European Journal of Education Studies
ISSN: 2501 - 1111
ISSN-L: 2501 - 1111
Available on-line at: www.oapub.org/edu

doi: 10.5281/zenodo.575871 Volume 3 | Issue 5 | 2017

DESIGNING THE INNOVATIVE LEARNING MANAGEMENT PLANS IN FORM OF THE STEM EDUCATION INSTRUCTIONAL METHOD TO DEVELOP THE PRIMARY STUDENTS OF THEIR CREATIVE THINKING LEARNING PROCESSES IN SCIENCE CLASS AT THE 2ND GRADE LEVEL

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Abstract:
The purposes of this research study for designing the innovative learning management lesson plans in the form of the *STEM Education Method* (STEMe) on *Magnetic Force Issue* in science class which were to develop an innovative learning management lesson plan that based on the model of learning management with the STEMe, students' learning achievements of their assessing pretest and posttest techniques based on the STEMe were compared, students' creative thinking abilities (CTA) of their pre-CAT and post-CAT based on the model of learning management with the STEMe were assessed, and students' learning achievements of their assessing posttest and their creative thinking abilities based on the model of learning management with the STEMe were associated. Administering this research target group which a sample consisted of 32-primary students at the 2nd grade level in the second semester in the academic year 2016 from Rajabhat Maha Sarakham University Demonstration School under the Office of Higher Educational Commission was selected. Using a main *Innovative Learning Management Lesson Plan* (ILMLP) in the form of the STEMe in 14 hours was designed. Students' learning outcomes of their pretest and posttest assessments were obtained using the 30-item *Science Achievement Test* (SAT). Students' performances of their creative thinking

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abilities were determined using the 8-item *Creative Thinking Ability Assessment* (CTAA). Statistically significant with means, standard deviation, percentage, independent t-test, simple and multiple correlations of Pearson's movement correlation were analyzed. The results of these research finding have found that followed as: The innovative learning management plans in the form of the STEMe were evaluated to determine performance criteria with the efficiency of the processing performance and the performance results (E_1/E_2) of the ILMLP to management of students' activities in science class indicated that of 99.55/80.10. The average mean scores of students' post learning achievements was a higher than the learning outcomes of their pre-test with the LAT on Magnetic Force Issue were differentiated evidence at the 0.01 level, significantly. Comparisons between students' creativity thinking abilities of their pre-SAT and post-SAT assessments were assessed with the CTAA based on the model of learning management with the STEMe were differentiated that evidence of statistically significant at the 0.01 level. Associations between students' learning outcomes of their posttest (SAT) assessment and their creative thinking abilities (CTAA) toward science in science class were related of the variance in previous critical thinking abilities and science rerated that evidence of statistically significant at the 0.01 level.

Keywords: instructional design, the innovative learning management lesson plans, STEM education method, primary students, creative thinking learning processes, science class

1. Introduction

1.1 Education in Thailand

Education in Thailand is provided mainly by the Thai government through the Minister of Education from pre-school to senior high school. A free basic education of twelve years is guaranteed by the constitution, and a minimum of nine years' school attendance is mandatory. In 2009, the Ministry of Education announced the extension of a free, mandatory education to fifteen years. Formal education consists of at least twelve years of basic education, and higher education. Basic education is divided into six years of elementary education and six years of secondary education, the latter being further divided into three years of lower- and upper-secondary levels. Kindergarten levels of pre-elementary education, also part of the basic education level, span 2–3 years depending on the locale, and are variably provided. Non-formal education is also supported by the state. Independent schools contribute significantly to the general

education infrastructure. Administration and control of public and private universities are carried out by the Office of Higher Education Commission, a department of the Ministry of Education (UNICEF, 2016).

1.2 Rajabhat Maha Sarakham University

Founded in 1925, Rajabhat Maha Sarakham University is a non-profit public higher education institution located in the suburban setting of the large town of Maha Sarakham (population range of 50,000-249,999 inhabitants). This institution has also branch campuses in the following location(s): Nong Khai. Officially accredited/recognized by the Ministry of Education, Thailand, Rajabhat Maha Sarakham University (RMU) is a large (enrollment range: 10,000-14,999 students) coeducational higher education institution. Rajabhat Maha Sarakham University (RMU) offers courses and programs leading to officially recognized higher education degrees such as pre-bachelor degrees (i.e. certificates, diplomas, and associate or foundation degrees), bachelor degrees, master degrees, doctorate degrees in several areas of study. This 92 years old H.E. institution has a selective admission policy based on entrance examinations and students' past academic record and grades. The admission rate range is 50-60% making this Thai higher education organization an averagely selective institution. International students are welcome to apply for enrollment. RMU also provides several academic and non-academic facilities and services to students including a library, housing, sport facilities and/or activities, financial aids and/or scholarships, study abroad and exchange programs, as well as administrative services (Rajabhat Maha Sarakham University, 2015).

1.3 Rajabhat Maha Sarakham University Demonstration School

Many universities operate demonstration schools, also known as laboratory schools as part of their teacher-training programmes. These schools provide student teachers with practice-teaching opportunities, and are also used by the universities for education research and development. The Rajabhat Maha Sarakham University Demonstration School is older dedicated teacher-training schools in Thailand, which opened in 1973 that has since been created or re-dedicated. As it is effectively departments of the RMU demonstration school doesn't come under the direct authority of the Ministry of Education, and has a greater degree of freedom in their operations than most state schools. They are generally viewed as providing higher-quality education, and entry into this school is extremely competitive. The RMU Demonstration School structure is divided into four key stages: the first three years in elementary school, the 1–3 grade

levels are for age groups 7–9; the second level, the 4 through 6 grade levels are for age groups 10–12; the third level, 7–9 grade level, is for age groups 13–15. The upper secondary level of schooling consists of the 10–12 grade levels for age groups 16–18 and is divided into academic and vocational streams. The school year is divided into two semesters. The first begins in the beginning of May and ends in October; the second begins in November and ends in March.

1.4 Instructional Design

Instructional design is the practice of creating the instructional experiences which make the acquisition of knowledge and skill more efficient, effective, and appealing (Merrill, Drake, Lacy, and Pratt, 1996). The process consists broadly of determining the state and needs of the learner, defining the end goal of instruction, and creating some "intervention" to assist in the transition. The outcome of this instruction may be directly observable and scientifically measured or completely hidden and assumed (Mayer, 1992). Instructional Design (ID) is designed to provide information about *instructional design* principles and how they relate to teaching and learning. Instructional design (or instructional systems design), is the analysis of learning needs and systematic development of instruction. Resources on this site were created by Kearsley and Culatta (2014). Effective instructional designers are also familiar with a wide range of educational technology that can be used for delivering learning experiences. Instructional design models provide a method, that if followed will facilitate the transfer of knowledge, skills and attitude to the learner. Presenting content in a simple, meaningful way is the art of good instructional design with advances in technology; researcher team has increasing options for teaching STEM subjects, and also more avenues to share successful methods because STEM learning is great for building critical thinking and problem-solving skills. The challenge is how to engage the broad range of students in subjects that are complex and highly sequential design for the STEM education instructional design is the main purpose in this research study.

2. STEM Education

Provides nearly 4,000 science, technology, engineering and math resources for PreK-5, 6-12 as well as free, self-paced modules for teachers teaching global climate change to middle school and high school students are instructional designs. All 38 K-12 STEM programs included in this report provide challenging content/curriculum, an inquiry-learning environment, defined outcomes/assessment, and sustained

commitment/community support. Each program entry gives an overview, defines target population and learning environment, and presents highlights of results. Contact information is provided. Intel believes that young people are the key to solving global challenges. A solid math and science foundation coupled with skills such as critical thinking, collaboration, and problem solving are crucial for their success. To help educators foster the next generation of innovators, Intel provides STEM curriculum, competitions, and online resources to encourage students' interest and participation (New Jersey Technology and Engineering Educator Association, 2015).

Students are extremely curious and impressionable, so instilling an interest at an early age could spark a lasting desire to pursue a career in any of these fields. By the time a student is ready to enter the work force, they must have enough knowledge to make invaluable contributions to our nation's STEM education. It is also important that schools have an ample amount of teachers who are experts in STEM, and these subjects should always be considered as high demand subjects. Student learning outcome performances clearly state the expected knowledge, skills, attitudes, competencies, and habits of mind that students are expected to acquire at an institution of higher education. Transparent student learning outcomes statements are; specific to institutional level and/or content level, clearly expressed and understandable by multiple audiences, prominently posted at or linked to multiple places across the other context, to be updated regularly to reflect current outcomes, and to be receptive to feedback or comments on the quality and utility of the information provided.

3. STEM Education in Thailand

Students are expected to be equipped for the 21st century, including necessary work skills, creativity and the ability to bring innovation and competence to the IT sector, but the number of those studying science and technology falls at every grade level. The Institute for the Promotion of Teaching Science and Technology (IPST) has initiated a new approach by emphasizing knowledge and skills which are suitable to professional life in a highly competitive economy and society. This is known as STEM education. STEM education is a learning innovation in which science, technology, engineering and mathematics are integrated. This approach engages learners in applying knowledge to problems in daily life, as well as finding new processes or solutions to benefit their lives and occupations through project-based and problem-based learning activities. According to IPST director Pornpun Waitayangkoon, learners with experience in STEM activities or projects will be better prepared to work in demanding positions in various sectors including agriculture, industry, energy,

environmental management, health services and transportation. STEM education should be not offered only to high school students who are going to enter university, because of the 12 million students nationwide, only 25-30% goes to university, while the rest are those who finish a compulsory nine-year education, are vocational certified or high school students. A majority of the country's workforce have studied nine or 12 years. The STEM Education Network objectives are to encourage integrated learning activities and enhance student creativity and application of knowledge in daily or professional life, and to establish a collaborative network of public and private organizations and personnel in promoting STEM education in Thailand (Boonruang, 2015).

3.1 Lesson Plans

A lesson plan is the instructor's road map of what students need to learn and how it will be done effectively during the class time. Before you plan your lesson, you will first need to identify the learning objectives for the class meeting. Then, you can design appropriate learning activities and develop strategies to obtain feedback on student learning. A successful lesson plan addresses and integrates these three key components: Objectives for student learning, Teaching/learning activities, and Strategies to check student understanding are provided. Specifying concrete objectives for student learning will help determine the kinds of teaching and learning activities and to use in class, while those activities will define how teachers will check whether the learning objectives have been accomplished (Milkova, 2012). In this research study, we were designed the steps for preparing a main lesson plan with the STEM education instructional method to create in six steps, which each step was accompanied by a set of questions meant to prompt reflection and aid you in designing your teaching and learning activities.

3.2 Designing the Innovative Learning Management Plans

At the heart of the learning management concept is the notion of 'design with intended outcomes'. In this sense 'learning management' emphasizes the 'learning' rather than the 'learner, so that the learner actually achieves something. Drawing on the metaphor of design, Learning management can be characterized as an artful arrangement of materials and circumstances into a planned form; a goal-directed problem-solving activity devised by a learning manager the teacher construct in a knowledge and creative economy to benefit the learning of all learners. Put simply, learning management is about generating defined learning outcomes into tangible learning gains

for learners. Its intent of the design metaphor is to provide learning managers with processes that enable them to respond creatively to cultural change within their discipline and so recreate what it means to be a 'teacher' in the 21st century epoch (Lynch and Smith, 2006).

3.3 Creative Thinking Ability

Creative thinking means thinking about new things or thinking in new ways. It is "thinking outside the box." Often, creativity in this sense involves what is called lateral thinking, or the ability to perceive patterns that are not obvious. The fictional detective Sherlock Holmes used lateral thinking in one famous story when he realized that a dog *not* barking was an important clue in a murder case (Doyle, 2017). Creative people can devise new ways to carry out tasks, solving problems, and meet challenges. They bring a fresh and sometimes unorthodox perspective to their work and can help departments and organizations to move in directions that are more productive.

In this research study, focused on Guilford' work; he was an early proponent of the idea that intelligence is not a unitary concept. Based on his interest in individual differences, he explored the multidimensional aspects of the human mind, describing the structure of the human intellect based on a number of different abilities. His work emphasized that scores on intelligence tests cannot be taken as a unidimensional ranking that some researchers have argued indicates the superiority of some people, or groups of people, over others. In particular, Guilford showed that the most creative people may score lower on a standard IQ test due to their approach to the problems, which generates a larger number of possible solutions, some of which are original. Guilford's work, thus, allows for greater appreciation of the diversity of human thinking and abilities, without attributing different value to different people (Guilford, 1980). In this research study, adapted version of Guilford's creative thinking skill test of his work in students' intelligence and creativity to the 8-item Creative Thinking Ability Assessment (CTAA) in 4 scales in science class for assessing students of fluency, flexibility, originality, and elaboration ability scales were used.

3.4 Creativity in STEM Education

Most of students who think of science and engineering as the exact opposite of art and creativity; those students are not scientists or engineers. Designing a more efficient assembly-line robot, writing an innovative new computer program, and developing a testable hypothesis are all highly creative acts. In fact, the history of science and technology are littered with projects that did not work, not because of any errors in

technique or methodology, but rather because people remained stuck in assumptions and habits of mind. Science and engineering need radical creativity in order to do anything new. Opportunities for creative thought in the workplace vary from the obviously artistic to the highly technical and yet inspired. Generally, anything that involves an "aha!" moment at some point is creative. See if anything on this list inspires you. Maybe you are already more creative than you thought (Doyle, 2017).

3.5 Selected of the Context of the Strand and Learning Standard in Science Learning Area

Observance of the principles of development of the brain and multiple intelligences is required to achieve learners' balanced development that has therefore prescribed the following eight learning areas: Thai Language; Mathematics; Science; Social Studies, Religion and Culture; Health and Physical Education; Art, Occupations and Technology; and Foreign Languages. In terms of the Strands and Learning Standards in Science learning core, which it contains of eight Strands and 13 Learning Standards. In this research study would be selected at the Strand 4: Forces and Motion that focused on the Standard SC4.2: Understanding of the characteristics and various types of motion of natural objects; having investigative process for seeking knowledge and scientific reasoning; transferring and putting the knowledge into practice was selected of the context of content limitation at the first phase. This research study will selected on *Magnetic Force Issue* in science class in the context for developing the designing the innovative learning management plans in form of the STEM education instructional method to develop the primary students of their creative thinking learning processes in science class at the 2nd grade level

3.6 Learning Problems in Rajabhat Maha Sarakham University Demonstration School

Based on the study of contextual problems of Rajabhat Maha Sarakham University Demonstration School was reported. Overall, it was found that students lack understanding about science, can't be used in everyday life of their bringing ideas to change the ways in which the original education. It is essential that the educator, relevant teachers, administrators, and administrators will have to analyze and understand thoroughly in order to be used correctly. Implementation of STEM education method to deploy that it based on a survey of problems within in the science classroom, lack of teamwork skills, lack of cooperation, lack of tolerance, lack of commitment to work, no enthusiasm for learning, interested in what is around the

teacher. This makes the child do not develop any and it is important to lack creative thinking. This significantly affects the students' achievements and behaviors. Inclusion of all problems will form and be aggravated when studying at the next level. The researcher has made the model of education in STEM education, to help developing education in school. To develop students' academic achievement and develop their creativity to be a foundation for the nation in the future is designed. In addition, STEM Education is one of the most popular concepts in the present. This is an integrated approach to education with the introduction of Science, Technology, Engineering (Engineering) and Mathematics (Mathematics) together.

4. Methodology

The policy of the *Basic Education Core Curriculum* B.E. 2551 (A.D. 2008) for learners' quality of primary learners at the grade 3 graduates are: to pose questions about living things, materials and objects as well as various phenomena in the surroundings; observe, explore and verify with the use of simple instruments, and communicate what has been learned through story-telling, writing or drawing pictures, and to apply scientific knowledge and processes in life and search for additional knowledge; implement the projects or work assignments as prescribed or in accord with their interests. The grade level indicators for the 2nd grade level are focused on experiment and explain forces originating from a magnet, to explain application of magnets for useful purposes, and to be able to their experiment and explain electrical forces resulting from rubbing some kinds of materials. So that research team was designed the innovative learning management plans in form of the STEM education instructional method to develop the primary students of their creative thinking learning processes in science class, to develop on experiment and explain forces originating from a magnet activities with the STEM Education is a learning management system that integrates interdisciplinary knowledge, including science, technology, engineering, and mathematics to bring knowledge to use real life problems, including future careers.

5. Research Aims

1. To develop an innovative learning management plan that based on the model of learning management with the STEM Education method.

2. To compare between students' learning achievements of their assessing pretest and posttest techniques based on the model of learning management with the STEM Education method.
3. To assess of the students' learning outcomes to their creativity thinking abilities based on the model of learning management with the STEM Education method.
4. To associate between students' learning achievements of their assessing posttest and their creative thinking abilities based on the model of learning management with the STEM Education method.

6. Research Procedures

6.1 Designing the Instructional Innovative Lesson Plans

Using the six steps for preparing a lesson plan to create a learning plan for learning management with learning process in STEM education in science content in science curriculum at the 2nd grade level in *Strand 4*: Forces and Motion and Standard Sc4.1 on Magnetic Force Issue with a main instructional innovative lesson plan for 11 sub-lesson plans were designed in time learning schedule total of 14 hours. This lesson plan is central to a successful lesson, research team knows what we have to cover in a lesson, but how will we do so and keep students engaged? Follow these simple steps to preparing a lesson plan, and hopefully.

Step I: Asking ourselves what we want our students to learn in each lesson, Think about the activities you can use in class to achieve the learning objectives.

Step II: Introducing the topic to the class? we could give a brief outline of what we want to cover in the lesson, or we can ask the students what they know already about the topic.

Step III: Timing an introduction and activities is vital to a successful lesson. Work out in advance what the difficulties might be and allow more time for these aspects of the lesson than for other, easier to grasp concepts and idea.

Step IV: Planning how we will check that students have understood the main points covered in the lesson. Of course, integral in lesson planning is having time to answer students' questions, or allowing another student to answer and explain.

Step V: Finding a way of summarizing what has been covered in a lesson. We can either do these ourselves, or elicit what they have learned from our students.

Step VI: Leaving time at the end of the lesson to recap and to explain what will be covered in the next lesson and how this will build on what students learned in the

present one. Also answer any queries that the students still have at the end of the lesson.

Applying the learning plan to the board to consider giving suggestions on the defective part was checked by the 5-professional experts who assessed the appropriateness and consistency of the content on each event process learning, media measurement and evaluation by content experts through the science curriculum and instruction and evaluation of the quality and appropriateness of the learning activities plan.

7. Research Instruments

7.1 The Science Achievement Test (SAT)

The 30-item *Science Achievement Test* (SAT) was assessed students' learning achievements to measure their pretest and posttest assessments with the innovative instructional lesson plans based on the model of learning management in the STEM Education Method that composed of the content: the shape of the magnet, magnetic force, magnetic field, permanent magnets and temporary magnets, the north-south orientation poles of the magnet, the magnetic parts attract good objects, how to magnetize iron as much as possible, and the use of magnets. The SAT is a multiple choice with 3 options.

7.2 The Creative Thinking Ability Assessment (CTAA)

Using the original version of the original of the Guilford's intelligence work; the *Guilford Divergent Thinking Questionnaire* was adapted to assess students' performances of their creative thinking abilities with the 24-item Creative Thinking Ability Test (CTAT) in 4 scales, namely *Fluency Thinking* (the ability to produce great number of ideas or problem solutions in a short period of time); *Flexibility Thinking* (the ability to simultaneously propose a variety of approaches to a specific problem); *Originality Thinking* (the ability to produce new, original ideas); *Elaboration Thinking* (the ability to systematize and organize the details of an idea in a head and carry it out) were built. Each scale consists of 6 items and the three response alternatives are: *Sometimes, Often* and *Very Often*.

7.3 The Rater Agreement Index (RAI)

Under the heading of reliability, most textbooks refer to classical reliability indexes as appropriate measures for determining interpreter agreement. It is argued that

interpreter agreement is a psychometric property that is theoretically different from classical reliability. Interpreter agreement indexes measure the degree to which two or more raters agree on the observation of one or more behaviors on one or more subjects and are not theoretically related to classical test theory. A detailed set of formulas is presented to illustrate a set of algebraically equivalent rater agreement indexes that are intended to provide the educational and psychological researcher and practitioner with a practical means of establishing a measure of rater agreement. The formulas are illustrated with a data set. The formulas can be used for dichotomous and continuous data for two or more raters, on one or more subjects, on one or more behaviors. These rater agreement indexes are useful with performance assessments such as observations, portfolios, performance evaluations, essay writing evaluations, authentic assessments, and so on, where multiple facets impact rater agreement (Burry-Stock, Shaw, Laurie, and Chissom, 2017).

7.4 Target Group

The target group for this research study was the primary students who sat at the 2nd grade level which sample size of 32 students in a science class in the second semester of academic year 2016 at Rajabhat Maha Sarakham University Demonstration School under the Office of Higher Education Commission.

7.5 Data Analysis

The *Instructional Innovative Lesson Plans* in form of the STEM education instructional method were analyzed with the IOC technique to assess the appropriateness and consistency of the science content. To analyze the effectiveness of the innovative instructional lesson plans based on the model of learning management in a STEM Education Method with the processing and performance resulting effectiveness at E1/E2 criteria. Students' learning achievements and their creative thinking ability test were analyzed with means, standard deviation, percentage, independent t-test, simple and multiple correlations of Pearson's movement correlation.

8. Results

The designing the innovative learning management plans in form of the STEM education instructional method to develop the primary students of their creative thinking learning processes in science class at the 2nd grade level aimed to develop an innovative learning management plan that based on the model of learning management

with the STEM Education method, to compare between students' learning achievements of their assessing pretest and posttest techniques based on the model of learning management with the STEM Education method, to assess of the students' responses of their pre and post creativity thinking abilities based on the model of learning management with the STEM Education method, and to associate between students' learning achievements of their assessing posttest and their creative thinking abilities based on the model of learning management with the STEM Education method. Administering this research target group which a sample consisted of 32-primary students at the 2nd grade level in the second semester in the academic year 2016 from Rajabhat Maha Sarakham University Demonstration School under the Office of Higher Educational Commission was selected. Students' performances and responses with a main *Innovative Learning Management Lesson Plan* (ILMLP) in the form of the STEMe in 14 hours were designed. Students' learning outcomes of their pretest and posttest assessments were obtained using the 30-item *Science Achievement Test* (SAT). Students' performances of their creative thinking abilities were determined using the 8-item Creative Thinking Ability Assessment (CTAA).

Statistically significant with means, standard deviation, percentage, independent t-test, simple and multiple correlations of Pearson's movement correlation were analyzed. The results of these findings have followed as:

8.1 The Effectiveness of the Innovative Instructional Lesson Plans

The effectiveness of the innovative instructional lesson plans based on the model of learning management of the STEM Education Method for administering learning management with a sample of 32 primary students at the 2nd grade level in science class with the processing and performance resulting effectiveness at 80/80 criteria. Table 1 reports of the effectiveness of the innovative instructional lesson plans.

As reports in Table 1 shows the results for the effectiveness of the innovative instructional lesson plans based on the model of learning management in the STEM Education Method. Effectiveness of lessons during the learning process (E1) reveals of 99.55 and the performance effectiveness (E2) indicate that of 80.10, so the lessoning effectiveness (E1/E2) evidences of 99.55/80.10 over the threshold setting is 80/80.

Table 1: Score Total, Mean, Standard Deviation, and Percentage for the Effectiveness Innovative Instructional Lesson Plans for the STEM Education Method

Efficiency Type	Total Score	$\overline{X}$	S.D.	Percentage
Efficiency Performance Processes (E1)	132	131.40	8.43	99.55
Efficiency Performance Results (E2)	30	24.03	24.03	80.10
The Lessoning Effectiveness (E1/E2) = 99.55/80.10				

N = 32

8.2 Validations of the SAT and CTAA

A. Validations of the SAT

The calculating value of the *Index of Item Objective Congruence* (IOC) must be omitted and ranged from 0.50 to 1.00. The 30-item *Science Achievement Test* (SAT) were assessed by the 5-professional experts and found that the IOC of the SAT was 0.06 - 1.00. The acceptable accuracy must be 0.80 or higher. It appears that the research plan developed by the researcher has an average ranged from 3.60 to 5.00, which was moderate to the highest and the difficulty ranged from 0.47 to 0.83 and discriminative validity ranged from 0.20 to 0.65

B. Validations of the CTAA

Students' performances of their creative thinking abilities were assessed using the 8-item Creative Thinking Ability Assessment (CTAA). The internal consistency (Cronbach alpha coefficient) was obtained for the sample in this present study as indices of scale reliability is 0.86.

8.4 Comparisons between Students' Learning Achievements of their Pretest and Posttest Assessments with the Innovative Instructional STEM Education Method

To compare between students' learning achievements of their pretest and posttest assessments with the innovative instructional lesson plans based on the model of learning management of the STEM Education Method. Using the 30-item *Science Achievement Test* (SAT) was assessed. Table 2 reports the statistically significance of the difference between students' learning outcomes of their pretest and posttest assessments. Using paired comparisons between different assessments of the same SAT as reports in Table 2.

Table 2: Average Mean, Standard Deviation, Mean Difference for the PPAT

Assessing Test	Total score	($\overline{X}$ =30)	Standard Deviation	Mean Diff.	*t*-Value	Sig. (ρ)
Pretest		11.03	2.32	13.00	15.35***	.000
Posttest		24.03	2.46			

N = 32, *ϱ < 0.05, **ϱ < 0.01, ***ϱ < 0.001

Students' learning achievements, the district would need assessments at two points in time, the average mean scores of pretest of 11.03 and posttest revealed as 24.03. In most case, the standard deviation for the pretest as 2.32 and for the posttest as 2.46, and the mean difference between pre-tests and post-tests of 13.00 were compared. It also provides support the learning management in a STEM Education Method that teacher needed to take differences into consideration when planning and designing science with the independent t-test, significantly ($\rho < 0.001$).

8.5 Designing the STEM Education Instructional Activities for Developing the Primary Students of their Creative Thinking Learning Processes in Science Class

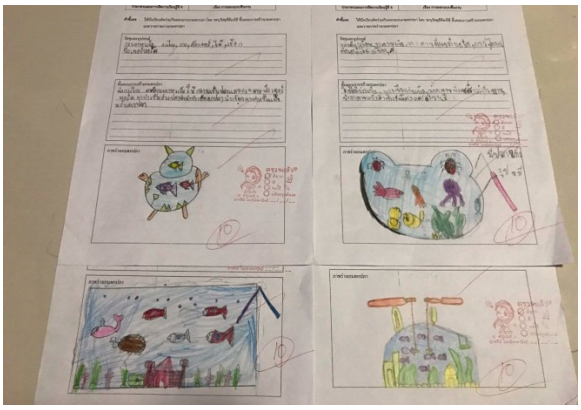
The designing the innovative learning management plans in form of the STEM education instructional method for managing learning activities according to the concept of science learning on magnetic force issue for primary students at the 2nd grade level, there are four creative ideas, namely; *Originality Thinking, Flexibility Thinking, Fluency Thinking, and Elaboration Thinking* scales.

A. Students' Responses of their Originality Thinking Scale

Originality thinking is the ability to produce new and original ideas; students' responses of their exotic idea were not unique to the original by students to design toys, fishing games. Using the ideas of exotic images 1 and 2 would be seen that students have different ideas in designing fishing games. According to each person's imagination, ratings are based on the frequency of duplicate designs. If students design fishing games like no other, they would have got score higher than many duplicates.

Students dare to show courage and try new things, would be used observation to answer questions in the classroom, exceptional expressions, students practice courage, dare to present new ideas by two teachers who would help to observe and take note and rate to answer and commenting (see in Figure 1.)

Students were designing fishing game toys using exotic ideas to their originality thinking



Student workbook on toy game design, using exotic ideas to their originality thinking

Students dare to comment after doing experimental activities

Most of students have the courage to think and dare to express different opinions from the classroom

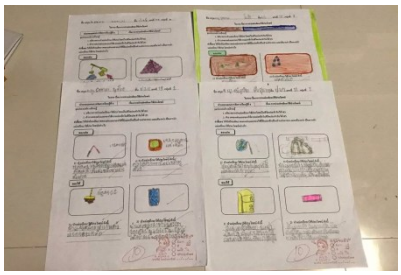
Figure 1: Students' responses of their originality thinking scale with their innovative learning management plans in form of the STEM education instructional method

B. Students' Responses of their Flexibility Thinking Scale

The flexibility thinking is the ability to simultaneously propose a variety of approaches to a specific problem. Students try to find many answers. Initially, the researcher showed the students a magnetic experiment from Figure 2, with the students to test the magnetism and unattractive when the activity was finished. The researcher team has summarized the knowledge of magnetic materials to students. Then, the researcher would use the activity to show students skills, to give the word "magnetic substance." Then, let students think of something with magnetic material were thought. This would lead students to multi-directional thinking. What type of magnetism can be magnetized? For example, magnetic materials that attract magnetism are nickel, cobalt, iron, etc. Magnetic materials are not attracted to gold aluminum paper then would be evaluated by researcher team. Students can think of one thing, there are many things to do in the work that they have created students brainstorm what can they would be

done to magnetism? Students have paint and told the benefits of toys made from the magnet also use the question? (see in Figure 2).

The first step in form of the STEM Education for their flexibility thinking abilities' activities



Students' drawing and creating ideas of their performances for their flexibility thinking abilities' activities

Groups' discussions for their flexibility thinking abilities' activities in science class

Figure 2: Students can create and think of one thing to many things to do in their work for their flexibility thinking abilities' activities

C. Students' Responses of their Fluency Thinking Scale

Fluency thinking ability reveals that the ability to produce great number of ideas or problem solutions in a short period of time. The ability of a person to think quickly and to respond in large quantities in a limited time to be divided by the researcher team for the assessing the maneuverability would be reported into two parts: students' responses of their fluency thinking ability in the words were wised whose they can use words fluently, researcher team used one minute oral quiz to answer questions by identifying materials with magnets can attract to measure the skill of thoughtful words. If a student was able to identify 10 or more magnetically attracted materials, they would be given a full 5 score points and then reduced to the next, respectively. In terms of the fluency in thinking, students can think what they want within the time limit, using this method of measuring skills by using a method to write materials that contain magnetic materials were identified (see in Figure 3).

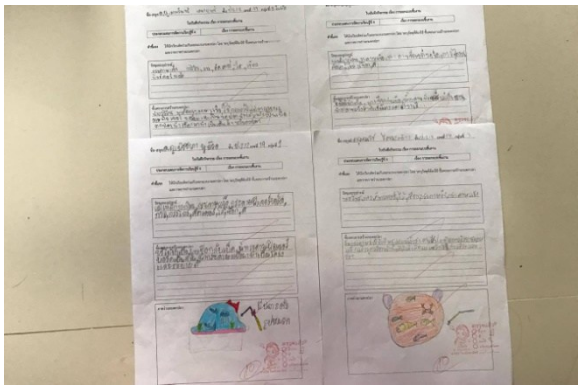
Students' oral quiz to answer questions by identifying materials

Students can think what they want within the time limit. Use this method of measuring skills by using a method to write materials that contain magnetic materials.

Figure 3: Fluency thinking ability indicates that the ability to produce great number of ideas or problem solutions in a short period of time

D. Students' Responses of their Elaboration Thinking Scale

Elaboration thinking ability is the ability to systematize and organize the details of an idea in a head and carry it out. This thinking ability response with the ideas in detail to decorate or expand the core idea to get more meaningful, thoughtfulness is a necessary feature in creating a work of novelty. Students try to use ideas and coordinate ideas together to make a contribution. Students have the discretion to think and expand the core ideas to be more complete. It is estimated from fishing games are detailed, elaborate, fully decorated, invention of fishing games that it helps to promote students' thoughts, successfully See in Figure 4).



Students try to use ideas and coordinate ideas together

Invention of fishing games was helped to promote students' thoughts, bring ideas from extended design. Need ideas prudent work to make the job succeed

Students invented fishing game by the idea prudent work to make the job succeed with the elaboration thinking abilities

Sample of Fishing Game Inventions for students' elaboration thinking abilities

Figure 4: Students' responses of their elaboration thinking abilities to think and expand the core ideas to be more complete with the fishing games

8.6 Assessments of Students' Creativity Thinking Abilities Based on the Model of Learning Management with the STEM Education Instructional Method

As above, the stage of the total creative evaluation of the second grade primary students with the qualitative and quantitative methods; observation of the worksheet, students' responses of their answers in the classroom, toy game fishing design was including the invention of fishing games itself; the assessment of student creativity was designed. There was an assessment of student creativity after their studying with the learning activities of their STEM instructional method. Table 3 reveals of students' performances of their creative thinking abilities with the 8-item Creative Thinking Ability Assessment (CTAA) in 4 scales, namely *Fluency Thinking* (the ability to produce great number of ideas or problem solutions in a short period of time); *Flexibility Thinking* (the ability to simultaneously propose a variety of approaches to a specific problem); *Originality Thinking* (the ability to produce new, original ideas); *Elaboration Thinking* (the ability to systematize and organize the details of an idea in a head and carry it out) with the average means scores, standard deviation, and signification of the means were analyzed of the assessing students' post creativity was conducted learning activities based on the concept of the STEM education method on Magnetic Force Issue for primary students at the 2nd grade level that it reports in Table 3.

Table 3: Scale means' score, means, standard deviations, scale internal consistency (Cronbach Alpha Reliability), discriminant validity and F-test for the CTAA

Scale	Average mean (5)	Standard deviation	Cronbach alpha reliability	Discriminant validity	Signification
Originality Thinking	3.25	2.27	0.73	0.81	Moderate*
Flexibility Thinking	4.33	1.53	0.84	0.78	High**
Fluency Thinking	4.23	1.41	0.82	0.78	High**
Elaboration Thinking	3.86	2.09	0.78	0.80	High**
Average Total	3.91	2.34	0.86		High**

N = 32, *ϱ < 0.05, **ϱ < 0.01, ***ϱ < 0.001

The results given in Table 3 show the mean scores for each of the four CTAA scales. As each scale has two items. The average mean scores ranged from 3.25 to 4.33 and average total score as 3.91, respectively. Table 3 reports the internal consistency which ranged from 0.73 to 0.84 when using the actually scores. As reported in Table 3, the discriminant validity coefficients (the mean correlation of a scale with the other scales) of students' creative thinking abilities ranged from 0.73 to 0.81. These figures suggest that the scales of the CTAA measure distinct although somewhat overlapping aspects of the creative thinking abilities. The statistically significant in signification was reflected students' responses of their creative thinking abilities for the CTAA of variability at level of 0.01.

8.7 Assessment of Students' Creativity with the Confidence of the Observers Using the RAI Consensus Index

Focused on the results of creative thinking abilities of students' performances were observed by the 2-observators, using the RAI consistency index was selected after the learning activities with the STEM instructional method were implemented. Researcher team used the *Rater Agreement Index* (RAI) as an index of agreement level of scores gained from two or more raters.

Table 4: Means and Standard Deviation for the Rater Agreement Index (RAI)

Scale	Mean **($\bar{X}$)**	S.D.	RAI Index
Originality Thinking	3.25	2.27	0.99***
Flexibility Thinking	4.33	1.53	0.99***
Fluency Thinking	4.23	1.41	0.99***
Elaboration Thinking	3.86	2.09	0.99***
Average Total	3.91	2.34	0.99***

N = 32, *ϱ < 0.05, **ϱ < 0.01, ***ϱ < 0.001

This index has a value from 0 to 1. If its value is nearly to 1, it means the raters have a strong agreement in scoring. On the other hand, if its value is nearly to 0, it means that that agreement is not strong. Thus, if the raters are trained and have a good knowledge of scoring, this index can indicate the standard of those scoring rubrics. Using the RAI consistency index, the RAI value was ***0.99.*** This means that the learners' creativity assessment form has a very consistent index used to evaluate creativity.

8.8 Associations between Students' Post-Learning Achievements and their Post-Creative Thinking Abilities with the Innovative STEM Education Instructional Method

Given the potential for students' learning achievements of their posttest assessment to their performances of their creative thinking abilities with the innovative instructional lesson plans based on the model of learning management in a STEM Education Method in science class, other student, teacher and classroom qualities were explored to determine their relationship with students' performances of their creative thinking abilities. Correlation's studies identified significant differences in students' learning achievements and their performances according to achievements made etc. In this study, it was also considered important to investigate associations that involved simple correlation and multiple regression analyses of relationships as a whole reported in Table 5.

Table 5: Associations between Students' Posttest Achievements for the SAT and their CTAA in Term of Simple Correlation (r), Multiple Correlations (R) and Standardized Regression Coefficient (β)

Variables	Mean ($\overline{X}$ = 100)	S.D.	Simple Correlation (r)	Standardized Regression Validity (β)	Multiple Correlation (R)	Efficiency Predictive Value (R^2)
Posttest Assessment (SAT)	80.10	8.05	0.37**	0.38**	0.6161**	0.3796**
CTAA	78.36	10.38				

N = 32, *ϱ < 0.05, **ϱ < 0.01, ***ϱ < 0.001

Simple correlation and multiple regressions analyses were conducted to examine whether associations exists between students' learning achievements of their posttest assessment to their performances of their creative thinking abilities with the innovative instructional lesson plans based on the model of learning management in a STEM Education Method. Table 6 shows the correlations between posttest assessment (SAT) and towards science. The CTAA creative thinking abilities among four scales were relative significantly, when using a simple correlation analysis (r) and standardized regression validity (β). The multiple correlations (R) was 0.6161 and the predictive efficiency (R^2) value indicated that 38% of the variances in students' creative thinking abilities to their science classes were attributable to their post learning achievement in their science classroom environment. The proportion of the variance in the dependent variable (SAT) that is predictable from the independent variable (CTAA), which it provides a measure of how well observed outcomes are replicated by the STEM education method, based on the proportion of total variation of students' learning outcomes explained by the STEM Education instructional model.

9. Conclusions

This research study was to design the innovative learning management plans in form of the STEM education instructional method to develop the primary students of their creative thinking learning processes in science class at the 2nd grade level. The aims of this research study were to develop an innovative learning management lesson plan that based on the model of learning management with the STEMe, students' learning achievements of their assessing pretest and posttest techniques based on the STEMe were compared, students' creative thinking abilities (CTA) of their pre-CAT and post-CAT based on the model of learning management with the STEMe were assessed, and

students' learning achievements of their assessing posttest and their creative thinking abilities based on the model of learning management with the STEMe were associated. Administering this research target group which a sample consisted of 32-primary students at the 2nd grade level in the second semester in the academic year 2016 from Rajabhat Maha Sarakham University Demonstration School under the Office of Higher Educational Commission was selected. Using a main *Innovative Learning Management Lesson Plan* (ILMLP) in the form of the STEMe in 14 hours was designed. Students' learning outcomes of their pretest and posttest assessments were obtained using the 30-item *Science Achievement Test* (SAT). Students' performances of their creative thinking abilities were determined using the 8-item *Creative Thinking Ability Assessment* (CTAA). Statistically significant with means, standard deviation, percentage, independent t-test, simple and multiple correlations of Pearson's movement correlation were analyzed.

Instructional Design (ID) is designed to provide information about *instructional design* principles and how they relate to teaching and learning. Instructional design (or instructional systems design), is the analysis of learning needs and systematic development of instruction. Resources on this site were created by Kearsley and Culatta (2014). Effective instructional designers are also familiar with a wide range of educational technology that can be used for delivering learning experiences. Instructional design models provide a method. Students are extremely curious and impressionable, so instilling an interest at an early age could spark a lasting desire to pursue a career in any of these fields. By the time a student is ready to enter the work force, they must have enough knowledge to make invaluable contributions to our nation's STEM education. According to the IPST, learners with experience in STEM activities or projects will be better prepared to work in demanding positions in various sectors including agriculture, industry, energy, environmental management, health services and transportation. STEM education should be not offered only to high school students who are going to enter university, because of the 12 million students nationwide, only 25-30% goes to university, while the rest are those who finish a compulsory nine-year education, are vocational certified or high school students. Its intent of the design metaphor is to provide learning managers with processes that enable them to respond creatively to cultural change within their discipline and so recreate what it means to be a 'teacher' in the 21st century epoch.

The 30-item *Science Achievement Test* (SAT) was assessed students' learning achievements to measure their pretest and posttest assessments with the innovative instructional lesson plans based on the model of learning management in the STEM Education Method. Adapted version of Guilford's creative thinking skill test of his

work in students' intelligence and creativity *to the 8*-item *Creative Thinking Ability Assessment* (*CTAA*) in 4 scales in science class for assessing students of fluency, flexibility, originality, and elaboration ability scales were used. Using the six steps for preparing a lesson plan to create a learning plan for learning management with learning process in STEM education in science content in science curriculum was selected on *Magnetic Force Issue* in science class in the context for developing the designing the innovative learning management plans in form of the STEM education instructional method to develop the primary students of their creative thinking learning processes in science class at the 2nd grade level. Interpreter agreement indexes measure the degree to which two or more raters agree on the observation of one or more behaviors on one or more subjects and are not theoretically related to classical test theory was assessed with the *Rater Agreement Index (*RAI) by researcher team. The internal consistency (Cronbach alpha coefficient) was obtained for the sample in this present study as indices of reliability for the SAT and CTAA.

The results for the effectiveness of the innovative instructional lesson plans based on the model of learning management in the STEM Education Method were found. Effectiveness of lessons during the learning process (E1) reveals of 99.55 and the performance effectiveness (E2) indicate that of 80.10, so the lessoning effectiveness (E1/E2) evidences of 99.55/80.10 over the threshold setting is 80/80. Students' learning achievements of their pretest and posttest technique, it also provides support the learning management in a STEM Education Method that teacher needed to take differences into consideration when planning and designing science with the independent t-test, significantly ($\rho < 0.001$). Students' responses of their four creative ideas, namely; *Originality Thinking, Flexibility Thinking, Fluency Thinking, and Elaboration Thinking* abilities indicated that at a high quality level. Associations between students' post-learning achievements and their post-creative thinking abilities with the innovative STEM education instructional method, the multiple correlations (R) was 0.6161 and the predictive efficiency (R^2) value indicated that 38% of the variances in students' creative thinking abilities to their science classes were attributable to their post learning achievement in their science classroom environment. The proportion of the variance in the dependent variable (SAT) that is predictable from the independent variable (CTAA), which it provides a measure of how well observed outcomes are replicated by the STEM education method, based on the proportion of total variation of students' learning outcomes explained by the STEM Education instructional model.

10. Discussions

A. What is instructional design?

In short, instructional design is the systematic process by which instructional materials are designed, developed, and delivered. The terms instructional design, instructional technology, learning experience (LX) design, educational technology, curriculum design, and instructional systems design (ISD), are often used interchangeably. The IDs are a few instructional design definitions from various resources on instructional design, instructional technology, educational technology, curriculum design, and instructional systems design. What is an Instructional Designer? Some may use the terms instructional designer, educational technologist, curriculum designer, and instructional technologist interchangeably. Instructional designers and instructional technologists have similar job roles, functions, and career paths. They also have similar instructional design higher education degrees and formal training. Instructional designers and instructional technologists are in high demand as organizations are turning towards instructional designers to solve business performance problems and to provide media-rich eLearning solutions. In this research study, regardless of the scope of the project, instructional designers almost always use one of a number of the STEM Education instructional design as a guide to one benefit of doing so is that the model helps delineate the activities that are to be included, and provides one with a comprehensive, holistic view of the entire course design. In that sense, the STEM model serves a “descriptive” function. But it also serve a prescriptive function, as they provide the structural and organization framework that will then be used to guide the creation of the particular instructional design. In this research study, a main *Innovative Learning Management Lesson Plan* (ILMLP) in the form of the STEM education in 14 hours was designed to indicate that high quality to the learning practice of creating "instructional experiences which make the acquisition of knowledge and skill more efficient, effective, and appealing appropriations.

B. What is STEM education?

STEM is a curriculum based on the idea of educating students in four specific disciplines science, technology, engineering and mathematics in an interdisciplinary and applied approach. Rather than teach the four disciplines as separate and discrete subjects, STEM integrates them into a cohesive learning paradigm based on real-world applications. STEM education focuses on the introductory level STEM courses, as well as awareness of the STEM fields and occupations. This initial step provides standards-based structured inquiry-based and real world problem-based learning, connecting all

four of the STEM subjects. The goal is to pique students' interest into them wanting to pursue the courses, not because they have to design. There is also an emphasis placed on bridging in-school and out-of-school STEM learning opportunities for primary school students. Ethnically, Asian students, especially Thai's students (the IPST) have historically displayed the highest level of interest in the STEM fields. Prior to 2001, students of an African-American background also showed high levels of interest in STEM fields, second only to the Asian and Thai demographics.

Creativity is something that you can learn. The only difference is many people must realize it take patience. The creative profession must also choose his or her thoughts carefully. There are scientific methods that have been tested and proven to help you learn to be creative. Below are some of these techniques along with quotes from those who have shown great talent in their works. There are important yet simple lessons all over we can learn-have a different color palette and take time off from your work-preparing yourself mentally to receive new experiences as well as training yourself to perceive thematic patterns-however the greatest lesson for all people and experiences, is one, that we can always learn to be more creative. Many perceive creativity to a talent for the chosen few. Others see it as something external that is mostly out of our control. Creativity is not an exclusive right to a selective group of people. It is true that there are those who are gifted with a greater aptitude for literal creative thinking but thinking and idea generation are skill that one can learn easily. As above discussion, the designing the innovative learning management plans in form of the STEM education instructional method to develop the primary students of their creative thinking learning processes in science class at the 2nd grade level are provided.

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