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RESEARCH ARTICLE

STUDENTS' LEARNING OUTCOMES ACCORDING TO INNOVATIVE INSTRUCTIONAL LESSON PLANS WITH FLIPPED CLASSROOM APPROACH ON SAFETY AND CHEMISTRY LABORATORY SKILL ISSUE

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ABSTRACT

Research on quantitative method for assessing students' learning outcomes according to innovative instructional lesson plans with Flipped Classroom Approach (FCA) instructional model was developed on safety and chemistry laboratory skill issue for devoting perceptions of psychosocial characteristics of chemistry laboratory classroom of their learning outcomes to their satisfaction toward integrated science process skills were assessed with the 50-item Learning Achievement Measurement (LAM), the 20-item Questionnaire on Student Satisfaction (QSS), and the 29-item Scientific Process Skill Assessment (SPSA) to administer 36 secondary students at the 10th grade level. The 8-FCA instructional innovative lesson plans were responded with the efficiency of the processing performance and the performance results (E1/E2) indicated that evidence of 79.67/78.00. Students' satisfaction of their learning design with the FCA in seven steps as Somewhat Satisfied Level with Likert's scale, and non-fitted and non-significant to a data set in four scales for the QSS are performances. Scientific process skills and the criteria learning outcomes at 75% of the FCA instructional approach were significant at the 0.001 level for the SPSA on five Integrated Science Process Skills, differently. Students' learning achievements of their post learning outcomes to their instructional design according to the FCA indicates that of the effective criteria as 75% were compared with the LAM, the result pieces of evidence of statistically significant at the level of 0.001, differently.

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INTRODUCTION

Instructional Designed in the 21st Century

As a field, instructional design is historically and traditionally rooted in cognitive and behavioral psychology, though recently constructivism has influenced thinking in the field (Mayer, 1992). This can be attributed to the way it emerged during a period when the behaviorist paradigm was dominating American psychology. There are also those who cite that, aside from behaviorist psychology, the origin of the concept could be traced back to systems engineering. The impact of each of these fields is difficult to quantify, however, it is argued that the language and the "look and feel" of the early forms of instructional design and their progeny were derived from this engineering discipline (Tennyson *et al*., 1997). Specifically, they were linked to the training development model used by the U.S. military, which were based on systems approach and was explained as "the idea of viewing a problem or situation in its entirety with all its ramifications, with all its interior interactions, with all its exterior connections and with full cognizance of its place in its context" for management of the education system (Silber and Foshay, 2010). However, education plays a major role in the social and economic development of the nation, the government's policies must be argued that improvement of dynamics teaching and learning process is much needed. It requires teachers to understand deeply the areas of instructional design as part of their instructional planning, to ensure our education system continues to progress in tandem. The features of the 21st Century Learning needs teachers to be involve in the dynamics learning process which is multi-sensory, collaborative, and kinesthetic learning experience integrated in the learning activities which enable students to achieve the 4Cs requirement (*Critical Thinker, Communicator, Collaborator, Creator*) developing "a globally competitive personality" (Fadel, Trilling, and Bialik, 2015). In respond to this development, changes must be made in the instructional planning to cater to the world demand. Children of today are leaders of tomorrow in sustaining the nations' stability and success. The curriculum and teaching strategies are reviewed

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and revised in accordance to the needs. More emphasis is on "learner-centered approach" where teachers are facilitators guiding learners in achieving the intended learners' learning outcomes (Richey and Klein, 2011). Hence, Mishra and Koehler (2006) argued that an extensive pedagogical knowledge is also required for them to accommodate and integrate technology, pedagogy and content knowledge (TPACK) effectively in their instructional planning. The 21st Century Education involves not only the learning process but covers the entire system of education engaging teachers, learners, policy makers, stake holders which play an important role in supporting and integrating all elements that foster learning (Zain, Muniandy, and Hashim, 2016). Thus, Oblinger and Oblinger (2005) suggested that *Traditional ID* models will have to be re-modeled and re-designed to deliver instructions which are more learner-centered than process-centered. In the 21st century, people have to have high level thinking skills called 21 century learning skills in order to solve new problems of the new world. They should know how to use their knowledge and skills. These learning skills can be summarized under the three main subtitles; information and communication skills, thinking and problem-solving skills, interpersonal and self-directional skills. When educational problems are changing, at the same time solution proposals to these problems are also changing. Therefore to achieve the goals for 21 Century Learning Skills require the new approaches and new methods (Reiser and Dempsey, 2012).

Theories and Principles of Instructional Design: Instructional design (ID), 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 *et al*, 2012). 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 (Kurt, 2016). There are many instructional design models but many are based on the ADDIE model, Problem-based Learning, Project-based Learning, Flipped Classroom Learning Approach, and etc.

The Flipped Classroom Instructional Design: A flipped classroom is an instructional strategy and a type of blended learning that reverses the traditional learning environment by delivering instructional content, often online, outside of the classroom. It moves activities, including those that may have traditionally been considered homework, into the classroom. In a flipped classroom, students watch online lectures, collaborate in online discussions, or carry out research at home while engaging in concepts in the classroom with the guidance of a mentor. In the traditional model of classroom instruction, the teacher is typically the central focus of a lesson and the primary disseminator of information during the class period. The teacher responds to questions while students defer directly to the teacher for guidance and feedback. In a classroom with a traditional style of instruction, individual lessons may be focused on an explanation of content utilizing a lecture-style. Student engagement in the traditional model may be limited to activities in which students work independently or in small groups on an application task designed by the teacher. Class discussions are typically centered on the teacher, who controls the flow of the conversation (Ryback and Sanders, 1980). Typically, this pattern of teaching also involves giving students the task of reading from a textbook or practicing a concept by working on a problem set, for example, outside school (Strauss, 2012).The flipped classroom intentionally shifts instruction to a learner-centered model in which class time explores topics in greater depth and creates meaningful learning opportunities, while educational technologies such as online videos are used to 'deliver content' outside of the classroom. In a flipped classroom, 'content delivery' may take a variety of forms. Often, video lessons prepared by the teacher or third parties are used to deliver content, although online collaborative discussions, digital research, and text readings may be used. It has been shown that the ideal length of the video lesson to be is eight to twelve minutes (Abeysekera and Dawson, 2015). Flipped classrooms also redefine in-class activities. In-class lessons accompanying flipped classroom may include activity learning or more traditional homework problems, among other practices, to engage students in the content. Class activities vary but may include: using math manipulative and emerging mathematical technologies, in-depth laboratory experiments, original document analysis, debate or speech presentation, current event discussions, peer reviewing, project-based learning, and skill development or concept practice (Bergmann, and Sams, 2012). Because these types of active learning allow for highly differentiated instruction, more time can be spent in class on higher-order thinking skills such as problem-finding, collaboration, design and problem solving as students tackle difficult problems, work in groups, research, and construct knowledge with the help of their teacher and peers (Bennett *et al*., 2016).

A teacher's interaction with students in a flipped classroom can be more personalized and less didactic, and students are actively involved in knowledge acquisition and construction as they participate in and evaluate their learning (Alvarez, 2011). Students may be more likely to favor the Flipped Classroom approach once they have taken the time to personally participate in this specific type of learning course. In a prior pharmaceutics course, for instance, a mere 34.6% of the 19 students initially preferred the Flipped Classroom setting. After all of the students had participated in the Pharmaceutical Flipped Classroom course, the number of those favoring this method of learning increased significantly, reaching a total of 89.5%. Individuals interested in a more problem-solving, hands-on form of learning are more likely to benefit from Flipped Classroom, as it sways from a traditional lecture learning style. Students may initially have certain doubts or fears regarding the use of Flipped Classroom, including: the fear of having to "teach oneself", as in, having a lack of proper guidance from a designated instructor, leading to greater pressure on the student to study the content rigorously in order to perform well in the course; Obtaining a greater amount of academic work in order to achieve success within the course, as a result of minimal guidance from an instructor; The fear of obtaining a greater sense of confusion on topics discussed, which may correlate to the heavy focus on group discussion and problem-solving activities that Flipped Classroom encourages (Rotellar, Cristina, and Jeff, 2016). This research study focused on the Flipped Classroom Approach (FCA), followed as the thinking ideas of Mo and Mao (2017), was composed of various components, such as: (this information only represents a few examples): video collections, power points, student discussion, and teacher/student online communication. It has been determined, through several conducted experiments, that certain aspects of the Flipped Classroom Approach are more beneficial to students than others. For instance, in a study conducted on the feedback received from students who had participated in a Flipped Classroom teaching module for college English reading, the following results were derived: 92.59% of the students ultimately accepted the Flipped Classroom teaching module in general[36] 59.26% of the students accepted the "video form" of the teaching module, essentially provided as a resource for the course 100.00% of the students believed that the "learning guide" link provided in the teaching module was necessary for performing well in the course. From these specific statistics, it can be determined that students felt that their experience within the Flipped Classroom was greatly benefitted by certain aspects of the course (such as the learning guide provided), while other portions of the module may have been unnecessary or insignificant to their learning (such as the video form of the module).

In terms of the steps of the FCA model, additional works of the *Mark Frydenberg of the Huffington Post* (2017) for designing research study: Many of the examples Education Dive shares illustrate unique models of how research team can invert their class. Designing of those steps of the flipped concepts right for chemistry classroom in 7 steps:

Step I: *The Standard Inverted Classroom*; Students are assigned the "homework" of watching video lectures and reading any materials relevant to the next day's class. During class time, students practice what they've learned through traditional schoolwork, with their teachers freed up for additional one-on-one time.

Step II: *The Discussion-Oriented Flipped Classroom*; Teachers assign lecture videos, as well as any other video or reading related to the day's subject — think TED Talks, YouTube videos, and other resources. Class time is then devoted to discussion and exploration of the subject. This can be an especially useful approach in subjects where context is everything — think history, art, or English.

Step III: *The Demonstration-Focused Flipped Classroom*; Especially for those subjects that require students to remember and repeat activities exactly — think chemistry, physics, and just about every math class — it is most helpful to have a video demonstration to be able to rewind and re-watch. In this model, the teacher uses screen recording software to demonstrate the activity in a way that allows students to follow along at their own pace.

Step IV: *The Faux-Flipped Classroom*; One great idea Education Drive uncovered is perfect for younger students for whom actual homework might not yet be appropriate. This flipped classroom model instead has those students watch lecture video in class — giving them the opportunity to review materials at their own pace, with the teacher able to move from student to student to offer whatever individual support each young learner needs.

Step V: *The Group-Based Flipped Classroom*; This model adds a new element to help students learn — each other. The class starts the same way others do, with lecture videos and other resources shared before class. The shift happens when students come to class, teaming up to work together on that day's assignment. This format encourages students to learn from one another and helps students to not only learn what the right answers are but also how to actually explain to a peer why those answers are right.

Step VI: *The Virtual Flipped Classroom*: For older students and in some courses, the flipped classroom can eliminate the need for classroom time at all. Some college and university professors now share lecture video for student viewing, assign and collect work via online learning management systems, and simply require students to attend office hours or other regularly scheduled time for brief one-on-one instruction based on that individual student's needs.

Step VII: *Flipping the Teacher*: All the video created for a flipped classroom doesn't have to begin and end with the teacher. Students too can make use of video to better demonstrate proficiency. Assign students to their record practice role-play activities to show competency, or ask each to film themselves presenting a new subject or skill as a means to "teach the teacher".

Innovative Instructional Lesson Plans according to the FCA: Innovative teaching is a necessity for all teachers in order to meet the educational needs of the new generations. However, teachers' competency for innovative teaching is a key factor influencing innovative teaching performance. The 7 habits of highly effective lesson plans: Start with the end in mind. This may sound obvious, but it's not how all teachers start, Take the shortest path, Assess reliably and efficiently, Build learning that lasts, Anticipate the unexpected, Move towards inter-lesson planning, and Plans better together. Move from the context of the Basic Educational Curriculum Core 2008 (Revised in 2017) of Thailand to the *Flipped Classroom Approach* (FCA). The research team has done the contents, but the majorities use the defined set of the 7-model steps associated with high-quality FCA. These methods include developing a focused question, using Medias, well crafted performance assessments, allowing for multiple solutions, enlisting community resources, and choosing engaging, meaningful themes for building up the innovative instructional lesson plans with the FCA. The FCA offers the best method we have presently for combining inquiry with accountability, and should be part of every teacher's repertoire (see in Methodology subsection).

Science Process Skills: Following as the ideas of Michael J. Padilla, Professor of Science Education, University of Georgia, Athens, GA (1990), who explained that one of the most important and pervasive goals of schooling is to teach students to think. All school subjects should share in accomplishing this overall goal. Science contributes its unique skills, with its emphasis on hypothesizing, manipulating the physical world and reasoning from data. The scientific method, scientific thinking and critical thinking have been terms used at various times to describe these science skills. Today the term "science process skills" is commonly used. Popularized by the curriculum project, Science - A Process Approach (SAPA), these skills are defined as a set of broadly transferable abilities, appropriate to many science disciplines and reflective of the behavior of scientists. SAPA grouped process skills into two types-basic and integrated. The basic (simpler) process skills provide a foundation for learning the integrated (more complex) skills. These skills are listed and described below.

Basic Science Process Skills: *Observing* - using the senses to gather information about an object or event. Example: Describing a pencil as yellow. *Inferring* - making an "educated guess" about an object or event based on previously gathered data or information. Example: Saying that the person who used a pencil made a lot of mistakes because the eraser was well worn. *Measuring* - using both standard and nonstandard measures and estimates to describe the dimensions of an object or event. Example: Using a meter stick to measure the length of a table in centimeters. *Communicating* - using words or graphic symbols to describe an action, object or event. Example: Describing the change in height of a plant over time in writing or through a graph. *Classifying* - grouping or ordering objects or events into categories based on properties or criteria. Example: Placing all rocks having certain grain size or hardness into one group. *Predicting* - stating the outcome of a future event based on a pattern of evidence. Example: Predicting the height of a plant in two weeks time based on a graph of its growth during the previous four weeks.

Integrated Science Process Skills: *Controlling variables* - being able to identify variables that can affect an experimental outcome, keeping most constant while manipulating only the independent variable are designed. Example: Realizing through past experiences that amount of light and water need to be controlled when testing to see how the addition of organic matter affects the growth of beans. *Defining operationally* - stating how to measure a variable in an experiment. Example: Stating that bean growth will be measured in centimeters per week. *Formulating hypotheses* - stating the expected outcome of an experiment are built. Example: The greater the amount of organic matter added to the soil, the greater the bean growth. *Interpreting data* - organizing data and drawing conclusions from it is analyzed. Example: Recording data from the experiment on bean growth in a data table and forming a conclusion which relates trends in the data to variables. *Experimenting* - being able to conduct an experiment, including asking an appropriate question, stating a hypothesis, identifying and controlling variables, operationally defining those variables, designing a "fair" experiment, conducting the experiment, and interpreting the results of the experiment. Example: The entire process of conducting the experiment on the affect of organic matter on the growth of bean plants. *Formulating models* - creating a mental or physical model of a process or event are calculated. Examples: The model of how the processes of evaporation and condensation interrelate in the water cycle. In this current study, adapted version from Michael J. Padilla (1990) to invent the *Scientific Process Skill Assessment* (SPSA) was modified by research team; the SPSA was assessed students' skills of their science process skills to their learning activities toward chemistry according to innovative instructional lesson plans with the FCA instructional design on safety and chemistry laboratory skill issue only of the *Integrated Science Process Skills* on five scales, and obtained of 29 items, and the five points Likert scales to response alternatives are: Very Low (VL = 1), Low (LO = 2), Moderate (MO = 3), High (Hi = 4), and Very High (VH = 5) levels.

Students' Satisfactions of their Classroom Learning Environment: Following as the additional work ideas of Mary C. Hill and Kathryn K. Epps (2010) in Kennesaw State University to guideline for modified the questionnaire on the *Questionnaire on Student Satisfaction* (QSS) by research team. The QSS was assessed students' perceptions to their performances toward their satisfactions on chemistry classroom according to their innovative instructional lesson plans with the FCA on safety and chemistry laboratory skill issue. Overall, the QSS obtained of 20 items, and the five response alternatives with Likert's scale. This study examined the effect of alternative scale formats on reporting of intensity of attitudes on Likert scales (Joshi, Kale, Chandel, and Pal, 2015) of agreement are: *Very satisfied, Somewhat satisfied, Neither satisfied nor dissatisfied, Somewhat dissatisfied, and Very dissatisfied* levels.

MATERIALS AND METHODS

Although research and evaluation in science education have relied heavily on the assessment of academic achievement and other valued learning outcomes, these measures cannot give a complete picture of the educational process. Because students spend up to 15,000 hours at school by the time they finish senior high school (Rutter, Maughan, Mortimore, Ouston and Smith 1979) or upper secondary educational school in Thailand Education System (Santiboon, 2013), students have a large stake in what happens to them at school and their reactions to and perceptions of their school experiences are significant. This research study reviews the research procedures in conceptualizing, assessing and investigating the determinants and effects of social and psychological aspects of the learning environments of chemistry classroom according to innovative instructional lesson plans with flipped classroom approach, which would be reported in subsections as following as:

Research Procedures: Research on science classroom learning environment student's learning outcomes according to innovative instructional lesson plans with flipped classroom approach on safety and chemistry laboratory skill issue was designed on population and sample group, research instruments that they were invented by research team, these instruments are valid and reliable, time limitation was controlled, research procedure was checked, qualitative and quantitative data were analyzed, statistically significant was assessed with the descriptive and inference statistics.

Research Objectives

1. To develop the innovative instructional lesson plans with the flipped classroom approach on safety and chemistry laboratory skill issue of secondary students at the 10 grade level.
2. To examine students' perceptions of their satisfactions with the instructional design according to the flipped classroom approach on safety and chemistry laboratory skill issue of secondary students at the 10^{th} grade level.
3. To assess students' scientific process skills of their post learning outcomes to their instructional design according to the flipped classroom approach on safety and chemistry laboratory skill issue of secondary students at the 10^{th} grade level that it is indicated that of the effective criteria as 75%.
4. To assess students' learning achievements of their post learning outcomes to their instructional design

according to the flipped classroom approach on safety and chemistry laboratory skill issue of secondary students at the 10th grade level that it is indicated that of the effective criteria as 75%.

Research *Instruments:* The research instruments were invented and designed for answering the research objectives by the research team, these instruments composed of the three research inventories, namely:

The Learning Achievement Measurement (LAM): The *Learning Achievement Measurement* (LAM) was designed and invented by the research team. The PLM is the multiple choice options on four options for assessing students' learning achievements on the safety and chemistry laboratory skill issue. The LAM was obtained of 50 items, and students would be spent time for their learning outcomes after they were participated of their instructional designed to their innovative instructional lesson plans with the *Flipped Classroom Approach* on safety and chemistry laboratory skill issue in one hour of time limitation.

The Questionnaire on Student Satisfaction (QSS): The *Questionnaire on Student Satisfaction* (QSS) was invented by research team. The QSS was planned to assess students' perceptions to their performances toward their satisfactions on chemistry classroom according to their innovative instructional lesson plans with flipped classroom approach on safety and chemistry laboratory skill issue. Overall, the QSS obtained of 20 items, and the five response alternatives with Likert's scale. This study examined the effect of alternative scale formats on reporting of intensity of attitudes on Likert scales (Joshi, Kale, Chandel, and Pal, 2015) of agreement are: *Very satisfied, Somewhat satisfied, Neither satisfied nor dissatisfied, Somewhat dissatisfied, and Very dissatisfied* levels.

Table 1. The Innovative Instruction Lesson Plans on Eight Lesson Plans to Design in 12 Hours

Innovative Instructional Lesson Objectives	Instructional Objectives	Periods of Time (Hours)
Firstly: Basic Practices in Chemistry Laboratory	Describe basic laboratory procedures.	2
Secondly: 2 Safety in Chemistry Laboratory	Explain safety in chemistry lab.	1
Thirdly: Accident Prevention with Equipment and Chemicals	Explain the prevention of accidents with the use of equipment and chemicals.	2
Fourthly: Measurement Equipment and Tools	Describe the principles and use of measuring equipment and instruments in chemistry labs.	1
Fifthly: reads unit of measure of substance.	Explain the principle of the unit of measurement.	2
Sixthly: Change Unit	Describe how to change units into SI units by using unit change factor.	1
Seventhly: scientific processes.	Describe the scientific process.	2
Eighthly: Science experiments	Explain scientific experiments.	1

The Scientific Process Skill Assessment (SPSA): The *Scientific Process Skill Assessment* (SPSA) was designed by research team together; the SPSA was assessed students' skills of their science process skills to their learning activities toward chemistry according to innovative instructional lesson plans with flipped classroom approach on safety and chemistry laboratory skill issue on five scales, and obtained of 29 items, each scale consists of 8 items and the five points Likert's scales to response alternatives are: *Very Low (VL = 1), Low (LO = 2), Moderate (MO = 3), High (Hi = 4), and Very High (VH = 5)* levels. Students' responses of their perceptions in 1 hour and researcher were analyzed collecting data, continually.

Population and Sample Size Group: The population consisted of 515 secondary students at the grade 10th level in 14 chemistry classes in Anukool Naree School, Mueang District, Kalasin Province in Thailand, whose they sat in the first semester in the academic year 2018 was populated. A sample size was the target group consisted of 36 secondary students at the grade 10th level in a 4/5 chemistry class in Anukool Naree School, Mueang District, Kalasin Province in Thailand, whose they sat in the first semester in the academic year 2018 was selected with the purposive random sampling technique as the experimental student group.

Validation of the Research Instruments: Research team invented the 3-research instrument, the drafts of the instruments were submitted to five (5) experts, two from the field of assessment and evaluation, two from chemistry content, one from curriculum and instruction context for integrating the drafts of research instruments and were tried out. The experts made amendments on the drafts in terms of adequacy, clarity of language and choice of terminology. In validating the instruments, the experts dropped and took out of the items-leaving items that some items were not cleared. Finally, the 50-item *Learning Achievement Measurement* (LAM), the 20-item *Questionnaire on Student Satisfaction* (QSS), and the 29-item *The Scientific Process Skill Assessment (SPSA)* are validate and reliable, and to have confirmed for further use in this study.

Chemistry Context Limitations: Because of the learning area of science is aimed at enabling learners to learn this subject with emphasis on linking knowledge with processes, acquiring essential skills for investigation, building knowledge through investigative processes, seeking knowledge and solving various problems. Learners are allowed to participate in all stages of learning, with activities organized through diverse practical work suitable to their levels. The main content areas are prescribed as follows the Basic Education Core Curriculum B.E. 2551 (A.D. 2008) (Revised edition, 2017) (Ministry of Education, 2018) on *Substances and Properties of Substances: properties of materials and substances; binding forces* *between particles; changes in the state of substances; solution formation and chemical reaction of substances, chemical equations and separation of substances.* Researcher team determined the nature and pattern of the innovative instruction lesson plans on the eight components, namely; Title Plans Title Subjects Class Time, Background, Learning Standards, Learning Objectives, Learning Objectives, The classroom learning process is reversed, Media / Learning Resources, and Evaluation. After that, we designed of the *Innovative Instruction Lesson Plans* on eight lesson plans that it was spent schedule times in 12 hours (Table 1).

their scientific skills, which reported in each Table according to each research objective, were personated.

Research Objective 1: To Develop the Innovative Instructional Lesson Plans with the *Flipped Classroom Approach* (FCA) on Safety and Chemistry Laboratory Skill Issue of Secondary Students at the 10th Grade Level

Students' learning outcomes were developed by the innovative instructional lesson plans with the FCA on Safety and Chemistry Laboratory skill issue of secondary students at the

Table 2. The Mean, Standard Deviation, Percentage, Total Score for the Efficiency of the Processing Performances and the Performance Results (E_1/E_2) of the FCA

Efficiency Types	Total Score	Students' Account	Mean	S.D.	Percentage
Efficiency of the Processing Performances (E1)	150	36	119.50	2.96	79.67
Efficiency of the Performance Results (E2)	50	36	39.00	2.98	78.00
Efficiencies of the Innovative Instructional Lesson Plan for the FCA (E1 / E2) = 79.67/78.00					

Table 3. Scale Means' Score, Means, Standard Deviations, Variance Scale Internal Consistency (Cronbach Alpha Reliability), and F-test for the QSS

Scale	Score Mean (25)	Scale Mean (5)	Standard Deviation by Score Mean	Variance	Cronbach alpha reliability	*F*-test	Classified Level from Scale Mean
Process Learning Activity	22.42	4.49	1.47	2.17	0.52	1.08	Somewhat Satisfied
Classroom Learning Environment	22.38	4.48	1.39	1.93	0.50	1.59	Somewhat Satisfied
Learning Media	21.92	4.39	1.69	2.87	0.52	0.91	Somewhat Satisfied
Benefit	21.81	4.36	1.58	2.48	0.52	0.64	Somewhat Satisfied
Average Total	22.10	4.43	4.31	18.58	0.69	1.18	Somewhat Satisfied

N = 36, *$\rho < 0.05$, **$\rho < 0.01$, ***$\rho < 0.001$

Data Analysis

The researcher team administered the three instruments the LAM, QSS and SPSA on the subjects (respondents); the equipment for the practical activities was supplied by the researchers with the help of the laboratory Assistants. The respondents were grouped into 5 and each group worked as a team to ensure close observation by the researcher. Every member of each group carried out the exercise at the same time. The researcher observed the respondent while they worked and used the Assessment Format for the *Scientific Process Skill Assessment* (SPSA) to rate each respondent according to his/her level of performance of the task. Students' responses of their learning achievements were assessed with the LAM to their satisfactions with the QSS. The data collected were analyzed using descriptive statistic, such as; mean and standard deviation, and associations between students' performances of their QSS and their SPSA were assessed with the inference statistics, such as; simple and multiple correlations, regression analysis, and determination efficiency predictive value.

RESULTS

Quantitative research method on this current research study was assessed students' learning outcomes according to innovative instructional lesson plans with *Flipped Classroom Approach* on *Safety and Chemistry Laboratory Skill* issue with the 50-item *Learning Achievement Measurement* (LAM), the 20-item *Questionnaire on Student Satisfaction* (QSS), and the 29-item *The Scientific Process Skill Assessment (SPSA)* in five scales. Students' developments of their learning achievements, performances of their satisfactions, and improving their scientific skills, and associating between their satisfactions and

10 grade level. The *Flipped Classroom Approach* (FCA) is an instructional strategy and a type of blended learning that reverses the traditional learning environment by delivering instructional content, often online, outside of the classroom. It moves activities, including those that may have traditionally been considered homework, into the classroom. In a flipped classroom, students watch online lectures, collaborate in online discussions, or carry out research at home while engaging in concepts in the classroom with the guidance of a mentor or teacher or instructor. In this research designs, research team planned to assess students' performances of their assignments to their FCA in terms of three phases; the 10-Report Paper, the 10-Activity Paper, and the 10-Delivering Instructional Content, often Online, outside of the Classroom, each paper was assessed as a five scoring score, the tantalizations indicate of 150 all the whole scores of this innovative instructional lesson plans with the *Flipped Classroom Approach* (FCA) that was the *Processing Performances' Efficiency* (E1). Students' learning achievements were assessed with the 50-item *Learning Achievement Measurement* (LAM), which it was the *Performance Resulting Efficiency* (E2). Determining the efficiency of the processing performances and the performance results (E1/E2) indicates that the percentage of E1/E2 as the result shows the statistically significant in Table 2. Table 2 reports of the effectiveness of the learning outcomes were developed by the innovative instructional lesson plans with the FCA on Safety and Chemistry Laboratory skill issue of secondary students at the 10 grade level. The Flipped Classroom Approach (FCA) in chemistry class of the 36-upper secondary students at the 10th grade level with the FCA instructional innovative lesson plans were responded with the efficiency of the processing performances and the performance results (E_1/E_2) indicated that evidence of 79.67/78.00, which was higher than with the criteria of 75/75 were developed.

Table 4. The Mean, Standard Deviation, Total Score, the Criteria Score of 75%, Mean Different, and Independent Variable t-test for the FCA Instructional Approach

Accounting Students	Total Score	Criteria Score 75%	Mean	S.D.	df	t-test	Sig. (p)
36	29	21.75	24.03	1.79	35	7.61	.000

Table 5. The Mean, Standard Deviation, Total Score, the Criteria Score of 75%, Mean Different, and Independent Variable t-test for the for the FCA Instructional Approach

Students' Number	Total Score	Criteria Score 75%	Mean	S.D.	df	t-test	Sig. (p)
36	50	37.50	39.00	2.98	35	3.01	.000

Research Objective 2: To Examine Students' Perceptions of their Satisfactions with the Instructional Design according to the Flipped Classroom Approach on Safety and Chemistry Laboratory Skill Issue of Secondary Students at the 10th Grade Level

Using the *Questionnaire on Student Satisfaction* (QSS) was assessed students' perceptions of their satisfactions with the instructional design according to the *Flipped Classroom Approach* on safety and chemistry laboratory skill issue of secondary students at the 10th grade level in four scales, namely; *Process Learning Activity, Classroom Learning Environment, Learning Media, and Benefit* scales. Overall, the QSS obtained of 20 items, each scale composes of five items, and the five response alternatives with Likert's scale.

This study examined the effect of alternative scale formats on reporting of intensity of attitudes on Likert's scales of agreement are: *Very Satisfied, Somewhat Satisfied, Neither Satisfied nor Dissatisfied, Somewhat Dissatisfied, and Very Dissatisfied* levels. The results given in Table 2 show the mean scores for each of the four FCA scales. As each scale has five items ranging from 21.81 to 22.42 and average total score mean as 22.10, the average scale mean scores ranged from 4.36 (Benefit) to 4.49 (Process Learning Activity), respectively. Table 2 reports the internal consistency which ranged from 0.50 to 0.52 when using the actually scores and indicates that of students' satisfactions of their learning design was assessed with the FCA method in seven steps as *Somewhat Satified Level* with Likert's scale. Using an *F*-test is the test statistic has an F-distribution; it is most often used when comparing statistical models that have been non-fitted and non-significant to a data set.

Research Objective 3: To Assess Students' Scientific Process Skills of their Post Learning Outcomes to their Instructional Design on Safety and Chemistry Laboratory Skill Issue with the FCA

The result of this research section would be reported of students' scientific process skills of their post learning outcomes to their instructional design according to the *Flipped Classroom Approach* (FCA) on safety and chemistry laboratory skill issue of secondary students at the 10th grade level that it is indicated that of the effective criteria as 75% are compared. Using and the 29-item Scientific Process Skill Assessment (SPSA) on five skills, namely; the 4-item *Formulating Hypotheses*, the 5-item *Defining Operationally*, the 4-item *Controlling Variables*, the 8-item *Experimenting*, and the 8-item *Interpreting Data Skills were assessed*. These skills are the *Integrated Science Process Skills*. Table 4 revealed that the differences between students' scientific process skills and the criteria learning outcomes at 75% of the FCA instructional approach were significant at the 0.001 level.

Research Objective 4: Students' Learning Achievements of their Post Learning Outcomes to their Instructional Design with the FCA and the Criteria Learning Outcomes at 75%

To assess students' learning achievements of their post learning outcomes to their instructional design according to the flipped classroom approach on safety and chemistry laboratory skill issue of secondary students at the 10th grade level that it is indicated that of the effective criteria as 75%. Using the 50-item *Learning Achievement Measurement* (LAM) was administered. The result of this research section would be reported in Table 5.

Table 5 reported that the differences between students' learning achievements of their post learning outcomes to their instructional design according to the *Flipped Classroom Approach* on *Safety and Chemistry Laboratory Skill Issue* of secondary students at the 10th grade level that it indicated that of the effective criteria as 75%. Using the 50-item LAM and the criteria learning outcomes at 75% were compared, the result evidences that statistically significant at the .001 level, differently.

Conclusions

Research on classroom learning environments, the major purpose of this research study devoted to perceptions of psychosocial characteristics of classroom has been to make this exciting research tradition in science education more accessible to wider audiences. In its attempt to portray prior work, attention has been given to instruments for assessing classroom including: some interesting new instruments were invented (the 50-item *Learning Achievement Measurement* (LAM), the 20-item *Questionnaire on Student Satisfaction* (QSS), and the 29-item *Scientific Process Skill Assessment* (SPSA), several lines of previous research (e.g., use of environment dimensions as dependent variables, person-environment fit studies of whether students achieve better in their learning outcomes, student's performances of their satisfactions to their developing science process skills), and teacher's use of learning environment perceptions in guiding practical attempts to improve their own classrooms to their developing the instructional innovative lesson plans with the instructional design in the 21st century, which it has been historically and traditionally rooted in cognitive and behavioral psychology, though recently constructivism has influenced thinking. Also new lines of research which suggest desirable future directions for the field were discussed, including the desirability of the quantitative and method, links between different innovative instructional designs with the *Flipped Classroom Approach* (FCA) in 7 steps. Upper students at the grade 10th level may be more likely to favor the Flipped Classroom approach once they have taken the time to personally participate in this specific type of learning chemistry class as the modernized educational environments, and incorporating educational environment ideas into developing science process skills' psychology through their performances are assessed by their teacher. According to the research objectives: the *Flipped Classroom Approach* (FCA) in chemistry class of the 36-upper secondary students at the 10th grade level in Anukool Naree School, Kalasin Province was selected through the instructional design with the FCA instructional innovative lesson plans were responded with the efficiency of the processing performances and the performance results (E1/E2) indicated that evidence of 79.67/78.00, which was higher than with the criteria of 75/75 were developed.

Using the actually scores and indicates that of students' satisfactions of their learning design was assessed with the FCA method in seven steps as *Somewhat Satisfied Level* with the Likert's scale, an F-test was the test statistic has an F-distribution; it is most often used when comparing statistical models that have been non-fitted and non-significant to a data set in four scales for the QSS. Students' performances of their scientific process skills and the criteria learning outcomes at 75% of the FCA instructional approach were significant at the 0.001 level for the SPSA on five *Integrated Science Process Skills*, differently. Students' learning achievements of their post learning outcomes to their instructional design according to the FCA indicated that of the effective criteria as 75%. Using the 50-item LAM and the criteria learning outcomes at 75% were compared, the result evidences of statistically significant at the level of .001, differently.

DISCUSSIONS

Researches on the *Flipped Classroom* have been promoted in field of science education that including: How to form groups? Preparation before class, What should be done in class?, Useful tools to support the activities, How to set up infrastructure to support the activities (The University of Hong Kong, 2018). A flipped classroom constitutes of two components–learning online and learning in face-to-face (F2F) sessions. In the pre-class stage, students need to watch a series of online videos. In the in-class stage, students are expected to apply the content of online videos in problem-based activities and produce textual and visual responses.

How have Thai's teachers designed of their classes, successfully? King Mongkut's University of Technology North Bangkok, Thailand was designed a learning activity model using the flipped classroom concept and to evaluate teacher's opinion toward the model, this model is appropriate for using in higher education. The overall of the teacher's opinion on the model was also at high level (Minwong and Jeerungsuwan, 2016). Another study on the investigation of the effects of flipped classroom instruction on language accuracy and active learning environment to improve students' English language accuracy in the EFL in an upper-secondary demonstration school, it found that, students' responses of their classes revealed that they had positive attitude toward flipped classroom instruction, particularly in the part of active learning (Thaichay and Sitthitikul, 2016). These reports of the study in field of Flipped Classroom instructional design is not cleared, the research team wishes to invent or build up for designing research study with the *Flipped Classroom* Approach for assessing students' performances of their satisfactions, their learning outcomes, and their improvement and development the process skills toward chemistry, exactly. Based on research on learning environments, several practical implications for policy-makers and practitioners can be drawn. First, learning environment assessments should be used in addition to student learning outcome measures to provide information about subtle but important aspects of classroom life. Second, because teachers and students have systematically different perceptions of the same classrooms, student feedback about classrooms should be collected.

Third, teachers should strive to create 'productive' classroom learning environments as identified by research (e.g., classroom environments with greater organization, cohesiveness and goal direction and less friction). Fourth, in order to improve student outcomes, classroom environments should be changed to make them more similar to those preferred by the students. Fifth, the evaluation of innovations, new curricula and reform efforts should include classroom environment assessments to provide process measures of effectiveness. Sixth, teachers should use assessments learning environments to monitor and guide attempts to improve classrooms. Seventh, learning environment assessments should be used by school psychologists in helping teachers change their styles of interacting with students and improve their classroom and school environments with the FCA or other instructional designing models.

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