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ASSESSING STUDENTS' CRITICAL THINKING ABILITIES AND SCIENCE ATTITUDES FOR ENHANCING THEIR LEARNING ACHIEVEMENTS THROUGH THE INSTRUCTIONAL APPROACHING MANAGEMENT WITH THE STEM EDUCATION INSTRUCTIONAL METHOD OF SECONDARY STUDENTS AT THE 10TH GRADE LEVEL

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Abstract:

A modern instructional design has been popular in the 21st century, the **STEM** education: a curriculum based on the idea of educating students in four specific disciplines of science, technology, engineering and mathematics and in an interdisciplinary and applied approach. The purposes of this research study were to develop activity-based learning conceptual approach with the STEM Education instructional method on the *Motion* issue to assess the efficiency of the processing performances and the performance results (E_1/E_2) at the determining criteria as 75/75, students' learning achievements of their critical thinking abilities and to attitudes toward science of their previous and later learning the assessing tests with the STEM education were compared, associations between students' learning achievements of their critical thinking abilities and their science attitudes toward physics with the STEM education instructional method were assessed. Administrations with the target group which a sample sizes of 64 secondary students at the 10th grade level in two classes from Jaturapakpiman Ratchadaphisek School under the Roi-Et Secondary Educational Service Area Office 27 with the purposive sampling technique. Students' instructional approaching management with the *STEM Education Instructional Lesson Plans* in six weeks in 15 periods in second semester in academic year 2016 was checked quality.

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Students' leaning achievements with the *Pretest and Posttest Assessing Designs* were evaluated. Students' perceptions were obtained of the 20-item *Critical Thinking Ability Test* (CTAT). Students' attitudes were assessed with a short form of *Test Of Science-Related Attitude* (TOSRA). Statistically significant differences were analyzed with t-test, ANOVA, associated between students' learning achievements and their critical thinking to their science attitude toward physics were examined with the simple, and multiple correlations, simple regression validity, and coefficient predictive value were associated. The results of these finding have found that: 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 lesson plans to management of students' activities indicated that of 83.85/81.29, which was higher than standardized criteria of 75/75. Students' learning achievements from the total score of 40 to their average mean score of pre-test ($\bar{x}$ = 15.57, S.D. = 7.06) and post-test ($\bar{x}$ = 32.51, S.D. = 1.63) assessments with the STEM Education instructional method were differentiated that evidence of statistically significant at the 0.001 level. Associations between students' learning outcomes of learning achievements and their critical thinking abilities to their science rerated attitudes toward physics, the coefficient predictive values (R^2) indicated that 4% and 5%, 4% and 16%, 33% and 36%, 61% and 62%, 14% and 20%, and 54% and 71% of the variance in students' learning outcomes of their pre and post learning achievements of their pre-test assessment and their later critical thinking abilities to their later science rerated attitudes, students' learning outcomes of their post-test assessment and their previous critical thinking abilities to their pervious science rerated attitudes, students' learning outcomes of their post-test assessment and their later critical thinking abilities to their later science rerated attitudes, students' learning performances of their previous critical thinking abilities to their pervious and later science rerated attitudes, and students' learning performances of their later critical thinking abilities to their pervious and later science rerated attitudes toward physics to their physics classes were attributable to their previous learning achievement with the STEM Education instructional method were associated, respectively. Based on all the findings, suggestions for improving student learning achievements in learning are of science on physics subject to enhance students' critical thinking abilities and their science attitudes with the STEM education instructional method of upper secondary students are provided, interestingly.

Keywords: assessment, critical thinking abilities, science attitudes, learning achievements instructional approaching management, STEM Education Instructional Method, secondary students

1. Introduction

By virtue of Sections 12 and 15 of the Administrative Organization of the Ministry of Education Act 2003 as well as approval of the Basic Education Commission for application of the Basic Education Core Curriculum 2008, the Ministry of Education hereby authorizes implementation of the Curriculum, the provisions of which are appended to this directive. The Basic Education Core Curriculum 2008 shall replace the Basic Education Curriculum 2001. Conditions and time frame for application of the Basic Education Core Curriculum 2008 shall be as follow: for model schools for curriculum implementation and those ready for such implementation, the names of which have been announced by the Ministry of Education: in academic year 2009, the Basic Education Core Curriculum 2008 shall be applied for Grades 1-6 and Grades 7 and 10; in academic year 2010, the Basic Education Core Curriculum 2008 shall be applied for Grades 1-6, and Grades 7, 8, 10 and 11; and as of academic year 2011, the Basic Education Core Curriculum 2008 shall be applied for all grades. For schools in general: in academic year 2010, the Basic Education Core Curriculum 2008 shall be applied for Grades 1-6 and Grades 7 and 10; in academic year 2011, the Basic Education Curriculum 2008 shall be applied for Grades 1-6 and Grades 7, 8, 10 and 11; and as of academic year 2012, the Basic Education Core Curriculum 2008 shall be applied for all grades (The Minister of Education of Thailand, 2008).

The visions of this curriculum aimed at enhancing capacity of all learners, who constitute the major force of the country, so as to attain balanced development in all aspects: physical strength, knowledge and morality. The notable principles are attainment of national unity; learning standards and goals are therefore set with a view to enabling the children and youths to acquire knowledge, skills, attitude and morality to serve as a foundation for Thai-ness and universal values of the learner-centred approach is strongly advocated. The following goals have consequently been set for achievement upon completing basic education: morality, ethics, desirable values, self-esteem, self-discipline, observance of Buddhist teachings or those of one's faith, and guiding principles of Sufficiency Economy; knowledge and skills for communication, thinking, problem-solving, technological know-how, and life skills; good physical and mental health, hygiene, and preference for physical exercise; and public-mindedness with dedication to public service for peaceful and harmonious co-existence (The Minister of Education of Thailand, 2012).

Furthermore, the new curriculum; 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 (The Promotion of Teaching Science and Technology (IPST), 2015).

Focused on the *Learning Standards and Indicators* in science learning core, the learning standards serve as the goals in developing learners' quality, monitoring for internal quality assurance is essential, as it indicates the extent of success in achieving the quality as prescribed in the pertinent standards. Indicators specify what learners should know and be able to perform as well as their characteristics for each grade level, indicators reflect the learning standards with the eights strands with the thirteen science standards. In the context of physics contents, they are obtained at the Strand 4: Forces and Motion Standard SC4.1 and Standard SC4.2, and Strand 5: Energy Standard SC5.1. In this research study was selected on the Strand 4: Forces and Motion Standard SC4.1 on *Types of Motions Issue* with the instructional management between STEM education method was instructional design for secondary students at the 10th grade level in this research study.

Instructional design, or instructional systems design (ISD), is the practice of creating "*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). The *Science, Technology, Engineering* and *Mathematics* (STEM, previously SMET) are a term that refers to the academic disciplines of science, technology, engineering and mathematics (New Jersey Technology and Engineering Educator Association, 2015). This term is typically used when addressing education policy and curriculum choices in schools to improve competitiveness in science and technology development. It has implications for workforce development, national security concerns and immigration policy (Gonzalez and Kuenzi, 2012). In this research study, using the instructional management between STEM education method for developing students' learning achievements and developing these instructional

model to creative thinking abilities and their attitudes toward physics of secondary students at the 10th grade level in physics classes were designed.

To help educators foster the next generation of innovators, Intel provides STEM curriculum, competitions, and online resources to encourage students' interest and participation. 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 (New Jersey Technology and Engineering Educator Association, 2015).

Critical thinking is the objective analysis of facts to form a judgment. The subject is complex, and there are several different definitions, which generally include the rational, skeptical, unbiased analysis or evaluation of factual evidence (Glaser, 2017). The ability to reason logically is a fundamental skill of rational agents; hence, the study of the form of correct argumentation is relevant to the study of critical thinking. The list of core critical thinking skills includes observation, interpretation, analysis, inference, evaluation, explanation, and metacognition. According to Reynolds (2011), an individual or group engaged in a strong way of critical thinking gives due consideration to establish for instance. In addition to possessing strong critical-thinking skills, one must be disposed to engage problems and decisions using those skills. Critical thinking employs not only logic but broad intellectual criteria such as clarity, credibility, accuracy, precision, relevance, depth, breadth, significance, and fairness (Jones, 1995). In this research study, critical thinking calls for the ability to: recognize problems, to find workable means for meeting those problems, understand the importance of prioritization and order of precedence in problem solving, gather and marshal pertinent (relevant) information, recognize unstated assumptions and values, comprehend and use language with accuracy, clarity, and discernment, interpret data, to appraise evidence and evaluate arguments, recognize the existence (or non-existence) of logical relationships between propositions, draw warranted conclusions and generalizations, put to test the conclusions and generalizations at which one arrives,

reconstruct one's patterns of beliefs on the basis of wider experience, and render accurate judgments about specific things and qualities in everyday life. Students' perceptions were obtained of the 20-item *Critical Thinking Ability Test* (CTAT) was assessed of their critical thinking abilities of this research study.

Using the short version of the *Test of Science Related Attitudes* (TOSRA) (Fraser, 1981; Santiboon and Fisher, 2005) that it used to assesses science-related attitudes along seven dimensions: social implications of science, normality of scientists, attitude toward scientific inquiry, adoption of scientific attitudes, enjoyment of science lessons, leisure interest in science, & career interest in science (Fraser, 1981). Fraser developed the survey to measure seven science related attitudes among secondary school students. Fraser based his design on the early work of Klopfer (1971). In his classification system, Klopfer's first scale was called "*Manifestation of favorable attitudes towards science and scientists.*" The TOSRA was used to associate student outcomes and the classroom-learning environment, particularly to add the measure of students' attitudes towards science and achievement. This research study references the extensive of Santiboon and Fisher's work that it was shown high reliability results for modifying version from the origin was all measured to assess changes in students' attitudes toward science and science related physics content issues**,** because of participating in physics classes with the instructional management between STEM education method were associated.

The driving force of 21st Century learning is the focus on preparing our young students to be successful in today's world. And because the world is changing so rapidly in our digital age, the needs of our students are progressing as well. the tenets of 21st Century learning and find out how you can enhance your teaching methods to best serve today's young learners, check out our article on the topic**:** "*What is 21st Century learning? How a master's degree can enhance the effectiveness of your classroom"* (Scherman, 2016). This present study was checked by education experts maintain that one of the most effective ways to make a lesson stick is to involve the students directly. This is why research team often sees student skits or mock trials. These hands-on activities can help transform a lesson into an experience. 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. As a result, students learning achievement with the instructional management between STEM education method is designed of the innovative lesson plan. 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 Jaturapakpiman Ratchadaphisek School under the Roi-Et Secondary Educational Service Area Office 27 is the context of research limitation in this study.

2. Methodology

Basically, the process by which instruction is improved through the analysis of learning needs and systematic development of learning experiences; the instructional designers often use technology and multimedia as tools to enhance instruction. It 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. 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. Researcher team was increasingly seeing an emphasis on STEM integration in upper secondary school classrooms such that students would learn and apply relevant math and science content while simultaneously developing engineering habits of mind. However, research in both science education and engineering education suggests that this goal of truly integrating STEM is rife with challenges. To compare between students' learning achievements were assessed, students' performances of their critical thinking abilities and their attitudes towards science were associated. The research methodology was following as:

3. Research Objectives

To design the instructional management with the STEM education method for enhancing their learning achievements through the instructional approaching management and developing students' critical thinking abilities and their attitudes toward science on the different types of motion issue of secondary students at the 10^{th} grade level in physics classes, the purposes of this research were followed as:

1. To develop activity-based learning conceptual approach with the STEM Education instructional method on the *Motion* issue with the efficiency of the processing performances and the performance results (E_1/E_2) at the determining criteria as 75/75.
2. To compare between students' learning achievements of their critical thinking abilities to their science attitudes toward their previous and later learning the assessing tests with the STEM education instructional method in physics subject on Different Types of Motion of upper secondary students at the 10^{th} grade level.

3. To associate between students' learning achievements of their tricking abilities and their science attitudes toward physics with the STEM education instructional method in physics subject on Different Types of Motion Issue of upper secondary students at the 10th grade level.

3.1 Selecting of the Context of the Strand and Learning Standard in Science Learning Area

The instructional learning plan, the STEM Education Method on Different Types of Motion Issue of secondary students at the 10th grade level in physics classes that followed as the content of physics in the Strand SC 4 of the Basic Education Core Curriculum 2008 and 2015 (Draft) were selected. Defining the nature and format of the innovative learning management plans composed of Name, Title, Title, Subject, Class, and Time; Learning Standards, Essence, Learning Objectives, Learning Management Process, STEM Education Method Processes, Media/Learning Resources, Evaluation, and Scientific Process Skills were designed in 15 hours for instructional and evaluating learning outcomes of students' learning activities in the first step of research methodology.

3.2 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 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. The 40-item *Leaning Achievement Test* (LAT) on Different Types of Motion Issue was created by the researcher team of 40 optional items in 4 multiple choice options was assessed in the second step of research methodology.

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

Exactly, with clear definitions of both STEM education 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 classes 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 in the third step of research methodology.

3.4 Created the Critical Thinking Abilities

Created of the *Cornell Critical Thinking Test Level Z* (Ennis and Millman, 1985) and Grant Tilus (2015) works for Colleges Education and writes student-focused article on behalf of Rasmussen College were adapted. The aims was to inspire, motivate and inform current and prospective students. Adapted version of the *6 Critical Thinking Skills You Need to Master Now* that was obtained in six scales, namely; Interpretation, Analysis, Inference, Evaluation, Explanation, and Self-Regulation skills to the 20-item *Critical Thinking Ability Test* (CTAT) that it has 6 optional components in 4 multiple choice options was assessed in the fourth step of research methodology.

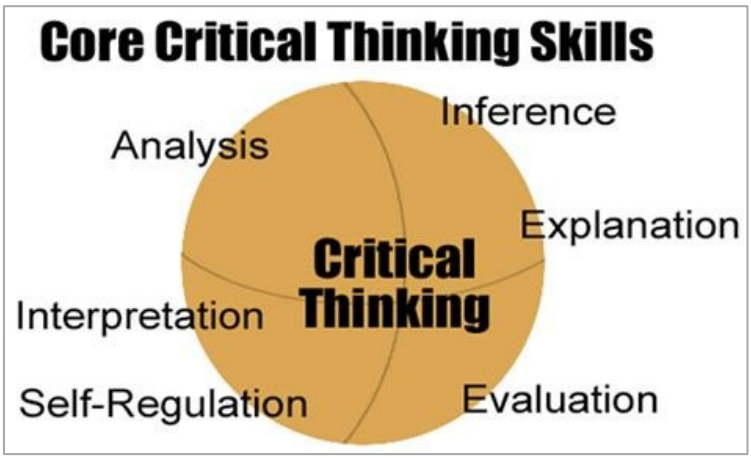

Figure 1: The 6 Critical Thinking Skills You Need to Master Now

Source: Tilus (2015)

3.5 Selecting the Test of Science-Related Attitudes (TOSRA)

The original of the *Test of Science-Related Attitudes* (TOSRA) was assessed science-related attitudes along seven dimensions: social implications of science, normality of scientists, attitude toward scientific inquiry, adoption of scientific attitudes, enjoyment of science lessons, leisure interest in science, & career interest in science and obtained of 70 items (Fraser, 1981). The term "attitude" is very common and popular in daily life. Everyone has given it its own meanings, concepts and definitions. An aim of this study was to explore the psychometric attitudes of the *Test of Science-Related Attitude* (TOSRA) to

adapt to the Thai version that it obtained of 21 items (Santiboon and Fisher, 2005) was assessed students' perceptions of their attitudes toward science in physics classes in the five step of research methodology.

3.6 Sample Size

Administration of this research study was the upper secondary educational school students who sat at the 10^{th} grade level which sample size of 64 students in two physics classes in the second semester of academic year 2016 at Jaturapakpiman Ratchadaphisek School under the Roi-Et Secondary Educational Service Area Office 27 with the purposive sampling technique.

3.7 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 focused on this research study was assessed students' critical thinking abilities and their attitudes toward science for enhancing their learning achievements through the instructional approaching management with the STEM education instructional method of secondary students at the 10^{th} grade level in the three main topics that followed as:

4.1 Validity and Reliability of Research Instruments

4.1.1 The IOC Value of the STEM Education Innovative Instructional Lesson Plan

The STEM education innovative instructional lesson plan was created learning plan offers the counselor to verify the content validity for students' learning activities, teaching materials, and evaluation in the learning management plan was corrected as suggested by the advisors and the 5-professional expert educators with the were reviewed and assessed the validity of content, purpose learning with the IOC value (*Index of Item Objective Congruence*), the acceptable accuracy must be 0.80 or higher. It

appears that the research plan developed by the researcher has an average of 3.60 to 5.00, which is moderate to the highest.

4.1.2 Validations of the Leaning Achievement Test (LAT)

The 40-item *Leaning Achievement Test* (LAT) on Different Types of Motion Issue was created by the researcher team of 40 optional items in 4 multiple choice options was assessed in the second step of research methodology. The LAT was used to analyze the difficulty, the discriminative value of the achievement test using the criterion-selection criteria was 0.21 - 0.79 and the discriminative value ranged from 0.23 to 0.94.

4.1.3 Validations of the Critical Thinking Ability Test (CTAT)

Using the 20-item *Critical Thinking Ability Test* (CTAT) that it has 6 optional components in 4 multiple choice options was assessed students' critical thinking abilities were assessed with the CTAT. The quality of the critical thinking ability test was then analyzed by qualitative (p), discriminative value (r), and confidence using the KR-20 formula. The CTAT was indicated that of the difficulty (p) ranged from 0.21 to 0.79, with the discriminative value (r) between 0.34-0.65 and 0.72.

4.1.4 Validations of the Test of Science-Related Attitudes (TOSRA)

The *Test of Science-Related Attitudes* (TOSRA) questionnaire was selected to use with the aim of investigating any possible relationships with the instructional management between STEM education method for developing students' attitudes toward science. The TOSRA consists of eight items and the five response alternatives are: *Almost Never* (1), *Seldom* (2), *Sometimes* (3), *Often* (4) and *Very Often* (5). The minimum score as 8 and maximum score as 40, and the average mean score range from 1.00 to 5.00 was indicated. The internal consistency (Cronbach alpha coefficient) was obtained for the sample in this present study as indices of scale reliability is 0.77.

4.2 The Effectiveness of the STEM Education Innovative Instructional Lesson Plan

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 10^{th} grade level in physics classes with the processing and performance resulting effectiveness at 75/75 criteria. Table 1 reports of the effectiveness of the innovative instructional lesson plan.

In Table 1 is shown 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 83.85 and the performance effectiveness (E2) indicate that of 82.2975.38, so the lessoning effectiveness

(E1/E2) evidences of 83.85/82.2978 over the threshold setting is 75/75. As reports in Table 1, the discriminant validity coefficients (the mean correlation of a scale with the other scales) of the innovative instructional lesson plans based on the model of learning management in a STEM Education Method indicated that 0.67 and 0.64 for the E1 and E2, respectively.

Table 1: Score Total, Mean, Standard Deviation, Variance, Cronbach Alpha Reliability, F-test and Percentage for the Effectiveness Innovative Instructional Lesson Plans for the STEM Education Method

Efficiency	Total score	Mean	$\bar{x}$	S.D.	Variance	α-Reliability	F-test	Percentage
Performance Processes (E1)	152	127.45	14.16	5.30	28.12	0.67	4489.88	83.85
Efficiency Performance Results (E2)	40	32.52	6.50	1.63	2.67	0.64	0.59	81.29
The Lessoning Effectiveness (E1/E2) = 83.85/82.29								

4.4 Comparisons between Students' Learning Achievements of their Pretest and Posttest Assessments with the STEM Education Innovative Instructional 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 classes with the 40-item *Leaning Achievement Test* (LAT) on Different Types of Motion Issue was created by the researcher team of 40 optional items in 4 multiple choice options 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 LAT as reports in Table 2.

Table 2: Total Score, Average Mean, Standard Deviation, Mean Difference, t-Value, and ANOVA (eta^2) Result for the LAT

Assessing Test	Total score ($\overline{X}$ =40)	Standard Deviation	Mean Diff.	*t*-Value	ANOVA (*eta*^{2})
Pretest	15.57	7.06	16.95	18.84***	0.65***
Posttest	32.52	1.63			

*N = 64, *ρ < 0.05, **ρ < 0.01, ***ρ < 0.001*

In Table 2, 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 15.57 and posttest revealed as 32.52. In most case, the standard deviation for the pretest as 7.06 and for the posttest as 1.63, and the mean difference between pre-tests and post-tests of 16.95 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 classes were assessed with the independent *t*-test and ANOVA (eta^2) significantly ($\rho < 0.001$).

4.5 Comparisons between Students' Critical Thinking Abilities of their Previous and Later Assessments with the STEM Education Innovative Instructional Method

To compare between students' learning achievements of their critical thinking abilities of their previous and later 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 classes with the 20-item *Critical Thinking Ability Test* (CTAT) on Different Types of Motion Issue was created by the researcher team of 40 optional items in 4 multiple choice options was assessed. Table 3 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 CTAT as reports in Table 3.

Table 3 reports students' critical thinking abilities at two points in time: before learning begins (previous test) and at the end (later test) of the CTAT in physics classes. The average mean scores of previous test of 12.34 and later test revealed that as 16.11. In most case, the standard deviation for the previous test as 2.22 and for the later test as 1.46, and the mean difference between two points of assessment of 3.77 were compared with the independent *t*-test and ANOVA (eta^2) significantly ($\rho < 0.001$).

Table 3: Total Score, Average Mean, Standard Deviation, Mean Difference, t-Value, and ANOVA (eta^2) result for the CTAT

Assessing Test	Total score ($\overline{X}$ =40)	Standard Deviation	Mean Diff.	*t*-Value	ANOVA (eta^2)
Previous Test	12.34	2.22	3.77	14.56***	0.42***
Later Test	16.11	1.46			

*N = 64, *ρ < 0.05, **ρ < 0.01, ***ρ < 0.001*

4.6 Comparisons between Students' Attitudes toward Science their Previous and Later Assessments with the STEM Education Innovative Instructional Method

To compare between students' attitudes toward science of their Previous and Later 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 classes with the 21-item *Test of Science-Related Attitudes* (TOSRA) was assessed. Table 4 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 TOSRA as reports in Table 4.

Table 4: Total Score, Average Mean, Standard Deviation, Mean Difference, t-Value, and ANOVA (eta^2) Result for the TOSRA

Assessing Test	Total score ($\overline{X}$ =5)	Standard Deviation	Mean Diff.	*t*-Value	ANOVA (*eta*^{2})
Previous Test	3.30	2.48	0.35**	4.96**	0.31**
Later Test	3.65	3.44			

*N = 64, *ρ < 0.05, **ρ < 0.01, ***ρ < 0.001*

Table 4 reports students' attitudes toward science at two points' previous test and later test of the TOSRA in physics classes. The average mean scores of previous test of 3.30 and later test revealed that as 3.65. In most case, the standard deviation for the previous test as 2.22 and for the later test as 1.46, and the mean difference between two points of assessment of 0.35 were compared with the independent *t*-test and ANOVA (*eta*^{2}) significantly ($\rho < 0.01$).

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

Students' learning achievements of their pretest and posttest assessment with the LAT to their perceptions of their previous creative thinking abilities with the innovative instructional lesson plans based on the model of learning management in a STEM Education Method in physics classes. Correlation's studies identified significant differences in students' learning achievements and their previous CTAT ($\bar{x} = 12.34, S.D. = 2.22$). 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' Pretest and Posttest Achievements for the Previous CTAT 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)
Pretest Assessment (LAT)	15.57	7.06	0.21	0.19	0.1936	0.0375
Posttest Assessment (LAT)	32.52	1.63	0.20	0.34	0.5710*	0.3261*

*N = 64, *ρ < 0.05, **ρ < 0.01, ***ρ < 0.001*

Table 6 reports the associations between students' learning outcomes of their pre-test and their posttest assessments to their pervious previous critical thinking abilities, the coefficient predictive values (R^2) indicated that 4% and 33% of the variance in previous critical thinking abilities to their physics classes was attributable to their previous learning achievement with the STEM Education instructional method, respectively. The simple correlation (r), standardized regression weight creative thinking validity (β) are non-correlations (p>.05), the multiple correlation (R) and the efficient predictive determinant (R^2) values are reported which show statistically significant are correlations (p<.05) for the posttest assessments to their pervious previous critical thinking abilities.

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

Students' learning achievements of their pretest and posttest assessment with the LAT to their perceptions of their later creative thinking abilities with the innovative instructional lesson plans based on the model of learning management in a STEM Education Method in physics classes. Correlation's studies identified significant differences in students' learning achievements and their later CTAT ($\bar{x} = 16.11, \mathrm{S.D.} = 1.46$). 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' Pretest and Posttest Achievements for the Later CTAT 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)
Pretest Assessment (LAT)	15.57	7.06	0.12	0.12	0.0217	0.0471
Posttest Assessment (LAT)	32.52	1.63	3.12**	3.02**	0.7813**	0.6105**

*N = 64, *ρ < 0.05, **ρ < 0.01, ***ρ < 0.001*

Table 6 reports the associations between students' learning outcomes of their pre-test and posttest assessments to their later critical thinking abilities. The coefficient predictive values (R^2) indicated that 4% and 61% of the variance in later critical thinking abilities and science rerated attitudes to their physics classes was attributable to their learning achievement with the STEM Education instructional method, respectively. The simple correlation (r), standardized regression weight creative thinking validity (β), multiple correlation (R) and the efficient predictive determinant (R^2) values are reported which show statistically significant are non-correlations (p>.05) for the pretest assessment and the later CTAT but it was responded to the r, β, R, and R^2 were associated for the posttest assessment, significantly ($\rho < 0.01$).

4.8 Associations between Students' Learning Achievements of their Pretest and Posttest Assessment and Previous Attitudes toward Science with the Innovative STEM Education Instructional Method

Students' learning achievements of their pretest and posttest assessment with the LAT to their perceptions of their previous creative thinking abilities with the innovative instructional lesson plans based on the model of learning management in a STEM Education Method in physics classes. Correlation's studies identified significant differences in students' learning achievements and their previous TOSRA ($\bar{x} = 3.30, S.D. = 0.36$). 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' Pretest and Posttest Achievements for the Previous TOSRA 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)
Pretest Assessment (LAT)	15.57	7.06	0.12	0.12	0.0217	0.0471
Posttest Assessment (LAT)	32.52	1.63	0.35*	0.35*	0.6011*	0.3614*

*N = 64, *ρ < 0.05, **ρ < 0.01, ***ρ < 0.001*

Table 7 reports the associations between students' learning outcomes of their pre-test and posttest assessments to their previous attitudes toward science (TOSRA). The coefficient predictive values (R^2) indicated that 5% and 36% of the variance in later previous attitudes toward science to their physics classes was attributable to their learning achievement with the STEM Education instructional method, respectively. The simple correlation (r), standardized regression weight creative thinking validity (β), multiple correlation (R) and the efficient predictive determinant (R^2) values are reported which show statistically significant are non-correlations (p>.05) for the pretest assessment and the previous TOSRA, it was indicated to the r, β, R, and R^2 were associated for the posttest assessment, significantly ($\rho < 0.05$).

4.9 Associations between Students' Learning Achievements of their Pretest and Posttest Assessment and their Later Attitudes toward Science with the Innovative STEM Education Instructional Method

Students' learning achievements of their pretest and posttest assessment with the LAT to their perceptions of their previous creative thinking abilities with the innovative instructional lesson plans based on the model of learning management in a STEM Education Method in physics classes. Correlation's studies identified significant differences in students' learning achievements and their later TOSRA ($\bar{x} = 3.65, \mathrm{S.D.} = 0.36$). 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 8.

Table 8: Associations between Students' Pretest and Posttest Achievements for the Later TOSRA 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)
Pretest Assessment (LAT)	15.57	7.06	0.12	0.12	0.3991	0.1593
Posttest Assessment (LAT)	32.52	1.63	0.33**	0.33**	0.7886**	0.6219**

*N = 64, *ρ < 0.05, **ρ < 0.01, ***ρ < 0.001*

Table 8 reports the associations between students' learning outcomes of their pre-test and posttest assessments to their previous attitudes toward science (TOSRA). The coefficient predictive values (R^2) indicated that 16% and 62% of the variance in later previous attitudes toward science to their physics classes was attributable to their learning achievement with the STEM Education instructional method, respectively. The simple correlation (r), standardized regression weight creative thinking validity (β), multiple correlation (R) and the efficient predictive determinant (R^2) values are reported which show statistically significant are non-correlations (p>.05) for the pretest assessment and the later TOSRA, it was indicated to the r, β, R, and R^2 were associated for the posttest assessment, significantly ($\rho < 0.01$).

4.10 Associations between Students' Previous Critical Thinking Abilities of their Previous and Later Attitudes toward Science with the Innovative STEM Education Instructional Method

Students' previous critical thinking abilities of their pretest and posttest assessment with the TOSRA to their perceptions of their previous creative thinking abilities with the innovative instructional lesson plans based on the model of learning management in a STEM Education Method in physics classes. Correlation's studies identified significant differences in students' learning achievements and their previous CTAT ($\bar{x} = 24.68, S.D. = 4.43$). 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 9.

Table 9: Associations between Students' Previous and Later Attitudes toward Science for the Previous CTAT 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)
Previous TOSRA	3.30	0.36	0.11	0.12	0.3701	0.1440
Later TOSRA	3.65	0.61	0.11	0.14	0.5451*	0.2971*

*N = 64, *ρ < 0.05, **ρ < 0.01, ***ρ < 0.001*

Table 9 reports the associations between students' previous critical thinking abilities of their previous and later assessments to their previous attitudes toward science (TOSRA). The coefficient predictive values (R^2) indicated that 14% and 30% of the variance in later previous CTAT were attributable to the STEM Education instructional method, respectively. The simple correlation (r), standardized regression weight creative thinking validity (β), multiple correlation (R) and the efficient predictive determinant (R^2) values are reported which show statistically significant are non-correlations (p>.05) for the previous TOSRA and the previous CTAT, it was indicated to the r, β, R, and R^2 were associated for the posttest assessment, significantly ($\rho < 0.05$).

4.11 Associations between Students' Later Critical Thinking Abilities of their Previous and Later Attitudes toward Science with the Innovative STEM Education Instructional Method

Students' learning achievements of their pretest and posttest assessment with the LAT to their perceptions of their previous creative thinking abilities with the innovative instructional lesson plans based on the model of learning management in a STEM Education Method in physics classes. Correlation's studies identified significant differences in students' learning achievements and their later CTAT ($\bar{x} = 32.21, \mathrm{S.D.} = 2.91$). 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 10.

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Table 10: Associations between Students' Previous and Later Attitudes toward Science for the Later CTAT 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)
Previous TOSRA	3.30	0.36	0.29**	0.30**	0.7348**	0.5400**
Later TOSRA	3.65	0.61	0.39***	0.39***	0.8440***	0.7124***

*N = 64, *ρ < 0.05, **ρ < 0.01, ***ρ < 0.001*

Table 10 reports the associations between students' later critical thinking abilities of their previous and later assessments to their previous attitudes toward science (TOSRA). The coefficient predictive values (R^2) indicated that 54% and 71% of the variance in later previous CTAT were attributable to the STEM Education instructional method, respectively. The simple correlation (r), standardized regression weight creative thinking validity (β), multiple correlation (R) and the efficient predictive determinant (R^2) values are reported which show statistically significant evidence of correlations (p<.01) for the previous TOSRA and the later CTAT, it was indicated to the r, β, R, and R^2 were associated for the later TOSRA and later CTAT, significantly ($\rho < 0.001$).

5. Conclusions

This paper is to report of the assessing students' critical thinking abilities and science attitudes for enhancing their learning achievements through the instructional approaching management with the STEM education instructional method of secondary students at the 10th grade level were examined. Designing the instructional method to investigate and examine of the effects of the activity-based on learning approaching management through the STEM education for fostering the critical thinking abilities, students' learning achievements, and their attitudes toward science in physics 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 64 students in two physics classes in the second semester of academic year 2016 at Jaturapakpiman Ratchadaphisek School under the Roi-Et Secondary Educational Service Area Office 27 with the purposive sampling technique. The context of the content that it composes of the Different Types of Motion Issue 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 critical thinking abilities and attitudes toward science.

The STEM education innovative instructional lesson plan was created learning plan offers the counselor to verify the content validity for students' learning activities, teaching materials, and evaluation in the learning management plan was corrected as suggested by the advisors and the 5-professional expert educators with the were reviewed and assessed the validity of content, purpose learning with the IOC value (*Index of Item Objective Congruence*), the acceptable accuracy must be 0.80 or higher. It appears that the research plan developed by the researcher has an average of 3.60 to 5.00, which is moderate to the highest when using for future in this research study.

Research instruments composed of the 40-item *Leaning Achievement Test* (LAT) was used to analyze the difficulty, the discriminative value of the achievement test using the criterion-selection criteria was 0.21 - 0.79 and the discriminative value ranged from 0.23 to 0.94. Using the 20-item *Critical Thinking Ability Test* (CTAT) that it has 6 optional components in 4 multiple choice options was assessed students' critical thinking abilities were assessed with the CTAT. The quality of the critical thinking ability test was then analyzed by qualitative (p), discriminative value (r), and confidence using the KR-20 formula. The CTAT was indicated that of the difficulty (p) ranged from 0.21 to 0.79, with the discriminative value (r) between 0.34-0.65 and 0.72. The *Test of Science-Related Attitudes* (TOSRA) questionnaire was assessed students' perceptions consists of eight items and five response alternatives are: *Almost Never* (1), *Seldom* (2), *Sometimes* (3), *Often* (4) and *Very Often* (5). The internal consistency (Cronbach alpha coefficient) was obtained for the sample in this present study as indices of scale reliability is 0.77. These instruments are validity and reliability when using for future in this research study.

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 83.85 and the performance effectiveness (E2) indicate that of 82.29, so the lessoning effectiveness (E1/E2) evidences of 83.85/82.29 over the threshold setting is 75/75. As reports in Table 1, the discriminant validity coefficients (the mean correlation of a scale with the other scales) of the innovative instructional lesson plans based on the model of learning management in a STEM Education Method indicated that 0.67 and 0.64 for the E1 and E2, respectively.

In terms of the comparisons between the 2-valiables were assessed. The average mean scores of pretest of 15.57 and posttest revealed as 32.52. In most case, the standard

deviation for the pretest as 7.06 and for the posttest as 1.63, and the mean difference between pre-tests and post-tests of 16.95 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 classes were assessed with the independent *t*-test and ANOVA (eta^2) significantly ($\rho < 0.001$). Students' critical thinking abilities at two points in time: before learning begins (previous test) and at the end (later test) of the CTAT in physics classes. The average mean scores of previous test of 12.34 and later test revealed that as 16.11. In most case, the standard deviation for the previous test as 2.22 and for the later test as 1.46, and the mean difference between two points of assessment of 3.77 were compared with the independent *t*-test and ANOVA (eta^2) significantly ($\rho < 0.001$). Students' attitudes toward science at two points' previous test and later test of the TOSRA in physics classes were compared. The average mean scores of previous test of 3.30 and later test revealed that as 3.65. In most case, the standard deviation for the previous test as 2.22 and for the later test as 1.46, and the mean difference between two points of assessment of 0.35 were compared with the independent *t*-test and ANOVA (eta^2) significantly ($\rho < 0.01$).

Associations between students' learning outcomes of their pre-test and their posttest assessments to their previous critical thinking abilities, the coefficient predictive values (R^2) indicated that 4% and 33% of the variance in previous critical thinking abilities to their physics classes was attributable to their previous learning achievement with the STEM Education instructional method, respectively. The simple correlation (r), standardized regression weight creative thinking validity (β) are non-correlations (p>.05), the multiple correlation (R) and the efficient predictive determinant (R^2) values are reported which show statistically significant are correlations (p<.05) for the posttest assessments to their pervious previous critical thinking abilities.

Associations between students' learning outcomes of their pre-test and posttest assessments to their later critical thinking abilities were assessed. The coefficient predictive values (R^2) indicated that 4% and 61% of the variance in later critical thinking abilities and science rerated attitudes to their physics classes was attributable to their learning achievement with the STEM Education instructional method, respectively. The simple correlation (r), standardized regression weight creative thinking validity (β), multiple correlation (R) and the efficient predictive determinant (R^2) values are reported which show statistically significant are non-correlations (p>.05) for the pretest assessment and the later CTAT but it was responded to the r, β, R, and R^2 were associated for the posttest assessment, significantly ($\rho < 0.01$).

Associations between students' learning outcomes of their pre-test and posttest assessments to their previous attitudes toward science (TOSRA) were investigated. The

coefficient predictive values (R^2) indicated that 5% and 36% of the variance in later previous attitudes toward science to their physics classes was attributable to their learning achievement with the STEM Education instructional method, respectively. The simple correlation (r), standardized regression weight creative thinking validity (β), multiple correlation (R) and the efficient predictive determinant (R^2) values are reported which show statistically significant are non-correlations (p>.05) for the pretest assessment and the previous TOSRA, it was indicated to the r, β, R, and R^2 were associated for the posttest assessment, significantly ($\rho < 0.05$).

Associations between students' learning outcomes of their pre-test and posttest assessments to their previous attitudes toward science (TOSRA). The coefficient predictive values (R^2) indicated that 16% and 62% of the variance in later previous attitudes toward science to their physics classes was attributable to their learning achievement with the STEM Education instructional method, respectively. The simple correlation (r), standardized regression weight creative thinking validity (β), multiple correlation (R) and the efficient predictive determinant (R^2) values are reported which show statistically significant are non-correlations (p>.05) for the pretest assessment and the later TOSRA, it was indicated to the r, β, R, and R^2 were associated for the posttest assessment, significantly ($\rho < 0.01$).

Associations between students' previous critical thinking abilities of their previous and later assessments to their previous attitudes toward science (TOSRA) were analyzed. The coefficient predictive values (R^2) indicated that 14% and 30% of the variance in later previous CTAT were attributable to the STEM Education instructional method, respectively. The simple correlation (r), standardized regression weight creative thinking validity (β), multiple correlation (R) and the efficient predictive determinant (R^2) values are reported which show statistically significant are non-correlations (p>.05) for the previous TOSRA and the previous CTAT, it was indicated to the r, β, R, and R^2 were associated for the posttest assessment, significantly ($\rho < 0.05$).

Associations between students' later critical thinking abilities of their previous and later assessments to their previous attitudes toward science (TOSRA) were associated. The coefficient predictive values (R^2) indicated that 54% and 71% of the variance in later previous CTAT were attributable to the STEM Education instructional method, respectively. The simple correlation (r), standardized regression weight creative thinking validity (β), multiple correlation (R) and the efficient predictive determinant (R^2) values are reported which show statistically significant evidence of correlations (p<.01) for the previous TOSRA and the later CTAT, it was indicated to the r, β, R, and R^2 were associated for the later TOSRA and later CTAT, significantly ($\rho < 0.001$).

6. Discussions

The main purposes of this research study were to assess students' critical thinking abilities and science attitudes for enhancing their learning achievements through the instructional approaching management with the STEM education instructional method of secondary students at the 10th grade level. One way was to find the efficiency of teaching innovation based on the E1/E2 criteria set. The innovation is complete all whole of steps. The average percentage score obtained from the whole group's learning process is close to the average score obtained from the post-test. It should not have a value difference of more than 5%, generally. In this recent study, the innovative instructional lesson plans based on the model of learning management for the STEM Education Method. Effectiveness of lessons during the learning process (E1) and the performance effectiveness (E2) revealed of 83.85/82.29. The results shows the finding of the E1/E2 indicates that of less than a value difference of ***5***% from the set of standardized criteria of 75/75, significantly.

The main purposes of this article are to outline a convenient questionnaire designed to assess students' learning achievements of their posttest outcomes and their perceptions of their critical thinking abilities to their attitudes towards science. The article describes various forms of the 40-item *Learning Achievement Test* (LAT) were assessed of their learning outcomes. The 20-item *Critical Thinking Ability Test* (CTAT), *and* the 8-item *Test Of Science-Related Attitude* (TOSRA). These instruments are validated and reliability for using the future in this research study and report its use in this research; and examines associations between students' learning of their posttest outcomes and their perceptions of their creative thinking abilities to their attitudes towards physics, as assessed by the LAT, CTAT, and student attitude with the TOSRA. This study has confirmed the reliability and validity of the research instruments; the LAT, CTAT, and TOSRA when used in physics classes.

This research study is in field of Educational research that aimed at developing critical thinking in adult learners, individually or in group problem solving and decision making contexts, continue to address these same three central elements. The results indicated that the relationship between critical thinking skills and abilities and critical thinking dispositions is an empirical question. Students have both in abundance, some have skills but not the disposition to use them, some are disposed but lack strong skills, and some have neither. A measure of critical thinking dispositions is the California Measure of Mental Motivation, Concordantly (Jones, 1995). Critical thinking is an important element of all professional fields and academic disciplines, the process of critical thinking involves the careful acquisition and interpretation of information and use of it to reach a well-justified conclusion that it indicated that enhancing

students' critical abilities to involve the concepts and principles of critical thinking can be applied to any context or case but only by reflecting upon the nature of that application for this current study.

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 classroom environments with simple and multiple correlations, standardized regression weight abilities and the coefficient predictive determinant value (R^2) were analyzed of associations between students' learning outcomes of their pre-test and their posttest assessments (LAT) to their previous and later critical thinking abilities (CTAT) towards their previous and later science attitudes (TOSRA) were assessed. the coefficient predictive values (R^2) indicated that the relationships between students learning of their pretest and their previous critical thinking abilities to their previous attitudes towards science are non-significant at the level of .05, and the R^2 indicated that of these values are less than 20% of the LAT, CTAT and TOSRA for the first assessments. However, the associations between students learning of their posttest and their later critical thinking abilities to their later attitudes towards science, statistically significant evidence at the level of .05, and the R^2 indicated that of these values are higher than 40% of the LAT, CTAT and TOSRA for the second assessments, correlatively. Finally, the assessing students' critical thinking abilities and science attitudes for enhancing their learning achievements through the instructional approaching management with the STEM education instructional method of secondary students at the 10th grade level in the context of Thailand's education are provided.

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