STEM Education as a Strategy for Enhancing Mathematical Achievement on Measurement

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Abstract

STEM education is now calling for integrative approach to worldwide schools. Effective instruction based on STEM education helps educators to design and make classroom much more effectiveness. This study aimed to investigate learning achievement of grade 8 students on measurement through STEM education practices. Forty grade 8 students were sampled by cluster random sampling and manipulated with measurement concepts through STEM education lesson plan. Achievement test and STEM education lesson plan were employed. One group pre-test post-test design was manipulated for experiment. Percentage, mean, standard deviation, and dependent t-test were used for data analysis. Students had post test score than those pretest score, and also posttest score higher than 75% of passing criteria with .05 level of statistical significance.

***Keyword**:* STEM education, mathematics, achievement, measurement

Introduction

Education is an essential mechanic in human development for modern societies, prosperous economy, and sustainable environments in the changing world (Bently, 2012; Derrictot, 2014). Especially, the 21st century education aims at people's intellect which is regarded the most important resources for global development (Carley & Spapens, 2017; Kahn & Agnew, 2017). This educational concept emphasizes on building learning communities where knowledge is co-created and transferred by the community members. It also focuses on integrative learning with multi-disciplines. Learners in this century are needed to use leaning competency and bring integrative knowledge to their lives with helpful modern information technology. Furthermore, they are developed to obtain awareness of nature rules, critical thinking skills, research skills, proper personalities, positive social valuables, and good health (McGaghie, 2015; Henriksen *et.al.*, 2016; Egan *et.al*., 2017).

Previous educational activities, knowledge was power and make difference. Learners, for this reason, need to be clever, higher score on testing, and well prepared to use knowledge as a tool to get advantages particularly from the workplace to world. Only competent learners were always provided with opportunities. However, in the 21st century, paradigm of educational management seems to different and tend to be changed. Learners have to be equipped with knowledge and experience in living well in the world (Young & Bittel, 2015). Man and nature have to rely on each other. Learners should be given opportunities to stand in the society. They should also be preached to have desirable human nature and holistic views as a basic development (Webber & Johnston, 2014).

Additionally, the 21st century citizens are facing self-conflicts. This is due to the fact that citizens in this present era are more dependent while they are actually reliant on one another. They are not sure which they should give priority to-themselves or the public. The 21st education should enable citizens to make a balance between themselves and the public. This so-called "skillset" should be introduced to schools (Reeves, 2006; Franco *et.al*., 2012).

Administrators and teachers have an important role to construct curricular and activities to respond to the skillset. Skillset learners are prepared to learn to live, learn to love, learn to learn, and love to learn that why 21st century learning to shape our students to face with uncertainty.

The world is now rapidly changed, education is also needed to adapt and learn how to prepare learners facing with modern lives, an asset which is worth being reserved and developed. Affairs or activities which were individually done in the past are more integrated in this century as they require various types of knowledge and skills. The application of modern technology is more integrated into the society in order to lay a foundation of knowledge (Becker & Park, 2011). In addition, leadership is a matter that is raised and introduced to administrators of all levels. Stakeholders of organizations are becoming more valuable and paid greater attention. It can be put that in this new era standardization is highlighted.

STEM education as known in integrative instruction which Science, Technology, Engineering, and Mathematics blended to learning and teaching. It aims to make learners think and do with creatively manipulated things to modern lives and environment (Brown *et.al.*, 2011; Nuangchalerm, 2018). It is an educational program developed to prepare students, STEM education aims to foster inquiring minds, logical reasoning, and collaboration skills (Wang, 2013). In addition, STEM education make learning and applying content to real life problem-solving by integrating content, interpreting and communicate information, engaging in inquiry and logical reasoning, collaborating as a team, and applying technology appropriately (Tseng *et.al*., 2013). These disciplines are in an interdisciplinary and applied theory into practice.

The production in the agricultural and industrial sectors has to meet the global standards. STEM education answer how to implement science and related to societies, so that the products can be accepted worldwide (Basham & Marino, 2013). Similarly, education is a process to produce quality citizens. Educational management has to be standardized. Teachers, as part of the process, have important roles to manage learner-centered learning in which learners are supported to construct knowledge. They should be able to produce valuable outcomes to the society. Learners are trained in critical thinking, are prepared to search for and select appropriate sources of knowledge. They are expected to use decision-making skills for the benefits of themselves and the public (Breiner, 2012).

This study aims to investigate learning achievement of grade 8 students on measurement through STEM education practices. The exploration need to compare the pre-test and post-test score of measurement lessons through STEM education. Also, to study posttest score higher than 80% of passing criteria. Findings can help educators understand STEM education in the role of classroom manipulation and provide information for designing STEM education curriculum.

Methodology

In the study, the one group pretest-posttest design was used. Participants were sampled by cluster random sampling, 40 students who studied in the grade 8 students, the first semester, academic year 2017. They were such students in the program of science-mathematics classroom. For gathering students' learning achievement and their progress through STEM education approach, mathematics lesson plans on "Measurement" were designed and divided into 10 lessons. The lesson plans were manipulated by each of lesson plans were used in 10 periods each of which lasted for 50 minutes. The quality of mathematics lesson plans was analyzed through content validity**.** Achievement test was constructed to measure students' understanding in the concept of measurement. A 40-multiple choice of testing was employed, the quality of test was analyzed through experts in both content and research methods. It was used between pre and post tests with panel participants in the study.

Results

To investigate effectiveness of STEM education learning activities, 10 lesson plans are studied and reported its effectiveness index as shown in Table 1.

Table 1 Score in each lesson plan STEM learning activities

Lesson Plan	Score	$\overline{X}$	S.D.	Percentage
1	10	7.00	1.20	70
2	10	8.00	1.02	80
3	10	9.00	0.80	90
4	10	9.00	0.80	90
5	10	8.50	1.04	85
6	10	7.50	1.10	75
7	10	9.50	0.75	95
8	10	9.00	0.79	90
9	10	9.00	0.81	90
10	10	8.50	1.04	85

Table 1 shows that lesson plan 1 had percentage at 70, is minimum score, but those others higher than 75% of score. Then, the effectiveness index is required to answer how STEM learning activities meet the requirements of study (Table 2). The effectiveness index can be shown in terms of while students learn through STEM education approach (E_1) and after students had learned (E_2).

Table 2 Effectiveness index of STEM learning activities

n	While				Post				E_1 / E_2
	Full score	$\overline{X}$	S.D.	E_1	Full score	$\overline{X}$	S.D.	E_2	
40	10	8.50	0.94	85	20	17.50	2.70	88.33	85.00/88.33

Table 2 illustrates that the effectiveness index (E_1/E_2) of STEM learning activities is 85.00/88.33, which passed the expected criteria of 80/80. Also, learning achievement is crucial component of instructional quality by assessing their knowledge and understanding in the concept measurement, mathematics subject seems to be difficult to students. STEM education is employed in terms of mathematical learning activities**.** Pre and post test scores are measured and tested by dependent t-test (Table 3).

Table 3 Comparing pre and post test scores

Test	n	Percentage	$\overline{X}$	S.D.	Gained score	t
Pre	40	50.57	11.13	1.84	25.20	20.61**
Post	40	75.37	16.03	1.17		

** Statistically significant level at .05

Table 3 Showing pre and post test scores of students through STEM education approach. It indicates that students had post test score than those pretest score, and also posttest score higher than 75% of passing criteria with .05 level of statistical significance.

Discussion

This study showed that students who had learned through STEM education approach can enhance their learning abilities. The post test score had higher than pre test and also posttest score higher than 75% of passing criteria with .05 level of statistical significance. This positive change met the objectives and the hypotheses of the study. Due to, the effectiveness index (E_1/ E_2) of the developed STEM lesson passed the criteria of 80/80. In this study, the greater effectiveness index than the pre-set criteria may result from the integration of the STEM education management into the measurement lesson plans that were systematically constructed. The construction process of these lesson plans were composed of a study of the curriculum and its handbook, principles, concepts, and related theories. The lesson plans were thoroughly evaluated by the group of experts before its actual implementation. Therefore, the lesson plans contained all important elements, and finally became practical among the students.

The findings from this study have given an insight into the positive effect from the systemized application of the developed STEM mathematics lesson plans to the actual classroom. The lesson plans had a positive influence on the students, particularly the poor achievement students (Han *et.al*., 2015). It provided guidelines to further develop the quality of mathematics teaching and learning activities which enabled co-operative learning and problem solving. Also, the students were trained to think broadly, improve their works, have more responsibilities, and generate good attitudes towards mathematics. These personalities serve the present government's proposed national development model under the concept "Thailand 4.0"-stabability, prosperity, and sustainability. However, STEM education lesson should study mathematics related learning materials such as handbooks, documents, lessons, and teaching and learning equipment.

Students should have diverse materials and equipment before introducing them to the classroom (Basham & Marino, 2013). It will help the teacher deeply understand both the using process of the materials and equipment and the process of teaching and learning. Once STEM education lesson, are well managed in the classroom, the students will practice thinking, doing, and self-improving. This builds student-centeredness atmosphere in the classroom. Stimulating students' interests can also result in successful learning activities and confidence in learning complicated mathematics lessons. STEM teachers should get the classroom or space ready for all the planned activities (. During the management of the STEM education lesson, teacher should always observe, collect, and record every small piece of data found in the process. After that, the data should be taken into analysis and action in the next lesson plan. In so doing, the activities done in the next lesson plan will become more effective and efficient.

Encouragement or compliments should be made when students do well in their jobs or presentations. Positive reinforcement gives students teamwork skills and creative thinking skills (Wang, 2013; Kwok, 2017). These skills are applicable to daily life. Teacher should be keen on designing activities that stimulate and enhance thinking skills. As a result, group members become more energetic and confident in completing the tasks (Schiefele, 2017). When they help one another in the group, they will learn that each group member is important and teamwork is grateful. Further study related to STEM education affecting learning achievements should focus on other mathematics lessons or different levels of students. It is recommended that future research should explore students' opinions after having completed STEM education lessons. The results of the opinion study will be guidelines for lesson activity improvement. Also, other variables such as positive attitudes on mathematics should be studied. Desirable learning atmosphere should be created. Students' brainstorming and effective thinking can be well generated under tranquility. Every student is responsible to make and maintain peaceful atmosphere into STEM classroom.

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