Creation of Learning Activity Package "Amazing Rubber" by using STEM Education Program for Developing 21st Century Skills of Students in High School Level

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ABSTRACT

This research aims at creating the learning activity package "Amazing Rubber" by using the STEM education program and to study the results after applying the package to the students. The experiment was performed among high-school students in Mea-Chan Wittayakum School, Chiang Rai province, Thailand. A quasi-experimental research with one-group pretest-posttest was designed and implemented. It was found that the effectiveness of the learning activity package yielded a score of 76.58/78.80, which was higher than that of the preset criteria. Learning achievement of the students had a higher score in the posttest than that of the pretest at .05 level of significance. The students' innovation skill was in a mean average level of 2.62, which showed a high level of effectiveness. The score of the students' satisfaction for participating in the learning activity package was in a mean average level of 4.31, which represent a high level of satisfaction.

Keyword : learning activity package, STEM education, 21st century skills, rubber

Introduction

According to The Eleventh National Economic and Social Development Plan of Thailand (2012-2016), the plan has led Thai population to possess moral ethnics that prolong an educational lifestyle in living with intellectual skills for every age class so as for them to live their lives decently. The social institute and local communities adapt themselves in the following of this dyanism. The aim of this plan declares a goal to achieve the learning environment as well as to have related skills to be able to apply knowledge from learning to their everyday lives. This also conformed to the core of an educational standardization in year 2008 that focused on 21st century educational perspective. To transform the changes for globalization, together with Thailand's participation in ASEAN, education agents should be prepared and to develop the system that support new era of academic innovations. Activity packages are one of an effective tools to achieve that and also leads students to apply those skills to their lives in 21st century [ref. Wicharn] A learning plan was then designed to meet 5

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important skills which were classified as Technology, Communication, Thinking, Solving and Living under student-based centralization. Yet PISA exposed the score of graduated high-school students in knowledge and necessary skills for qualified people. The results showed that the scientific knowledge of Thailand was 51st from 65 countries (Department of Education, 2008). From the analysis of the O-NET paper (year 2012-2013), Chemistry was one of the subjects that yielded as low as 30 percent in a score average (NES, 2011). This phenomenon indicated that a standard learning plan from the national academic standardization did not meet the students' requirements. The previous learning plan form the Department of Academic Standardization presented failures in increasing students' knowledge and academic achievement. The previous learning plan did not bring students to the high level of education, reflecting a lack of skill in analyzing and solving abilities of the students. Skills are also necessary for the students that are studying in 21st era. Low scores in Sciences may be caused from the determination and evaluation of courses standardized by the Department of Basic Education Committee (BEC). BEC determined and evaluated students subject by subject in eight groups (Department of Education). The test papers did not meet knowledge standards in various fields, and the students could not integrate their knowledge and get idea how to solve problems in the papers. It was very different from PISA. PISA test papers integrate all of scientific knowledge. PISA extends teaching platforms together with integrates various fields of knowledge to solve problems. This prominent teaching scheme then integrates Sciences, Technology, Engineering and Mathematics to the students real lives (Ponthip,2013). This also conformed to the case study of La Maque Middle School, Texas, USA. A Project-based learning has been designed and tested by integrating an engineering prospect to the world's educational standard. It was found that the students' cognitive level increased with their accessibility of knowledge among the participations. It was also found that when a teacher uses a day life event or surroundings, the students alerted and got involved in the activities with high interests (Tally, 2012). Furthermore, an activity package develops students to have thinking skills that leads to congruent ideas. Local technology packages also develop students' solving skills coupled with their creativity (Zarina, 2010).

Applying STEM to basic Chemistry courses with the integration of knowledge concept of the chemical reaction and polymer to rubber should help. Rubber is a new economic plant of Chiang Rai province. Chiang Rai has the most area of rubber planting in northern part of Thailand (Department of Agricultural Education). Then, the knowledge regarding rubber solutions in terms of chemical compositions will lead students to apply their knowledge to solve for problems in rubbering process.

The authors then created an activity package entitled "Amazing Rubber" using STEM coupled with an educational development in 21st century skills for high school students. This research also aims to instruct an education platform that prepare people to the changes of 21st era for more intense educational competition.

Research objectives

1. To create an activity package "Amazing Rubber" using STEM education and 21st century skills for developing high school students' learning
2. To study the effectiveness of the learning results after applying an activity package to high school students

Methodology

The population of this study were 350 students in grade 10 of Mae Chan Wittayakom School in Chiang Rai Province, Thailand. The experiment was performed in the second

semester of year 2014 in ten classes. Thirty samples were taken from the population by stratified random technique.

The tools for research consisted of:

1. An activity package "Amazing rubber" following STEM education that were divided into two activities: Rubber sheet formula and Water storage rubber bag. The package used 22 hours for the experiment. The study was performed in second semester of year 2014. The package was then verified by individuals, groups and bulk quality test. The result showed an effectiveness score of 76.58/78.80.

2. The study achievement in the topic of "Chemical Reaction and Polymers" using 30 items multiple-choiced test papers. The papers were validated to congruency of contents yielding the scores of 1 when applied to 100 of non-sample grade 11 students with the p-score of 0.30-0.65 and the resolution (r-score) of 0.20-0.80. The papers were then calculated for a reliability by KR-20 formula (Kuer-Richardson), resulting in the score of 0.81.

3. Form of learning and innovation skills determination. Each item was scaled into five-point Likert scale. Eight items were verified for congruency in contents, yielding the score of 1.

4. Form of satisfaction in the "Amazing rubber" activity package. Thirteen items were scaled into five-point Likert scale. Each item was verified for congruency and quality. The test for congruency yielded the score of 1 and had a reliability score of 0.77 as calculated with Cronbach's method.

Research Protocol

A Quasi Experimental Design couple with One-Group Pretest-posttest design was then applied to the students with the STEM education. The students were then tested for an innovation skill before learning and after having finished their course. Finally, the determination of satisfaction was then performed.

The analysis of the students' effectiveness (E1/E2) was then calculated using a percentage of score before and after the course. The comparison of an effectiveness was examined using an independent T-test method. Knowledge and innovation skills were then tested and carried out. The satisfaction score was then calculated using a score average and standard deviation.

Results

The results were analyzed and divided into two parts.

Part I: Creating an activity package "Amazing rubber" using STEM education **to meet 75/75 standard criteria.**

Table 1: An effectiveness of activity package "Amazing rubber"

Activities/ Contents	Effective of process (E_1)	Effective of output (E_2)	E_1/ E_2
1.Rubbersheet formular	75.80	77.37	75.80/77.37
2. Rubber bag	77.36	80.23	77.36/80.23
Overview	76.58	78.80	76.58/78.80

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The effectiveness of process (E1) and the effectiveness of output (E2) of “Amazing rubber” activity package using STEM education for high school students were calculated and reached the score of 76.58/78.80. The calculated scores were higher than the standard criteria at 75/75.

Part II: Study of students impact when applying an activity package to the high school student in Mae Chan Wittayakom. The results was classified in to three contexts as the following:

2.1 The comparison of pretest-posttest scores as shown in Table 2,

Table 2: Comparison of pretest-posttest scores of “Amazing rubber” activity package

Test	n	X	S.D.	t	p-value
Pre	30	12.27	3.37	10.98*	0.00
Post	30	20.07	3.31		

Calculated with significantly statistical confidential level of .05

*$t_{0.05\ df=29}$ = 1.6991

Form the results, it was indicated that the posttest score yielded higher values than the pretest at a statistical confidential level of .05

2.2 The study of learning and innovation skills when applying “Amazing rubber” activity package. The results are as shown in Table 3,

Table 3: Comparison of learning and innovation skills

learning and innovation skills	Result	
	X	level
Discussion and problem solving	2.41	high
Communication and participation	2.60	high
Creativity and innovation	2.84	high
Average	2.62	high

According to Table 3, the average score of learning and innovation skills was 2.62, resulting in the high level. An average of each item was then classified. The highest score of items was noted to be “Creativity and academic innovation”. The second was noted to be “Communication and participation”, and the third was “Discussion and problem solving” respectively.

2.3 Evaluation of the students’ satisfaction of “Amazing rubber” activity package using STEM. It was found that, Students highly satisfied after learning from the package with an average score of 4.32. The highest score was indicated in the item of “Interesting of an activity”

Discussion

Part I: Creating an activity package "Amazing Rubber" using STEM education to meet 75/75 standard criteria. The “Amazing Rubber” was integrated into basic high-school Chemistry. It

was consisted of two topics. The first activity entitled “Rubber Sheet Formula” yielded an effectiveness of 75.80/77.37 and the latter activity entitled “Water Storage Rubber Bag” yielded an effectiveness of 77.36/80.23. Each topic had higher scores of the students effectiveness than the preset criteria (75/75). The results met the research objectives congruently.

Part II: The study of students’ impact over an application of the package. Three main contexts were studied:

2.1 Comparison of academic achievement before and after applying the package. The effectiveness score showed different values at .05 level of significance. The posttest score was higher than the pretest one, achieving the research hypothesis. STEM education was also integrated into the package, including chemical reactions and polymers (Chemistry), rationality and ratios (Mathematics). This integration then allowed the students to make a tool for solving problems in their rubber farm with congruent process of engineering and technology. To solve the problem, students needed to understand the principles of chemical reaction and polymers that led them to have comprehension and the use of correct tools for solving the problems. This results conformed with Telly (2012), which studied STEM method under Problem-based Learning (PBL) and integrated engineering activities in the “World System” package. It was found that the students’ scores increased after they participated in such learning process.

The results also met the study of Becker and Park (2011) that integrated STEM to undergraduate students. It was found that students understood the principles of Mathematics and Sciences. They also understood the reason why they had to learn and took advantages from the subject. This helped to illustrate the students’ attention in learning Mathematics and Science attentively.

2.2 Students’ skills in knowledge and innovation when applying “Amazing Rubber”. After the students participated in the STEM program, a score of learning skill increased to an average of 2.62 which indicated a high level of cognition. When classified into items, it was found that the highest score was in “creativity and innovation” which possessed 2.84. The innovation and creativity brought the students to design their own innovative things used for solving problems in their everyday life. The package also designed to meet a cooperative working environment. A group discussion and presentation in front of the class were then added to the package. Students worked happily together with their own creativities. The results conformed with Fang’s (2013) study, stated that the improvement of students’ learning skills using STEM were brainstorming with YO-YO activities. This technique increased the students’ scores and new ideas for the Physics class. The results also met Telly’s (2012) study that performed higher scores in skills when students got involved in such activity.

2.3 Evaluation of satisfaction when applying package to students

The students’ satisfaction scores in the “Amazing rubber” learning package using STEM was then determined. The package yielded an average score of 4.31 which indicated high. When classified into items, the highest score was “Interesting of package”, yielding a score of 4.78. This may be caused from the designed package having focused on the students’ independent thinking that led the student to create new innovative tools to solve the problem. They also had changes in making their own tools and experiments. This was completely

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different from the old suite that let the students doing the pre-designed experiments by fixed protocol and the results of the experiment were identical in every experiment. This package also challenged the students to design the tools to solve the problems. The students had fun and had positive attitudes in the class.

Suggestions

1. This activity package may be integrated into the local courses
2. STEM may be applied to integrate the knowledge between different subjects prominently.

Conclusion

From the research, an activity package "Amazing Rubber" was constructed by using STEM that yielded an effectiveness score of 76.58/78.80 which was in higher value than that of the preset criteria (75/75). When apply the package to a randomized class of grade 10 students of Mae Chan Wittayakom School, the achievement of the students' in the posttest learning score was higher than the pretest one significantly. The difference between both scores was at .05 statistical level of significance. The scores of the students' learning and innovation skills was also at the high level at 2.62. An evaluation of the students' satisfaction in the package was also tested and yielded a high level with the score of 4.31.

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REFERENCES

[1] Becker, Henry K. and Park Kyungsuk. (2012). Effects on Integrative Approached among Science,Technology.Engineering, and Mathematics (STEM) Subject on Student' Learning : A Preliminary Meta- Analysis. Journal of STEM Education, 23 – 37.

[2] Boonchom Srisaard.(2002). Development of Teaching. Bangkok : Suweeriyasarn. Department of Agriculture. (2011). Rubber plantation in Thailand. Retrieved September 12, 2013, from http://www.rubberthai.com/statistic/stat_index.htm.

[3] Department of Curriculum and Instruction Development.(2010). The Basic Education Core Curriculum B.E. 2551. Bangkok : Express Transportation Organization of Thailand.

[4] National Institute of Educational Testing Service. (2011). Report of the O-net system. Retrieved September 1, 2013, from http://www.onetresult.niets.or.th/AnnouncementWeb/Login.aspx.

[5] Ning Fang. (2013). Increasing Hing School Students' Interest in STEM Education Through Collaborative Brainstorming with yo-yos. Journal of STEM Education, 8 – 14.

[6] Pagon prachunban.(2009). Research Methods in the Social Sciences : Phitsanulok : Ratanasuwan printing.

[7] Pontip Siripudtrachai. (2013). STEM Education and skills development in the 21st century. Journal of Managemen, 49 – 56.

[8] Talley, Terry. (2012). STEM Strategies : Project Based Learning in Earth/Space Systems. Retrieved December 13, 2013, from

http://www.utmb.edu/tstem/articles/STEMStrategies_PBLand%20Earth_Space_Systems_Final.pdf.

[9] Wichan panich. (2012). Way of learning for students in the 21st century. Bangkok: Sodsrisaridwong Foundation.

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