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STEM Education-Based Learning Management for Creative Thinking Development: Length Measurement Lessons of Grade 3 Students

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Abstract

The main purpose of this research was to develop 3rd grade students' creativity to meet a criterion of 70% by using the STEM Education-based learning management. The target sample included six 3rd grade students of Dongsankaewdongsamran School, Chanuman District, Amnat Charoen Province, Thailand. This research took place in the second semester in the academic year 2020. The design of this research was action research conducted in two cycles. The research instruments were 1) two lesson plans based on the STEM Education-based learning management, 2) the Torrance Test of Creative Thinking (TTCT), 3) a student behavior observation form, and 4) an interview form. Statistics for data collection were mean and percentages. The results showed that in cycle 1 the STEM Education-based learning management improved four students (66.67%) to pass the criterion of 70%. In cycle 2, two students passed the criterion of 70%. All of them finally passed the criterion (100.00%). In conclusion, the STEM Education-based learning management can promote and develop students' creativity in each cycle.

Keywords: STEM Education, Learning management, Creative thinking, Length measurement, Mathematics, Grade 3, Primary education

1. Introduction

Today's world is rapidly advancing due to the use of technology to connect data in all regions of the world. Scientific and technological advancements and social changes occurring in the 21st century are important factors in all people's ways of life. These factors have also changed the educational paradigm. In the present paradigm, educational management of all levels emphasizes advanced thinking skills such as creativity, problem-solution, and critical thinking. It also accentuates communication skills, the use of technology for knowledge search, and social skills (Siriwan, 2016). The 21st century skills have become important strategies that many parties jointly research in order to create models and propose practices to enhance the effectiveness of educational management. As the current educational system has shifted from knowledge provision to skill development, key knowledge and principles are taught to learners to understand concepts and theories used as a knowledge base to grow their knowledge (Pengpit, Sukjairungwattana, & Chantaranamchoo, 2020). Creative and innovative skills are also vital as they serve thinking that enables a person to think, to understand and solve a problem, and to predict obstacles. As a result, the person can solve any problems well (Roopchom, Chanunan, Warasing, & Kijkuakul, 2021).

Creativity is significant for work and daily life. It enables a person to create unprecedented works or innovations that benefit both the person and the public effectively. Besides, creativity makes learning happen, especially creative activities arranged to allow learners to use their imagination. As a consequence, initiatives for problem-solving lead to new things

and application to living and society (Promkham, 2020). Promotion of creativity at an early age is vital to grow a person to be a creative adult in the future. Brain development makes a person clever. Practice of thinking or trying new things on a regular basis builds self-confidence, self-esteem, and self-gratification. These characteristics enhance patience, initiative, and joy in a person (Loha & Jongkonklang, 2019). Creativity, in particular, is the ability of an individual to think in multiple directions, bringing his/her past experience into connection with new situations. This creates new or unprecedented ideas. A person's creativity can be achieved when the person is thoughtful, fearless, critical, and conceptually independent (Hajeekhadae, Portjanatanti, Rorbkorb, & Waewthongrak, 2019). Creativity is consisted of four components; originality, fluency, flexibility, and elaboration (Chuelooppo, Bongkotphet, & Warangkanagool, 2018). It is mentioned that creative individuals possess original, fluent, and flexible thoughts. They are observant, suspicious, sensitive to problems, and curious. They prefer to probe by posing odd questions, have a sense of humor, and have self-confidence. Creative individuals are autonomous, not easily dependent on others. These diverse characteristics of creative people are contained in the same person, but they do not necessarily have to exist in one person. These characteristics vary from person to person (Leelasornchai, Panawong, & Kaewurai, 2018).

In developing learners to have creative skills, a concept employed in learning management is STEM Education. This concept of education is the integration of science, technology, engineering, and mathematics. STEM Education enables learners to apply knowledge to solving problems or situations that are connected to their daily lives. In STEM Education, they need to research, build a body of knowledge, communicate, encourage creativity, and develop works. They are active learners. They have to work as a team. Moreover, they must be able to utilize technology to acquire knowledge and improve their learning in both study and future careers (Suwanich, 2017; Polyiem, 2018; Khwana & Khwana, 2019; The Institute for the Promotion of Teaching Science and Technology, 2014). STEM Education has great contribution to the development of Thai students to meet international standards. STEM Education enhances achievements in sciences and mathematics of students at all age levels. Students with STEM Education skills will be able to apply knowledge to addressing problems, gaining new knowledge related to various issues of STEM. Once students have understood the characteristics of STEM including the scientific process and engineering designs, they will have logical thinking. That is to say, they will understand reasons and logic through the scientific process, mathematical systems, and engineering processes in designing inventions or innovations (Pimpala & Seechaliao, 2018). STEM Education also encourages students to solve problems step-by-step in a systematic manner. It stimulates and challenges students to learn and link problems to real situations (Muakmuenwai, 2017).

In line with Sanegan and Jasuwan (2017) who did research on STEM Education-integrated learning management to promote creativity of the 21st century for elementary school students. They found that the research improved the students' ability of engineering design based on STEM Education. This educational approach improved the students' ability of designing and creating works. The previous research concluded that when students are satisfied with their works, have fun and enthusiasm, the participation in activities is higher. This consequently

results in higher learning achievements. According to Phumkhonsarn (2017), a related previous study confirms that learning achievements and scientific creativity of 5th grade students are improved through STEM Education. In that study, the scientific creativity was high and the learning achievements were higher than the pre-set criterion of 75%. The scientific creativity and the learning achievements were better at a significant level of 0.5. According to the focus of the school curriculum of Dongsankaewdongsamran School (Revised School Curriculum) based on the Basic Education Core Curriculum B.E. 2551 (2008), it aims at developing analytical thinking, synthetic thinking, and creative thinking. The school students are expected to build a body of knowledge or information to make appropriate decisions about themselves and the society. The school curriculum also aims to develop teachers and supportive staff to arrange learning activities so that students are encouraged to apply their knowledge to creating works which are useful and practical to real-life problem solving (Dongsankaewdongsamran School, 2018). In conclusion, teachers should employ a variety of learning management approaches. These approaches should be connected to the real world and the necessary skills of the 21st century such as creative thinking skills. This is due to the above-mentioned claim that creative individuals can create themselves and the environment in an appropriate way. Creative individuals are enjoyable, inspired by imagination, and perseverant in achieving their goals (Panmanee, 2014).

Observing the learning behavior of the 3rd grade students at Dongsankaewdongsamran School, it was found that the students lacked the creativity components; originality, fluency, flexibility, and elaboration. They repeatedly produced the same kind of works. They did not create more interesting pieces of work. From an interview among teachers of different subjects, they reported that the students did not create new ideas as they dare not express ideas. They were afraid of making mistakes. This might be due to teacher-centeredness. This teaching method blocks the students from generating ideas. In line with the Torrance Test of Creative Thinking (TTCT) (Torrance, 1974), it showed that the creative thinking ability of eight 3rd grade students was at a high level (25.00%), other eight students at a moderate level (25.00%), and sixteen of them at a low level (50.00%).

In light of the importance of STEM Education above, it is worth integrating STEM Education into learning management in order to enhance creative thinking. Therefore, this research was conducted with an objective to develop creative thinking through STEM Education-based learning management for a lesson of length measurement of grade 3 students. It was hypothesized that the STEM Education-based learning management would result in the students being able to create ideas and imaginations, extend existing ideas and applying them to daily life optimally.

2. Research Objective

To develop creative thinking of grade 3 students through STEM Education-based learning management to pass a criterion of 70%.

3. Research Methodology

3.1 Participants

The target group in this research was the 3rd grade students at Dongsankaewdongsamran School in Chanuman District, Amnat Charoen Province, Thailand. The sample participants were the students who did not pass a criterion of 70% set by the researcher. To select the participants, the researcher tested them with any types of research instruments. The research took place in the second semester of the academic year 2020.

3.2 Instruments

3.2.1 Lesson Plans Based on STEM Education

The lesson plans were taken from unit 9 on length measurement. The level of students was grade 3. The duration of each lesson plan is 4 hours, so the 2 lesson plans last for 8 hours in total. The titles of the lesson plans are as follows; A Modeling Clay Tower and A Paper Plane.

The structure of each lesson plan includes learning standards, key learning indicators, learning content, learning objectives, a learning management process (STEM Education-based learning management), materials, equipment and learning resources, measurement and evaluation, and assessment tools.

3.2.2 The Torrance Test of Creative Thinking (TTCT)

Thinking Creatively with Picture Figural Form A with 3 activities was administered to assess the 4 components of creative thinking; originality, fluency, flexibility, and elaboration.

3.2.3 Student Behavior Observation Form

This form was used to record the students' behavior from the beginning to the end of each class hour. The form kept the actual behaviors, comments, and suggestions to improve the next cycle of the lesson.

3.2.4 Interview Form

This is a semi-structured interview form. The issues and questions were prepared beforehand. However, the interview was conducted flexibly in interviewing the students while performing activities in each cycle.

3.3 Data Collection

3.3.1 Research Design

This is action research. The methodology is based on Kemmis & McTaggart. It consists of 4 stages: planning, conducting, observing, and reflecting.

3.3.2 Research Procedure

The data collection procedure includes the following steps:

(1) An orientation was held among the target students. The purpose of this orientation was to

prepare them for the STEM Education-based learning management, and for the data collected from worksheets, the observation, and the interview.

(2) The students were separated into groups of 3-4 based on their mathematical achievements in the first semester. The grouping technique was heterogenous competence.

(3) The lesson plans based on STEM Education were taken from unit 9 on length measurement. The level of students is grade 3. The duration of each lesson plan is 4 hours, so the 2 lesson plans last for 8 hours in total. The lesson plans were managed in 2 cycles.

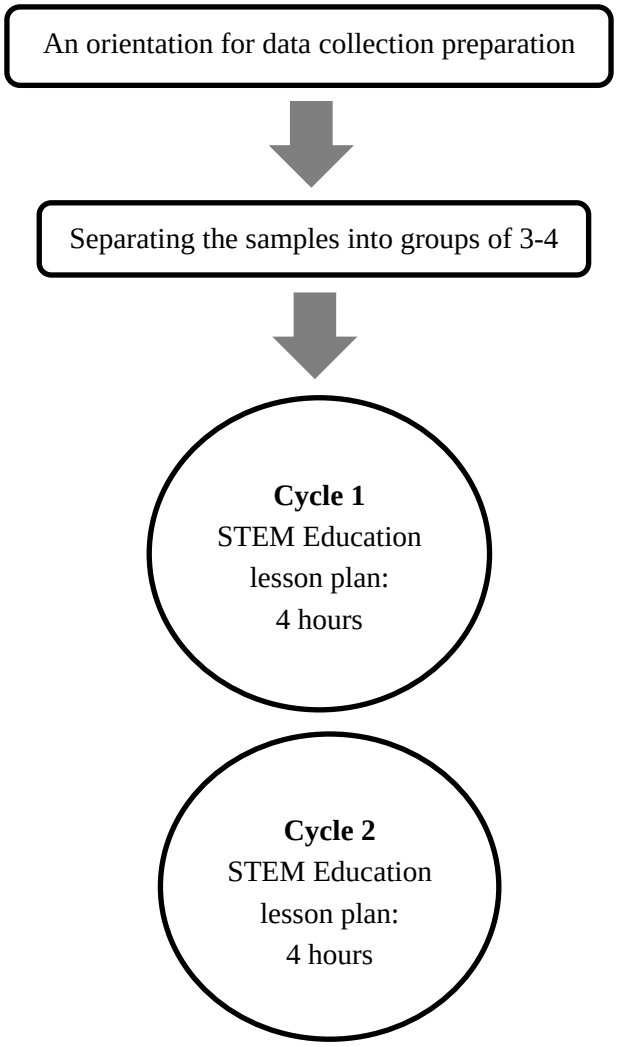

Figure 1. Research procedure

3.4 Data Analysis

Both quantitative and qualitative statistical methods were used for the data analysis. (1) Quantitative statistics included percentage and mean ($\bar{x}$). The creative thinking scores were

calculated by mean and percentage. The scores were benchmarked against the criterion of 70%. The results from the benchmark reflected the quality of the learning management. The results gave guidelines to improvement of the next cycle. (2) Qualitative statistics elaborates important findings by describing the students' behaviors from observations, interviews, and end-of-cycle creativity measurement. The results were analyzed, discussed, and concluded to versualize effective approaches or practices. The data obtained from the teacher's post-learning form was analyzed, interpreted, summarized, and reflected. The results gave guidelines to improvement of the next cycle.

4. Discussions

The development of creativity for grade 3 students via the STEM Education-based learning management in cycle 1 revealed that the 6 students had an average creativity score of 73.89. Four of them (66.67%) passed the criterion of 70%. Similarly, in cycle 2, the 2 target students had an average creativity score of 78.89. All of them (100.00%) passed the criterion of 70%. These findings indicated that the students gained higher creativity which was affected by the STEM Education-based learning management. As mentioned above, the STEM Education is integration of sciences, technology, engineering, and mathematics. The STEM Education allows learners to apply their knowledge to solve problems or situations that are connected to their daily lives. Researching, knowledge building, and communication enhance creativity and development of works. This sort of learning management also enables learners to build teamwork skills and technology skills to search for knowledge to support their learning. This is consistent with Naramitpanich (2017) who studied a design of the STEM Education lesson plans to improve the creative learning process in the science class of grade 2 students. The results of that previous research unveiled that the STEM Education lesson plans improved the students' thinking methods, question asking, problem solving, information retrieval skills, and new discovery analysis. They were found to have integrated scientific and mathematical knowledge into problem-solving. In addition, the STEM Education encouraged learners to explore and examine answers and have logical rational thinking. Learning skills are built and knowledge is linked to problem-solving approaches with a systematic thinking process. During the learning activities, an overview of contents was presented. The contents and their key elements and sub-elements were linked well. This helped the students view and explain relationships in the target contents. As a result, the students improved their creativity which is an important skill in living in the highly competitive 21st century. This discovery accorded with Sakulsri (2017) who examined the STEM Education-based learning management to promote creativity and achievement of grade 6 students. She found that the learning activities based on the concept of the STEM Education were an approach to boost the students' science learning achievements and creativity. The STEM Education-based learning management additionally encouraged them to work in groups, searching for knowledge by themselves, generating advanced thinking skills such as analytical thinking and creative thinking. More importantly, the students learned by doing. They were happy to learn and did cross-disciplinary integration. This is also consistent with Champawatta, Pansuppawat, and Choosup (2019) whose research was development of creative thinking of 3rd grade students on material and object lessons by the STEM Education-based learning management. The

samples were the 3rd grade students enrolled in Ban Nonsawan School, Don Ya Nang School Cluster under the jurisdiction of Bueng Kan Primary Educational Service Area Office in the academic year 2018. The sample class included 20 students obtained from cluster random sampling. The research instruments used in that previous research were lesson plans, a creativity measurement form, an achievement test, and a satisfaction questionnaire. The statistics used in the data analysis included mean, percentage standard deviation, and the t-test (Dependent Sample). That previous research found the improvement of the creative thinking of the 3rd grade students on materials and objects learned through the STEM Education-based learning management. The post-test score was greater than the pre-test one at a statistically significant level of .05. This indicated that they gained higher post- learning achievements at a statistically significant level of .05.

Based on the present and previous research, it can be concluded that the STEM Education-based learning management can promote and develop students' creativity due to their creativity scores improved in each cycle. Furthermore, the qualitative data obtained from the students confirmed that the progress of students resulted from the STEM Education-based learning management. This type of learning management made them enjoyable, active in learning, and interested in learning activities. During the activities, the students were set free to explore knowledge, to apply knowledge to problem-solving, and to design their own works. In addition, those activities promoted their teamwork skills. They accepted decisions of the group members. They all collaborated to solve assigned problems. There was collaboration within one group and across the groups. The students generated new ideas and had the courage to discuss and exchange them both within the group and between other groups. They were able to present their works in a logical way. Therefore, the STEM Education-based learning management can improve students' creativity.

5. Conclusions

In cycle 1, there were 6 target students. The STEM Education-based learning management was administered in 5 steps. These steps result from a study and synthesis of the teaching procedures of diverse researchers and educators. The findings showed that the 6 students had an average creativity score of 73.89. Four students (66.67%) passed the criterion of 70%.

In cycle 2, there were 2 target students. The STEM Education-based learning management was completed in the 5 steps again. However, the activities in each step were revised to fit the time limit. The findings revealed that the students had an average creativity score of 78.89. All of them (100.00%) passed the criterion of 70%.

6. Recommendations

6.1 For Implementations

(1) As the STEM Education-based learning management can promote students' creativity, teachers should practice this approach on a regular basis.

(2) In the designing and developing stages of the STEM Education-based learning management, activities should be appropriate and consistent with real problems or situations

so that students can apply them in daily life.

(3) To meet effective STEM Education-based learning, teachers must have a method in grouping students. This is to support cooperative learning. Books and materials must be available enough to allow students to explore and practice creative thinking.

(4) In the STEM Education-based learning management, students are provided with authentic experience through various activities. Some of them require a lot of time. Thus, teachers should implement those activities with appropriate flexibility to lead the learning process along with the development of creativity in accordance with the intended objectives.

6.2 For Further Research

(1) The STEM Education-based learning management should be incorporated into other subject matters or student levels to examine differences or changes in the development of students' creativity.

(2) A comparative study between the STEM Education-based learning management and other teaching approaches should be done. For instance, group learning, individual learning, and online learning can be compared in order to gain the most appropriate teaching approach.

(3) Activities of the STEM Education-based learning management should be designed in accordance with the school context, school environment, social conditions so that students can apply the knowledge gained to solve problems existing in their daily life.

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References

Champawatta, A., Pansuppawat, T., & Choosup, N. (2019). The development of creative thinking of Prathomsuksa 3 students on the topic of materials and objects by using STEM Education. *Journal of Curriculum and Instruction Sakon Nakhon Rajabhat University, 11*(31), 59-70. Retrieved from https://jci.snru.ac.th/ArticleViewFile?ArticleID=779&FileArticle=779-ArticleTextFile-20191125100730.pdf

Chuelooppo, S., Bongkotphet, T., & Warangkanagool, C. (2018). STEM Education through engineering design process for developing 10th grade students' creative thinking in rotational motion topic. *Social Sciences Research and Academic Journal, 13*(37), 119-132. Retrieved from https://so05.tci-thaijo.org/index.php/JSSRA/article/view/92815/96865

Dongsankaewdongsamran School. (2018). *Dongsankaewdongsamran School Curriculum (Revised Curriculum, B.E. 2561) based on the Basic Education Core Curriculum, B.E. 2551 (A.D. 2008)*. Amnat Charoen: Dongsankaewdongsamran School.

Hajeekhadae, A., Portjanatanti, N., Rorbkorb, N., & Waewthongrak, W. (2019). Effect of STEM Education approach on biology achievement, scientific creativity and instructional satisfaction of grade 11 students. *Journal of Education, Prince of Songkla University, Pattani Campus, 30*(1), 170-180. Retrieved from https://so02.tcithaijo.org/index.php/edupsu/article/view/186887/131500

Khwana, T., & Khwana, K. (2019). STEM Education for learning management to work skills in the 21st century. *Journal of Graduate School, 16*(73), 1-12. Retrieved from https://so02.tci-thaijo.org/index.php/SNGSJ/article/view/97029/137757

Leelasornchai, A., Panawong, C., & Kaewurai, W. (2018). The development of mathematics project-based learning activities based on STEM Education to enhance creative thinking and learning achievement on "probability" for grade 9 students. *Journal of Graduate Studies in Northern Rajabhat Universities, 8*(14), 165-182. Retrieved from https://so02.tci-thaijo.org/index.php/JGNRU/article/view/89694/102395

Loha, P., & Jongkonklang, S. (2019). The development of assertive behavior and creative thinking of early childhood students by STEM Education. *Ratchaphruek Journal, 17*(1), 121-128. Retrieved from https://so05.tci-thaijo.org/index.php/Ratchaphruekjournal/article/view/175226/125361

Muakmuenwai, J. (2017). Adapting traditional activities into STEM trend. *The Institute for the Promotion of Teaching Science and Technology Magazine, 45*(205), 50-53. Retrieved from https://emagazine.ipst.ac.th/205/IPST205/assets/common/downloads/IPST-Mag-205.pdf

Naramitpanich, P. (2017). *Designing the innovative learning management plans in the form of the STEM Education to develop the primary students' creative thinking learning processes in science class at the 2nd grade level* (Unpublished Master's thesis, Rajabhat Mahasarakham University, Mahasarakham, Thailand).

Panmanee, A. (2014). *Training to think, think creatively*. Bangkok: Chulalongkorn University Press.

Pengpit, P., Sukjairungwattana, T., & Chantaranamchoo, N. (2020). The factors relations the 21st century skills of undergraduate students in Kasetsart University, Kamphaeng Saen Campus. *Journal of Education. Silpakorn University, 18*(1), 319-338. Retrieved from https://so02.tci-thaijo.org/index.php/suedujournal/article/view/191001/165188

Phumkhonsarn, A. (2017). *A study of learning achievement and scientific creative thinking of 5th grade students by using STEM Education* (Unpublished Master's thesis, Rajabhat Maha Sarakham University, Mahasarakham, Thailand). Retrieved from http://fulltext.rmu.ac.th/fulltext/2560/124436/Phumkhonsarn%20Atitaya.pdf

Pimpala, S., & Seechaliao, T. (2018). Instructional approach STEM using social media to enhance creative thinking skills for primary 6 students. *Journal of Technology Management Rajabhat Maha Sarakham University, 5*(2), 71-82. Retrieved from https://ph02.tci-thaijo.org/index.php/itm-journal/article/view/125890/129964

Polyiem, T. (2018). STEM Education: Introduction to integrated classroom. *Journal of Faculty of Education Pibulsongkram Rajabhat University, 5*(2), 122-135. Retrieved from https://so02.tci-thaijo.org/index.php/edupsru/article/view/108253/109721

Promkham, S. (2020). *STEM Education on plant life for promoting creative thinking and learning achievement of grade 10th students* (Unpublished Master's thesis, Rajabhat Maha Sarakham University, Mahasarakham, Thailand). Retrieved from http://fulltext.rmu.ac.th/fulltext/2563/M128543/Promkham%20Sirinya.pdf

Roopchom, S., Chanunan, S., Warasing, A., & Kijkuakul, S. (2021). An action research on developing learning management in the topic of acid base using engineering design process following STEM Education to enhance grade 11 students' creativity and innovation skill. *Journal of Education Naresuan University, 23*(1), 308-320. Retrieved from https://so06.tci-thaijo.org/index.php/edujournal_nu/article/view/172261/167590

Sakulsri, S. (2017). *Learning activity management based on STEM Education for fostering creative thinking and students learning achievement at the 6th grade level* (Unpublished Master's thesis, Rajabhat Maha Sarakham University, Mahasarakham, Thailand). Retrieved from http://fulltext.rmu.ac.th/fulltext/2560/123195/Sakulsri%20Saowakhon.pdf

Sanegan, R., & Jasuwan, S. (2017). 21st century skill learning model development for creative thinking to primary school's students in Bangkok. *Journal of MCU Social Science Review, 6*(3), 86-99. Retrieved from https://so03.tci-thaijo.org/index.php/jssr/article/view/245653/166187

Siriwan, N. (2016). *STEM Education*. Bangkok: The National Assembly Radio and Television Broadcasting Station.

Suwanich, C. (2017). STEM Education and learning management for teacher students to provide 21st century learner's characteristics under Thailand Policy 4.0. *Journal of Education, Silpakorn University, 18*(15), 18-27. Retrieved from https://so02.tci-thaijo.org/index.php/suedujournal/article/view/174819/125137

The Institute for the Promotion of Teaching Science and Technology. (2014). *STEM Education*. Bangkok: The Institute for the Promotion of Teaching Science and Technology. Retrieved from http://www.stemedthailand.org/wp-content/uploads/2015/03/Intro-to-STEM.pdf

Torrance, E. P. (1974). *Torrance test of creative thinking: Directions guide and scoring manual*. Boston, MA: Personnel Press.

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