Using technology, hands-on, and fieldwork activity for GLOBE learning in secondary school

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Abstract. As technology plays a crucial role in daily life, The Institute for the Promotion of Teaching Science and Technology (IPST) has designed “GLOBE Trees around Us” workshop based on GLOBE protocols (Green-Up, Green-Down, and tree height) using learning elements in order for students to measure tree height through mobile application together with Green-Up and Green-Down protocols through lecture and hands-on activities. According to the results from 150 student’s handbooks, more than 87% of students were able to understand Green-Up, Green-Down and tree height protocol by using video clips, paper leaf mock-up, mobile application and fieldwork activity. From the interview of nine teachers from four schools about the Green-Up activity, it shows that about 80% of students concentrated on the workshop better than they did in the classroom and felt enjoyable during the hands-on activity. In terms of the learning elements, it is found that almost 90% of teachers thought they were beneficial to apply in this workshop, especially the GLOBE Observer application. All the teachers agreed that the application is easy to use, and all related materials are easy to prepare. However, the limitation of activity is that the application is not compatible with some devices. Teachers also planned to use the learning elements in classroom or science camp to promote student interest and understanding. In addition, the students may gain problem-solving, collaboration, communication, and thinking skills from attending this workshop.

1. Introduction

The Global Learning and Observations to Benefit the Environment (GLOBE) Program is an international science and education program that provides students and the public worldwide with the opportunity to participate in data collection and the scientific process [1]. The application of GLOBE Trees in GLOBE Observer was launched in conjunction with NASA’s ICESat-2 satellite. This application focuses on tree height measurement which is one of the ICESat-2 missions, resulting in the attainment of tree height data collected. Consequently, the scientists can compare students’ tree height data to the ICESat-2 mission tree height data. This information can be used in many aspects such as land use monitoring and carbon storage in each area. Beside the measurement of tree height, it is also a gateway to understand many aspects on the environment.

Technology becomes crucial resource and tool because of its dynamic in development and application in [2]. Student interest can improve by technology because it brings enjoyment and attract their attention to the study. [3]. According to Santos, student motivation and student self-efficacy could be increased by technology [4]. The evidences from Parry [5] and Ahmad Fauzi Mohd Ayub [6] show that the emerging technology brings high potential on work and learning. Moreover, students are able
to develop a more positive attitude during learning because they get real-life experiences with enjoyable, meaningful and relevant learning. Research shows that the integration of technology benefits technically to increase the quality of task and work, enhance access a plenty of resources and, most of all, to amplify student learning [7].

For students, the exploration in outdoor activity helps promote their interest in broadest senses [8]. Outdoor activity can create motivation and bring out children’s potential [9]. Enjoyable experiences from outdoor activities were widely discuss [10-11]. According to Trina, beside of the indoor classroom, schoolyard can enhance learning in action for children [12]. Outdoor play usually gets less conflicts as students will help each other and cooperate to solve problems [13]. For teachers, outdoor activity facilitates deeper understanding about student’s learning and adult’s educational intervention [12].

In Thailand, the government encourages all schools to implementing technology teaching into their curriculum in order to provide students the opportunity to solve problems in daily life [14]. GLOBE Thailand administered by IPST takes this opportunity to encourage and support students to develop technological skills by using ICT tools to increase their interest to proceed lessons in classroom. According to Hill [15], technology helps improve education due to its potential to create activities and environment for students to be able to engage activity with knowledge. The workshop was designed for students to measure trees height by using application together with Green-Up and Green-Down protocols through lecture and hands-on activities. Hands-on activity can gain more knowledge and experiences better than lecture [16]. Moreover, the workshop includes the observation in school as Bell said that fieldwork activity provides students more experience with the natural world as well as gaining knowledge, skills, understanding or appreciation with environment [17]. However, from my prior experiences, several students who had used clinometer have to find tree height using trigonometry calculation, which is hard for student. Apart from the calculation, the application also hinders students if they have with no prior tutorial on using the application. They might incorrectly conduct the tree height measurement. The objectives for this research are to create an active/hands-on learning activity with more interesting approach for students to explore the concept of GLOBE Biosphere protocol and promote students to be able to measure tree height using GLOBE Observer mobile application.

2. Method

2.1. Background
This research is a qualitative study include secondary student in four Schools in Thailand. And nine teachers who observed students doing the activity from the beginning till the end. (2-3 teachers in each school.)

2.2. Data collection
Data collected using student handbooks was distributed randomly, Teachers interview and GLOBE Observer results.

2.3. Instrument
The student handbook, interviewing question had been designed by academic staffs of IPST and two experts related to GLOBE protocol (Green-Up [18], Green-Down [19], and Tree height) while the database of GLOBE Observer application shows an ability of student to measure tree height.

The student hand book
The student handbook used in this workshop consisted of three parts. The first part is to explain Green-Up phenology. The second part is to identify Green-Down phenology using trees leaf material developed by academic staffs of IPST. And the last part is to identify information of tree after fieldwork observation (Tree height, Tree leaf color, Tree and Tree leaf characteristic) as shown in table 1.

The interview questions had been designed for teacher and categorized into five parts, the first part contains questions related to the Green-Up and Green-Down phenology. The second part contains Tree
height observation using GLOBE Observer application. The third part is composed of fieldwork observation. The fourth part consists of materials used in workshop. The last part of the interview question ask about the attitude towards this workshop as shown in table 2, 3 and 4.

**Table 1.** Student handbook activity

| Activity                                      |
|----------------------------------------------|
| Part 1 Explain Green-Up phenology           |
| Part 2 Identify color of tree leaf mock-up  |
| Explain Green-Down phenology                |
| Part 3 Identify tree height using GLOBE Observer application |
| Identify tree and tree leaf characteristics  |

**Table 2.** List of questions for part 1- 3

| Types of question                                              | “Can” or “Cannot”                                           | Evidence |
|---------------------------------------------------------------|-------------------------------------------------------------|----------|
| Part 1 Understand (Green-Up phenology by explaining Green-Up phenology) | Please define student action | Evidence |
| Understand (Green-Down phenology by explaining Green-Down phenology) | | |
| Understand (Identify color of tree leaves)                     | | |
| Perceive (Give reason why Green-Up and Green-Down phenology is important) | | |
| Part 2 Understand (How to use GLOBE Observer application in measuring tree height) | | Evidence |
| Perceive (Give reason why tree height is important)             | | |
| Part 3 Understand (Identify tree height using GLOBE Observer application) | | Evidence |
| Understand (Identify tree leaf characteristics)                 | | |
| Communicate (Present their tree observation)                    | | |

- “Can” means the subject stated is effective.
- “Cannot” means the subject stated is not effective.
### Table 3. List of questions for part 4.

| Part 4 | Video clip about Green-Up phenology | “Can” or “Cannot” create students’ interest | Evidence |
|--------|-------------------------------------|---------------------------------------------|----------|
|        | Paper leaf mock-up for identify color in Green-Down phenology |                                            |          |
|        | Video clip of tree height measurement using in GLOBE Observer application. And then student demonstration. |                                            |          |
|        | GLOBE Observer application help student to measure tree height. |                                            |          |
|        | Fieldwork (tree height measurement and tree observation ) |                                            |          |

- “Can” means the subject stated is effective.
- “Cannot” means the subject stated is not effective.

### Table 4. List of questions for part 5

| Part 5 | Questions | “Yes” or “No” | Please specifies reason |
|--------|-----------|---------------|-------------------------|
|        | Do you think that in the future you will apply learning elements (technology, hands-on and fieldwork activity) in your class |               |                         |
|        | Do you think that technology can help student learning? |               |                         |
|        | Do you think that in the future this workshop will be implemented in your school? |               |                         |

- “Yes” means the subject stated is effective.
- “No” means the subject stated is not effective.

There are three steps in doing this research which are planning, conducting, and collecting data. This model is very relevant especially for the context of having a practiced action research which is always carried out in the classroom during teaching and learning session.

- **Step 1**: Planning. The workshop is based on GLOBE Biosphere protocol [20] which divided into 4 activities: There are Green-Up (watching video clip about leaf growth), Green-Down (watching video clip and hands-on activity for specify color change of tree leaf using tree leaf mock-up), Tree height measurement using GLOBE Observer application (watching video clip about tree height measurement and student demonstration) and fieldwork activity. Prepared materials: 1) Handbook, 2) Video clip for Green-Up activity, 3) Various types of tree leaf paper, 4) GLOBE color guide for training process of Green-Down activity, 5) Demonstration video of GLOBE Trees application, 6) Mobile device, 7) Measurement tape, and 8) Student’s presentation tools.
Figure 1. Materials used in the activity

- **Step 2:** Conducting the workshop. The “GLOBE Trees around Us” workshop was done in 3 hours and 30 minutes with four parts. The first part is the lecture with video clips approximately for one hour on Green-Up and Green-Down protocols and tree height using GLOBE Observer application. The next part is 45-minute hands-on activity for Green-Up, Green-Down protocols and also tree measurement demonstration by using GLOBE Observer application and one-hour fieldwork activity. The last part was 45-minute for student’s presentation. Then, students send all data through GLOBE Observer application.

- **Step 3:** Collecting data. The data has been collected through student’s handbooks and teacher interview on the observation of group activities.

3. **Result and Discussion**

The results of 150 student’s handbooks were obtained as follows:

3.1 **Answers in student’s handbooks**

Student’s handbook is divided into three parts. The first part is about Green-Up phenology followed by the second part about Green-Down phenology. The last part is fieldwork. The detail of data is shown in table 5.

| Table 5. Answers in student’s handbooks. |
|------------------------------------------|
| Activity | Number of “correct” respondents |
| Part 1 Students could explain about Green-Up phenology correctly. | 131 |
| Part 2 Students could identify color of tree leaves correctly. | 145 |
| Students could explain about Green-Down phenology correctly. | 135 |
| Part 3 Students could identify tree height using GLOBE Observer application. | 95 |
| Students could identify tree and tree leaf characteristics. | 135 |

- “Correct” means the student answer is effective.
- “Incorrect” means the student answer is not effective.
According to the table 5, the results from 150 student’s handbooks with the correct answer indicate that 87% of the students gave explanation of Green-Up phenology correctly while the remaining 13% of the students could only give the definition of Green-Up but could not explain the steps of Green-Up phenology in detail. Moreover, the students who could correctly identify color of tree leaves from paper leaf mock-up are at 97% while the students who could give explanation of Green-Down phenology are at 90%. In terms of fieldwork, students who were able to describe tree and tree leaf characteristics are at 90%. After measuring tree height, only 63% of the students could send complete data using GLOBE Observer application due to internet connection problems.

3.2 The teacher interview response
I have conducted the interviews of nine teachers from five schools who observed the workshop. The questions in the interview were divided into five parts. The teacher interview response for part 1 – 3 is shown in table 6.

| Table 6. Teacher interview response for part 1 2 and 3. |
|---------------------------------------------------------|
| Types of question                                      | Number of “Can” respondents | Evidence                                           |
| Part 1 Understand (Green-Up phenology by explaining Green-Up phenology) | 8                             | Students could explanation about Green-Up phenology correctly. |
| Understand (Green-Down phenology by explaining Green-Down phenology) | 9                             | Students could explain about Green-Down phenology correctly. |
| Understand (Identify color of tree leaves)             | 9                             | Students could identify color of tree leaves correctly. |
| Perceive (Give reason why Green-Up and Green-Down phenology is important) | 7                             | Students were able to explain why Green-Up and phenology is important. |
| Part 2 Understand (How to use GLOBE Observer application in measuring tree height) | 8                             | Students were able to use GLOBE Observer application in measuring tree height properly. |
| Perceive (Give reason why tree height is important)     | 7                             | Students were able explain why tree height is important. |
| Part 3 Understand (Identify tree height using GLOBE Observer application) | 8                             | Students could identify tree height using GLOBE Observer application properly. |
| Understand (Identify tree leaf characteristics)         | 8                             | Students could describe tree leaf characteristics clearly. Moreover, students felt cheerful during the activity. |
Communicate (Present trees observation data) 9 Most of the students could explain the steps of tree measurement and discuss in group to get the correct data to record in their handbook. Moreover, they could present their observation with complete and clear data.

- “Can” means the subject stated is effective.
- “Cannot” means the subject stated is not effective.

According to the table 6, teachers found that more than 88% of students understood about the meaning of Green-Up, Green-Down phenology and tree height measurement as they could explain and describe contents correctly. Chen [21] stated that creating the atmosphere of explorative learning such as fieldwork and outdoor activity could enhance active learning and urge their learning interest. During fieldwork activity (Part 3) in observing characteristics of tree leaves and tree height, it is found that more than 88% of students were able to show tree height measurement and explain in detail of tree leaf results. Moreover, when students went in fieldwork, they felt relaxed in exploring trees even in the middle of the sunny day. Students could use GLOBE Observer application properly and explain the whole steps in measuring tree to teachers. When their friends got problems with their application, they would discuss and try to find solution. According to Vandercruysse, apart from improving technological skills, students may gain higher learning outcomes [22]. On the other hand, the results showed that 77% of the students were able to explain and describe about the importance of Green-Up phenology, Green-Down phenology and tree height clearly. The remaining 13% were not concerned about the implications of this activity as it was just an extracurricular activity. The detail of the teacher interview in part 4 on the learning elements that were used in the workshop is shown in table 7.

Table 7. Teacher interview for part 4.

| Learning elements | Number of “Can” respondents | Responses |
|-------------------|------------------------------|-----------|
| Part 4            |                              |           |
| Video clip about Green-Up phenology. | 8 | All the teachers agreed that Green-Up video could make student understand and explain Green-Up phenology correctly. Moreover, students showed enjoyment and interest while watching video. |
| Paper leaf mock-up. | 9 | All the teachers said that the students could specify color of paper-tree leaves correctly and they actively discussed about the color of tree leaves. Moreover, students showed enthusiasm to be the first group to present their results. Tree leaf mock-ups are easy to prepare. |
| Video clip of tree height measurement using in GLOBE Observer application. | 8 | Eight teachers said that the video clip of tree height measurement using in GLOBE Observer application could help students measure tree height properly. However, some students were confused as the video clip was too fast to understand some steps. |
Student’s demonstration on tree model using GLOBE Observer application. 9 All the teachers said the demonstration helped students to remind the steps and cautions of the application.

GLOBE Observer application for tree measurement. 8 Eight teachers said the application was free of charge and easy to use. However, it had some technical problem which was not compatible on some types of mobile devices. Also, as the application was in English, some students ignored some steps during the measurement due to language barrier.

Fieldwork 9 All the teachers said that the students were active to go outside classroom and observe trees. Furthermore, skills and knowledge from this activity could apply in daily life.

- “Can” means the subject stated is effective.
- “Cannot” means the subject stated is not effective.

According to the table 7, teachers found that 88% of students liked all learning elements as they were enjoyable and enthusiastic. All the teachers agreed that students liked this activity because they could manipulate materials on their own. Furthermore, during presentation after the fieldwork, the students showed responses and interactions much better than they did in normal classroom. They also discussed with each other in groups about what they found. The benefits from the presentation and discussion during fieldwork helped students develop communication skills. When they got different data or answers, they would discuss on their evidences to support their answers. In addition, when friends had problems, they would cooperate to find solutions in which the students may gain problem-solving skills. For Green-Up video clip, paper leaf mock-up, student’s demonstration and fieldwork activity, all teachers agreed that these materials could bring students enjoyment and interest. Furthermore, paper leaf mock-up was easy to prepare. On the other hand, 22% of teachers commented that the video clip was too fast for some students to follow, and some students ignored some steps during the measurement due to language barrier.

In the last part, the questions focus on teacher’s attitude as shown in table 8.

**Table 8. Teacher interview for part 5.**

| Questions                                                                 | “Yes” or “No” Please specifies reason |
|---------------------------------------------------------------------------|----------------------------------------|
| Part 5 Do you think that in the future you will apply learning elements (technology, hands-on and fieldwork activity) in your class? | All nine teachers agreed to use technology and implement hands-on and fieldwork activity in classroom. Moreover, they planned to do it very soon. Furthermore, some teachers said that if they had a chance, they would use this workshop in science camp. |
| Do you think that learning elements (technology, hands-on and fieldwork) can help student learning? | All nine teachers agreed that the learning elements helped students learning and gave examples from this workshop; video clips showed that students learned the contents of a video and then described the contents briefly. In terms of the |
According to the table 8, all the teachers thought that using learning elements (technology, hands-on and fieldwork activity) into classroom helped promote student interest and enhance better learning ability. In the future, if they have an opportunity, they will use this workshop in schools. In accordance with the results shown above, it can be stated that the Green-Up, Green-Down and tree height protocol using video clips, paper leaf mock-up, mobile application and fieldwork activity works well so that it could be utilized by most of the students. Moreover, answers in student’s handbooks demonstrate that the students understand the content very well. This also implies that the learning elements are practical and user-friendly. Furthermore, in part of teacher interview, it is totally agreed that as some activities included in the workshop are hands-on, student’s concentration is obviously much longer than it does in common classroom activity. It is also shown that the activity time used is not too long for the students to keep focusing on the activity.

The learning elements used in the workshop can promote student’s better understanding about Green-Up phenology, Green-Down phenology, and tree height protocol and draw their attention to learn more about its relevant knowledge. For instance, paper leaf mock-up is easy for students to specify the color and explain the reason why they ascribe each color. This activity allows students to practice by themselves before the fieldwork; as a result, they can do it expertly during the fieldwork. However, for tree height measurement, video used is quite fast for the students to follow some steps of the process. For this case, repetition of the process can help students understand and recheck the steps in tree height measurement. In addition, the mobile application is an effective material as it is free of charge and can be used anywhere and anytime.

In creating activities for students to learn through technology, hands-on activity and fieldwork can raise their interest and motivate their learning to become active learners as Sun [23] found that merging technology into classroom can motivate student’s interest by making it meaningful. Moreover, he stated that after teachers succeed in triggering student interest, it can promote skills such as problem-solving, creative thinking, and collaboration skills. Not only is using technology in classroom important, but creating activity that students can practice by themselves or in small groups such hands-on activity also helps promote deeper understanding as Allen said students get better understanding of complex knowledge when they get experience by themselves [24]. Furthermore, building a learning environment such as outdoor activity or fieldwork can offer prime time opportunities for students to get more relevant to their real life, so students would see that their study is meaningful as well as enhancing their additional skills such as communication skill, critical thinking etc. When the classroom is flipped, active learning may occur. As students in class actively interact more in providing support and feedback, it will finally bring conceptual change in students [25–27].
The limitation in this study is that some schools have limited space of green area, and some bases of trees were blocked so that tree height could not be observed properly. In terms of curriculum, this workshop is an extracurricular activity, which the students may not pay attention as much. Moreover, due to the lack of internet access, some students cannot complete sending observation data to GLOBE database. Also, some mobile devices are not compatible with the application. Furthermore, to gain more accurate and precise data, the students need to practice some measurement beforehand.

The recommendation in this study is to make such activity more engaging and meaningful, teacher should integrate it in normal class, such as Mathematics in the topic of Trigonometry, Science in the topic of Ecology, or Geography in the topic of height and tree.

4. Conclusion
This workshop can create an active learning activity and build student interest, such as a hands-on activity for the students to explore the concept of GLOBE Biosphere protocol or an activity that promotes interaction among students and teachers. Moreover, as they are familiar with technology in their daily life, the students are able to measure tree height properly by using GLOBE Observer mobile application. For the overall aspect from this workshop, the students may gain problem-solving, collaboration, communication, and thinking skills.

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