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International
Journal
Of Modern Engineering Research (IJMER)

A STEM Education Activity in Physics on "Designing And Making Khom Loy (Small Thai Traditional Hot-Air Balloons)"

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ABSTRACT: *This study aimed to develop STEM Education activities in Physics on designing and making Khom Loy (small Thai traditional hot-air balloons.) The local in the north of Thailand use Khom Loy to cerebrate important events such as Loy Krathong Day. The samples of this study were 35 students from2 groups from high-school level and undergraduate level. The research instruments were 1.) a test of the abilities to integrate knowledge in Physics and Mathematics to explain the movement of balloons, and 2) 2 sets of questionnaire on attitudes towards Physics and on learner satisfaction. The results of the activities were 7 steps as follows: 1) informing the tasks of the activities and informing students how to evaluate the learning outcomes 2) letting students make Khom Loy based on their own experience 3) training students on the motion of Khom Loy based on Physics and Mathematics 4)analyzing factors related to designing the Khom Loy and writing a diagram reflecting the relationships among the factors 5) analyzing the designs of Khom Loy in possible ways and choosing the best to make it 6) designing Khom Loy in papers , and 7) making actual Khom Loy based on the design in papers and test the performance of Khom Loy. The results of using the STEM activities revealed that the abilities to integrate knowledge in Physics and Mathematics after using STEM education activity were significantly higher than before applying STEM activity at .05. In addition, the satisfaction of STEM activity was at high level.*
KEYWORDS:*STEM Education , Physic , Khom Loy , small hot-air traditional balloon , balloon*

Date of Submission: 18-04-2018 Date of acceptance: 03-05-2018

I INTRODUCTION

STEM Education is an approach to create learning activities to help learners experience the integration of knowledge in Sciences, Mathematics, and Technology. Engineering Process Design is used in order to find the best solution. The main objective of STEM Education is to enable students to see the importance and be interested in Sciences, Mathematics, and Technology than they used to. [1]

STEM Education was introduced to Thailand as a supplementary teaching in a compulsory education level since 2015, still there are several issues that need solving such as the actual timeframes of time to apply activities in classrooms, instructors' knowledge and experience, teaching materials including suitable activities with teaching contexts and students' living.

Khom Loy is a traditional small hot-air balloon in several shapes such as spheres, cylinders, cartoon characters, and animals. The core structure of Khom Loy is usually from bamboo, and papers are attached around the bamboo sheet structure (See Figure 1). Inside the balloons, there are a combination of candle and tissue paper or cloth soaked with oil as fuel. When the hot air inside the balloons increase, the density inside lowers. The air inside the balloons is light, so Khom Loy is able to soar.

Fig. 1 Khom Loy (Small hot-air traditional balloon)

Developing a STEM Education activity in Physics on designing and making Khom Loy is well-known among Thai youth. It is developed in order to increase learners' positive attitudes and to improve leaners' knowledge integration in Physics, Mathematics, Technology, and others to explain the phenomenon and solve the problems. This aims to increase students' attitudes towards Physics and realizes the importance of Physics, Mathematics, and Technology. It also helps reduce problems in studying Physics and improve students in other aspects such as skills in 21st century.

Objectives:
1. To develop a STEM Education activity in Physics on Designing and Making Khom Loy
2. To evaluate the effects on the students by comparing Pre and Post experiments in terms of abilities to integrate the knowledge of Physics and Science to explain the motions of Khom Loy and students' attitudes towards Physics, and students' satisfaction towards STEM Education activity.

II RESEARCH METHODOLOGY

1. The researcher studied and analyzed related studies. Then 35 students and instructors were asked to join a focus group discussion. 7 experts in teaching Physics, STEM Education, and Engineers were interviewed.
2. The researcher created a first draft a STEM Education activity on designing and making Khom Loy. 7 experts in Physics were asked to discuss and to revise the activity. The revised activity was piloted with a small group of 9 twice to avoid external interference. After that, it was experimented with 35 students from the actual classroom twice. The students were high-school students and undergraduate students. The obtained data were statistically analyzed and the results were reported.

III RESULTS OF THE STUDY

1. The STEM Education activity in Physics on designing and making Khom Loy has learning processes as follows:
Step1: 3-4 students were grouped. The instructors informed each group to compete the designing and making Khom Loy. Materials, sizes, or types of fuel are not strictly fixed. When Khom Loy was heated, it had to soar in the air more than 5 minutes. The most effective Khom Loy would be the winner of this competition. (Effective performance is equal to the ratio between the weight of Khom Loy with its fuel and timeframes from the beginning of soaring in the air to the falling down to the ground.)

Step 2: Students made Khom Loy based on their experience. If the students had their own experience, they could make Khom Loy themselves, yet the Khom Loy would not be effective enough. Meanwhile students who did not have any experience making Khom Loy might have failed. At this stage, students could realize that background knowledge in Sciences, Mathematics, Technology, and Engineering Design Process were needed to deal with difficult tasks and to avoid the failures. Experience might not be enough.
Step 3: The participants studied Physics on making Khom Loy. [2][3][4]Khom Loy sample with volume (V) was able to soar because of the buoyant force, This is equal to the weight of the outside air, which is equal to the volume of the balloon. ($\rho_o Vg$) more than the sum of Khom Loy weight (mg) + the weight of the fuel (Mg) + the weights of air inside of Khom Loy ($\rho_i Vg$)that show Fig 2. It can be seen as an equation 1 and equation 2 below.

$$\rho_o Vg \quad > \quad mg + Mg + \rho_i Vg \qquad (1)$$

$$(\rho_o - \rho_I)V \quad > \quad m + M \qquad (2)$$

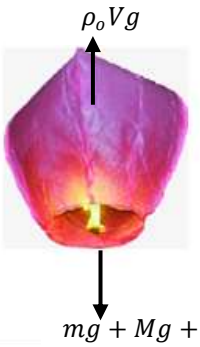

Figure 2. The force acting to Khom Loy while burning fuel.

ρ_o and ρ_i were the external and internal air density of Khom Loy respectively. The students found the air density in different temperatures from Websites. To ensure the participants' comprehension, the instructors should apply the most appropriate approach for students' potentials. For example, the instructors explained if students had time limits or lower competence, or using self-study with students along with instructors' guidance.

Step 4: Students analyzed the related factors that had effects on designing Khom Loy and wrote a diagram to see the relationships among the factors. There were several ways to analyze and write a diagram. For example, the instructors suggested students to think of the related factors that could have effects on making Khom Loy according to the given tasks. The factors could be same, similar or different. After that, the instructors suggested students to display a diagram to see the relationships among the factors from caused factors to affected factors. Students could have similar diagrams as shown in Figure 3.[5][6]

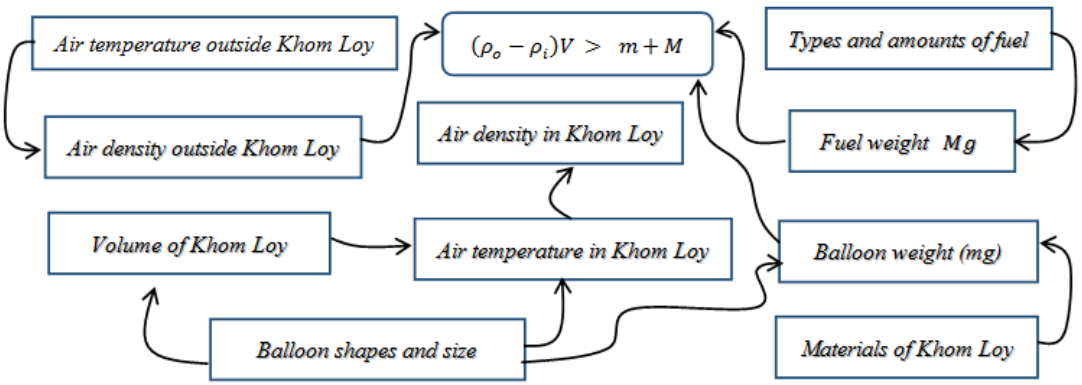

Figure 3. Samples of logical diagrams showing the relationships among factors of Khom Loy

Step 5: The instructors guided the learners to find the possible ways to make Khom Loy. Then students chose the best way to make Khom Loy such as designing shapes and sizes of Khom Loy→calcaulating the volume of Khom Loy→ selecting the materials to make Khom Loy →calculating the weight of balloon→selecting type and amounts of fuel→calculating the fuel weight →estimating the temperatures inside Khom Loy while burning the fuel →estimating the temperatures outside Khom Loy→ calculating the air density outside of Khom Loy while burning the fuel →comparing whether $(\rho_o - \rho_i)V$ more than $m + M$ or not and having enough to make Khom Loy soar. If not, turning back to repeat design.

Step6: the instructors let students design Khom Loy in papers based on their preference in Step 5. Students had to take sure that it could be possible to make Khom Loy. The instructors suggested students apply Technology such as computers and smartphones to find the air density with the applications that designed Khom Loy on the Internet. That was useful to students to recalculate and, make the best design.

Step 7: Students made a real Khom Loy from their drawing. Then the effective performances and among groups were tested and compared. Finally, students evaluated the learning outcomes.

2. Effects on the Participants

2.1 The results from comparing 2 groups of the participants on knowledge integration in Physics and Mathematics to explain the motions of Khom Loy between pre- and post – experiments and satisfaction towards the STEM Education activity were displayed in Table 1 and Table 2 respectively. The results of the evaluation in all aspects of the 2 sample groups were significantly different at .05.

Evaluation Aspects	Pre-experiment		Post-experiment		Wilcoxon Value	Wilcoxon Prob.
	$(\bar{x})$	*sd.*	$(\bar{x})$	*sd.*		
Knowledge integration	3.87	0.73	7.63	0.58	4.143	.000*
Attitudes towards Physics	3.45	0.67	4.63	0.49	3.839	.000*
Satisfaction	$\underline{x}$ = 4.74 ; S.D. = 0.45 ; very satisfied					

*p>.05

Table1. Results of evaluation from 22 high-school students

Evaluation Aspects	Pre-experiment		Post-experiment		Wilcoxon Value	Wilcoxon Prob.
	$(\bar{x})$	*sd.*	$(\bar{x})$	*sd.*		
Knowledge integration	3.93	0.70	7.87	0.64	3.624	.000*
Attitudes towards Physics	3.40	0.50	4.40	0.50	3.638	.000*
Satisfaction	$\underline{x}$ = 4.82 ; S.D. = 0.67 ; very satisfied					

*p>.05

Table2. Results of evaluation from 15 undergraduate students

IV. THE RESULTS FROM STUDENTS' OBSERVATION

The students were highly interested in and enjoyed with this activity, trying to design their own Khom Loy to be the most effective and beautiful. They tried to find the best explanation in Physics and equations to explain the motions of the Khom Loy. In addition, the participants found a developed Khom Loy design program from the Internet in order to make the Khom Loy to be the most effective. When the students were asked for their opinions towards the STEM activity, they agreed that they realized the importance of Physics, Mathematics, and Technology more deeply than before joining the activity because they knew that it was difficult to design Khom Loy to be effective without the integration of the knowledge in Physics, Mathematics, and Technology.

V. CONCLUSION

In summary, the instructor was able to apply a STEM Education activity in Physics on designing and making Khom Loy in order to change the students' attitudes in a positive way. Furthermore, the instructor was able to increase students' abilities to integrate the body of knowledge in Science, Mathematics, and Technology to explain the phenomenon and solve the problems.

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Chalongchai Teevasuthornsakul." A STEM Education Activity in Physics on "Designing And Making Khom Loy (Small Thai Traditional Hot-Air Balloons)"." International Journal Of Modern Engineering Research (IJMER), vol. 08, no. 05, 2018, pp. 10–13.