A Development of Learning Innovation “Debris Flow Monitoring” with Problem Based Learning Approach: A Case Study at the Amphur Khao Phanom, Thailand

Ratchasak Suvannatsiri1+ and Kitidech Santsichaianant2
1Learning Innovation in Technology Program
2 Department of Civil Technology Education
Industrial Education and Technology, King Mongkut’s University of Technology Thonburi, Thailand

Abstract. The debris flow is a type of the violent natural disaster in Thailand which is increasing and also migrating to the risk areas continuously. It can make damages for life and property. Early warning system to detect the debris flow is necessary to reduce the damages. Presently, most of students studying in Geotechnical Engineering lack of knowledge in this area, since the situation of the disaster may be too complex and need to involve with several monitoring data. Consequently, a development of learning innovation “Debris Flow Monitoring” has been created to help students to understand in both theory and monitoring technique. This article presents a development of learning innovation “Debris Flow Monitoring” with problembased learning approach: a case study at the KhaoPhanomBenja Mountain, Amphur KhaoPhanom, Krabi on 29 March 2011. A mountain model with miniature monitoring instruments were set up for students to practice in monitoring trial where they themselves are able to set up alarm scenario for early warning system under the problembased learning approach.

Keywords: Debris Flow, Disaster, Geotechnical Engineering, Monitoring Instrument, Problem Based Learning.

1. Introduction

Many years ago in Thailand, the landslide is a violent natural disaster which damaged living things and properties rapidly. It is still violent continuously nowadays. The changing of climate makes a storm. The changing of land using such as the land of forest was changed to agricultural. The increasing population and migration to the land continuously is the cause of landslide events making economic and social condition stop abruptly, and also since the budgets taken to help disaster victims and restoration of the area affected where limited[1-2]. Serious landslides in Thailand had taken place since 1970 to 2006, total about 534 died[3] and since 2007 to 2011 total about 64 died[4]. There were 51 risky provinces of landslide in Thailand [5] were almost landslide cases were in type of flowing of soil, sand, stones and trees or debris flow urged by rainfall more than 100 mm/day and still cumulative in 2-3 days. Although the geology of the area was the rock formation but was easily decayed. The soil was coarse-fine texture soils. The landscape was taken place at the steep hills, plateaus, valleys and cliffs [6]. The 11th (2012–2016) National Economic and Social Development Plan of Thailand aims to prepare to prevent the natural disaster. Developing of training and learning innovation is concentrated for educational organization, especially major in science and engineering by integrating learning and real life working together. Modern learning styles and instruction media are used for learners to learn, think and be able to adapt in daily life[7]. From the data of many countries, landslides can be predicted if they are seriously studied, therefore, problems and victims will be decreased [8]. The concept for present work was developed for the undergraduate students who are the most important leader group of developing country to prevent the landslides problem. There are 38 universities in Thailand, where teachbachelor of geotechnical engineering and are being the members of Engineering Institute of Thailand in the fields of civil, mining, irrigation, water resources and geological engineering, and civil technology education [9]. Presently, most of students studying in geotechnical engineering lack of knowledge in this

Corresponding author. Tel.: +662-470-8508; fax: +662-427-8886.
E-mail address: 53501820@st.kmutt.ac.th.

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area, since the situation of the disaster may be too complex and need to involve with several monitoring data. Due to the difficulty to go to the disaster site, students have still been taught in a lecture-based teaching. Therefore, a new teaching style should be developed to be different from the past. The student could be encouraged to study in both experiential and lifelong learning [10-11]. Problem Based Learning (PBL) is one of the interesting learning styles of Constructivist Learning Theory that might solve several problems as mentioned above. PBL is one of learning innovation to encourage the learners to think systematically and to learn actively. Authors had selected PBL to use in a development of learning in bachelor of geotechnical engineering. The very important step of PBL is to show actual situation presenting and actuating the learners to have self-directed learning [12-15] since it is too complex and difficult to understand. Therefore, authors have created visual situation from a case study of actual situation. Visual situation was created for learners to study by themselves through several scenarios. This research is concentrated to the visual situation; the debris flow monitoring which is a part of the instructional package under the PBL. The objectives of this research were: 1) to create and test the efficiency of an instructional package “Debris Flow Monitoring” for teaching by PBL, 2) to compare learning achievement of learners between pre-test and post-test, 3) to evaluate the satisfaction of learners who learned by PBL and 4) to evaluate the behaviors and skills of the learners by the facilitators.

2. Methodology

Authors conducted a study pattern of the PBL on the principles conceptualized by Lynda Wee [15]. Authors applied the pattern of PBL as mentioned above by creating 5 learning steps of PBL activities including: 1) sample group orientation and pre-test (3 in-class hours), 2) visual situation for debris flow monitoring from a case study of actual situation (3 in-class hours), 3) PBL process by using FILA template (F = Facts, I = Ideas, L = Learning Issues, A = Action Plans) (3 in-class hours), 4) searching for information and sharing ideas (a week outside class) and 5) result presentation, discussion, post-test and evaluation (3 in-class hours).

Instructional package of PBL was consisted of: 1) the observation template for virtual situation (see Appendix), 2) PBL sheet by using FILA template, 3) pre-test and post-test forms of multiple 4 choices (20 questions), 4) questionnaire of satisfaction and 5) authentic evaluation forms of PBL.

Sample group was the 4th year undergraduate students in Bachelor degree of Science in Industrial Education (major in civil engineering), Department of Civil Technology Education, Faculty of Industrial Education and Technology, King Mongkut’s University of Technology Thonburi. The 8 students of simple random sampling were divided into 2 groups and did pre-test and post-test (one group pre-test and post-test design). This experiment was a preliminary exercise. The result may will be developed and improved before using in universities or used in the future to educate people at the disaster areas.

2.1 Sample group orientation and pre-test

Sample group orientation was taken place for understanding knowledge about the process of PBL. Learners tried on doing a sample of PBL activities and did the pre-test in the classroom.

2.2 Visual Situation for Debris Flow Monitoring from a Case Study of Actual Situation

2.2.1 Actual Situation for Debris Flow Monitoring

A case study at the KhaoPhanomBenja Mountain, Amphur KhaoPhanom, Krabi on 29 March 2011 was used as a prototype of disaster where raining had been continuously taken place for 5 days. The accumulate precipitation of over 1200 mm was unofficially reported by the cup-type rain gauge in which recorded by the villagers. Therefore, soil, sand, stone and trees on the top of the mountains were moved from the elevation of the mean sea level of 1402 m. to the village. There were 12 victims dead [5, 16]. This area had no early warning system at the time. Consequently, a year later, a pilot debris flow warning system was selected to be used in this area. Debris flow detection sensor model code MC-0692/1 of Oyo Corporation [17] was installed at KhaoPhanomBenjaby Geotechnical Engineering Research and Development Center (GERD), Kasetsart University, on 19 August 2012. Debris flow sensor would warn and sent early warning to the village chief. Since it was expensive and expended from abroad, so the GERD was able to install only a unit at the site (Figure 1).
2.2.2. Virtual Situation for Debris Flow Monitoring

From the situation at Khao Phanom Benja Mountain, a setup of virtual situation was created as shown in the Figure 2 and 3. Virtual situation was consisted of: 1) mountain model, 2) debris flow imitation, 3) miniature electronic detection switches (model of debris flow detection sensor), 4) wireless closed circuit camera system and 5) rule, problem, criteria and diagram of situation.

A model with scaled mountain and water channels was made in scale of 1:5000. Its base was made of 1x1.5 m² wood plate. The mountain area was made of foam sheet. At the top of the mountain, a small hole was scraped as a starter point of debris flow imitation. Water channels were scraped to be slope from starter point to the toe of the mountain model. At the toe of the mountain model, there were two locations of villages. Miniature electronic detection switches were setup along the water channels. Wireless closed circuit camera systems were setup with two cameras. The first camera was installed at a starter point of debris flow imitation. Another camera was installed outside a model area to observe elapsed time, LED warning light and background activity. Village model was created at the toe of the mountain model as the final destination of debris flow. The diagram and actual model are shown in the Figure 2 and 3. Detection warning system used in the virtual situation was made by a type of miniature electronic switch. The switch was selected from several types of micro switches in the market (Figure 4). The final switch is selected to be the model of actual sensor (debris flow detection sensor codeMC- 0692 /1 of Oyo Corporation). The switch was able to detect the movement of debris flow imitation. When debris flow imitation impacted to a switch, a signal was sent to electronics board controlled by microcontroller to control LED light and buzzer warning (Figure 5). Debris flow imitation had been tried out with several materials, such as, engine oil, industrial lubricants, condensed milk and mucilage but the materials were not suitable to be the debris flow imitation. At last, hair conditioner mixed with fine grain sand was chosen for its viscousness and velocity similar to actual debris flow. The mix could control flowing time and easily to be cleaned. (Figure 6). Wireless closed circuit camera system was setup to observe virtual situation at the different room. The room is simulated as a village chief’s house at site. There are two location of learning spaces, i.e., the spaces of virtual situation and another room simulated as the village chief’s house. Miniature electronic detection switches were setup independently by learners on the mountain model (Figure 7). Then, learners were simulated as a village chief in his house to monitor situation.
through the camera system. While learners were monitoring, in the simulated house they wouldnot see and
know when the actual debris flow imitation impacting the switches and also locations of village. Figure
8shows the environment as described above.Authors created the observation template that included of rule,
problem, criteria and diagram of virtual situation for learners to guide and practice step by step. The
observation templatewas made for learners to predict time of debris flow imitation moving from the starter
point to the locations of village (see Appendix). This template was useful for learners to predict the
evacuation and impaction time.

Steps of virtual situation activity were consisted of: 1) facilitators guided learners about actual situation
for debris flow at site, the observation template, the mountain model, miniature monitoring instruments, and
debris flow imitation. 2) learners trailed setting up the miniature switches and pouring debris flow imitation
with observing its velocity, 3) learners had system thinking and group brainstorming to locate the miniature
switches, 4) learners were moved to another room simulated as the village chief’s house. After that
facilitators started to pour debris flow imitation at the starter point and initiated time count. Learners
monitored situation (only elapsed time and warning system) through the camera system. While learners were
monitoring situation at another room, they would predict when the debris flow imitation impacted the village
by recording in the observation template. Finally, learner’s prediction of evacuation and impaction times were
interesting close to the time observed in model.

Fig.4: Micro switches of size 5 mm. (circle around)

Fig.5: Miniature electronic detection switches

Fig.6: Debris flow imitation

Fig.7: Learners setup switches on a mountain model

Fig.8: Learners monitored situation through the camera

2.3 PBL Process by Using FILA Template

Learners had got a given problem from facilitators to use with FILA template. Activity of PBL process by
using FILA template was taken place in the library to search further information by learner themselves; such
as textbooks, journals and e-learning.

2.4 Searching for Information and Sharing Ideas

Searching for information and sharing ideas outside the classroom for learners would be the self-directed
learning. Each of learners would share and discuss about his searching information by himself to prepare the
presenting of results from a given problem.

2.5 Presenting the Results, Discussion, Post-Test and Evaluation

Learners presented and discussed results of problem to facilitators in the classroom (Figure 9). Then,
learners themselves evaluated the satisfaction and did the post-test. While learners were doing such activities,
facilitators observed and evaluated with authentic evaluation forms of PBL.
3. Results and Conclusion

The results of present work were followed: 1) the efficiency of the instructional package “Debris Flow Monitoring” for teaching by PBL was higher than the standard criteria of Meguigans’s formula 1.2 (at full marks of 20: pre-test x = 8 and post-test x = 17), 2) the learning achievement of post-test was higher than pre-test at statistical significance at 0.05, 3) the learners that learned by PBL satisfaction with learning and teaching by PBL at high level, and 4) the learners have been evaluated the behaviors and skills (participation in the group, communication, preparation and self-directed learning) by the facilitators at high level. The research found that this instructional package is interested, expectably to be developed to a perfect instructional package for being a part of geotechnical and environmental engineering in an university also to be applied as a tool to educate people to prevent the disaster at a risk area.

4. Acknowledgments

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5. Appendix: Observation Template for Virtual Situation

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<tr>
<th>Rule, problem and criteria of situation.</th>
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<tbody>
<tr>
<td>Rule:</td>
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<tr>
<td>1. You were the chief of the village, ToolFlam and HooyStukChow.</td>
</tr>
<tr>
<td>2. The chief of the village must give all villagers early warning during an hour (1 minutes), before the debris flow moves through the ToolFlam and HooyStukChow village. Since they could have been evacuated to the safe area in one hour (3 minutes).</td>
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<tr>
<td>3. There are 3 minutes: electronic detection switches.</td>
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<tr>
<td>4. You can write 0 to 9 in the diagram.</td>
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<tr>
<td>5. Ring: 1 time, early warning before evacuation and ring 2 times, for telling the identified time of debris flow will come to the village.</td>
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**Problem:**
From the debris flow of the Khao Hanaum Doi Thungbor, Ampho Pong, Kebti on 29 March 2012, it can make damages for lives and properties because no debris flow warning systems was set up to alert these. Some villagers told that at midnight of that day, they have heard a loud noise in a house on the top of a mountain. They all thought it was only lightning, so no one evacuated the village. At 3 a.m., early in the morning, the debris flow moved through the village. The chief of the village and all of villagers had just only warning systems before an hour; they could have been evacuated to the safe area time.

**Criteria of scores:**
1. Ring: 1 time, early warning before evacuation. Nearly or no less than an hour (3 minutes) (5 points)
2. Ring 2 times, for telling the identified time of debris flow will come to the village (The woman who rings the most nearly time) (3 points)
3. The chief of village who couldn’t ring 1 time before telling the identified time of debris flow come to the village. They must give their points to the opposite in time (Ringing is better, heavy up).

**The scale of virtual situation with actual situation:**

<table>
<thead>
<tr>
<th>Time</th>
<th>Distance</th>
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<tbody>
<tr>
<td>3 min. = 1 hr</td>
<td>100 cm. = 5000 cm</td>
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6. References


