Enhancing Grade 10 Students’ Achievement and the 21st Century Learning Skills by Using Information Based on STEM Education

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Abstract. The purposes of this study are to (1) develop students’ achievement of learning technology focusing on solving current environmental and social issues in daily life, and (2) examine the results of using information technology media based on STEM education to enhance the 21st century learning skills of grade 10 students. The action research method was used in this study by dividing into 3 action parts. The instrument used to collect data of students’ learning activities was observation form to assess teachers’ teaching strategies and abilities to integrate information and communication technology (ICT) knowledge into the contents based on Technological Pedagogical Content Knowledge (TPCK) approach. After the 3 action parts completed, data were analyzed, aiming to develop students’ learning achievement. The samples were a total of 40 students in grade 10 in the semester 1 of academic year 2017. The findings showed that using information technology media in teaching based on STEM education in line with TPCK approach developed the 21st century learning skills of students in grade 10 effectively. The approach consists of 5 steps: 1) introduction; 2) cognitive conflict; 3) reflective activity; 4) cognitive restructuring; and 5) summary and evaluation. The 5 representations reflecting students’ 21st century learning skills were found at a high level including academic excellence, bilingual communication skills, creativity and innovation skills, problem-solving skills and responsibility for the social issues, attitude towards global awareness. The overall development of the 21st century learning skills of grade 10 students was at the highest level ($$\bar{x}=4.57$$, S.D. = 0.72). The result of students’ ONET assessments with specific aptitude skills at a higher level reflected that their learning achievement developed. Moreover, students were able to communicate in Thai and English. Students had competence in designing learning activities to share ideas and projects reflecting their responsibility to solve environmental and social issues. Students also demonstrated their creativity and innovation skills in designing visual webpage and provided presentation showing their global awareness by understanding the diverse culture and religion across the world.
1. Introduction
The demand for personnel in the field of science, mathematics, technology has been rapidly growing in the past two decades while the need in engineering tends to decrease in the 21st century. However, the reports show the decline in students entering to higher education in science, mathematics, technology. This results from the poor educational management of teaching and learning in science and mathematics in schools, resulting in the lack of motivation in learning [3]. In addition, the importance of acquiring knowledge linked to students’ everyday life and future career path has not been highlighted. Although developing education for the 21st century requirements aims to provide the meaningful knowledge for the learners to construct necessary and innovative skills in their future profession, students’ perception towards science and mathematics learning is that they cannot relate themselves to the content [2].

The development of students’ learning achievement and 21st century learning skills using information technology media in activity-based teaching in accordance with the Science Technology Engineering and Mathematics (STEM) Education was implemented with grade 10 students at Phuwiang wittayakhom school in the academic year 2018. The STEM education mainly focuses on providing opportunities to students to construct self-learning in science, mathematics, and technology to apply knowledge in their daily life and future career [2].

Moreover, the STEM education approach addresses on developing students’ systematical thinking, collaborative working skills, communication skill, and creativity through variety of learning activities and projects. The activity-based teaching and learning combines the knowledge of science, mathematics, technology, and foundation of engineering design. Therefore, students’ completed project would reflect their understanding towards the concepts of the four subjects and be able to optimize the knowledge to solve problems in the future [1].

In the perspective of Thailand’s Basic Education Core Curriculum B.E. 2551 (A.D. 2008), the STEM education relates to three teaching and learning departments: science, mathematics, and technology and occupational and technology [2]. Based on STEM education, the teaching and learning management in these three modules aims to develop the students’ literacy in science, mathematics and technology which is in line with the objectives of core curriculum of in enhancing the students’ achievement and the 21st century learning skills.

2. Objectives
To investigate the learning achievement of grade 10 students in the semester 1 of academic year 2017 after using information technology media in activity-based teaching according to STEM education approach by comparing between pre- and post-test scores.

To enhance the 21st century learning skills of grade 10 students in Phuwiang wittayakhom school in academic year 2017 by using information technology media in activity-based teaching according to STEM education approach.

3. Population and samples
The population used in this study was a total of 365 students in grade 10 in Phuwiang wittayakhom school in academic year 2017. The 40 students in grade 10 class 2 were selected by using cluster purposive sampling technique.

3.1. Research tools
The research tools used in this study are as follows:

1. Teacher’s information technology media in 8 contents in the subject of technology and communication and 8 learning plans of STEM education,

2. The assessment used in this study consists of 40 questions with 4-multiple choices to measure students’ learning achievement. The reliability of the assessment was 0.83,

3. The observation form is used to observe students’ learning structure, and the 5-scale measurement is used to assess students’ 21st century learning skills. The reliability of the measurement was 0.84.
4. Research methodology and data collection

This research was an action research which was divided into 3 action parts. Research tools were teachers’ lesson plan, and information technology media based on STEM education. The 1st-3rd learning plans were used in the first action part, followed by the 4th-5th learning plans in the second action part, and the 6th-8th learning plans in the final action part, respectively. To collect data of teacher’s teaching competence, the observation form was used to assess teacher’s teaching abilities in integrating the Technological Pedagogical Content Knowledge (TPCK) approach and ICT knowledge into the content by using TPCK as assessment. The information technology media used in this study were learning resources e.g. applications, webpages, internet, multimedia, and e-books. The students’ learning activities are also assessed by using observation form, interview, and quizzes.

5. Data analysis

The data were analyzed by using descriptive statistics, mean, standard derivation, percentage, dependent t-test to identify the difference between pre- and post-test scores. The analysis of content including students’ interpretation and the logical reasoning is used to conclusion.

6. Results

6.1. Students can analyze problems and present logical reasoning with mathematic principles to describe phenomena in different contexts. From the teaching and learning activities based on STEM education, the project of packaging design for containing fermented fish was selected by students as they aimed to solve problems in their community. Students reflected their abilities in applying the knowledge of technology and providing presentation by using information technology media effectively.

Furthermore, students sought additional information to develop their design and innovative skills in the project. By implementing the activities, students linked the knowledge of three subjects: science, mathematics, and technology to solve the problems appropriately. Consequently, the post-test scores of grade 10 students were higher than the pre-test score at significant value of 0.01. These results showed that students’ achievement developed after the implementation of teaching and learning activities based on STEM education.

6.2 The overall development of the 21st century learning skills of grade 10 students was at the highest level (\( \bar{x} = 4.57, \text{ S.D.} = 0.72 \)). The results of 5 representations in TPCK assessment are described as follows:

The representation of students’ technology skills was at a high level (\( \bar{x} = 4.76, \text{ S.D.} = 0.79 \)). There was evidence that students used technology to seek more information and link it with the content efficiently; consequently, they interpreted the content, made accurate conclusion and provided presentation properly. This reflected that students can apply knowledge to solve problems in their daily life effectively.

The representation of students’ academic excellence was found at the highest level (\( \bar{x} = 4.66, \text{ S.D.} = 0.64 \)) from the empirical findings reflecting students’ specific aptitudes (e.g. projects to solve community’s problems of packaging designs of fermented fish).

The representation of students’ creativity and innovation skills was at the highest level (\( \bar{x} = 4.55, \text{ S.D.} = 0.65 \)) from the evidence that students planned and designed learning activities and projects of packaging designs. The students were creative and innovative to design the webpage and share ideas among groups to seek solutions for the community’s problems.

The representation of students’ attitude towards global awareness was at the highest level (\( \bar{x} = 4.53, \text{ S.D.} = 0.69 \)), meaning that students were able to construct self-learning and manage complexity under the difficult circumstances of multi religious and cultural community. Students demonstrated their positive attitudes towards responsibility for the social issues and firmly held global awareness.

The representation of students’ bilingual communication skills was at the high level (\( \bar{x} = 4.34, \text{ S.D.} = 0.84 \)).
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