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AFFECTING THE ACTIVITY-BASED ON LEARNING APPROACHING MANAGEMENT THROUGH THE STEM EDUCATION INSTRUCTIONAL METHOD FOR FOSTERING THE CREATIVE THINKING ABILITIES, LEARNING ACHIEVEMENTS AND ENVIRONMENTAL PERCEPTIONS IN PHYSICS LABORATORY CLASSES OF SECONDARY STUDENTS AT THE 10TH GRADE LEVEL

Chumpon Chanthala[1i],
Toansakul Santiboon[2],
Kamon Ponkham[3]
[1,2]Department of Science Education, Faculty of Education
Rajabhat Maha Sarakham University, Maha Sarakham, Thailand 44000
[3]Department of Physics, Faculty of Science and Technology
Rajabhat Maha Sarakham University, Maha Sarakham, Thailand 44000

Abstract:
This study focuses on investigating the effects of students' activity-based on learning approaching management through the popular instruction; *STEM Education Instructional Model* on the Second Newton's Law (spring and conservative law) issue for fostering students' creative thinking abilities of their learning achievements to their students' perceptions of their physics laboratory classroom environments. Administrations, which the sample size consisted of 48 upper secondary educational students at the 10th grade level from Mahasarakham University Demonstration School with cluster random sampling technique was selected. The purposes of this research study were to analyze of the processing performances and the performance results (E_1/E_2) efficiency at the determining criteria as 75/75. Students' learning achievements with the pre-test and post-test design were assessed. Students' learning achievements of their post-test assessment and their creative thinking abilities of their perceptions to their physics laboratory class towards physics were associated. Using the STEM Education instructional innovation's lesson plans were managed the instructional activities, the *Pre-Test* and *Post-Test Assessments* were designed, students' creative

[i] Correspondence: email chumpon603@gmail.com toansakul35@yahoo.com.au

thinking abilities were fostered with the 24-item *Guilford Creative Thinking Questionnaire* (GCTQ), and students' perceptions of their classroom learning environment obtained of the 35-item *Physics Laboratory Environment Inventory* (PLEI) was determined. Statistically significant were analyzed with the Simple and Multiple Correlations, Standardized Regression Weight Validity (β), and Coefficient Predictive Value (R^2) were associated. The results of these research findings have revealed as: students were evaluated to determine performance criteria with the efficiency of the processing performance and the performance results (E_1/E_2) of the STEM Education instructional method's innovation lesson plans to management to the activity-based learning approach indicated that 78.23/75.38, which was higher than standardized criteria of 75/75. Students' learning achievements of their pre-test and post-test assessing differences were also found evidence at the 0.01 level, significantly. Associations between students' learning achievements of their post-test assessment indicated that 26% of the coefficient predictive value (R^2) of the variance in students' creative thinking abilities was attributable to their perceptions for the CTAT. Students' learning outcomes of their post-test assessment, the R^2 value indicated that 35% of the variances in students' perceptions to their physics laboratory classes for the PLEI. Students' perceptions of their PLEI classes, the R^2 value indicated that 57% of the variances in students' responses to their creative thinking abilities were attributable to their affecting the activity-based on learning approaching management through the STEM education instructional method for fostering their creative thinking abilities to their learning achievements and their perceptions in physics laboratory classes of upper secondary students at the 10th grade level are provided.

Keywords: activity-based on learning, STEM education instructional method, creative thinking abilities, learning achievements, students' perceptions in physics laboratory classes

1. Introduction

Previous research studies on the effects of students' learning show empirical evidence on the positive effect on students' performance through the adoption of innovations in the technology of teaching and learning**.** However, innovations do not affect all teaching methods and learning styles equally (Merino and Serradell, 2014). Rather, it depends on some variables, such as the strategy of a school towards the adoption of instructional design methods, students' abilities, innovation, physics laboratory instruments and materials are used in the upper secondary educational process by teachers and students. The selection of a methodology that matches the innovations on instructional lesson plans with the instructional design methods from a controlling and the experimental physics laboratory environment inventories, to set-up performed within the STEM education method, and using an empirical model based on structural equations. To predict the research results shows that motivation is the main variable affecting performance of students' foster creativity thinking abilities in physics, to confirm the importance of these factors as a source of educational efficiency.

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.

Using students' and teachers' perceptions to study educational environments can be contrasted with the external observer's direct observation and systematic coding of classroom communication and events. Defining the classroom or school environment in terms of the shared perceptions of the students and teachers has the dual advantage of characterizing the setting through the eyes of the participants themselves and capturing data which the observer could miss or consider unimportant. Students are at a good vantage point to make judgments about classrooms because they have encountered many different learning environments and have enough time in a class to form accurate impressions. Also, even if teachers are inconsistent in their day-to-day behaviour, they usually project a consistent image of the long-standing attributes of classroom environment. Later in this chapter, discussion focuses on the merits of combining quantitative and qualitative methods when studying educational environments (Fraser & Tobin 1991). Because of the critical importance and uniqueness of laboratory settings in science education, an instrument specifically suited to assessing the environment of science laboratory classes at the senior high school or higher education levels was developed (Fraser, Giddings & McRobbie 1993). The *Science Laboratory Environment Inventory* (SLEI) was field tested and validated simultaneously with a sample of over 5,447 students in 269 classes in six different countries (the USA, Canada, England, Israel, Australia and Nigeria), and cross-validated with 1,594 Australian students in 92 classes (Fraser & McRobbie 1997), 489 senior high school biology students in Australia (Fisher, Henderson & Fraser, 1997) and 1,592 grade 10 chemistry students in Singapore (Quek, Wong, & Fraser, 2002). Santiboon and Fisher (2005) adapted version from the original of the SLEI to the PLEI (*Physics Laboratory Environment Inventory*) was assessed to upper secondary education level evidence of 4,576 students in 105 school classes throughout of Thailand. The aims of this research were to the strongest tradition in past classroom environment research has involved investigation of associations between students' cognitive and affective learning outcomes and their perceptions of psychosocial characteristics of their physics laboratory classrooms (Santiboon, 2012; Santiboon, Thongbu, & Saihong, 2016). In this research study, using the PLEI to assess students' perceptions of their physics laboratory classes, associations with students' cognitive and affective outcomes have been established for this sample group with their science attitudes and creative thinking abilities.

Guilford 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 24-item *Guilford Divergent thinking Questionnaire* (GDTQ) in 4 scales in physics laboratory classes of fluency, flexibility, originality, and elaboration ability scales were used.

Thailand is a developing country by economic prosperity is a metric Thailand believes this figure according to the opinion of the West counties. The numbers are the basis for measuring the possibility of different countries. In the world and one factor, this has a direct effect on the competitiveness of the economy, the quality of education of the population. Education reform has changed many times during the various governments. There are several levels of education that are updated every ten years. The concept of educational reform policy is diverse. The intention of the leading academics who wish to educate Thailand is equal to civilization. They adapted or introduced Western educational system concepts into the Thai education system by looking forward to Thailand's development of human resources leap forward. There are times when the education system is facing failure in applying the principles and policies of the dream education to practical applications. Therefore, the educational discourse is that Thai students are mice using the educational curriculum (Siriratanajit, 2013).

The Office of the Social Promotion of Learning and Quality of Youth (2012) reflects the problem of the management of science education in Thailand by Tom Corkoran (Co-director of the Institute for Educational Policy Studies) of Columbia University to criticize the phenomenon of Thai science classrooms and reflect on the scientific learning situation of Thai students. PISA scored 49th out of 64 countries, with an average score of 425, below the OECD score of 100, which is said to be 100 points of study up to 2 years. Therefore, the scientific learning of Thai students is lagging behind the international level for 2 years. The average score in Thailand in 2009 was 4 points higher than the average in the PISA score to memorize the weak student analysis for trying to put too much content and content until Thai students do not have the opportunity to gain insight into the content and Thailand has only a few science experts, only 0.62% are compared to the international average (OECD), this group of students is 10%. While Shanghai, Japan and Korea have a student population of up to 20%, it is unlikely that Thailand has a very low scientific success rate compared to Thailand's investment in education, which is higher than the countries scoring higher than Thailand. The important thing to take into account is that Thai literacy scores from PISA scores on analytical reading were at a very low level. Moreover, the average in schools outside of Bangkok has stilled at level 0, especially the one that contains more than one paragraph, it is assumed of many students have reading problems affect other grades because students can't read the proposition to understand. Therefore, the Institute for the Promotion of Teaching Science and Technology (IPST) encourages science teachers to teach language skills and readings to students. Especially, reading the analytical proposition, but still failed of the problem, it all ties together. The course focuses on many subjects, lesser school hours exams focused on content, these are the conditions that make the teacher teach this, not the instructor, students do not want to be a good instructor but this is the context that directs the instructor to teach like this (Office of Social Promotion for Learning and Quality of Youth, 2012).

Montri Chulawattantoon (2013) gave opinions on Thai science teaching in Thailand is urgently needed to develop science and technology teaching, to keep up with the ever-changing world of change, which the problem is how to bring about tangible concrete development. All parties must come together to brainstorm to lead a pragmatic approach seriously based on current facts. Learning in STEM Education is a learning management that is not focused on memorization, theories or scientific rules and mathematics. Therefore, to understand those theories or rules through real practice, along with the development of problem solving skills and the discovery and analysis of new discoveries are integrated together, they can be used or integrated into daily life. The learning management model is based on the five principles of teaching, focusing on integration for helping students build links between their four subject areas of their daily life and career in the 21st century skills' development, challenging student thinking and the opportunity for students to comment. The purpose of the study is to encourage the students to love and value the learning of science, technology and engineering, and mathematics (Vasquez, Sneider, and Comer, 2013)

In the last decades, based on relevant studies and monitoring as well as evaluation of the curriculum in application during the past six years, strengths of the Basic Education Curriculum 2001 were identified. It facilitated decentralization of educational authority, enabling local communities and schools to participate and play important roles in preparing curriculums which met their real needs. Clear concepts and principles for promoting learners' holistic development were quite apparent. Nonetheless, the outcomes of these studies revealed several problems arising from lack of clarity. Shortcomings were found in provisions of the curriculum itself, its application and emerging unsatisfactory outcomes, resulting in confusion and uncertainty of practitioners at school level in preparing their own curriculums. Most schools were ambitious in prescribing the learning areas, leading to overcrowded curriculums. Excessively high expectations were also set. Measurement and evaluation did not correlate with the standards set which effected on preparation of certifying documents and transferring of learning outcomes. Moreover, problems regarding learners' ability to acquire essential knowledge, skills, capacities and desired characteristics were quite disconcerting (Bureau of Academic Affairs and Educational Standards, 2008). Furthermore, the new curriculum; the Basic Core Curriculum B.E. 2551 (A.D. 2008) and the Basic Core Curriculum B.E. 2558 (A.D. 2015) (Draft) has prescribed a structure of minimum time to be allotted to each subject area for each grade level. Schools are given opportunities to increase learning time allotment, depending on their readiness and priorities. Improvement has been made to the process of measuring and evaluating learners' performance as well as criteria for graduation at each educational level. Adjustment has also been made for streamlining certification which correlates with learning standards, thus facilitating application of certifying documents. From the context of this basic core curriculum problem of learning management in science classroom in physics course is integrated. The problem of achievement of learning management at source has been achieved as low. The Institute the Promotion of Teaching Science and Technology (IPST) has been trying to solve the problems of learning management model with the integration of science education, this is just the beginning. Although there are eight centers, eight centers are located in different parts of the country (Ministry of Education, 2015).

Based on the above-mentioned concept, the researchers adopted a STEM Education teaching model to provide academic capacity for learning and promoting scientific creativity in science laboratories of the enable learners to be productive and skilled in their thinking processes. Thus, the model of STEM Education teaching and learning was integrated into the model of science experiment of the upper secondary students at the 10th grade level at Mahasarakham University Demonstration School (Secondary School) is the context of research limitation in this study.

2. Methodology

The Basic Education Core Curriculum B.E. 2551 is aimed at the full development of learners in all respects - morality, wisdom, happiness, and potentiality for further education and livelihood. The following goals have consequently been set for achievement upon completing basic education at inculcating learners with the following five key competencies: Communication Capacity, Thinking Capacity, Problem-Solving Capacity, Capacity for Applying Life Skills, and Capacity for Technological Application

2.1 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 8 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.

2.2 Pretest-Posttest Designs for Assessing the Achievements of Learning

A main innovative lesson plan was provided a general definition of student achievement, defined factors that impact a student's ability to achieve and explains what research shows about successful student achievement with the 5-sub lesson plans. Student achievement has become a hot topic in education today, especially with increased accountability for classroom teachers. The ultimate goal for any teacher is to improve the ability level and prepare students for adulthood. Defining student achievement and factors that impact progress is critical to becoming a successful teacher. Student achievement measures the amount of academic content a student learns in a determined amount of time. Each grade level has learning goals or instructional standards that educators are required to teach. Standards are similar to a 'to-do' list that a teacher can use to guide instruction. Student achievement will increase when quality instruction is used to teach instructional standards. Researchers want to monitor the effect of a new teaching method upon groups of students. Pretest-posttest designs were an expansion of the posttest only design with the target groups, one of the simplest methods of testing the effectiveness of an intervention. In this design, which was given the treatment and the results were gathered at the end with statistical analysis that can then determine the intervention had a significant effect.

2.3 Using the Popular Instructional Method in 21st-Century: STEM Education

To design in the instructional model for provide all the tools and strategies of this research study' plan to need to design integrated, interdisciplinary STEM lessons and units that are relevant and exciting to the target group students. With clear definitions of both STEM and STEM literacy, the authors argue that STEM in itself is not a curriculum, but rather a way of organizing and delivering instruction by weaving the four disciplines together in intentional ways. Rather than adding two new subjects to the curriculum, the engineering and technology practices can instead be blended into existing mathematics and science lessons in ways that engage students and help them master 21st century skills. STEM Innovative Lesson Plans of the essentials was built how to begin the STEM integration journey with: five guiding principles for effective STEM instruction, physics laboratory classroom environments were responded of what these principles look like in action of students' perceptions, sample activities that put all four STEM fields into practice, and lesson planning templates for STEM units were assessed by the professional expert educators were checked of their efficiency quality, this was the third phase.

2.4 Approaches to Studying Educational Environments

Defining the physics laboratory classroom environment in terms of the shared perceptions of the students has the dual advantage of characterizing the setting through the eyes of the participants themselves and capturing data. Students are at a good vantage point to make judgments about classrooms because they have encountered many different learning environments and have enough time in a class to form accurate impressions. Also, even if researcher team was inconsistent in their day-to-day behaviour, they usually project a consistent image of the long-standing attributes of classroom environment. According to Moos's (1974) scheme for classifying human environment in three basic types of dimension are *Relationship Dimensions* (which identify the nature and intensity of personal relationships within the environment and assess the extent to which people are involved in the environment and support and help each other), *Personal Development Dimensions* (which assess basic directions along which personal growth and self-enhancement tend to occur) and *System Maintenance and System Change Dimensions* (which involve the extent to which the environment is orderly, clear in expectations, maintains control and is responsive to change). Many studies have drawn on scales and items in existing questionnaires to develop modified instruments which better suit particular research purposes and research contexts. The critical importance and uniqueness of laboratory settings in science education, an instrument specifically suited to assessing the environment of science laboratory classes at the senior high school or higher education levels was developed (Fraser, Giddings & McRobbie 1995). Adapted version of the *Science Laboratory Environment Inventory* (SLEI) what the SLEI has five scales (each with seven items) and the five response alternatives are Almost Never, Seldom, Sometimes, Often and Very Often to the *Physics Laboratory Environment Inventory* (PLEI) was used in this research study. This is the fourth phase of this research methodology.

2.5 Adapted the Building Guilford's Work to Tests of Creative Thinking Ability

Creative thinking skills are essential for success in learning and success in life (Fisher, 2006). Creative thinking skills equips students to go beyond the information given, to deal systematically, flexibly with problems and situations, to adopt a critical attitude to information and arguments as well as to communicate effectively (McGuinness, 1999). Guilford (1950) proposed creativity as the ability to produce a new idea into existence via divergent thinking or arrive at many solutions to a problem, and offered three dimensions to describe creativity: (i) fluency: ability to generate lots of ideas; (ii) flexibility: ability to look at a question or topic from multiple perspectives; and (iii) originality: is the crux of creativity. Creativity can also mean to generate unique or unusual and unexpected ideas. To evaluate creativity, there must be measurable indicators to determine how much students have gained from learning. The formal psychometric measurement of creativity is usually considered to have begun with Guilford (1950). Guilford's group constructed several tests to measure creativity in 1967 such as: plot titles; quick responses; figure concepts; unusual uses; remote associations; and remote consequences. In this research study, adapted and improved version of the Guilford first proposed the concept of "divergent thinking" in the 1950s, when he noticed that creative people tend to exhibit this type of thinking more than others. Associated divergent thinking with creative, appointing it several characteristics: **fluency** (the ability to produce great number of ideas or problem solutions in a short period of time); **flexibility** (the ability to simultaneously propose a variety of approaches to a specific problem); **originality** (the ability to produce new, original ideas); **elaboration** (the ability to systematize and organize the details of an idea in a head and carry it out) were built. This is the fifth phase of this research methodology.

3. Research Objectives

1. To analyze the effectiveness of the innovative instructional lesson plans based on the model of learning management in a STEM Education Method of secondary students at the 10th grade level in physics laboratory environment classes with the processing and performance resulting effectives at 75/75 criteria.
2. 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 in a STEM Education Method of secondary students at the 10th grade level in physics laboratory environment classes.
3. To analyze of the associations between students' learning achievements of their posttest assessment and their creative thinking abilities with the innovative instructional lesson plans based on the model of learning management in a

STEM Education Method of secondary students at the 10th grade level in physics laboratory environment classes.

4. To analyze of the associations between students' learning achievements of their posttest assessment and their perceptions to their learning environments with the innovative instructional lesson plans based on the model of learning management in a STEM Education Method of secondary students at the 10th grade level in physics laboratory environment classes.
5. To analyze of the associations between students' creative thinking abilities and their perceptions of their learning environments with the innovative instructional lesson plans based on the model of learning management in a STEM Education Method of secondary students at the 10th grade level in physics laboratory environment classes.

3.1 Research Procedures

A. Creating and Validating the Quality of Innovation and Learning Management Plans

The *STEM Education Innovative Learning Plan* for the Elastic Vehicle issue consists of 5 learning units, namely; Newton's Law of motion 1, Newton's second law of motion, horizontal movement, spring force, and motion elastic cars.

B. Creating and Validating the Quality of Implementing, Creating, and Evaluating Innovation

Step 1: Investigations of the Basic Education Core Curriculum B.E. 2551 and 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.

Step 2: Examine the innovation techniques learning units related to content and equations related to innovation.

Step 3: Define the content of the innovation, the elastic vehicle, in line with its content and behavior, wants to develop creativity.

Step 4: Model prototypes through innovative learning styles related the 5-learning plans.

Step 5: Brings the prototype of innovation, the rubber elastic vehicle goes to the curriculum and instructional specialists, and the STEM educational experts were checked. The results of the analysis were found to be valuable; the quality of the tool was at 4.79. Quality/Consistency/Link/Cover of learning management plan with purpose as much as possible.

Step 6: Bringing innovative innovations to try out with students. Non-experimental group Experimentalists recorded scores during the study and after learning by using the 75/75 efficiency benchmarking method, which yielded a 78.23/75.38 efficiency rating, which was well above the threshold.

3.2 Research Instruments

A. The Pretest and Posttest Achieving Test (PPAT)

Using the 50-item *Pretest and Posttest Achieving Test* (PPAT) were assessed of students' learning achievements to measure their pretest and posttest assessments with the innovative instructional lesson plans based on the model of learning management in a STEM Education Method of secondary students at the 10th grade level in physics laboratory environment classes about the contents of Newton's Law of Motion 1, Newton's Law of Motion 2, Linear Movement, Spring Force, Elastic Vehicle Practice all of them are 4 multiple options in the 10-innovative learning lesson plans.

B. The Physics Laboratory Environment Inventory (PLEI)

Adapted version of the *Science Laboratory Environment Inventory* (SLEI) (Fraser, Giddings & McRobbie 1993) which the SLEI has five scales (each with seven items) and the five response alternatives are Almost Never, Seldom, Sometimes, Often and Very Often to the 35-item *Physics Laboratory Environment Inventory* (PLEI) (Santiboon, 2012) was used in this research study. The PLEI has five scales and each scale contains with seven items. This instrument is appropriate for the upper secondary education which contains 35 items and five scales which are *Student Cohesiveness* (SC), *Open-Endedness* (OE), Integration (I), *Rule Clarity* (RC), and *Material Environment* (ME) and the five response alternatives are *Almost Never, Seldom, Sometimes, Often* and *Very Often*.

C. The Guilford Creative Thinking Questionnaire (GCTQ)

Using the original version of the original of the Guilford's intelligence work; the *Guilford Divergent Thinking Questionnaire* was adapted to assess students' perceptions of their creative thinking abilities with the 24-item *Guilford Creative Thinking Questionnaire* (GCTQ) 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 five response alternatives are: *Almost Never, Seldom, Sometimes, Often* and *Very Often*.

3.3 Target Group

The target group for this research study was the upper secondary educational school students who sat at the 10^{th} grade level which sample size of 48 students in two physics laboratory classes in the second semester of academic year 2016 at Mahasarakham University Demonstration School (Secondary School), Kantharawichai District, Mahasarakham Province under the Office of Higher Education Commission.

3.4 Research Limitation

The setting up of the sample and the consequent collection of data were then preceded as below:

A. Content Limitations

The content of research study covers on physics content that it composes of the Newton's First Law of Motion, Hook's Law, and the Law of Conservation of Energy from 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.

B. Resource Limitation

Step 1: The STEM Education Innovative Learning Plan consisted of 5-sub lesson plans were checked the efficiency quality by the 3-professional expert educators.

Step 2: The 50-item Pretest and Posttest Achieving Test (PPAT) was checked by the 2-professional expert educators with the IOC.

Step 3: Using the research instruments were assessed students' target of 48 students in two physics laboratory classes

C. Variable Limitation

Independent Variable: the STEM Education Innovative Learning Plan consisted of 5-sub lesson plans

Dependent Variable: learning achievement of learners from pre-test and post-test, promoting creativity of students, and students' perception of the environment in physics laboratory classes.

3.5 Data Analysis

Using the foundational statistic with percentage, mean, standard deviation for analyzing the basically data was examined. The validity and reliability of research instruments were assessed with internal consistency Cronbach alpha reliability and discriminant validity. Statistically significant was differentiated data to compare with the independent variable t-test and ANOVA results (eta^2). Associations between students' learning achievements of their posttest outcomes and their creative thinking abilities to their perceptions toward their physics laboratory classroom environments with simple and multiple correlations, standardized regression weight abilities and the coefficient predictive value (R^2) were used.

4. Results

The investigations of the effects of the activity-based on learning approaching management through the STEM education instructional method for fostering the creative thinking abilities, learning achievements, and environmental perceptions in physics laboratory classes of students at the 10th grade level were administered with the sample size consisted of 48 upper secondary educational students at the 10th grade level from Mahasarakham University Demonstration School by cluster random sampling technique was selected. The purposes of this research study were to analyze of the processing performances and the performance results (E_1/E_2) efficiency. Students' learning achievements with the pre-test and post-test designs were assessed. Students' learning achievements of their post-test assessment and their creative thinking abilities of their perceptions to their physics laboratory class towards physics were associated. Using the STEM Education instructional innovation's lesson plans were managed the instructional activities, the *Pre-Test* and *Post-Test Assessments* were designed, students' creative thinking abilities were fostered with the 24-item *Guilford Creative Thinking Questionnaire* (GCTQ), and students' perceptions of their classroom learning environment obtained of the 35-item *Physics Laboratory Environment Inventory* (PLEI) was determined. Statistically significant were analyzed with the Simple and Multiple Correlations, Standardized Regression Weight Validity (β), and Coefficient Determinant Predictive Value (R^2) were associated.

4.1 The Effectiveness of the Innovative Instructional Lesson Plans

To analyze the effectiveness of the innovative instructional lesson plans based on the model of learning management in a STEM Education Method of secondary students at the 10th grade level in physics laboratory environment classes with the processing and performance resulting effectiveness at 75/75 criteria. Table 1 reports of the effectiveness of the innovative instructional lesson plans

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)	100	78.23	5.74	78.23
Efficiency Performance Results (E2)	100	75.38	5.00	75.38
The Lessoning Effectiveness (E1/E2) = 78.23/75.38				

Table I shows the result for the effectiveness of the innovative instructional lesson plans based on the model of learning management in a STEM Education Method. Effectiveness of lessons during the learning process (E1) reveals of 78.23 and the performance effectiveness (E2) indicate that of 75.38, so the lessoning effectiveness (E1/E2) evidences of 78.23/75.38 over the threshold setting is 75/75.

4.2 Validations of the GCTQ and PLEI

Tables 2 and 3 show the description of quantitative data of analyzing responses for upper secondary students' assessments reported for the GCTQ and PLEI. Internal consistency (Cronbach alpha coefficient) and the mean correlation of each scale with the other scales were obtained for the sample in this present study as indices of scale reliability and discriminant validity for the GCTQ and PLEI, respectively.

4.2.1 Validations of the GCTQ

Table 2 reveals of students' perceptions of their creative thinking abilities with the 24-item *Guilford Creative Thinking Questionnaire* (GCTQ) 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).

The results given in Table 2 show the mean scores for each of the four GCTQ scales. As each scale has six items ranging from 24.19 to 25.17 and average total score as 24.77. The average mean scores ranged from 4.03 to 4.19 and average total score as 4.13, respectively. Table 1 reports the internal consistency which ranged from 0.60 to 0.73 when using the actually scores. A successful evaluation of discriminant validity on each scale shows that a scale of the GCTQ is correlated with other scales designed to measure theoretically the different three scales. Using an *F*-test is the test statistic has an F-distribution; it is most often used when comparing statistical models that have been fitted to a data set.

Table 2: Scale means' score, means, standard deviations, scale internal consistency (Cronbach Alpha Reliability), discriminant validity and F-test for the GCTQ

Scale	Mean (30)	Average mean (5)	Standard deviation	Cronbach alpha reliability	Discriminant validity	*F*-test
Originality Thinking	24.19	4.03	2.49	0.60	0.66	2.69*
Flexibility Thinking	24.94	4.16	2.55	0.62	0.65	2.82*
Fluency Thinking	24.79	4.13	2.13	0.63	0.65	2.47*
Elaboration Thinking	25.17	4.19	2.09	0.73	0.62	2.53*
Average Total	24.77	4.13	7.51	0.82		1.86**

N = 48, *ρ < 0.05, **ρ < 0.01, ***ρ < 0.001

As reported in Table 2, the discriminant validity coefficients (the mean correlation of a scale with the other scales) of students' creative thinking abilities ranged from 0.62 to 0.66. These figures suggest that the scales of the GCTQ measure distinct although somewhat overlapping aspects of the creative thinking abilities. The statistically significant in an *F*-test was the ratio of two scaled sums of squares reflecting different sources of variability at level of 0.05.

4.2.2 Validations of the PLEI

Internal consistency (Cronbach alpha coefficient) and the mean correlation of each scale with the other scales were obtained for sample in this present study as indicates of scale reliability and discriminant validity for the PLEI. A summary of these values obtained of the PLEI is report in Table 3.

Table 3: Scale Internal Consistency, Discriminant Validity, and F-test for the PLEI

Scale	Mean (35)	Average mean (5)	Standard deviation	Cronbach alpha reliability	Discriminant validity	F-test
Student cohesiveness	29.88	4.27	2.93	0.70	0.69	3.79**
Open-endedness	29.44	4.21	2.78	0.63	0.71	2.78*
Integration	28.81	4.12	2.69	0.69	0.70	3.23*
Rule clarity	29.44	4.21	2.93	0.71	0.69	2.84*
Material environment	30.14	4.31	2.75	0.74	0.68	4.09**
Total	29.54	4.22	1.48	0.79		3.65**

N = 48, *ρ < 0.05, **ρ < 0.01, ***ρ < 0.001.

In Table 3, the results show the mean scores for each of the five PLEI scales. As each scale has seven items, the minimum and minimum scores for each scale would be 7 and 35, which means the scale ranged from 28.81 to 30.14 using the actually scores. Table 3 reports the reliability coefficients for the different PLEI scales and these figures suggest that the scales of the PLEI measure district although somewhat overlapping aspects of the physics laboratory environment. The distinct of the scales were also checked with the Cronbach alpha coefficient and discriminant validity.

Table 4: Factor Loading for Items of the PLEI

Factor Loading					
Item No.	**Student cohesiveness**	**Open-endedness**	**Integration**	**Rule clarity**	**Material environment**
1	***0.82***				
2	***0.77***				
4	***0.53***				
7	***0.52***				
5	***0.47***				
3	***0.45***				
6	***0.43***				
8		0.80			
13		0.80			
10		0.69			
14		0.66			
9		0.64			
12		0.56			
11		0.43			
15			0.80		
16			0.78		
21			0.72		
19			0.72		
23			0.69		
17			0.64		
18			0.42		
26				0.88	
27				0.78	
25				0.75	
24				0.71	
23				0.71	
28				0.62	
22				0.40	
32					0.89
35					0.89
34					0.88

Factor Loading					
Item No.	**Student cohesiveness**	**Open-endedness**	**Integration**	**Rule clarity**	**Material environment**
31					0.61
30					0.60
33					0.53
29					0.52
% of variance	36.54	31.96	32.22	37.58	33.23
Eigenvalue	2.57	2.24	2.26	2.63	2.33

*Loading smaller than 0.30 omitted, the simple consisted of 48 students in 2 classes.

The validity and reliability of the PLEI reports the internal consistency ranging from 0.63 to 0.74 using the students' actually scores was used. The statistically significant in an *F*-test was the ratio of two scaled sums of squares reflecting different sources of variability at level of 0.05. These figures suggest that the scales of the PLEI measure distinct although somewhat overlapping aspects of the physics laboratory environment. The distinct nature of the scale was checked with a factor analysis which is described in Table 4.

To describe variability among correlated variables in terms of a potentially lower number of unobserved variables called Factor Loading Analysis was searched to find independent latent variables. Followers of factor analytic methods believe that the information gained about the interdependencies between variables can be used later to reduce the set of variables in a dataset in this research. There has been significant controversy in the field over differences between the two techniques on exploratory factor analysis versus principal components analysis. From the point of view of exploratory analysis, the percent of variance and the eigenvalues are inflated component loadings, and contaminated with error variance. Table 4 reveals of the results of this analysis. Table 4 lists the items which were found to have factor loading greater than 0.30, which is the minimum value conventionally accepted as meaningful in factor analysis, and hence, the results lend support to the factorial validity of the PLEI.

4.3 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 in a STEM Education Method of secondary students at the 10th grade level in physics laboratory environment classes with the 50-item *Pretest and*

Posttest Achieving Test (PPAT) was assessed. Table 5 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 PPAT as reports in Table 5.

Table 5: Average Mean, Standard Deviation, Mean Difference for the PPAT

Assessing Test	Total score ($\overline{X}$ =50)	Standard Deviation	Mean Diff.	*t*-Value	ANOVA (eta^2)
Pretest	21.50	5.51	10.65	21.05***	0.77***
Posttest	32.15	4.38			

N = 48, *$\rho < 0.05$, **$\rho < 0.01$, ***$\rho < 0.001$.

To identify teachers' contributions to students' learning achievements, the district would need assessments at two points in time: before learning begins and at the end of the physics course. These assessments can be thought of as pre-tests and post-tests. The average mean scores of pretest of 21.50 and posttest revealed as 32.15. In most case, the standard deviation for the pretest as 5.51 and for the posttest as 4.38, and the mean difference between pre-tests and post-tests of 10.65 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 physics curriculum in the physics laboratory were assessed with the independent t-test and ANOVA (*eta^2*) significantly ($\rho < 0.001$).

4.4 Associations between Students' Learning Achievements of their Posttest Assessment and their Creative Thinking Abilities with the Innovative STEM Education Instructional Method

Given the potential for students' learning achievements of their posttest assessment to their perceptions of their creative thinking abilities with the innovative instructional lesson plans based on the model of learning management in a STEM Education Method in physics, other student, teacher and classroom qualities were explored to determine their relationship with students' perceptions of their creative thinking abilities. Correlation's studies identified significant differences in students' learning achievements and their perceptions 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 6.

Table 6: Associations between Students' Posttest Achievements for the PPAT and their GCTQ in Term of Simple Correlation (r), Multiple Correlations (R) and Standardized Regression Coefficient (β)

Variables	Mean ($\overline{X}$)	S.D.	Simple Correlation (r)	Standardized Regression Validity (β)	Multiple Correlation (R)	Efficiency Predictive Value (R^2)
Posttest Assessment (PPAT)	3.21	0.04	0.19*	0.21*	0.5128*	0.2629*
GCTQ	4.13	0.31				

N = 48, *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 perceptions 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 (PPAT) and towards physics. The GCTQ 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 0.5128 and the predictive efficiency (R^2) value indicated that 26% of the variances in students' creative thinking abilities to their physics classes were attributable to their post learning achievement in their physics laboratory classroom environments. The coefficient of determination, denoted R^2 and pronounced "R squared", is a number that indicates the proportion of the variance in the dependent variable (PPAT) that is predictable from the independent variable (GCTQ). 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.

4.5 Associations between Students' Learning Achievements of their Posttest Assessment and their Physics Laboratory Environment Classes with the Innovative STEM Education Instructional Method

Given the potential for students' learning achievements of their posttest assessment to their perceptions of their creative thinking abilities with the innovative instructional lesson plans based on the model of learning management in a STEM Education Method in physics, other student, teacher and classroom qualities were explored to determine their relationship with students' perceptions of their perceptions in physics laboratory environment classes. Correlation's studies identified significant differences in students' learning achievements and their perceptions 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 7.

Table 7: Associations between Students' Posttest Achievements for the PPAT and their PLEI in Term of Simple Correlation (r), Multiple Correlations (R) and Standardized Regression Coefficient (β)

Variables	Mean ($\overline{X}$)	S.D.	Simple Correlation (r)	Standardized Regression Validity (β)	Multiple Correlation (R)	Efficiency Predictive Value (R^2)
Posttest Assessment (PPAT)	3.21	0.04	0.23*	0.19*	0.5910*	0.3493*
PLEI	4.19	0.30				

N = 48, *ϱ < 0.05, **ϱ < 0.01, ***ϱ < 0.001.

The reports in Table 7, The multiple correlations (R) was 0.5910 and the predictive efficiency (R^2) value indicated that 35% of the variances in students' creative thinking abilities to their physics classes were attributable to their post learning achievement in their physics laboratory classroom environments. The coefficient of determination denoted R^2 is a number that indicates the proportion of the variance in the dependent variable (PPAT) that is predictable from the independent variable (PLEI). 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.

4.6 Associations between Students' Creative Thinking Abilities and their Perceptions in Physics Laboratory Environment Classes with the Innovative Instructional Lesson Plans based on the STEM Education Method

To explore the students' perceptions of the creative thinking abilities and their physics laboratory learning environment to assess the relationships between of these with the innovative instructional lesson plans based on the STEM education method. In this section, physics laboratory classroom environment dimensions have been used as criterion variables in research aimed at identifying how the classroom environment varies with the 35-item *Physics Laboratory Environment Inventory* (PLEI) in five scales. The creativity in this sense involves what is called lateral thinking or the ability with the 24-item *Guilford Creative Thinking Questionnaire* (GCTQ) in four scales, using internal consistency reliability the GCTQ had a value of 0.82 which was considered satisfactory for further use in this study. In Table 7, the sample correlation (r), and standardized regression weight validity values (β) are reported which show statistically significant correlations ($p<0.05$).

In this study, it was also considered important to investigate associations between science students' perceptions of their physics laboratory classroom learning environments with their creative thinking abilities toward physics. In Table 7, the sample correlation (r) and standardized regression weight creative thinking validity (β) values are reported which show statistically significant correlations ($p<.05$).

Table 8: Associations between Students' Perceptions for the PLEI and their GCTQ in Term of Simple Correlation (r), Multiple Correlations (R) and Standardized Regression Coefficient (β)

Scale	**Simple Correlation Validity *(r)***	**Standardized Regression Weight Validity (β)**
Student Cohesiveness	0.15*	0.20*
Open-Denseness Scale	0.19**	0.23**
Integration Laboratory	0.36***	0.44***
Laboratory Rule Charity	0.33***	0.35***
Material Environments	0.18*	017*
Multiple Correlation *(R)*	0.7520**	
Coefficient of Determination (R^2)	0.5656**	

The multiple correlations (R) was 0.7520, and the coefficient of determination denoted R^2 and pronounced that indicates that 57% of the proportion of the variance in the dependent variable (PLEI) that is predictable from the independent variable (GCTQ) of the variances in students' creative thinking abilities to their physics classes were attributable in their physics laboratory classroom environments with the STEM Education Method of secondary students at the 10th grade level in physics laboratory environment classes are provided.

5. Conclusions

This research study was designed to investigate and examine of the effects of the activity-based on learning approaching management through the STEM education instructional method for fostering the creative thinking abilities, learning achievements, and environmental perceptions in physics laboratory classes of students at the 10th grade level for the target group that was the upper secondary educational school students who sat at the 10th grade level which sample size of 48 students in two physics laboratory classes in the second semester of academic year 2016 at Mahasarakham University Demonstration School (Secondary School), Kantharawichai District, Mahasarakham Province under the Office of Higher Education Commission. The context of the content that it composes of the Newton's First and Second Laws of Motion, Hook's Law (Spring Motion), and the Law of Conservation of Energy from the Strand 4: Forces and Motion that focused on the Standard SC4.2 from the Basic Education Core Curriculum B.E. 2551 was aimed at the full development of learners in all respects - morality, wisdom, happiness, and potentiality for further education was selected of the context of the strand and learning standard in science learning area in terms of students' perceptions of their learning environment and their creative thinking ability toward physics.

Pretest-Posttest Designs for assessing students' learning achievements was defined factors that impact a student's ability to achieve and explains what research shows about successful student achievement with the 5-sub lesson plans. The preferred method to compare participant groups and measure the degree of change occurring as a result of treatments or interventions were assessed. Pretest-posttest designs are an expansion of the posttest only design with nonequivalent groups, one of the simplest methods of testing the effectiveness of an intervention. In this design, which uses two groups, one group is given the treatment and the results are gathered at the end. The student group receives no treatment, over the same period of time, but undergoes exactly the same tests. Statistical analysis can then determine if the intervention had a significant effect. The result for the effectiveness of the innovative instructional lesson plans based on the model of learning management in a STEM Education Method was designed. Effectiveness of lessons during the learning process (E1) reveals of 78.23 and the performance effectiveness (E2) indicate that of 75.38, so the lessoning effectiveness (E1/E2) evidences of 78.23/75.38 over the threshold setting is 75/75.

Focused on the comparisons compare between students' learning achievements of their pretest and posttest assessments with the innovative instructional lesson plans based on the model of learning management in a STEM Education Method of secondary students at the 10^{th} grade level in physics laboratory environment classes were assessed. The result for the effectiveness of the innovative instructional lesson plans based on the model of learning management in a STEM Education Method was designed. Effectiveness of lessons during the learning process (E1) reveals of 78.23 and the performance effectiveness (E2) indicate that of 75.38, so the lessoning effectiveness (E1/E2) evidences of 78.23/75.38 over the threshold setting is 75/75.

In terms of the validity and reliability of the research instruments, the description of quantitative data of analyzing responses for upper secondary students' assessments reported for the 24-item *Guilford Creative Thinking Questionnaire* (GCTQ) in 4 scales and the reliability coefficients for the different the *Physics Laboratory Environment Inventory* (PLEI) scales and these figures suggest that the scales of the PLEI measure district although somewhat overlapping aspects of the physics laboratory environment. The distinct of the scales were also checked with the Cronbach alpha coefficient and discriminant validity ranging from 0.63 to 0.74 using the students' actually scores was used and to have factor loading greater than 0.30 were found, which is the minimum value conventionally accepted as meaningful in factor analysis, and hence, the results lend support to the factorial validity of the PLEI.

The average mean scores of pretest of 21.50 and posttest revealed as 32.15. In most case, the standard deviation for the pretest as 5.51 and for the posttest as 4.38, and the mean difference between pre-tests and post-tests of 10.65 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 physics curriculum in the physics laboratory were assessed with the independent t-test and ANOVA (eta^2) significantly ($\rho < 0.001$).

Associations between students' learning achievements of their posttest assessment and their creative thinking abilities with the innovative instructional lesson plans based on the model of learning management in a STEM Education Method of secondary students at the 10th grade level in physics laboratory environment classes. The multiple correlations (R) was 0.5128 and the predictive efficiency (R^2) value indicated that 26% of the variances in students' creative thinking abilities to their physics classes were attributable to their post learning achievement in their physics laboratory classroom environments. The coefficient of determination, denoted R^2 and pronounced "R squared", is a number that indicates the proportion of the variance in the dependent variable (PPAT) that is predictable from the independent variable (GCTQ). 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.

Associations between students' learning achievements of their posttest assessment and their perceptions to their learning environments with the innovative instructional lesson plans based on the model of learning management in a STEM Education Method of secondary students at the 10th grade level in physics laboratory environment classes. The reports in Table 7, The multiple correlations (R) was 0.5910 and the predictive efficiency (R^2) value indicated that 35% of the variances in students' creative thinking abilities to their physics classes were attributable to their post learning achievement in their physics laboratory classroom environments. The coefficient of determination denoted R^2 is a number that indicates the proportion of the variance in the dependent variable (PPAT) that is predictable from the independent variable (PLEI). 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.

Associations between students' creative thinking abilities and their perceptions of their learning environments with the innovative instructional lesson plans based on the model of learning management in a STEM Education Method of secondary students at the 10^{th} grade level in physics laboratory environment classes. The multiple correlations (R) was 0.7520, and the coefficient of determination denoted R^2 and pronounced that indicates that 57% of the proportion of the variance in the dependent variable (PLEI) that is predictable from the independent variable (GCTQ) of the variances in students' creative thinking abilities to their physics classes were attributable in their physics laboratory classroom environments with the STEM Education Method of secondary students at the 10^{th} grade level in physics laboratory environment classes are provided.

6. Discussions

The results of this research study have probably got some ideas of how experiments should be run. Why don't researchers just look at something, poke it with a stick, and then study the changes? Researchers are always making things super complicated. The reason ran a pretest-posttest experiment is to see if your manipulation, the thing that to be able to looking at, has caused a change in the participants. Since student is being manipulated in the same way, any changes and see across the group of participants is likely from the manipulation. This means teachers test them before doing the experiment, then teachers run their experimental manipulation, and then teachers test them again to see if there are any changes. So how does this really work? This is the research designed for assessing students' assessments of their pretest and posttest techniques were compared.

Whilst this posttest only design does find many uses, it is limited in scope and contains many threats to validity. It is very poor at guarding against assignment bias, because the researcher knows nothing about the individual differences within the control group and how they may have affected the outcome. Even with randomization of the initial groups, this failure to address assignment bias means that the statistical power is weak.

Focused on the PLEI, the results of the present study were compared with those of previous studies conducted in Australia, the USA, Canada, England, Israel and Nigeria. It was found that the physics laboratory classes reflected lower levels of Integration and Material Environment, and higher levels of Rule Clarity, than Australian, American, Canadian and Israeli science classes. However, the level of Open-Endedness in laboratory class is relatively lower than that of the Australian, American and Canadian science classes. In the area of differences, there were differences in perceptions of science laboratory classroom environments for both the sample as well as for the samples from the other countries. Associations between students' perceptions of the nature of the science laboratory classroom environment and their learning achievements and their creative thinking ability outcomes also existed for all samples in all the countries concerned, including Thailand.

As researchers strive to better prepare students for real world careers and challenges, we need to focus on developing students' creative thinking skills. Educators can encourage students to become 21st-century problem solvers by introducing them to a wide variety of thinking tools. Affording students the opportunity to flex their creative problem solving skills offers them the chance to practice skills that are highly prized in real-world situations. Entering college or the workforce with well-developed creative thinking skills proves a great advantage for today's new grads. In education, we routinely teach students how to use various sets of cognitive tools to make academic work easier, more efficient, or more productive: for example, research methods, note-taking strategies, or ways to remember and organize information. In teaching thinking, we need to give students cognitive tools and teach them to use these tools systematically to solve real-life problems and to manage change. These tools apply to two essential categories: creative thinking abilities. Suggestions that the effects of the activity-based on learning approaching management through the STEM education instructional method for fostering the creative thinking abilities, learning achievements, and environmental perceptions in physics laboratory classes of students at the 10^{th} grade level that should be needed to know how to implement authentic STEM teaching and learning into classrooms are following as the 21^{st} century, responsibility.

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