The Performance, Satisfaction, and Perception of Thai Primary Students Through Flipped Classroom for Environmental Sustainability Course at Assumption College Nakhon Ractchasima of Thailand

Witthaya Thepkom and Thanawan Phognsatha
Assumption University, Thailand
Corresponding Author, E-mail: bro.witthaya@gmail.com

****

Abstract

This research aimed to compare the primary 5 student's performance, determine the levels of student's satisfaction, and explore the student's perception after studying with the flipped classroom, traditional classroom, and virtual classroom in environmental sustainability course. The quasi-experimental research design was applied to compare the post-performance score of the three classrooms. A sample of 126 students, from primary 5 in Modern Language Program at Assumption College Nakhon Ratchasima, were purposively selected and divided into three classrooms according to prior knowledge and learning level equally. The flipped classroom was applied to the experimental group while the other two control groups received the traditional classroom and virtual classroom respectively. The data was analyzed using frequency, percentage, mean score, and standard deviation. The research hypotheses were tested using F-Test of Analysis of Variance (ANOVA), Independent Samples T-Test, and the content analysis, from the focus group interview, was additionally obtained to support the hypotheses and answer the research questions.

The results showed statically significant that after studying with the three classrooms; the students in the flipped classroom received the best post-performance score, gained the highest level of satisfaction, and provided the most positive perception comparing to the other two classrooms in environmental sustainability course. Therefore, the flipped classroom is considerably encouraged as effective learning approach to improve student's performance, satisfaction, and perception in environmental sustainability course. Theoretical and practical implications are discussed.

Keywords: Flipped Classroom; Student's Performance; Student'sSatisfaction; Student's Perception.

Introduction

The technology has clearly played the major role and transformed the traditional learning approach to the new learning approach in which both teachers and students are much facilitated by its functioning anytime and anywhere especially in the teaching and learning process in this era (Jacobs, 2010). Even though, the advancement of technology has tremendously personalized the individual learning style through the online learning platform that widely prevailed for the learners. It may not fully assist learners progress in learning performance, especially among the students in the lower educational levels since the actual classroom is still neccessary to shape the learners' holistic dimensions.

* Received: February 10, 2024; Revised: February 20, 2024; Accepted: February 24, 2024

Thus, the flipped classroom is proposed as the combination of in and out classroom which blends the use of advanced technology to personally learn through the online platform at home prior to the class and engage the actual classroom with more active and collaborative atmosphere in environmental sustainability course (Nayar & Koul, 2020; Warren, Reily, Herdan & Lin, 2020; Lo, Han, Wong & Tang, 2021). The course aims at increasing student's awareness on the urgent environmental issues and promoting the student's natural and conservational skills of appreciation in environment. With the combination of its method, the study explores the effectiveness of implementing the flipped classroom in environmental sustainability course at the primary level.

The research was conducted among 126 primary 5 students in Modern Language Program at Assumption College Nakhon Ratchasima. Its purpose is to investigate the student's performance, satisfaction, and perception after studying with the flipped classroom, traditional classroom, and virtual classroom. The flipped classroom combines the online self-study class at home and runs the activity-based method in class. While the traditional classroom follows the actual class of lecture-based method whereas the virtual classroom is based on the lecture-based method using online live-streaming software.

The findings will much benefit students, teachers, researchers, and practitioners in the field of environment science, sustainable resources development, and educational technological developers by using the flipped classroom. Therefore, its significance will not only promote the use of advanced technology but also improve the student's performance, satisfaction, and perception through its method.

Research Objectives

1) To compare the primary 5 student's performance after studying with the flipped classroom, traditional classroom, and virtual classroom in environmental sustainability course at Assumption College Nakhon Ratchasima of Thailand.

2) To compare the primary 5 student's performance after studying with the flipped classroom, traditional classroom, and virtual classroom in environmental sustainability course at Assumption College Nakhon Ratchasima of Thailand according to gender and grade point average (G.P.A)

3) To determine the levels of the primary 5 student's satisfaction after studying with the flipped classroom, traditional classroom, and virtual classroom in environmental sustainability course at Assumption College Nakhon Ratchasima of Thailand.

4) To explore the primary 5 student's perception after studying with the flipped classroom, traditional classroom, and virtual classroom in environmental sustainability course at Assumption College Nakhon Ratchasima of Thailand.

Literature Review

The Existence of Traditional Classroom

For ages the traditional classroom known as conventional classroom was prevalent in all classrooms. The basic definition is a face-to-face interaction between teachers and students in which a teachers is considered as a deliverer using available materials in the classroom in transferring information and knowledge and students are merely a receiver of the information and knowledge that to be transmitted by the teachers. Even though the rapid development of advanced technology, the main approach still remains unchanged. Naturally, the approach is

only obliged with the students' techniques and abilities in which does not stimulate the sense or mind, and on the contrary it only promotes the memory learning. Thus, the approach mainly focuses on the lecture-based which limits student's value learning skills (Damodhara & Rengarajan, 2007; Belias, Sdrolias, Nikolaos, Koutiva & Koustelios, 2013; Li, Qi, Wang & Wang, 2014; Tularam & Machisell, 2018).

The Rise of Virtual Classroom

As the advancement of technology has rapidly arisen, the new pedagogical methods have been introduced as the valuable tools to assist the classroom more interestingly. A virtual classroom is described as a web-based environment that allows an individual to take part in a live event without attending in the real place. The environment is arranged in the comfort and appropriate situation of place that helps listening to the lecture and having an interaction as if the action is taking place in traditional classroom through the convenience of advanced technological devices at personal place (Turoff, 2007). Hocutt (2022) described that there are a huge range of fantastic virtual classroom platforms that avail and apply for the students which are mostly developed by the popular software companies that teachers might select but the most essential thing to be selected is the engagement tools that provide and function appropriately, creatively, and systematically.

The Application of Flipped Classroom

Blended learning has been introduced which promotes social interaction, opportunities, facilitate accessing information and save time for active learning in class. Its function also provides the opportunity for both individual and group work in an effective way as well as the synchronous activities that teacher and students involve in learning process with numbers of visual-audio documents which create a rich environment in teaching and learning process. Moreover, it is a fact that blended learning approach could enhance the student's responsibilities in line with individual learning performance including there is a range model of blended learning that are introduced for selecting and applying in the teaching and learning process. The flipped classroom is placed as one out of those models (Staker & Horn, 2012).

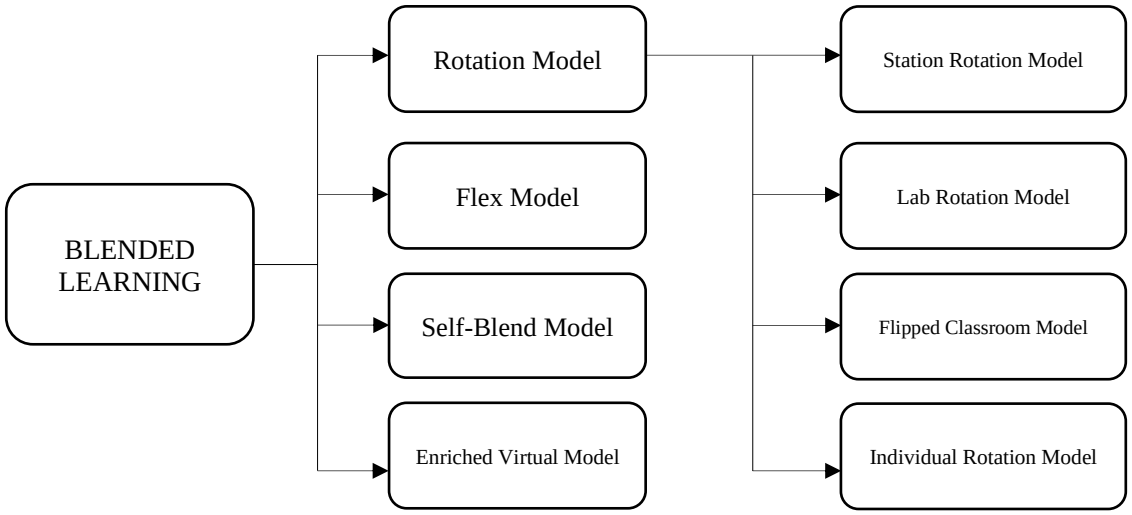

Figure 1: Flipped Classroom as a Blended Learning Model

Flipped classroom is also described as "A blended learning model which meaningful and active learning activities are carried out as part of cooperative learning in classroom setting while an individual learning is proceeded outside of school setting via the use of class videos, slides, articles, and learning documents in digital platform". Thus, flipped classroom is parallelly implemented in two significant phases, first out of the class-independent study through the online platform and second in class-inquiry-based activities. In this sense, the out of class activities is prepared a foundation for the in-class activities (Bergmann & Sams, 2012).

The cognitive tasks play a major role with alignment of constructive learning theory throughout the learning activities within the framework of flipped classroom application. In this regard, Bloom's taxonomy is linked to have more insight of the flipped classroom practices. Generally, the low-level cognitive tasks (Remembering & Understanding) are performed outside the class while the higher-level cognitive tasks (Applying, Analyzing, Evaluating, and Creating) are mainly performed inside the class (Eppard & Rochdi, 2017).

Strayer (2007) stressed that the flipped classroom is the activity-based learning with the utilization of educational technologies to perform the effectiveness of the model. In addition to that, Taylor & Statler (2014) stated that there is a relationship between student engagement and learning progress through the flipped classroom activities. Thus, the students participate in the teaching and learning process and evaluate such learning gained, interact with peers, cooperate the learning activities, develop the critical thinking skills through the frequent discussion activities, and learn more to connect between the existing knowledge and new knowledge. In this regard, the flipped classroom increases the level of participation among the students significantly and it is possible to realize the active learning process meaningfully.

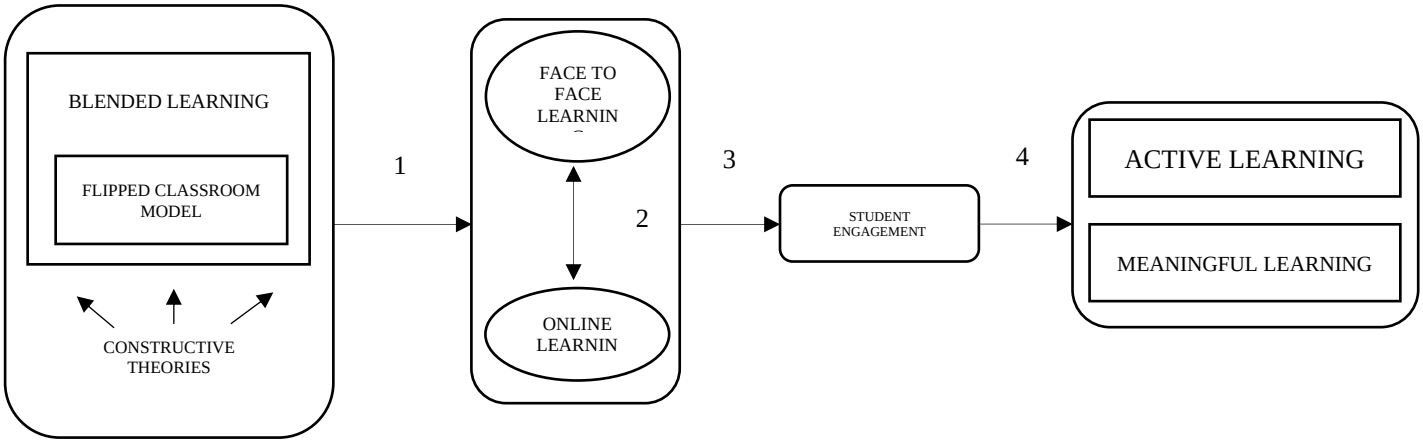

Figure 2: A Process of Flipped Classroom

Research Methodology

Research Design

A mixed-method design was applied to conduct the study using quasi-experimental research to compare the primary 5 student's performance, determine the levels of student's satisfaction, and explore the student's perception after studying with the flipped classroom, traditional classroom, and virtual classroom in environmental sustainability course at Assumption College Nakhon Ratchasima of Thailand. The independent variables include three types of classrooms: the flipped classroom as experimental group, traditional classroom, and virtual classroom as control groups. The dependent variables are the student's performance, student's satisfaction, and student's perception after studying with the three classrooms. The study has been conducted for 4 weeks.

Population and Sample

The research population consisted of 126 primary 5th students who study in Modern Language Program (MLP) at Assumption College Nakhon Ratchasima, Nakhon Ratchasima Province of Thailand.

All 126 primary 5th students were selected as the sample group using the purposive sampling technique. The students were equally split into three classrooms according to their prior knowledge and learning level using the student's pre-performance test: the flipped classroom as experimental group (42 students), the traditional classroom as the control group (42 students), and the virtual classroom as the control group (42 students).

Research Treatment

The quasi-experimental research was employed to conduct the study. To achieve the research aims, the study used the three-group designs to collect, compare, and analyze data both quantitative and qualitative research methods. The student's pre-performance test was measured the prior knowledge and learning level, and arrange into the three classrooms equally before beginning of the class. The experimental group received the environmental sustainability course based on the flipped classroom while the other two control groups received the environmental sustainability course based on the traditional classroom and virtual classroom respectively. The post-performance test was measured to compare the student's performance after studying with the three classrooms. Meanwhile, the student's satisfaction was determined the levels of the students whereas the student's perception was additionally explored among the students after studying with the three classrooms.

Table 1: The Research Procedure

Before Class	During Class	After Class
Student's Performance	Flipped Classroom	Student's Performance Student's Satisfaction Student's Perception
	Traditional Classroom	
	Virtual Classroom	

The research procedure was divided into three main steps applying to all three classrooms: one experimental group and two control groups.

1. Before class: the students were measured the prior knowledge and learning level in environmental sustainability course before arranging into three groups equally.

2. During class: the students received the learning activities in environmental sustainability based on the three different classrooms for 4 weeks.

3. After class: at the end of the 4th week, the post-performance test was measured to compare the student's performance. Meanwhile the satisfaction questionnaire was given to determine the levels of student's satisfaction whereas the focus group interview was additionally employed to explore the student's perception.

Table 2: Operationalization of Variables During the Class

Variables	Definition	Operationalization	Measurement
Flipped Classroom	A teaching and learning method that combines between out-classroom individual learning and in-classroom active learning. Out-classroom individual learning specifies as a self-directed study through the online learning resources of google classroom application such as the videos, recorded lessons, before the classroom begins. Whereas in-classroom active learning refers to the learning that takes place in the classroom based on the active and collaborative learning environment. (Strayer, 2007; Bergmann & Sams, 2012; Staker & Horn, 2012; Taylor & Statler, 2014)	A blend-based method (Pre-Class, In Class, and Post Class Summary)	**1. Student's Performance** Excellent (90-100 points) Very Good (80-89 points) Good (70-79 points) Medium (60-69 points) Pass (50-59 points) Fail (below 50 points) **2. Student's Satisfaction** Highest (Average 4.51-5.00) High (Average 3.51-4.50) Medium (Average 2.51-3.50) Low (Average 1.51-2.50) Lowest (Average 1.00-1.50) **3. Student's Perception** A content Analysis
Traditional Classroom	A face-to face classroom delivering with the entire content: theoretical and practical contents through the main delivery of lecture. (Damodhara & Rengarajan, 2007;	A lecture-based method via actual classroom (In Class and Post Class Summary)	

	Belias, Sdrolias, Nikolaos, Koutiva & Koustelios, 2013; Li, Qi, Wang & Wang, 2014; Tularam & Machisell, 2018)	
Virtual Classroom	A teaching and learning method that runs through the Google Meet Application synchronously and asynchronously. The delivery is based on the use of voice, video, chat, and provided features in the software for the delivery of teaching and learning process. (Benjamin, 1994; Salmon, 2000; Turoff, 2007; Mangal & Mangal, 2009; Hocutt, 2022; Schlusmans, Giesbertz, Rusman & Spoelstra, 2009)	A web-based method via virtual classroom (In Class and Post Class Summary via Google Meet)

Research Instruments

The research instruments were consisted of four types of instruments as described in the following.

Lesson Plan

The lesson plans were differently designed based on the environmental sustainability course for the three classrooms: the flipped classroom, traditional classroom, and the virtual classroom. Each lesson plan contained the same learning contents namely the planet earth, the pollution and environmental effect, and the care and conservation challenge lasting for 4 hours as a total summary of 12 hours within 4 weeks.

Pre- and Post-Performance Test

Before beginning the class, the pre-performance test was conducted to ascertain the student's prior knowledge and learning level. The students were arranged into the three classrooms according to their pre-performance equally before commencing the class. At the end of the class, the post-performance test was given to compare the student's performance after studying with the three classrooms. The pre- and post-performance tests were similarly prepared by the instructor based on the same learning contents in environmental sustainability course containing three parts: multiple-choice part, fill in the blank part, the writing part.

Questionnaire

The questionnaire was applied to determine the levels of student's satisfaction using the College and University Classroom Environment Inventory (CUCEI) developed by Fraser,

Fisher & McRobbie (1996) which was previously used in the research of Chien (2007). By the end of the class, the students were given to complete the questionnaire after studying with the three classrooms. The questionnaire was consisted of 6 main factors: Student Cohesiveness (SC), Teacher Support (TS), Involvement (IN), Task Orientation (TO), Cooperation (CO), and Equity (EQ).

Focus Group Interview

The focus group interview was essentially designed to explore the student's perception after studying with the three classrooms. The focus group interview was constructed by reviewing the previous related research studies containing the three questions adapted from the previous research of Nathawat (2020).

Validity and Reliability of Research Instruments

To obtain validity and reliability of the research instruments, the details were described in the following table.

Table 3: Validity and Reliability Procedure

Research Instruments	Validity	Reliability
1. Lesson Plans	The researcher prepared and adjusted the lesson plans by obtaining the correction and congruence with a careful check according to the formatting elements. No validity and reliability were required.	
2. The Pre- and Post-Performance Test	The three experts reviewed and validated the test using the Index of Item Objective Congruence (IOC). The IOC value was accepted at 0.756	The pilot test was done with the 30 students using Cronbach's Alpha Coefficient. The value was accepted at 0.929.
3. Questionnaire	The researcher adapted the College and University Classroom Environment Inventory (CUCEI) developed by Fraser, Fisher & McRobbie (1996) which was previously used in the research of Chien (2007). Hence, the validity was already established.	The pilot test was done with the 30 students using Cronbach's Alpha Coefficient. The value was accepted at 0.966.
4. Focus Group Interview	The three experts reviewed and validated the questions using the Index of Item Objective Congruence (IOC). The IOC value was accepted at 1.00.	Since, the purpose of the focus group interview was to explore student's perception after studying with the three classrooms as the additional information with a content analysis. So, the reliability value was not required.

Data Collection Procedure

The data collection procedure was described as follows.

Before class: Prior to the experiment, students were given the pre-performance test to measure their prior knowledge and learning level in environmental sustainability course. This served as the data for arranging the three classrooms equally.

During class: For 4 weeks of study, students attended different classrooms: the flipped classroom, traditional classroom, and the virtual classroom in environmental sustainability course.

After class: At the end of study, students received the post-performance test to compare their performance while the questionnaire was provided to determine the levels of satisfaction and the focus group interview was additionally used to explore perceptions after studying with the three classrooms.

Prior to the experiment, all sample students were provided a consent form and detailed explanation of the research processes including the purpose of the experiment. During the data collection process, regular communication and feedback with students were promptly responded to ensure understanding and engagement in the study.

Data Analysis

The research used the Statistical Package for the Social Science Program (SPSS) to test the research hypotheses. The descriptive statistics were reported using frequency, percentage, mean score, and standard deviation. Meanwhile the inferential statistics were tested using F-Test of Analysis of Variance (ANOVA), Independent Samples T-Test, and the content analysis, from the focus group interview, was additionally obtained to support the hypotheses and answer the research questions.

Research Conceptual framework

The study aimed to compare the student's performance, determine the levels of student's satisfaction, and explore the student's perception after studying with the flipped classroom, traditional classroom, and virtual classroom.

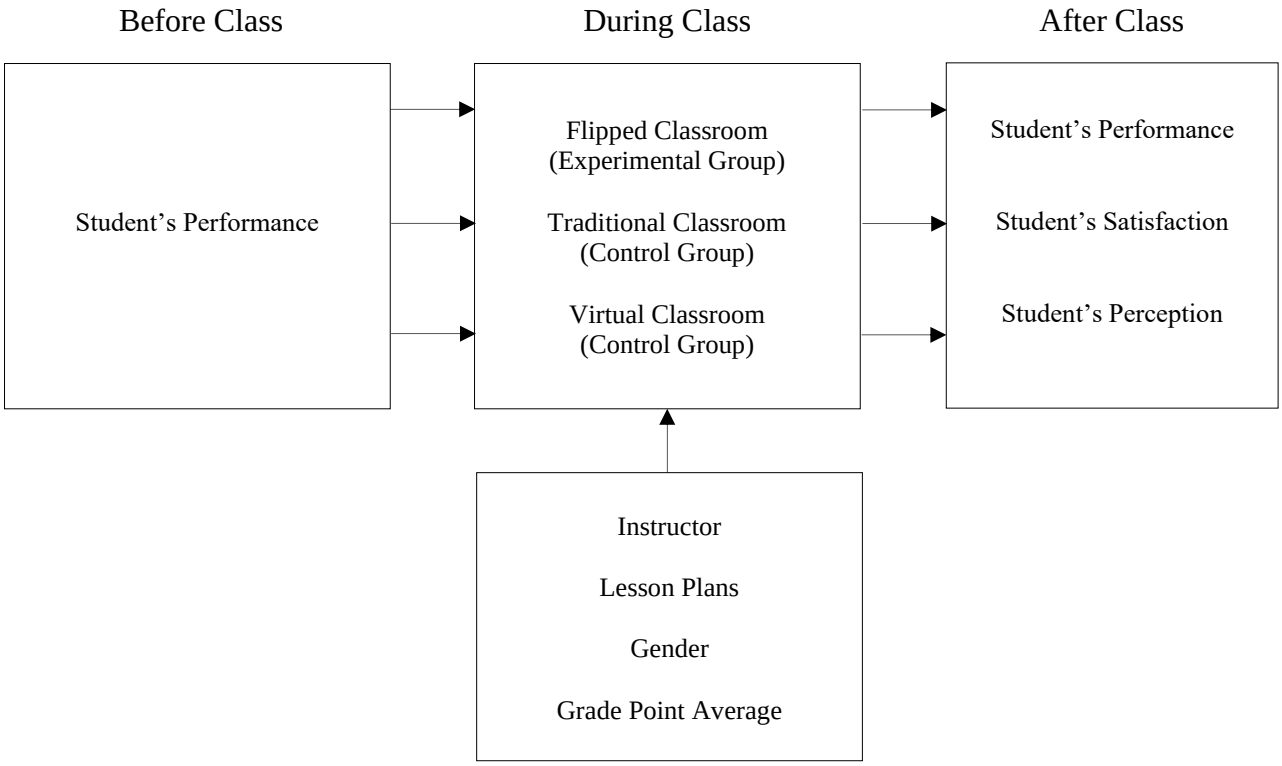

Figure 4: Research Conceptual framework

Research Results

The data was collected to measure the research hypotheses from the sample group of 126 students among the primary 5th students in Modern Language Program who studied with the flipped classroom as experimental group, traditional classroom, and virtual classroom as control groups at Assumption College Nakhon Ratchasima. The hypotheses testing results are as follows.

Hypothesis 1

$H_0$1: There was no significant difference among the primary 5 student's performance after studying with the flipped classroom, traditional classroom, and the virtual classroom in environmental sustainability course at Assumption College Nakhon Ratchasima of Thailand.

H_a1: There was significant difference among the primary 5 student's performance after studying with the flipped classroom, traditional classroom, and the virtual classroom in environmental sustainability course at Assumption College Nakhon Ratchasima of Thailand.

Table 4: Means and Standard Deviations Summary of Student's Post-Performance Test

Classrooms	Mean	S.D.	Participants
Flipped Classroom	31.29	5.274	42
Traditional Classroom	26.17	10.385	42
Virtual Classroom	24.62	9.902	42
Total	**27.33**	**9.197**	**126**

Table 5: A Comparison of Mean Difference of Student's Post-Performance Test

Classrooms	SS	df	MS	F	Sig.
Between Classrooms	991.444	2	495.722	6.363*	.002
Within Classrooms	9582.214	123	77.904		
Total	**10573.659**	**125**			

According to the data from Table 4 and 5, the F-Test of Analysis of Variance (ANOVA) was measured to compare the student's post-performance test after studying with the three classrooms. The results indicated that there was a significant difference of student's post-performance test among the three classrooms. The flipped classroom (M = 31.29, S.D. = 5.274), the traditional classroom (M = 26.17, S.D. = 10.385), and the virtual classroom (M = 24.62, S.D. = 9.902), $f = 6.363$, $p = .002$. Which means that the flipped classroom is the most effective learning classroom.

Table 6: A Comparison of Mean Difference of Student's Post-Performance Test Using Scheffe Method

Post-Performance Test	Classrooms		Mean Difference	Sig.
Post-Performance Test	Flipped Classroom	Traditional Classroom	5.024*	.036
		Virtual Classroom	6.571*	.004
	Traditional Classroom	Virtual Classroom	1.548	.725

According to the data from Table 6, the F-Test of Analysis of Variance (ANOVA) using Scheffe Method was measured the mean difference of student's post-performance test after studying with the three classrooms. The results indicated that there was a significant difference of student's post-performance test using Scheffe method between the flipped classroom and traditional classroom (Mean Difference = 5.024), $p = .036$, and the flipped classroom and virtual classroom (Mean Difference = 6.571), $p = .004$. Which means that the flipped classroom is more effective than traditional and virtual classrooms. Whereas there was no significant difference of student's post-performance test using Scheffe method between the traditional classroom and virtual classroom (Mean Difference = 1.548), $p = .725$. That means there is equal in learning performance either in the traditional classroom or in the virtual classroom.

Hypothesis 2

$H_0$2: There were no significant differences among the primary 5 student's performance after studying with the flipped classroom, traditional classroom, and the virtual classroom in environmental sustainability course at Assumption College Nakhon Ratchasima of Thailand according to Gender and Grade Point Average (G.P.A).

H_a2: There were significant differences among the primary 5 student's performance after studying with flipped classroom, traditional classroom, and the virtual classroom in environmental sustainability course at Assumption College Nakhon Ratchasima of Thailand according to Gender and Grade Point Average (G.P.A).

Table 7: A Comparison of Mean Difference of Student's Post-Performance Test According to Gender

Classrooms	Boys		Girls		T-Test	Sig. (2-tailed)
	Mean	S.D.	Mean	S.D.		
Flipped Classroom	29.90	5.127	32.48	5.221	-1.610	.115
Traditional Classroom	25.77	8.965	26.60	11.980	-.255	.800
Virtual Classroom	25.59	11.504	23.55	7.937	.663	.511
FC & TC & VC	**27.05**	**9.054**	**27.62**	**9.413**	**-.351**	**.727**

Note: FC = Flipped Classroom; TC = Traditional Classroom; VC = Virtual Classroom

According to the data from Table 7, the independent samples T-Test was measured to compare the mean difference of student's post-performance test after studying with the three classrooms according to gender. The result indicated that there was no significant difference of student's post-performance test in all three classrooms according to gender, t = -.351, p = .727. Which means that in all classrooms there is an equal learning performance of boys and girls.

Table 8: A Comparison of Mean Difference of Student's Post-Performance Test According to Grade Point Average (G.P.A)

Classrooms	≥ 3.25		< 3.25		T-Test	Sig. (2-tailed)
	Mean	S.D.	Mean	S.D.		
Flipped Classroom	32.46	4.549	29.50	5.813	1.851	.072
Traditional Classroom	25.68	11.861	26.57	9.248	-.271	.788
Virtual Classroom	29.79	9.807	20.35	7.866	3.391*	.002
FC & TC & VC	**29.56**	**9.257**	**25.16**	**8.669**	**2.757***	**.007**

Note: FC = Flipped Classroom; TC = Traditional Classroom; VC = Virtual Classroom

According to the data from Table 8, the independent samples T-Test was measured to compare the mean difference of student's post-performance test after studying with the three classrooms according to grade point average (G.P.A). The results indicated that there was a significant difference of student's post-performance test in overall and in the virtual classroom

according to grade point average (G.P.A), t = 2.757, p = .007, and t = 3.391, p = .002. Which means that in overall and in the virtual classroom, the students who have G.P.A greater than or equal to 3.25 are better in learning performance than those students who have G.P.A less than 3.25. Whereas there was no significant difference of student's post-performance test in the flipped classroom and traditional classroom according to grade point average (G.P.A), t = 1.851, p = .072, and t = -.271, p = .788. Which means that in both flipped classroom and traditional classroom, there is an equal learning performance of the students either having G.P.A greater than or equal to 3.25 or having G.P.A less than 3.25.

Hypothesis 3

$H_0$3: There were no significant differences on the levels of the primary 5 student's satisfaction after studying with the flipped classroom, traditional classroom, and the virtual classroom in environmental sustainability course at Assumption College Nakhon Ratchasima of Thailand.

H_a3: There were significant differences on the levels of the primary 5 student's satisfaction after studying with the flipped classroom, traditional classroom, and the virtual classroom in environmental sustainability course at Assumption College Nakhon Ratchasima of Thailand.

Table 9: Means and Standard Deviations Summary of Student's Satisfaction in All Factors

Factors	Flipped Classroom		Traditional Classroom		Virtual Classroom	
	Mean	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
1. Student Cohesiveness	4.42	.397	3.62	.713	2.97	.717
2. Teacher Support	4.29	.397	3.36	.802	2.82	.755
3. Involvement	4.19	.487	3.24	.827	2.72	.724
4. Task Orientation	4.50	.393	3.60	.680	3.20	.623
5. Cooperation	4.44	.357	3.59	.779	3.05	.653
6. Equity	4.36	.379	3.39	.682	2.93	.683
Total	**4.36**	**.349**	**3.47**	**.705**	**2.95**	**.626**

According to the data from Table 9, the result showed that the total student's satisfaction in flipped classroom was at the high level (M = 4.36, S.D. = .349). Whereas in traditional classroom and virtual classroom, the results showed that the total student's satisfaction was at the medium level (M = 3.47, S.D. = .705) and (M = 2.95, S.D. = .626) respectively.

Table 10: A Comparison of Mean Difference of Student's Satisfaction in All Factors

Factors	Classrooms	SS	df	MS	F	Sig.
1. Student Cohesiveness	Between Classrooms	43.916	2	21.958	55.764*	.000
	Within Classrooms	48.433	123	.394		
	Total	**92.349**	**125**			
2. Teacher Support	Between Classrooms	46.378	2	23.189	50.713*	.000
	Within Classrooms	56.243	123	.457		
	Total	**102.621**	**125**			
3. Involvement	Between Classrooms	46.609	2	23.304	48.340*	.000
	Within Classrooms	59.298	123	.482		
	Total	**105.907**	**125**			
4. Task Orientation	Between Classrooms	37.378	2	18.689	55.715*	.000
	Within Classrooms	41.259	123	.335		
	Total	**78.638**	**125**			
5. Cooperation	Between Classrooms	41.225	2	20.612	53.223*	.000
	Within Classrooms	47.636	123	.387		
	Total	**88.861**	**125**			
6. Equity	Between Classrooms	44.335	2	22.168	61.748*	.000
	Within Classrooms	44.157	123	.359		
	Total	**88.492**	**125**			

According to the data from Table 10, the F-Test of Analysis of Variance (ANOVA) was measured to compare the mean difference of students' satisfaction after studying with the three classrooms in all factors. The result indicated that there were significant differences after studying with the three classrooms in all factors and in each factor. The results showed that in Student Cohesiveness, f = 55.764, p = .000, in Teacher Support, f = 50.713, p = .000, in Involvement, f = 48.340, p = .000, in Task Orientation, f = 55.715, p = .000, in Cooperation, f = 53.223, p = .000, in Equity, f = 61.748, p = .000. Which means that after studying with the flipped classroom, traditional classroom, and virtual classroom, students in each classroom receives satisfactions differently. In summary, the students felt the best satisfaction with the flipped classroom classroom (M = 4.36 S.D. =.349 High Level) followed by the traditional classroom (M = 3.47 S.D. =.705 Medium Level). The least satisfaction was virtual classroom (M = 2.95. S.D. =.626 Medium Level).

Table 11: A Comparison of Mean Difference of Student's Satisfaction Using Scheffe Method

Factors	Classrooms		Mean Difference	Sig.
1. Student Cohesiveness	Flipped Classroom	Traditional Classroom	.797*	.000
		Virtual Classroom	1.443*	.000
	Traditional Classroom	Virtual Classroom	.645*	.000
2. Teacher Support	Flipped Classroom	Traditional Classroom	.992*	.000
		Virtual Classroom	1.470*	.000
	Traditional Classroom	Virtual Classroom	.547*	.001
3. Involvement	Flipped Classroom	Traditional Classroom	.943*	.000
		Virtual Classroom	1.470*	.000
	Traditional Classroom	Virtual Classroom	.526*	.003
4. Task Orientation	Flipped Classroom	Traditional Classroom	.907*	.000
		Virtual Classroom	1.300*	.000
	Traditional Classroom	Virtual Classroom	.392*	.010
5. Cooperation	Flipped Classroom	Traditional Classroom	.848*	.000
		Virtual Classroom	1.389*	.000
	Traditional Classroom	Virtual Classroom	.541*	.001
6. Equity	Flipped Classroom	Traditional Classroom	.967*	.000
		Virtual Classroom	1.422*	.000
	Traditional Classroom	Virtual Classroom	.455*	.003

According to the data from Table 11, the F-Test of Analysis of Variance (ANOVA) using Scheffe Method was measured the mean difference of student's satisfaction after studying with the three classrooms. The results indicated that there were significant differences of student's satisfaction after studying with the three classrooms in all factors and in all classroom comparison, $p = < .05$.

Table 12: Summary of Hypotheses Testing

Hypotheses	Results
$H_0$1: There was no significant difference among the primary 5 student's performance after studying with the flipped classroom, traditional classroom, and the virtual classroom in environmental sustainability course at Assumption College Nakhon Ratchasima of Thailand.	Rejecting the null hypothesis
$H_0$2: There were no significant differences among the primary 5 student's performance after studying with the flipped classroom, traditional classroom, and the virtual classroom in environmental sustainability course at Assumption College Nakhon Ratchasima of Thailand according to Gender.	Retaining the null hypothesis according to gender
$H_0$2: There were no significant differences among the primary 5 student's performance after studying with the flipped classroom, traditional classroom, and the virtual classroom in environmental sustainability course at Assumption College Nakhon Ratchasima of Thailand according to Grade Point Average (G.P.A).	Rejecting the null hypothesis according to grade point average (G.P.A)
$H_0$3: There were no significant differences on the levels of the primary 5 student's satisfaction after studying with the flipped classroom, traditional classroom, and the virtual classroom in environmental sustainability course at Assumption College Nakhon Ratchasima of Thailand.	Rejecting the Null Hypothesis

In addition to the three hypotheses, the focus group interview was exclusively taken place by purposively selecting the three students in each class to obtain their perception after studying with the three classrooms and answer the 4th research question. The summary of the focus group interview was described as follows.

Flipped Classroom

The result showed that students who studied with the flipped classroom perceived well with the class. They did enjoy the learning activities that enhanced them to get involved with friends. They didn't feel bored and difficult with the class.

Traditional Classroom

The result showed that students who studied with the traditional classroom didn't perceive well with the class. They felt uneasy and unhelpful since they had passively kept listening to the lecture and there was no chance to work with friends and got a practice.

Virtual Classroom

The result showed that students who studied with the virtual classroom hardly perceived well the class. They enjoyed and got excited at the beginning of the class when they joined the class via the computer. After then, they didn't feel satisfied since the class was solely focused on the lecture rather than playing games or having interaction. Moreover, the main problem during the class was the network and internet connection which interrupted the class to run smoothly.

Discussion

The findings of the study are discussed according to the research questions as follows.

1. In response to the first research question, the result showed that the students who studied with the flipped classroom were significantly gained the most effective learning performance in environmental sustainability course at Assumption College Nakhon Ratchasima of Thailand. The result is aligned with the studies done by Mohammadi, Barati & Youhanaee (2019), Pozo Sánchez, López Belmonte, Moreno Guerrero & López Núñez (2019), Halasa, Abusalim, Rayyan, Constantino, Nassar, Amre, Sharab & Qadri, (2020), Srinivasan & Kumar (2020), Nathawet (2020), Campillo-Ferrer & Miralles-Martínez (2021), Shao & Liu (2021) and Holm, Rognes & Dahl (2022) which showed similar results that after implementing flipped classroom, there was significant improvement in student's performance, student's satisfaction, and student's perception better than the comparing classroom approaches including the feedback was extremely positive after studying with the flipped classroom. As per qualitative implementation, the success of its method depends on the learning design and implementation.

2. In response to the second research question, the results showed in the followings.

Toward the gender, the boy and girl students showed no difference of the post-performance scores after studying with the three different classrooms. Both had equal learning performance in environmental sustainability course at Assumption College Nakhon Ratchasima of Thailand. This was because the boy and girl students gained the similar post-performance scores in all classrooms. The result is aligned with Aggarwal, Thakur, Agrawal, Jhajharia, Madaan & Mahapatra (2019) who studied about the learning achievement among the first-year medical students with implementation of the flipped classroom. Interestingly, the result showed on evidence of statistiscal difference in learning performance neither better nor worse comparing to other types of learning approaches.

Toward the grade point average (G.P.A), the result of the overall and in the virtual classroom showed that the students who have G.P.A greater than or equal to 3.25 learned better than who have G.P.A less than 3.25. Whereas in flipped classroom and traditional classroom, the result showed no difference of students who have G.P.A more or less. This is also aligned with Aggarwal, Thakur, Agrawal, Jhajharia, Madaan & Mahapatra (2019) who studied about the learning achievement among the first-year medical students with implementation of the flipped classroom. Interestingly, the result showed on evidence of statistiscal difference in learning performance neither better nor worse comparing to other types of learning approaches.

3. In response to the third research question, the result showed that the students who studied with the flipped classroom satisfied most in all the six factors: Student Cohesiveness, Teacher Support, Involvement, Task Orientation, Cooperation, and Equity in environmental sustianability course at Assumption College Nakhon Ratchasima of Thailand. The result is

aligned with the studies done by Mohammadi, Barati & Youhanaee (2019), Pozo Sánchez, López Belmonte, Moreno Guerrero & López Núñez (2019), Halasa, Abusalim, Rayyan, Constantino, Nassar, Amre, Sharab & Qadri, (2020), Srinivasan & Kumar (2020), Nathawet (2020), Campillo-Ferrer & Miralles-Martínez (2021), Shao & Liu (2021) and Holm, Rognes & Dahl (2022) which showed not only students learned better learning performance than other types of classrooms but also the feedback was extremely positive after studying with the flipped classroom.

4. In response to the fourth research question, the result showed that students who studied with the flipped classroom perceived the approach better than the other two classrooms. The students did enjoy the learning activities that enhanced them to get involved with friends with no difficulties as well as availabilities to help prepare the learning content well prior to the class. Whereas the students in traditional classroom and virtual classroom, they didn't perceive well with these two approaches. They felt uneasy and unhelpful while the network and internet connection was the main problem in virtual classroom. Interestingly, the result is also aligned with Oudbier, Spaai, Timmermans & Boerboom (2022) studied about enhancing the effectiveness of flipped classroom in the health science education: a state-of-the-art review. The result revealed the six main factors that affect the effectiveness of the flipped classroom namely student characteristics, teacher characteristics, implementation, task characteristics, out-of-class activities, and in-class activities. Exclusively, mediating factors are, among other factors, for instance the learner's level of self-regulated learning, teacher's role and motivation, assessment approach, and guidance during self-study by means of prompts or feedback. In addition, Say (2020) also found the result of the flipped class implementation in science teaching that the effectiveness of its method was achieved successfully and positively. Whereas the problems of internet access and hardware inadequacy were needed to pay a great intention for the more effective implementation.

Notable Findings

The study contains valuable research findings that may be directly or indirectly relevant to the research questions as follows.

Student's Interaction and Engagement: Researcher has observed the students with lively interaction and engagement in the flipped classroom since the flipped classroom approach provides more learning resources and activities which students can be more actively involved in environmental suitability course, collaborating, and interacting with other students.

Student's Ability to Personalize the Learning Independently: A combination of in and out of class learning environment can promote student's ability to personalize their learning independently. By giving students autonomy to choose, they can personalize their learning independently according to their own interests and needs in the learning process, improve their initiative and learning effect.

Student's Acceptance and Competence of Technology Use: A flipped classroom approach involves the use of technology tools and online platforms such as videos, online discussion boards. The researcher observed that student's acceptance and competence to use these technologies. It has been found that students were able to use them proficiently to support their learning. Additionally, the useful and effective guidance would appropriately be provided to enhance the successful outcomes.

Student's Performance, Satisfaction, Perception: With a flipped classroom approach, Student's performance was far better than the traditional classroom approach and the virtual

classroom approach. In addition, the flipped classroom approach showed better student's satisfaction and student's perception in environmental sustainability course.

These additional valuable research findings provide a more comprehensive and practical understanding of the implementation of the flipped classroom approach. The approach highlights the potential advantages of flipped classroom and provide useful guidance for educational practice and future research.

Recommendations

The recommendations may be applied to different stakeholders as follows.

Instructional Practitioners: The findings provide the best practical method based on flipped classroom. Educators can refer to these findings to adopt the flipped classroom approach in their curricula to enhance student's performance, student's satisfaction, and student's perception. This includes selecting appropriate online resources and tools, designing effective online interactive activities, and incorporating technology into both the in and out of class activities.

Students: The findings highlight the positive impact of flipped classroom approach on student's performance, satisfaction, and perception. Educators can draw on these results to enhance students to actively participate in the related areas of environmental sustainability, collaborate and interact with their classmates, and promote collaboration and discussion among students both in and out of the class through online platforms. This is essential for developing student's collaborative skills, creativity, and critical thinking.

Technology Application and Training: The findings also provide useful practical guidance on technology application and training. Educators can understand student's competence and the use of technology and provide training and support according to student's needs by choosing the appropriate technical tools for students to accustom with online platform and digital resources to improve student's technical abilities and learning results.

Education Policy and Reform: The findings also have practical implications for education policy and reform. Governments and educational institutions can bring these results to promote the flipped classroom approach in education policy making and education reform. This may involve an emphasis on teacher training and professional development to enhance their abilities to teach and use technology in the flipped classroom environment.

The flipped classroom approach can widely apply in all subject areas. Thus preparing all who would get involved with will help better learning experiences and learning outcomes. This shall also drive innovative implementation in education and benefit educators, students and education policy makers.

Recommendations for Future Research

In order to enable researcher to explore this topic more comprehensively and in depth when conducting research on similar topics in the future, here are some possible recommendations for future research.

1. In-depth Exploration of Implementation of Flipped Classroom: Future research may further explore the implementation of flipped classroom in environmental sustainability course. The impact of flipped classroom on student's performance, student's satisfaction, and student's perception can be assessed by comparing the differences between the flipped classroom and other types of classrooms in the larger scale with different learning environments.

2. Student's Differences and Needs: Future research could pay more attention to student characteristics and needs to determine the adaptability and effectiveness of flipped classroom for different types of students. Student characteristics, student's level of self-regulated learning, and student's technical competence are the main factors that can be considered to understand the impact of flipped classroom on student's differences and needs of guidance for educational practice.

3. Emerging Technologies: Future research could focus on the exploration of emerging technologies in environmental sustainability course such as virtual reality, augmented reality, and artificial intelligence including the development of conservational environment invention. Researchers can explore how to effectively incorporate these emerging technologies and assess their impact on student's ability and student's practical learning progress.

4. Teacher Roles and Training Needs: Future research could focus on teacher roles and training needs in implementing the effective flipped classroom. Researchers can further investigate the effective strategies of teachers in implementing the flipped classroom and how to develop teacher's ability to teach and use technology in flipped classroom.

5. Applying an Interdisciplinary Approach: Future research could have an interdisciplinary approach by integrating environmental sustainability course with other in-depth subject areas (such as math, social science, physical education etc.). This will help to gain more dimensional understanding and perspective and enrich the effective implementation of flipped classroom.

References

Aggarwal, K., Thakur, B., Agrawal, M., Jhajharia, S., Madaan, H., & Mahapatra, S. K. (2019). A comparative study between flipped classroom and traditional lecture-based classroom in first year medical students. *International Journal of Research in Medical Sciences*. 7 (10), 3654. https://doi.org/10.18203/23206012.ijrms20194191

Belias, D., Sdrolias, L., Nikolaos, K., Koutiva, M., & Koustelios, A. (2013). Traditional Teaching Methods Vs. Teaching Through The Application Of Information And Communication Technologies In The Accounting Field: Quo Vadis? *European Scientific Journal*. 9, 73–101.

Benjamin, A. (1994). Affordable, Restructured Education: A Solution through Information Technology. *RSA Journal, Vol. 142, No. 5449* (1994), 45-9.

Bergmann, J., & Sams, A. (2012). *Flip your classroom: Reach every student in every class every day*. International Society for Technology in Education.https://books.google.co.th/books?id=72YqBgA AQBAJ

Campillo-Ferrer, J. M., & Miralles-Martínez, P. (2021). Effectiveness of the flipped classroom model on students' self-reported motivation and learning during the COVID-19 pandemic. *Humanities and Social Sciences Communications*. 8 (1), 176. https://doi.org/10.1057/s41599-021-00860-4

Chien, C. F. (2007). *Development, validation and use of an instrument for assessingbusiness management learning environments in higher education in Australia: The business management education learning environment inventory(BMELEI)* (Doctoral dissertation, Curtin University).

Damodharan, V. S. & Rengarajan, V. (2007). Innovative Methods of Teaching. *Online.* Retrieved February, 21 2024. from https://www.researchgate.net/publication/ 347306546_ Innovative_ Methods_of_Teaching

Eppard, J., & Rochdi, A. (2017). A framework for flipped learning. International Association for Development of the Information Society. In *13th International Conference of Mobile Learning* https://files.eric.ed.gov/fulltext/ED579204.pdf

Fraser, B. J., Fisher, D. L., & McRobbie, C. J. (1996). Development, Validation, and Use of Personal and Class Forms of a New Classroom Environment Instrument. Paper Presented at the Annual Meeting of the American Educational Research Association. *Online.* Retrieved February, 21 2024. From https://scirp.org /reference/ referencespapers.aspx?referenceid=3067599

Halasa, S., Abusalim, N., Rayyan, M., Constantino, R. E., Nassar, O., Amre, H., Sharab, M., & Qadri, I. (2020). Comparing student achievement in traditional learning with a combination of blended and flipped learning. *Nursing Open*. 7 (4), 1129–1138. https://doi.org/10.1002/no p2.492

Hocutt, M. (2022). 10 Online Teaching Tools & Platforms for Your Virtual Classroom. *Online.* Retrieved February, 21 2024. from https://livestorm.co/blog/online-teaching-tools-platforms

Holm, L. B., Rognes, A., & Dahl, F. A. (2022). The FLIPPED STEP study: A randomized controlled trial of flipped vs. traditional classroom teaching in a university-level statistics and epidemiology course. *International Journal of Educational Research Open*, *3*, 100-197. https://doi.org/10.1016/j.ijedro.2022.100197

Jacobs, H. H. (2010). *Curriculum 21: Essential education for a changing world*. Association for Supervision and Curriculum Development.

Li, F., Qi, J., Wang, G., & Wang, X. (2014). Traditional Classroom vs E-learning in Higher Education: Difference between Students' Behavioral Engagement. *International Journal of Emerging Technologies in Learning (IJET)*. 9 (2), 48. https://doi.org/ 10.3991/ijet.v9i2.3268

Lo, C.-M., Han, J., Wong, E. S. W., & Tang, C.-C. (2021). Flexible learning with multicomponent blended learning mode for undergraduate chemistry courses in the pandemic of COVID-19. *Interactive Technology and Smart Education, ahead-of-print*(ahead-of-print). https://doi.org/10.1108/ITSE-05-2020-0061

Mangal, S. K., & Mangal, U. (2019). *Essentials of educational technology*. PHI Learning Pvt. Ltd.

Mohammadi, J., Barati, H., & Youhanaee, M. (2019). The Effectiveness of Using Flipped Classroom Model on Iranian EFL Learners' English Achievements and Their Willingness to Communicate. *English Language Teaching*. 12 (5), 101. https://doi. org/10.5539/elt.v12n5p101

Nathawet, P. (2020). The Study on The Use of Flipped Classroom Strategy to Develop Grammatical Accuracy in Writing and The Students' Perceptions Towards Flipped Classroom. Faculty of Humanities, Srinakharinwirot University. *Online.* Retrieved February, 21 2024. from http://ir-ithesis.swu.ac.th/dspace/bi tstream/123456789/ 730/1/gs601130030.pdf

Nayar, B., & Koul, S. (2020). Blended learning in higher education: A transition to experiential classrooms. *International Journal of Educational Management*. 34 (9), 1357–1374. https: //doi.org/10.1108/IJEM-08-2019-0295

Oudbier, J., Spaai, G., Timmermans, K., & Boerboom, T. (2022). Enhancing the effectiveness of flipped classroom in health science education: A state-of-the-art review. *BMC Medical Education*. 22 (1), 34. https://doi.org/10.1186/s12909-021-03052-5

Pozo Sánchez, S., López Belmonte, J., Moreno Guerrero, A. J., & López Núñez, J. A. (2019). Impact of Educational Stage in the Application of Flipped Learning: A Contrasting Analysis with Traditional Teaching. *Sustainability*. 11 (21), 59-68. https://doi.org/10.3390/su11215968

Salmon, G. (2000). *E-Moderating*: *The Key to Teaching and Learning Online*. London: London, UK.

Say, F. S., & Yildirim, F. S. (2020). Flipped Classroom Implementation in Science Teaching. *International Online Journal of Education and Teaching*. 7 (2), 606-620.

Schlusmans, K., Giesbertz, W., Rusman, E., & Spoelstra, H. (2009). The introduction of a virtual classroom instrument at the Open University of the Netherlands.

Shao, M., & Liu, X. (2021). Impact of the Flipped Classroom on Students' Learning Performance via Meta-Analysis. *Open Journal of Social Sciences*. 09 (09), 82-109. https://doi.org/10.4236/jss. 2021.99007

Srinivasan, M. S., & Kumar, H. (2020). FLIPPED CLASSROOM MODEL–A POSSIBILITY IN THE INDIAN HIGHER EDUCATION SYSTEM. *Journal of Critical Reviews*, *7*(15), 1486-1490

Staker, H., & Horn, M. B. (2012). *Classifying K–12 blended learning. Mountain View*. CA: InnosightInstitute, Inc.

Strayer, J. F. (2007). *The effects of the classroom flip on the learning environment: A comparison of learning activity in a traditional classroom and a flip classroom that used an intelligent tutoring system.* Doctoral Dissertation. The Ohio State University.

Taylor, S. S., & Statler, M. (2014). Material matters: Increasing emotional engagement in learning. *Journal of Management Education.* 38 (4), 586-607.

Tularam, G.A., & Machisella, P. (2018). Traditional vs Non-Traditional Teaching and Learning Strategies -- The Case of E-Learning!. *International Journal for mathematics teaching and learning.* 19, 129-158. Retrieved from https://core.ac.uk/download/pdf/151740254.pdf

Turoff, M. (2007). *Designing a virtual classroom, department of computer and information science*. New Jersey Institute of Technology.

Warren, L., Reilly, D., Herdan, A., & Lin, Y. (2020). Self-efficacy, performance, and the role of blended learning. *Journal of Applied Research in Higher Education*. 13 (1), 98–111. https://doi.org/10.1108/JARHE-08-2019-0210