COMPARISONS OF THE INSTRUCTIONAL MANAGEMENT BETWEEN STEM EDUCATION METHOD AND THE 5E-INQUIRY MODEL FOR DEVELOPING STUDENTS' CREATIVE THINKING ABILITIES AND THEIR ATTITUDES TOWARD PHYSICS ON MOMENTUM AND COLLISION ISSUE OF SECONDARY STUDENTS AT THE 10th GRADE LEVEL IN PHYSICS CLASSES

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Abstract:

The purposes of this research were to develop an innovative instructional lesson plan based on the models of learning management in the STEM Education Method and the 5E-Inquiry Model curricula of secondary students at the 10th grade level on *Momentum and Collision Issue* in physics classes with the processing and performance resulting effective standardized criteria at the level of 80/80, to compare between students' learning achievements of their pre and posttests, to evaluate students' performances of their creative thinking abilities with the instructional designing methods, to assess students' attitudes toward physics, to associate between students' learning achievements of their post tests and their creative thinking abilities and their attitudes toward physics, and to predict the relationships between students' performances of their creative thinking abilities and their attitudes toward physics. Administrations with the target sample groups, which consisted of 50 experimental and 46 controlling group students to manage learning activities with the STEM Education Method and the 5E-Inquiry Model from Sarakhampittayakom School, Thailand with the Purposive Random Sampling technique was selected. Using the research type of the Quasi-

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experimental research was experimented in Two-Group Pretest-Posttest Design. Students' learning activities of their processing and performance resulting effective with the innovative instructional lesson plan in 16 periods. Students' learning achievements were assessed with the 30-item *Learning Achievement Test* (LAT) with four multiple choices, Students' responses of their creative thinking abilities were assessed with the 24-item *Creative Thinking Ability Test* (CTAT) in four scales; students' attitudes were assessed with a short version of the 8-item *Test Of Physics-Related Attitude* (TOPRA). Statistically significant were analyzed with average mean score $\overline{(X)}$, standard deviation, *(S.D.)*, percentage, independent variable t-test, One-Way ANOVA (*eta²*), Simple Correlation (r), Standardized Regression Coefficient (β), Multiple Correlation (*R*), and the Coefficient Predictive Value: (*R²*) were used. The results of this research findings: the effectiveness of the innovative learning management lesson plan on Momentum and Collision Issue of the secondary students at the 10th grade level in the form of STEM Education Method (E1/E2) is 83.70 / 83.47, and based on the 5E-Inquiry Model of (E1 / E2) was 80.00/80.58. Students' learning achievements of their pretest and post tests for both STEM Education Method and the 5E-Inquiry Model were differentiated (*p*< 0.001), significantly. The CTAT and the TOPRA by Cronbach alpha coefficient evidence of 0.88 and 0.79 were validated and reliability. Associations between students' learning achievements of their post-test (PoLAT) and their CTAT, the *R²* value indicated that 47% and 42% of the variance in students' creative thinking abilities of their physics classes were attributable to their post learning achievements, students' learning achievements of the LAT and their TOPRA toward physics, the *R²* value indicated that 50% and 36% of the variance in students' creative thinking abilities of their physics classes were attributable to their PoLAT learning achievements, the coefficient predictive determinant values between students in their CTAT and TOPRA toward physics, the *R²* value indicated that 67% and 26% of the variance in students' creative thinking abilities of their physics classes were attributable to their attitudes toward physics in the STEM Education Method and the 5E-Inquiry Model, statistically significant was also found at the 0.01 level, respectively. In terms of the 5E-Inquiry Model, statistically significant was not found at the 0.05 level between students' creative thinking abilities and their attitudes toward physics.

Keywords: comparisons, the instructional management, STEM education method, the 5E-inquiry model, creative thinking abilities, attitudes toward physics, physics classes

1. Introduction

As far back as 2002, the Ministry of Education announced experimental application of the Basic Education Curriculum 2001 in its pilot and network schools. Mandatory implementation was subsequently effected in all schools providing basic education from academic year 2003 to the present time. Problems and issues of concern included the provisions, application process and outcome of the curriculum. The problems identified were confusion and uncertainty in preparing school curriculums; schools' ambition in prescribing learning areas and expected outcomes; measurement and evaluation did not correlate with the standards set, which effects on preparation of certifying documents and transferring of learning outcomes. Consequently, the Office of the Basic Education Commission (OBEC), under close supervision of the Basic Education Commission Board, revised the Basic Education Curriculum 2001 in order to prepare the subsequent Basic Education Core Curriculum 2008. In so doing, OBEC availed the outcomes of the studies undertaken and benefited from the data and information provided in the Tenth National Economic and Social Development Plan (2007-2011). The Basic Education Core Curriculum 2008 thus prepared will undoubtedly provide all educational service area offices, local offices and basic education institutions under jurisdiction of various agencies with an appropriate framework and guidance for preparing the pertinent curriculum. The basic education to be provided to all Thai children and youths will be of higher quality in regard to acquisition of essential knowledge and skills required for learners' lives in the constantly changing society. Learners will also be able to acquire knowledge for continuous lifelong self-development. 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, it shall be applied for Grades 1-6, and Grades 7, 8, 10 and 11; and (3) From academic year 2011, it shall be applied for all grades from academic year 2012, this Core Curriculum 2008 shall be applied for all grades (Ministry of Education Thailand, 2012).

The learning standards and indicators prescribed in this document will enable agencies concerned at all levels to clearly visualize expected learning outcomes throughout the entire course of study. It will provide relevant local agencies and schools with confidence in their collaborative efforts to prepare school curriculums of higher quality and harmony. Learning measurement and evaluation will have greater clarity, thus eliminating the problem of inter-school transfer of learning outcomes. The Basic Education Core Curriculum is aimed at the full development of learners in all respects - morality, wisdom, happiness, and potentiality for further education and livelihood on learners' development for attainment of the following desired characteristics, which enable learners to enjoy their lives as Thai citizens and global

citizens. Observance of the principles of development of the brain and multiple intelligences is required to achieve learners' balanced development to have therefore prescribed the following eight learning areas; 1) Thai Language, 2) Mathematics, 3) Science, 4) Social Studies, Religion and Culture, 5) Health and Physical Education, 6) Art, 7) Occupations and Technology, and 8) Foreign Languages (Ministry of Education Thailand, 2012).

Focused on the science learning area, 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 *Momentum and Collision Issue* with the instructional management between STEM education method and the 5E-inquiry model were instructional designs for secondary students at the 10th grade level.

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). There are many instructional design models but many are based on the 5E-Inquiry Instructional Model with the five phases: *engage, explore, explain, extend/elaborate*, and *evaluate*. As a field, instructional design is historically and traditionally rooted in cognitive and behavioral psychology, though recently constructivism has influenced thinking in the field (Barufaldi, 2002). 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 and the 5E-inquiry model for developing students' learning achievements and developing these instructional models to creative thinking abilities and their attitudes toward physics on momentum

and collision issue of secondary students at the 10th grade level in physics classes were designed.

In terms of the creative thinking, it means thinking about new things or thinking in new ways. It is "*thinking outside the box*." Often, creativity in this sense involves what is called lateral thinking, or the ability to perceive patterns that are not obvious. Creative or innovative thinking is the kind of thinking that leads to new insights, novel approaches, fresh perspectives, and whole new ways of understanding and conceiving of things. The products of creative thought include some obvious things like music, poetry, dance, dramatic literature, inventions, and technical innovations. But there are some not so obvious examples as well, such as ways of putting a question that expand the horizons of possible solutions, or ways of conceiving of relationships that challenge presuppositions and lead one to see the world in imaginative and different ways (Facione, 2013). Focused on 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 classes of fluency, flexibility, originality, and elaboration ability scales were used. In this research study, to associate between students' creative thinking abilities and their attitudes toward physics in physics classes were assessed.

Adapted version of the short version of the *Test Of Physics-Related Attitude* (TOPRA) (Santiboon and Fisher, 2005) from the original of the *Test of Science Related Attitudes* (TOSRA) 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 physics and physics related issues because of participating in physics classes with the instructional management between STEM education method and the 5E-inquiry model.

Because of all teachers have been there tried to explain the concepts in a way of their students will understand, some lessons simply will not stick. If teacher teach secondary students, teacher might run into this with abstract lessons, like teaching about responsibility, honesty or being considerate of others. If teacher is teaching teens, tackling complex issues like social justice, government or politics may be the most common culprits. 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. Within innovative learning instructional plans, the role of the teacher shifts to something closer to that of a facilitator. Rather than calling on a single student at a time, the children are given the opportunity to discuss class materials in groups. Maximizing the level of interaction and participation sparks engagement; students begin to learn from one another, rather than solely learning from the teacher. As a result, students learning achievement with the instructional management between STEM education method and the 5E-inquiry model are soared.

2. Methodology

This research was designed and conducted to investigate the results of STEM education and the 5E-Inquiry methods for exploring the five-step knowledge of momentum and collision issue in physics classes. The research procedures of the study were as follows: students' learning achievements to develop their creative thinking abilities and their attitude towards physics were assessed with students' perceptions on the physics classroom environments. The research should be beneficial to the learning activities of physics teachers to use as the research instruments to develop students to be able to use

the knowledge, creative ability to create new innovations for society and live in a happy learning society are research procedures.

3. Research Objectives

To design the instructional management between STEM education method and the 5E-inquiry model for developing students' creative thinking abilities and their attitudes toward physics on momentum and collision issue of secondary students at the 10th grade level in physics classes, the purposes of this research were followed as:

1. To develop an innovative instructional lesson plan based on the models of learning management in a STEM Education Method and the 5E-Inquiry Model with the processing and performance resulting effective at 80/80 standardized criteria.

2. To compare between students' learning achievements of their pre and posttests with the STEM Education Method and the 5E-Inquiry Model on Momentum and Collision Issue.

3. To evaluate students' performances of their creative thinking abilities with the STEM Education Method and the 5E-Inquiry Model.

4. To assess students' attitudes toward physics with the STEM Education Method and the 5E-Inquiry Model.

5. To associate between students' learning achievements of their post assessing tests and their creative thinking abilities with the STEM Education Method and the 5E-Inquiry Model.

6. To associate between students' learning achievements of their post assessing tests and their attitudes toward physics with the STEM Education Method and the 5E-Inquiry Model.

7. To predict the relationships between students' performances of their creative thinking abilities and their attitudes toward physics with the STEM Education Method and the 5E-Inquiry Model.

4. Research Procedures

Step I: Creating and Finding Quality Instruments for Research
The instructional learning plan, the STEM Education Method, and the 5E-Inquiry Model on Momentum and Collision 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. 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, and the 5E-Inquiry Model Processes, Media/Learning Resources, Evaluation, and Scientific Process Skills.

Step II: Creating the Innovative Instructional Plan with the STEM Education Method
To create a learning plan for the STEM education method of science learning area strand on momentum and collision issue with the main innovative lesson plan in 16 hours was instructed in the experimental student group.

Step III: Creating the Innovative Instructional Plan with the 5E-Inquiry Model
Creating a learning plan for the 5E-Inquiry Model of science learning area strand on momentum and collision issue with the main innovative lesson plan in 16 hours was instructed in the controlling student group.

Step IV: The Innovative Instructional Plans were Checked
The creating the innovative instructional plans with STEM Education Method and the 5E-Inquiry Model were apply the revised learning management plans as suggested by the 2-supervisors and the 5-professional expert educators were checked to assess consistency, content validity and consideration, and evaluated the appropriability of the two innovative learning management plans for using the learning plan were developed by the researcher team.

Step V: Analyzing the Innovative Instructional Plans were Tried Out
The innovative instructional plans were tried out and applied the scores obtained from experts' assessments to analyze the mean to find out the quality of the learning plan. Appropriateness of plan by using a 5-scale rating scale model then improved the learning plan based on expert recommendations. The result of the quality of the innovative learning management plans using the STEM Education Method and the 5E-Inquiry Model were most appropriate, with an average of 4.20 to 5.00. Finally, to apply improved learning management plan were used with the two students' target groups in the tenth grade level at Sarakhampittayakom School.

4.1 Research Instruments

4.1.1 The Learning Achievement Test (LAT)
The physics content analysis and learning objectives were built with a 4-multiple choice and students' learning outcomes of their pre and posttest design with the *Learning Achievement Test* (LAT) were assessed of their learning outcomes.

4.1.2 The Creative Thinking Ability Test (CTAT)

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 *The Creative Thinking Ability Test (CTAT)* in 4 scales, namely *Fluency Thinking* (the ability to produce great number of ideas or problem solutions in a short period of time); *Flexibility Thinking* (the ability to simultaneously propose a variety of approaches to a specific problem); *Originality Thinking* (the ability to produce new, original ideas); *Elaboration Thinking* (the ability to systematize and organize the details of an idea in a head and carry it out) were built. Each scale consists of 6 items and the five response alternatives are: *Almost Never, Seldom, Sometimes, Often* and *Very Often*.

4.1.3 The Test of Physics-Related Attitude (TOPRA)

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 of *the Test Of Physics-Related Attitude (TOPRA)* that it obtained of 8 items.

4.2 Sample

To compare between students' learning achievements of their pre and posttests with the STEM Education Method and the 5E-Inquiry Model on Momentum and Collision Issue of secondary students at the 10th grade level in physics classes. The sample size was separated into two groups. Currently studying in the second semester of academic year 2016, Sarakhampittayakom Sombat Pittayakom School under the Secondary Education Service Area Office 26 was selected.

4.2.1 The Experimental Student Group

The sample of the experimental student group was a total of 50-secondary students at the tenth grade level, who conducted the learning activities in the form of the STEM Education Method study called experimental student group.

4.2.3 The Controlling Student Group

The sample of the controlling student group consisted of 46-secondary students at the tenth grade level, who conducted the learning activities in the form of the 5E-Inquiry Model study called controlling student group.

4.3 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 classroom environments with simple and multiple correlations, standardized regression weight abilities and the coefficient predictive determinant value (R^2) were analyzed.

5. Results

The focused on comparisons of the instructional management between STEM education method and the 5E-inquiry model for developing students' creative thinking abilities and their attitudes toward physics on *Momentum and Collision Issue* of secondary students at the 10th grade level in physics classes. 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 towards physics were associated. Using the STEM Education and the 5E-Inquiry Model instructional innovation's lesson plans and were managed the instructional activities, the *Learning Achievement Test (LAT)* were designed; students' creative thinking abilities were fostered with the 24-item *Creative Thinking Ability Test (CTAT)*. Statistically significant were analyzed with the Simple and Multiple Correlations, Standardized Regression Weight Validity (β), and Coefficient Determinant Predictive Value (R^2) were associated. This result is intended to follow as the research objectives in this section:

5.1 The Effectiveness of the Innovative Instructional Lesson Plans
5.1.1 The Effectiveness of the Innovative Instructional Lesson Plan for the STEM Education Method
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 environment classes with the processing and performance resulting effectiveness at 80/80 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	$\overline{\text{X}}$	S.D.	Percentage
Efficiency Performance Processes (E1)	200	167.4	3.29	83.70
Efficiency Performance Results (E2)	30	25.04	5.25	83.47
The Lessoning Effectiveness (E1/E2) = 83.70/83.47				

Table 1 shows the result for the effectiveness of 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) reveals of 83.70 and the performance effectiveness (E2) indicate that of 83.47, so the lessoning effectiveness (E1/E2) evidences of 83.70/83.47 over the threshold setting is 80/80.

5.1.2 The Effectiveness of the Innovative Instructional Lesson Plan for the *"5E-Inquiry Model"*

To analyze the effectiveness of the innovative instructional lesson plans based on the model of learning management in the 5E-Inquiry Model of secondary students at the 10th grade level in physics environment classes with the processing and performance resulting effectiveness at 80/80 criteria. Table 2 reports of the effectiveness of the innovative instructional lesson plans

Table 2: Score Total, Mean, Standard Deviation, and Percentage for the
Effectiveness Innovative Instructional Lesson Plans for the 5E-Inquiry Model

Efficiency Type	Total Score	$\overline{\text{X}}$	S.D.	Percentage
Efficiency Performance Processes (E1)	120	96.00	3.12	80.00
Efficiency Performance Results (E2)	30	24.17	2.80	80.58
The Lessoning Effectiveness (E1/E2) = 80.00∕80.58				

Table 2 shows the result for the effectiveness of the innovative instructional lesson plans based on the model of learning management in the 5E-Inquiry Model. Effectiveness of lessons during the learning process (E1) reveals of 80.00 and the performance effectiveness (E2) indicate that of 80.58, so the lessoning effectiveness (E1/E2) evidences of 80.00∕80.58 none the threshold setting is 80/80.

5.2 Validations of the LAT, CTAT and TOSRA
5.2.1 Validation of the Learning Achievement Test (LAT)

The 30-item *Learning Achievement Test (LAT)* was designed to assess students' achievements of their pretest and posttest, the LAT evaluation form submitted to professional experts to determine the appropriateness of content, language, idioms, and

content validity analysis by finding the consistency index between the test and the learning object with the *Index of Item and Objective Congruence* (IOC); The LAT was analyzed for the quality of the individual, the difficulty (P), and the discriminative power (B). Using the Brennan method was used to select the items with a Difficulty (P) ranging from 0.20 - 1.00 and the discriminative power of items ranging from 0.20 to 1.00, there were 30 items were used for students' learning achievements of their pretest and posttest designs.

5.2.2 Validation of the Creative Thinking Ability Test (CTAT)

Table 3 reveals of students' perceptions of their creative thinking abilities with the 24-item *Creative Thinking Ability Test* (CTAT) in 4 scales, namely *Fluency Thinking, Flexibility Thinking, Originality Thinking*, and *Elaboration Thinking* scales.

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

Scale	Mean (30)	Average mean (5)	Standard deviation	Cronbach alpha reliability	Discriminant validity
Originality Thinking	19.80	3.30	0.75	0.64	0.66
Flexibility Thinking	21.06	3.51	0.70	0.67	0.65
Fluency Thinking	19.62	3.27	0.77	0.65	0.66
Elaboration Thinking	20.46	3.41	0.83	0.67	0.64
Average Total	20.22	3.37	0.76	0.88	

As reported in Table 3, the discriminant validity coefficients (the mean correlation of a scale with the other scales) of students' creative thinking abilities ranged from 0.64 to 0.67. These figures suggest that the scales of the CTAT measure distinct although somewhat overlapping aspects of the creative thinking abilities.

5.2.3 Validation of the Test of Physics-Related Attitude (TOPRA)

The TOPRA questionnaire was selected to use with the aim of investigating any possible relationships with the instructional management between STEM education method and the 5E-inquiry model for developing students' creative thinking abilities and their attitudes toward physics. The TOARA consists of eight scales. The internal consistency (Cronbach alpha coefficient) was obtained for the sample in this present study as indices of scale reliability is 0.79.

5.3 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 the STEM Education Method of secondary students at the 10th grade level in physics classes with the 30-item pretest and posttest *Learning Achievement Test* (LAT) was assessed.

Table 4: Average Mean, Standard Deviation,
Mean Difference for the LAT of the STEM Education

Assessing Test	Total score ($\overline{X}$ =30)	Standard Deviation	Mean Diff.	*t*-Value	ANOVA (eta²)
Pretest	15.36	3.32			
			9.68	17.21***	0.87***
Posttest	25.04	6.56			

N = 50, *ǫ < 0.05, **ǫ < 0.01, ***ǫ < 0.001

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 LAT outcomes. The average mean scores of pretest of 15.36 and posttest revealed as 25.04. In most case, the standard deviation for the pretest as 3.32 and for the posttest as 6.56, and the mean difference between pre-tests and post-tests of 9.68 were compared. It also provides support the learning management in the STEM Education Method that teacher needed to take differences into consideration when planning and designing physics curriculum in the physics class were assessed with the independent *t*-test and ANOVA (*eta²*) significantly ($\rho < 0.001$).

5.4 Comparisons between Students' Learning Achievements of their Pretest and Posttest Assessments with the Innovative Instructional 5E-Inquiry Model

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 the 5E-Inquiry Model of secondary students at the 10th grade level in physics classes with the 30-item pretest and posttest *Learning Achievement Test* (LAT) 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 LAT outcomes. The average mean scores of pretest of 17.28 and posttest revealed as 24.17. In most case, the standard deviation for the pretest and posttest as 2.83 similarly, and the mean difference between pre-tests and

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post-tests of 6.89 were compared. It also provides support the learning management in the 5E-Inquiry Model that teacher needed to take differences into consideration when planning and designing physics curriculum in the physics class were assessed with the independent *t*-test and ANOVA (*eta²*) significantly (*ρ< 0.001*).

Table 5: Average Mean, Standard Deviation, Mean Difference for the
LAT of the STEM Education

Assessing Test	Total score ($\overline{X}$ =30)	Standard Deviation	Mean Diff.	*t*-Value	ANOVA (eta²)
Pretest	17.28	2.83			
			6.89	18.72***	0.57***
Posttest	24.17	2.83			

N = 46, *ρ < 0.05, **ρ < 0.01, ***ρ < 0.001

5.5 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 the 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 relatively 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 LAT and
their CTAT in Term of Simple Correlation (r), Multiple Correlations (R) and
Standardized Regression Coefficient (β) of the STEM Education Method

Variables	Mean ($\overline{X}$)	S.D.	Simple Correlation (r)	Standardized Regression Validity (β)	Multiple Correlation (R)	Efficiency Predictive Value (R^2)
Posttest Assessment (LAT)	4.17	0.55			0.6841**	0.4681**
The CTAT						
Originality Thinking	4.58	0.19	0.20*	0.20*		
Flexibility Thinking	4.54	0.17	0.67***	0.62***		
Fluency Thinking	4.54	0.20	0.31**	0.30**		
Elaboration Thinking	4.57	0.18	0.42**	0.42**		

N = 50, *ρ < 0.05, **ρ < 0.01, ***ρ < 0.001.

Table 6 shows the correlations between posttest assessment (LAT) and towards physics. The CTAT 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 0.6841 and the predictive efficiency (R^2) value indicated that 47% of the variances in students' creative thinking abilities to their physics classes were attributable to their post learning achievement in their physics class. 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 (LAT) that is predictable from the independent variable (CTAT), significantly ($\rho < 0.01$).

5.6 Associations between Students' Learning Achievements of their Posttest Assessment and their Creative Thinking Abilities with the Innovative 5E-Inquiry Model

Similarity, 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 5E-Inquiry Model in physics to determine their relationship with students' perceptions of their creative thinking abilities. The correlation identified significant relatively in students' learning achievements and their perceptions according to achievements made. 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 LAT and
their CTAT in Term of Simple Correlation (r), Multiple Correlations (R) and
Standardized Regression Coefficient (β) of the 5E-Inquiry Model

Variables	Mean ($\overline{X}$)	S.D.	Simple Correlation (r)	Standardized Regression Validity (β)	Multiple Correlation (R)	Efficiency Predictive Value (R²)
Posttest Assessment (LAT)	4.03	0.47			0.6445*	0.4154*
The CTAT Originality Thinking	4.05	0.28	0.24*	0.20*		
Flexibility Thinking	3.82	0.42	0.28**	0.21*		
Fluency Thinking	3.84	0.37	0.19*	0.15*		
Elaboration Thinking	3.90	0.34	0.26**	0.23**		

N = 46, *ρ < 0.05, **ρ < 0.01, ***ρ < 0.001.

Table 7 reveals the correlations between the posttest assessments (LAT) towards physics. The CTAT among four scales were relative significantly, when using a simple correlation analysis (r) and standardized regression validity (β). The multiple correlations (R) was 0.6445 and the predictive efficiency determinant (R^2) value indicated that 42% of the variances in students' creative thinking abilities to their physics classes were attributable to their post learning achievement in their physics class, significantly ($\rho < 0.05$).

5.7 Associations between Students' Learning Achievements of their Posttest Assessment and their Attitudes towards Physics with the Innovative STEM Education Instructional Method

The potential for students' learning achievements of their posttest assessment to their perceptions of their *Test Of Physics-Related Attitude* (TOPRA) with the innovative instructional lesson plans based on the model of learning management in the STEM Education Method in physics, other student, teacher and classroom qualities were explored to determine their relationship with students' perceptions of their attitudes towards physics. Correlation's studies identified significant relatively in students' learning achievements and their perceptions according to achievements were assessed. 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' Posttest Achievements for the LAT and
their TOPRA in Term of Simple Correlation (r), Multiple Correlations (R) and
Standardized Regression Coefficient (β) of the STEM Education Method

Variables	Mean ($\overline{X}$)	S.D.	Simple Correlation (r)	Standardized Regression Validity (β)	Multiple Correlation (R)	Efficiency Predictive Value (R^2)
Posttest Assessment (LAT)	4.17	0.55	0.25**	0.25**	0.7073**	0.5003*
TOSRA	4.42	0.24				

N = 50, *ϱ < 0.05, **ϱ < 0.01, ***ϱ < 0.001

Table 8 shows the correlations between students' learning outcomes of their posttest assessment (LAT) and their attitudes toward physics with the TOPRA were relative significantly, when using a simple correlation analysis (r) and standardized regression validity (β). The multiple correlations (R) were 0.7073 and the predictive efficiency (R^2) value indicated that 50% of the variances in students' attitudes towards physics to their physics classes were attributable to their post learning achievement. The coefficient of determination is a number that indicates the proportion of the variance in the dependent variable (LAT) that is predictable from the independent variable (TOPRA), significantly (*ρ< 0.01*).

5.8 Associations between Students' Learning Achievements of their Posttest Assessment and their Attitudes towards physics with the Innovative 5E-Inquiry Model

Similarity, the potential for students' learning achievements of their posttest assessment to their perceptions of their attitudes towards physics with the innovative instructional lesson plans based on the 5E-Inquiry Model with students' perceptions were assessed. Table 9 reports the correlation identified significant relatively in students' learning achievements and their perceptions according to achievements. 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 reveals the correlations between the posttest assessments (LAT) towards physics. The TOPRA among eight items were relative significantly, when using a simple correlation analysis (r) and standardized regression validity (β). The multiple correlations (R) was 0.6037 and the predictive efficiency determinant (R^2) value indicated that 36% of the variances in students' attitudes towards physics to their physics classes were attributable to their post learning achievement in their physics class, significantly (*ρ< 0.05*).

Table 9: Associations between Students' Posttest Achievements for the LAT and
their TOPRA in Term of Simple Correlation (r), Multiple Correlations (R) and
Standardized Regression Coefficient (β) in Terms of the 5E-Inquiry Model

Variables	Mean ($\overline{X}$)	S.D.	Simple Correlation (r)	Standardized Regression Validity (β)	Multiple Correlation (R)	Efficiency Predictive Value (R^2)
Posttest Assessment (LAT)	4.03	0.47	0.20*	0.20*	0.6037*	0.3645*
TOSRA	4.15	0.29				

N = 46, *ǫ < 0.05, **ǫ < 0.01, ***ǫ < 0.001

5.9 Associations between Students' Perceptions of their Creative Thinking Abilities and their Attitudes towards Physics with the Innovative STEM Education Instructional Method

The potential for students' perceptions of their creative thinking abilities (CTAT) and their attitudes towards physics (TOPRA) with the innovative instructional lesson plans based on the model of learning management in the STEM Education Method in physics, other student, teacher and classroom qualities were explored to determine their relationship with students' perceptions of their attitudes towards physics. Correlation's studies identified significant relatively in students' perceptions of their CTAT and their TOPRA were assessed. 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.

Table 10: Associations between Students' Perceptions of their Creative Thinking Abilities (CTAT) and their Attitudes towards Physics (TOPRA) in Term of Simple Correlation (r), Multiple Correlations (R) and Standardized Regression Coefficient (β) of the STEM Education Method

Variables	Mean ($\overline{X}$)	S.D.	Simple Correlation (r)	Standardized Regression Validity (β)	Multiple Correlation (R)	Efficiency Predictive Value (R^2)
CTAT	3.37	0.76	0.55***	0.53***	0.8172***	0.6678***
TOSRA	4.42	0.24				

N = 50, *ǫ < 0.05, **ǫ < 0.01, ***ǫ < 0.001

Table 10 shows the correlations between students' perceptions of their creative thinking abilities (CTAT) and their attitudes towards physics (TOPRA were relative significantly, when using a simple correlation analysis (r) and standardized regression validity (β). The multiple correlations (R) were 0.8173 and the predictive efficiency (R^2) value

indicated that 67% of the variances in students' attitudes towards physics to their physics classes were attributable to their post learning achievement, significantly ($\rho <$ *0.001*).

5.10 Associations between Students' Perceptions of their Creative Thinking Abilities and their Attitudes towards Physics with the Innovative 5E-Inquiry Model

Similarity, the potential for students' perceptions of their creative thinking abilities (CTAT) and their attitudes towards physics (TOPRA) with the innovative instructional lesson plans based on the 5E-Inquiry Model with students' perceptions were assessed. Table 11 reports the correlation identified significant relatively in students' learning achievements and their perceptions according to achievements. 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 11.

Table 11: Associations between Students' Perceptions of their Creative Thinking Abilities (CTAT) and their Attitudes towards Physics (TOPRA) in Term of Simple Correlation (r), Multiple Correlations (R) and Standardized Regression Coefficient (β) in Terms of the 5E-Inquiry Model

Variables	Mean ($\overline{X}$)	S.D.	Simple Correlation (r)	Standardized Regression Validity (β)	Multiple Correlation (R)	Efficiency Predictive Value (R^2)
CTAT	3.27	0.77	0.18*	0.17*	0.5104*	0.2605*
TOSRA	4.15	0.29				

N = 46, *ρ < 0.05, **ρ < 0.01, ***ρ < 0.001

Table 11 reports the correlations between students' perceptions of their creative thinking abilities (CTAT) and their attitudes towards physics (TOPRA) among eight items were relative significantly, when using a simple correlation analysis (r) and standardized regression validity (β). The multiple correlations (R) was 0.5104 and the predictive efficiency determinant (R^2) value indicated that 26% of the variances in students' attitudes towards physics to their physics classes were attributable in their physics class, significantly (*ρ< 0.05*).

6. Conclusions

This paper reports of the comparisons of the instructional management between STEM education method and the 5E-inquiry model for developing students' attitudes towards physics and their attitudes toward physics on momentum and collision issue of secondary students at the 10th grade level in physics classes. The purposes of this

research were to develop an innovative instructional lesson plan based on the models of learning management in the STEM Education Method and the 5E-Inquiry Model curricula of secondary students at the 10th grade level on Momentum and Collision Issue in physics classes that following as the Basic Education Core Curriculum 2008 under the Office of the Basic Education Commission (OBEC) and the National Economic and Social Development Plan of the Ministry of Education of Thailand. Selecting the learning standards and indicators prescribed in this document will enable agencies concerned at all levels to clearly visualize expected learning outcomes throughout the entire course of this study with the Science Learning Core in the context of physics contents, they are obtained at the Strand 4: Forces and Motion Standard SC4.1 and Standard SC4.2 and focused on the Strand 4: Forces and Motion Standard SC4.1 onto *Momentum and Collision Issue* with the instructional management between STEM education method and the 5E-inquiry model were instructional designs for secondary students at the 10th grade level were designed.

The purposes of this research were to develop an innovative instructional lesson plan based on the models of learning management in the STEM Education Method and the 5E-Inquiry Model curricula of secondary students at the 10th grade level on Momentum and Collision Issue in physics classes with the processing and performance resulting effective standardized criteria at the level of 80/80, to compare between students' learning achievements of their pre and posttests, to evaluate students' performances of their creative thinking abilities with the instructional designing methods, to assess students' attitudes toward physics, to associate between students' learning achievements of their post tests and their creative thinking abilities, to associate between students' post learning achievements and their attitudes toward physics, and to predict the relationships between students' performances of their creative thinking abilities and their attitudes toward physics. Administrations with the target sample groups, which consisted of 50 experimental and 46 controlling group students to manage learning activities with the STEM Education Method and the 5E-Inquiry Model; respectively from Sarakhampittayakom School under the Secondary Educational Service Area 26, Mahasarakham in Thailand with the Purposive Random Sampling technique was randomized.

In this research study, the instructional learning was designed with the *Science, Technology, Engineering* and *Mathematics* (STEM, previously SMET) are a term that refers to the academic disciplines of science, technology, engineering and mathematics. The term is typically used when addressing education policy and curriculum choices to improve competitiveness in science and technology development. It has implications for workforce development, national security concerns and immigration policy. The 5E-Inquiry Learning Method is an instructional model based on the constructivist

approach to learning, which says that learners build or construct new ideas on top of their old ideas. The 5E-Inquiry Learning Method can be used with students of all ages, including adults. Each of the 5E-Inquiry Learning Method describes a phase of learning, and each phase begins with the letter "E": Engage, Explore, Explain, Elaborate, and Evaluate. The 5E-Inquiry Learning Method allows students and teachers to experience common activities, to use and build on prior knowledge and experience, to construct meaning, and to continually assess their understanding of a concept. In this research study, using the instructional management between STEM education method and the 5E-inquiry model for developing students' learning achievements and developing these instructional models to creative thinking abilities and their attitudes toward physics on momentum and collision issue of secondary students at the 10th grade level in physics classes were designed with the processing and performance resulting effective standardized criteria at the level of 80/80. 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) reveals of 83.70 and the performance effectiveness (E2) indicate that of 83.47, so the lessoning effectiveness (E1/E2) evidences of 83.70/83.47 and evidences of 80.00∕80.58 none the threshold setting is 80/80 for the 5E-Inquiry Model.

Research instruments were used with the 30-item *Learning Achievement Test* (LAT) with a 4-multiple choice and students' learning outcomes of their pre and posttest design with the *Learning Achievement Test* (LAT) were assessed of their learning outcomes. The 24-item *Creative Thinking Ability Test* (CTAT), the original version of the original of the Guilford's intelligence work was adapted to assess students' perceptions of their creative thinking abilities in 4 scales, namely *Fluency Thinking*; *Flexibility Thinking*; *Originality Thinking*; and *Elaboration Thinking* were built. Each scale consists of 6 items and the five response alternatives are: *Almost Never, Seldom, Sometimes, Often* and *Very Often*. The *Test Of Physics-Related Attitude* (TOPRA) was to explore the psychometric attitudes of the *Test of Science-Related Attitude* (TOSRA) to adapt to the Thai version of *the Test Of Physics-Related Attitude (TOPRA)* that it obtained of 8 items. These instruments are validated and reliability for using the future in this research study.

The sample size was separated into two groups. The experimental student group was a total of 50-secondary students and the controlling student group consisted of 46-secondary students at the tenth grade level, who conducted the learning activities in the form of the STEM Education Method and the 5E-Inquiry Model, respectively. 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.

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 the STEM Education Method and the 5E-Inquiry Model of secondary students at the 10th grade level in physics classes with the 30-item pretest and posttest *Learning Achievement Test* (LAT) was assessed. It also provides support the learning management in the STEM Education Method that teacher needed to take differences into consideration when planning and designing physics curriculum in the physics class 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 STEM education instructional method and the 5E-Inquiry Model were assessed. The multiple correlations (R) was 0.6841 and the predictive efficiency (R^2) value indicated that 47% of the variances in students' creative thinking abilities to their physics classes were attributable to their post learning achievement in their physics class. 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 (LAT) that is predictable from the independent variable (CTAT), significantly ($\rho< 0.01$) for the STEM Education method learning outcomes. The multiple correlations (R) was 0.6445 and the predictive efficiency determinant (R^2) value indicated that 42% of the variances in students' creative thinking abilities to their physics classes were attributable to their post learning achievement in their physics class, significantly ($\rho< 0.05$) for the 5-E Inquiry Model of students' learning outcomes.

Associations between students' learning achievements of their posttest assessment and their attitudes with the TOPRA towards physics with the innovative STEM education instructional method and the 5-E Inquiry Model were assessed. The multiple correlations (R) were 0.7073 and the predictive efficiency (R^2) value indicated that 50% of the variances in students' attitudes towards physics to their physics classes were attributable to their post learning achievement. The coefficient of determination is a number that indicates the proportion of the variance in the dependent variable (LAT) that is predictable from the independent variable (TOPRA), significantly ($\rho< 0.01$) for the STEM Education method learning outcomes. The multiple correlations (R) was

0.6037 and the predictive efficiency determinant (R^2) value indicated that 36% of the variances in students' attitudes towards physics to their physics classes were attributable to their post learning achievement in their physics class, significantly ($\rho < 0.05$) for the 5-E Inquiry Model of students' students' performances were associated.

Associations between students' perceptions of their creative thinking abilities and their attitudes towards physics with the innovative STEM education instructional method and the 5-E Inquiry Model were predicted. The multiple correlations (R) were 0.8173 and the predictive efficiency (R^2) value indicated that 67% of the variances in students' attitudes towards physics to their physics classes were attributable to their creative thinking abilities, significantly ($\rho < 0.001$) for the STEM Education method of students' performances. The multiple correlations (R) was 0.5104 and the predictive efficiency determinant (R^2) value indicated that 26% of the variances in students' attitudes towards physics to their physics classes were attributable in their physics class, significantly ($\rho < 0.05$) for the 5-E Inquiry Model students' responses.

7. Discussions

There are several ways to check the quality of teaching innovation. One way is to find the efficiency of teaching innovation based on the E1/E2 criteria set. If the innovation of teaching plan is effective when the learner has performed various steps of the high quality is checked. 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) reveals of 83.70 and the performance effectiveness (E2) indicate that of 83.47, so the lessoning effectiveness (E1/E2) evidences of 83.70/83.47 and evidences of 80.00/80.58 none the threshold setting is 80/80 for the 5E-Inquiry Model. 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 80/80, significantly.

In previous sets of notes in this series research team analyzed a pretest-posttest, two-group, quasi-experimental design using blocking, matching, and analysis of covariance procedures. Those procedures were used to analyze the differences in posttest scores after any pretest score differences were "held constant." The interaction is a comparison of the differences between the posttest and pretest scores in each treatment group. In this set of notes, we will take a different approach and look at the *change* from the pretest and posttest scores. The data that we displayed in the analysis of covariance notes are redisplayed here using the pretest and posttest means

within each treatment condition. The 30-item Learning Achievement Test (LAT) question of interest is whether the improvement in scores from pretest to posttest is greater for the experimental group with the learning activities of the STEM Education method indicated that higher than mean scores of the learning activities of the 5E Inquiry Model for the control group in physics classes. It also provides support the learning management in the STEM Education Method that teacher needed to take differences into consideration when planning and designing physics curriculum in the physics class were assessed with the independent t-test and ANOVA (eta^2) significantly ($\rho<0.001$) from the 5E-Inquiry Learning Model, 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 creative thinking abilities to their attitudes towards physics. The article describes various forms of the 30-item *Learning Achievement Test* (LAT) were assessed of their learning outcomes. The 24-item *Creative Thinking Ability Test* (CTAT), *and* the 8-item *Test Of Physics-Related Attitude* (TOPRA). 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 TOPRA. This study has confirmed the reliability and validity of the research instruments; the LAT, CTAT, and TOPRA when used in physics classes.

Associations between students' learning achievements of their posttest assessment and their creative thinking abilities with the innovative STEM education instructional method and the 5E-Inquiry Model were assessed. The R^2 coefficient determinant values indicated that 47% and 42% of the variances in students' creative thinking abilities to their physics classes were attributable to their post learning achievement, respectively. Students' learning achievements of their posttest assessment and their attitudes with the TOPRA towards physics with the innovative STEM education instructional method and the 5-E Inquiry Model, the R^2 coefficient determinant values indicated that 50% and 36% of the variances were assessed in students' attitudes towards physics to their physics classes were attributable to their post learning achievement. The relationships between students' perceptions of their creative thinking abilities and their attitudes towards physics with the innovative STEM education instructional method and the 5-E Inquiry Model were predicted, the predictive efficiency (R^2) values indicated that 67% and 26% of the variances in students' attitudes towards physics to their physics classes were attributable to their creative thinking abilities with their attitudes towards physics, significantly ($\rho< 0.001$). This result confirms that STEM Education is an educational approach that integrates

knowledge from four fields: Science, Technology, Engineering, and Mathematics. This unified approach leads to the development of new processes or products that are useful in everyday life and work. To know more about STEM education in Thailand, STEM Education is an educational approach that integrates knowledge from four fields: Science, Technology, Engineering, and Mathematics. Teaching STEM in primary and secondary education can help students become interested in STEM careers and build a nation's STEM-educated workforce that can be used to meet the demands of business and industry in a complex and technology-driven economy. In terms of the 5E-Inquiry Learning Model that it has been popular for learning management in Thailand, a current model must be amended to maintain its value after new information, insights, and knowledge have been gathered. Such is now the case with the highly successful 5E learning cycle and instructional model. But rather to ensure instructors do not omit crucial elements for learning from their lessons while under the incorrect assumption they are meeting the requirements of the learning cycle (Enhancing Education, 2002).

The 21st century partnership for STEM Education (21PSTEM) is an independent, nonprofit research and action organization dedicated to identifying and implementing ways to transform education to empower learners and improve lives. By working of nearly 40 collegiate, nonprofit and for-profit partners, 21PSTEM develops and manages both large and small scale projects where diverse and varied expertise can be utilized in a collaborative environment to maximize program effectiveness and efficacy (The 21st Century Partnership for STEM Education, 2016). These comparisons of the instructional management between STEM education method and the 5E-inquiry model for developing students' attitudes towards physics and their attitudes toward physics on momentum and collision issue of secondary students at the 10th grade level in physics classes are provided, significantly.

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COMPARISONS OF THE INSTRUCTIONAL MANAGEMENT BETWEEN STEM EDUCATION METHOD AND
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ATTITUDES TOWARD PHYSICS ON MOMENTUM AND COLLISION ISSUE OF SECONDARY STUDENTS AT
THE 10th GRADE LEVEL IN PHYSICS CLASSES