome of the GLOBE SRC from 2009 to 2020 such as total number of research, the example of the research, trend of research type and descriptions of the project over the last decade. The learning outcome of students when they learned by doing environmental science project. The revised Bloom taxonomy was examined in this cognitive process dimension.

2. Research Methods

2.1. Methodology

This study was divided into 3 steps: (1) Collect and organize the ESS research (2) Classify the ESS research into 4 types of research, and (3) Analyse ESS research types by using Revised Bloom Taxonomy.

Firstly, Collect and organize the ESS research. This study focused on the ESS researches that submitted and presented in the final round of GLOBE SRC from 2009 – 2020. Titles and abstracts were collected and organized from the GLOBE SRC proceeding 2009 – 2020. The total of 451 researches were collected and sorted out. The GLOBE SRC has two major groups of presentation: oral presentation and poster presentation. This competition was divided into 3 levels: Upper primary level, Lower Secondary level and Upper Secondary level. Secondly, Classify the ESS researches into 4 types of research. When using the criteria of research design, methodology and result of the research, there were 4 types of research namely: Experimental research, Survey research, Invention research and Theory research [13]. The research types define as below:

- Experimental research is the research that has a research design to study the relation between independent variable, dependent variable and control variable that effect on the experiment.
- Survey research is the research that collect and survey data, then organize these data and study the connection of the result.
- Invention research is the research that researcher applies the scientific theory for inventing something, typically a process or device to solve the problems or needs.
- Theory research is the research that present the new Science theory or principle or review the theory and find the new knowledge or theory.
The titles and abstracts were analyzed and classified the research type. Then, analyzed the trend of research type and descriptions of the GLOBE SRC project in 2009 - 2020. Next, analyze ESS research types by using Revised Bloom Taxonomy on cognitive process dimension [14]. The cognitive process dimension are divided into six levels namely: Remember, Understanding, Apply, Analyze, Evaluate and Create [15–17]. Using Revised Bloom Taxonomy as criteria for classification of the process of thinking and learning when students learned from their research. Finally, compile the data and report.

2.2. Materials
This study focus on the ESS research that submitted and presented in the final round in the GLOBE SRC. Firstly, titles and abstracts from the GLOBE SRC proceeding from 2009 – 2020 were used to analyze in this study. The ESS research presentations consist of two major groups: oral and poster presentation. This competition was divided into 3 levels; there are upper primary level, lower secondary level and upper secondary level. Secondly, the cognitive process dimension according to Revised Bloom Taxonomy is used to classify the process of thinking and learning. Finally, Microsoft Excel program is used to sort out and compare the data.

3. Results and Discussion

3.1. Amount of Earth System Science (ESS) research from 2009 - 2020
The total number of ESS researches which passed the qualifying round and presented in the final round at GLOBE Student Research competition (GLOBE SRC) from 2009 – 2020 as shown in the table 1.

| Year | Oral Presentation | Poster Presentation | Total |
|------|-------------------|---------------------|-------|
| 2009 | 19                | 13                  | 32    |
| 2010 | 20                | 20                  | 40    |
| 2011 | 20                | 20                  | 40    |
| 2012 | 20                | 22                  | 42    |
| 2013 | 8                 | 0                   | 8     |
| 2014 | 15                | 0                   | 15    |
| 2015 | 20                | 25                  | 45    |
| 2016 | 20                | 24                  | 44    |
| 2017 | 25                | 17                  | 42    |
| 2018 | 21                | 15                  | 36    |
| 2019 | 26                | 33                  | 59    |
| 2020 | 25                | 23                  | 48    |
| Total| 239               | 212                 | 451   |

The total of 451 ESS researches were submitted and presented at GLOBE SRC in 2009 – 2020. The presenters were divided into 2 groups; oral presentation and poster presentation. The number of oral presentation were more than poster presentation. In 2013-2014 and 2018, ESS researches presented only 8, 15 and 36 respectively. This shown a downward trend in terms of research quantity because the quality of the research didn’t meet the judgement rubrics and criteria. The number of the researches that presented in the final round is depend on many reasons such as the quality of the research, the lack of school budget to spend on the conference expense, the budget of the GLOBE SRC project of that year.
Moreover, when look at the location of GLOBE SRC schools that submitted the researches. The result shown in figure 1. The researched were submitted from the school that came from all parts of Thailand. The schools were located in 57 provinces. The most part is in the northeastern part of Thailand, there were 18 provinces (31.6%) that schools in this area submitted the researches. Whereas, the east part of Thailand had only 4 provinces (7%).

![Figure 1. Location of GLOBE SRC schools in Thailand.](image)

3.2. Earth System Science Research Classification

This study classified Earth System Science Research into 4 types. There were 313 survey researches (69%), 115 experimental researches (26%) and 23 invention researches (5%). There are none of the theory research type. The theory research is the research that present the new Science theory or principle or review the theory and find the new knowledge or theory [13]. On the other hand, the ESS research is the research that students have learned and understood the earth system by investigating real science in natural setting, seeking answers through experiment and inquiry. However, since the GLOBE SRC inception, in 2009 and 2012 – 2013, there are none of the invention researches. It should more publicizing for promoting school to do the invention research. Hence, there were more amount of survey and experimental research type. The result as shown in the table 2.

| Year | Experimental research (%) | Survey research (%) | Invention research (%) |
|------|---------------------------|--------------------|------------------------|
| 2009 | 9.4                       | 90.6               | 0.0                    |
| 2010 | 10.0                      | 87.5               | 2.5                    |
| 2011 | 10.0                      | 87.5               | 2.5                    |
| 2012 | 19.0                      | 81.0               | 0.0                    |
| 2013 | 12.5                      | 87.5               | 0.0                    |
| 2014 | 20.0                      | 66.7               | 13.3                   |
| 2015 | 35.6                      | 55.6               | 8.9                    |
| 2016 | 45.5                      | 47.7               | 6.8                    |
| 2017 | 28.6                      | 66.7               | 4.8                    |
The result shown that trend of the experimental research increased and invention research slightly increased from 2014 to 2020 as shown in figure 2. In 2014, IPST has implemented STEM Education at every level of learning to enhance the 21st century skills [1] in critical thinking, problem solving, collaboration and creativity as well as to develop their appreciation of science, mathematics and technology education, and to increase their motivation to learn. In addition, the project-based learning approach is the key approach to develop and improve the cognitive learning and important skills of the students [6,18]. Hence, the schools have been encouraged to submit their researches. Moreover, the students integrated their Science, Mathematics and Technology knowledge for seeking the answer of their research questions in the last six years. The research title samples as shown in table 3.

**Table 3. Earth System Science research classification in 2009 - 2020**

| Research type      | Research title                                                                 |
|--------------------|--------------------------------------------------------------------------------|
| Survey research    | - *The effect of different environmental and ecology in the different district on Dengue situation in Chiang Mai Province, Thailand.* Montfort College Primary Section, Chiang Mai Province  |
|                    | - *The study of relationship between soil moisture on the harvest season with the sweetness of pomelo (White Grapefruit Cucumber)* Khuruprachasan School, Chainat Province |
| Experimental research | - *The study of physical factors that affect the growth of mussels. (Perna viridis) at the gulf of Thailand to create the patterns of* |
Research type | Research title
--- | ---
 | simulated pole raising shellfish that can affect the flow rate in the growth of the mussels.  
Bangkok Christian College, Bangkok
- *Study of Drought Endurance Rice Varieties by Controlling Soil Temperature and the Change of Leaf Color*  
Lampang Kalayanee School, Lampang Province
| Invention research | - *The study of coral propagation by using the “Ruan Wan 3” model*  
Phlu Ta Luang Witthaya School, Chonburi Province
- *The study of plant pot product made by Legumes leaves to nursery the Bird Chili (Capsicum frutescens Linn.)*  
Donchanwitthayakhom School, Kalasin Province

3.3. Revised Bloom Taxonomy classification

According to revised Bloom Taxonomy [14–16], when examined the learning outcome from project-based learning approach. The research type was analysed on the cognitive process dimension of student learning outcome. The data shown that the survey research and experimental research were the evaluating category that is on the high level of thinking. Students integrated their knowledge by applying, analysing and evaluating when they did ESS research. They analysed the data and made judgement based on criteria and standard. As table 3, the researchers from Khuruprachasan School, they can evaluate the relationship between soil moisture on the harvest season with the sweetness of pomelo. For the invention research was the creating category. It is the top category. Students designed and created an equipment or a model or system to solve the environment problem. They generated the new knowledge and served the needs. As table 3, the researchers from Phlu Ta Luang Witthaya School, Chonburi Province. This school is located near east coast of Thailand. They studied the coral propagation by using the “Ruan Wan 3” model. They developed and redesigned the “Ruan Wan 3” model from the “Ruan Wan 2” model for coral propagation. They designed and created the equipment to solve the environment problem and served the needs. Project-based learning connected students to all main categories of Bloom taxonomy namely: knowledge, comprehension, application, analysis, synthesis and evaluation as Kraft study [19].

In addition, teacher was the key person for achieving this approach. They were an advisor or facilitator of the research and facilitated their students to do research. From OECD Commissioned paper [20,21] shown that “collective teacher efficacy is a significant predictor of student achievement. On teacher’s aspect, when they engaged students with science project. They could increase their counselling skill, professional development and get more self-confident as Dogan study [22]. Moreover, project-based learning, problem-based learning and GLOBE scientific inquiry approaches that teacher applied to their class. These approaches can enhanced student learning outcomes. Students employed the application of the knowledge and skills as they doing their researches. These improve their higher order of thinking achievement [8,23]. My viewpoint, some researchers that continued submit the ESS research to the GLOBE SRC, their research had trend to be the invention research type and probably get a chance to win the competition. Moreover, they obtained learning experiences and knowledge from the other schools.

4. Conclusions

The total of 451 ESS researches were collected and analyzed. These passed the qualifying round and presented in the final round at GLOBE Student Research competition (GLOBE SRC) in 2009 – 2020. The result indicated that research type was 313 survey researches (69%), 115 experimental researches (26%) and 23 invention researches (5%). The trend of the experimental research increased, and invention research slightly increased in the last six years. According to revised Bloom taxonomy, students who did the ESS research, they had the high-level cognitive process dimension; the survey and experimental
research were evaluating category and the invention research was creating category, the top of the
category. Furthermore, they got the learning and innovation skills that are very important for them. In
addition, the future study will focus on the development of the learning and innovation skills of the
students who continued submit ESS research to the GLOBE SRC. These skills are very important to
ensure 21st century readiness for every students.

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