Title	MOOCsと教育的ゲーミフィケーションを掛け合わせた教育の有用性と適合性およびEラーニングの結果とその保持に影響する因子について
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Effectiveness and suitability of MOOCs hybrid learning with educational gamification model and factors that affect e-learning outcome and retention

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Japan Advanced Institute of Science and Technology

Doctoral Dissertation

Effectiveness and suitability of MOOCs hybrid learning with educational gamification model and factors that affect e-learning outcome and retention

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ABSTRACT

This dissertation focus on effective e-learning model that is suitable to solve rural education problem. Education is the important fundamental in any society but some students do not have a chance to obtain the standard education. E-learning was established to fill this gap. It can provide long distance learning with good curriculum to a wider group of population. However, each model of e-learning still has its specific problem and effectiveness of some methods are still in debatable, when applied these models to rural education.

MOOCs hybrid learning and educational gamification have become core model to support rural learning. E-learning models have been originally designed for developed countries education. However, there are some obstacles to make use of them in developing countries. In case of Thai education, there is an inadequate number of rural teachers, and these teachers must teach vary subjects in which they have low experience. Moreover, most rural students are low-performing student, who study in Rural and Low-Income Schools (RLISs). Developing MOOCs hybrid learning and educational gamification model to reduce number of low-performing students are an effective way to enhance an education system.

In this dissertation, we propose a MOOC hybrid learning and educational gamification model that is suitable and effective for rural education. We simultaneously identify factors and features that affect learning outcome and knowledge retention. In addition, quantitative research approach using paired t-test to determine the difference in scores between the pre and post-tests. Kruskal-Wallis (H Test) was operated to investigate and find the relationships between scores' improvements and factors. The data was collected from 314 students for MOOCs hybrid teaching model and 251 students for educational gamification model. Students were in grades 7-10 (13-16 years old) and randomly selected from a public school in rural Thailand.

The results show that MOOCs hybrid learning and gamification model are effective for urban and rural schools and can solve developing countries' education problems. We also found that group activities (e.g., peer tutoring and forum discussions), and academic achievement improve students' learning ability.

Keywords: Massive open online courses (MOOCs), e-learning, active learning, flipped learning, educational gamification, e-learning factor, learning retention

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CHAPTER 1
INTRODUCTION

Utilizing the effective knowledge is the key success for future education. Most people change their behavior to receive data and information from the Internet. Likewise, in the education sector, conventional teaching style has emerged to the e-learning platform. E-learning provides long distance learning which can conduct anytime and anywhere in the world. E-learning has been identified to be effective learning platform since the Internet has improved communication and connection quality (Allen & Seaman, 2007). E-learning offers high value compared to traditional training options. Learner can learn at their own pace and spend their time to learn what they want to know. Moreover, it is simply learned online and easily accessed through various devices such as smartphones, computer, and tablets.

1.1. Background

1.1.1. Education problem

Nowadays, basic education is a fundamental resource for any societies. In the last two centuries, global literacy rates have been increasing. (Barro & Jong, 2010). However, some developing countries have not. More than 72 million children in early age cannot access to basic education (Jdamena & Dakar, 2017). Especially in a rural area, students are more likely to leave school than doubles in the city. (United Nations Educational Scientific and Cultural Organization, 2014). Vyborny & Birdsall (2008) report that one more year of the effective education can increase 10% of personal income in the future. It also contributes to social capital and long-term economic growth (Lee et al., 2016). According to OECD's Programme for International Student Assessment (PISA), which tests the learning ability of the 15-year-old students on 3 subjects; mathematics, reading, and science. These tests are designed to assess students' knowledge and problem-solving skills. It has started in 2000 and repeated every three years. Singapore, Japan, South Korea, Taiwan, and Hong Kong are consistently the top 5 countries in mathematics and sciences. For the result, PISA report that there is no country which participated in PISA 2012, can claim all students have achieved a potential based level of science, mathematics, and reading (OCED, 2012). These mean even developed countries still have low performance students. The effective way to improve an education is to reduce the number of low performance students. Ludger (2001) and Cascio (2016) present many factors affecting low student performance. Student motivation and learning disability create an obstacle to obtaining learning content. Teachers also play an important role in student performance. If teachers have more experience and small age differences between teachers and students, they can understand younger students and increase students' motivation. Schools can be contributing factors to low-performing students. Some schools cannot provide more teachers and appropriate infrastructure. Classes become overcrowded and teachers cannot focus on teaching. Family also is a significant factor in a student's academic performance. Poverty living, and do not have time to care about their children's learning ability, children will lose their academic focus and obstruct their learning ability.

1.1.2. E-learning trends

Using Internet and data online has increased. More than 1 billion people are using Facebook worldwide. People spend more than 15 hours per person in a month. (Statista, 2016). Online educational technology is one of new equipment that supports online learning. The online courses and electronic degree are provided through online learning management systems (LMS), discussion in forum, live lectures, or Skype etc. (Allen & Seaman, 2007). However, there still have some problems with e-learning. Students resist adapting from traditional classroom and instructor-led to computer-based training in a virtual classroom. Moreover, many schools lack necessary e-learning equipment such as highly efficient devices and Internet connections that are required for online courses. Students are also lack of computer literacy and self-motivation. They tend to give up from the online learning. These are a major barrier for rural students and schools. (Sunil, 2016).

In the previous studies of the effectiveness of e-learning, most of the researches provided many interesting findings that can classify into two main issues. The first group of research focuses on methods and factors that influence on effectiveness. They try to examine the effectiveness by comparing between two modes (interactive and non-interactive modes) with traditional method (classroom instruction). Most of the result shows that e-learning in an interactive mode was better than e-learning in a non-interactive mode (Clark, 2004). Nevertheless, e-learning in a non-interactive and interactive mode still cannot replace the traditional teaching. The second group studied factors that influence on effectiveness. Two main factors are internal factors such as student experience, motivation or satisfaction and external factors like environment, instructor, technology, course flexibility or design and model. (Andrew & Bradley, 2005; Steen, 2008).

In the recent year, many new approaches are emerged in the education sector. MOOCs (Massive Online Open Courses) is one of the popular approaches, which can support massive learner and open access through websites such as Coursera, Edx, and Khan Academy (Bozkurt et al., 2015). Gamification is the new approach that applies game mechanics, game elements and competition to engage and motivate people to reach their achievement. (Huotari & Hamari, 2012). Moreover, blended learning and flipped learning models are emerging, the students learn new material by reading or learning from lecture videos outside of the classroom and then uses class time to do the interactive work such as discussion, problem-solving, or debates (Berrett, 2014). These new approaches and models have been successfully bridged the inequality education gap (Vicki, 2014).

1.2. Research motivation

In this section, we describe the direction and scope of this research. This research is motivated by the education problem in developing countries, especially in rural area, where is long distance from civilization and do not have entrenched education systems. There are the massive need for effective low-cost education. Many countries in developing area do not have nearly enough schools, teachers, and infrastructures. These are the reason why the most educational innovation could happen in poorer place. Accordingly, Thai education system, which is failing in term of effectiveness and accountability (Tangkitvanich, 2013). Many schools in Thailand are Rural and Low-Income Schools (RLISs) that have less than 600 students with low family income. Moreover, most students are the low-performing students. Some of them cannot read and write because rural schools lack infrastructure, teaching materials, and instructors. (Lathapipat, et al., 2015) Most teachers must teach various subjects, including those in which they have low experience. Although, Thailand government spent a enormous amount of national budget on education, education system still worsens in performance. (TDRI, 2012). Therefore, e-learning was created to fill inequality education gap. It provides the effectiveness in term of learning contents and instructional quality. Even though e-learning is the powerful approaches to solving the education problem, new e-learning approaches (e.g. Massive Online Open Courses, Flipped learning, and Gamification), have been invented mainly for developed countries' education, especially regarding individual learning style. These approaches create many problems when they are applied in developing countries (Berrett, 2014). In addition, there are specific problems of each e-learning models. For example, MOOCs faced with assessment method for massive students and sinking of completion rate problems, and educational gamification still has problems in term of effectiveness and accountability (Bailey, et al., 2013). Thus, Active and Flipped learning were determined to solve these problems. Hybrid learning model, which integrated Active, Flipped, and learning content, was designed to upgrade e-learning model and developed the effective features that are suitable for rural education.

1.3. Problem statement

Education is the important fundamental in every country, but there are some group of people is not privileged to study in the good public schools that provide the standard education. E-learning occurs to bridge this gap. However, each model of e-learning still has its specific problem and effectiveness of some methods are still in debatable

In this study, we investigate the learning outcome and knowledge retention when students use our two proposed models. Moreover, this research proposes the following current problems arising in rural education and e-learning model.

- Due to student problem, most of rural students got low academic achievement. They are low potential students and get a hard time to understand the contents, and some are slow to grasp the knowledge. Moreover, students just remember the core of contents then they will rapidly forget it.
- Teacher are the biggest problems in rural education. In rural school, there are insufficient amounts of teachers. Most of them have low teaching experience. They must teach many subjects for both experienced and unexperienced subjects. In addition, teaching material is an old version and lacks.
- In a remote area, infrastructure and equipment are other important problems when applying e-learning model. Internet accessibility and computers are still required to apply the new model.
- Due to intrinsically motivation, Student's satisfaction is the core of learning process. Terrible course design and unexperienced teacher are the cause of low student's satisfaction.
- The specific problem of each e-learning models, in this research, is conducted two models; MOOCs hybrid learning, and Educational gamification. Both of them have

some limitations. They need some features to solve these problems and adapt for rural students.

1.4. Research objective

This research is designed to solve the rural education problems by using the blended learning model, which is used one part of traditional learning and one part of e-learning. Both MOOCs hybrid learning and Educational gamification use flipped learning methods. Students learn the content from their home and do the group activities in the classroom. These two models were created to support the same goal by reducing the low-performing students and try to identify suitable factors and features, helping them to improve learning outcome and retention. From the result of two model, we will propose the new learning framework, which integrates the potential features and factors from two models. This learning framework provides learning effectiveness and suitability for the different group of students. The objectives of this research include.

- To propose a new MOOCs hybrid learning model that helps teacher provide the better content through designed framework. This could increase the effectiveness and accountability to match students' satisfaction.
- To test the effectiveness of MOOCs hybrid learning and Educational gamification model in term of learning outcome.
- To identify the features and factors that influence on learning outcome
- To provide the direction of improvement for E-learning

1.5. Research question

Thus, this dissertation under the title of "Effectiveness and suitability of MOOCs hybrid learning with educational gamification model and factors that affect e-learning outcome" aims to respond with these research questions.

- How to develop and design MOOCs and educational gamification hybrid learning models which suitable and effective for the rural learners?
- What are features and factors that positively affect on learning outcome and knowledge retention?

1.6. Research design

1.6.1. Data collection

In terms of primary data, the main methods are divided into two parts. The first step is content testing by using pilot test. The purpose is to confirm the validity and reliability of the contents. Validity test is performed by (i) Item Objective Congruence Index (IOC) method. IOC provides a result from 3 experts in academic fields. The result of validity test confirms or rejects the content and exams. Moreover, internal consistency and reliability were measured by using the (ii) Kuder–Richardson Formula 20 test (KR-20) which aims to evaluate and reconstruct the content and exams. After pilot testing has been completed, the field-testing was performed (Titie, et al., 2016). The Second step is field test method. It is the main research approaches to understand rural education problem and find the suitable solution to solve the problems. The field test designed to collect students' satisfactions, personal data, test the effectiveness of models, and find the factors that positively affect learning outcome and knowledge retention. The data was collected from 314 students for MOOCs hybrid learning model and 251 students for educational gamification. The students were in grades 7-10 (13-16 years old) and randomly selected.

1.6.2. Data analysis

The data analysis is conducted by SPSS statistical program. (iii) Pair t-test was used to compare the mean of score values before and after learning. (Pre and post-test). (iv) Kruskal-Wallis (H Test) test was used to find and compare the effect and linkage between learning scores and factors. We also applied (vi) Tukey's honestly significant difference (HSD) Post Hoc test to analyze the sub-results effect.

1.6.3. Statistical tools

(i) Validity test, Item Objective Congruence Index (IOC) method

Base on this research, we adopted content validity by using IOC (Index of item – Objective Congruence) that provided validity and evaluates the consistency of the test. There is formula to calculate its

$$\mathrm{IOC} = \frac{\sum R}{N} \qquad (1.1)$$

Where

R = sum of score from expert

N = number of expert

IOC index is between +1 and -1

The evaluation using three experts to provide the consistency score. If the test consists with objective, provide "+1". If the test does not consist with objective, provide "-1". If the expert is not sure about this content, provide "0" This test is consisting with an objective. If the score is more than 0.5, test is consisting with objective (Rovinelli & Hambleton, 1977)

(ii) Trust and reliability test, Kuder and Richardson Formula 20 (KR-20) method

Due to reliability measurement, we adopted Kuder and Richardson Formula 20 test to evaluate the internal consistency measurements. Performing the split half method on all questions and check each question is either right or wrong. An incorrect question scores 0 and a correct question scores 1. The test statistic is

$$\rho_{KR20} = \frac{K}{K-1}\frac{\left(1-\sum_{j=1}^{K} p_j q_j\right)}{\sigma^2} \qquad (1.2)$$

Where

K = number of questions

pj = number of people in the sample who answered question j correctly

qj = number of people in the sample who didn't answer question j correctly

σ2 = variance of the total scores of all the people taking the test = VARP (R1) where R1 = array containing the total scores of all the people taking the test.

Values range from 0 to 1. A high value indicates reliability (Kuder & Richardson, 1937).

(iii) Paired t-test

In this research, we compare the Pre and Post-test score by t-test, which is statistical hypothesis test. It uses to find that two data sets are significantly different from each other (Laerd, 2016).

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}} \tag{1.3}$$

Where

$\bar{X}_1$ and $\bar{X}_2$ = means of the two group

S_1^2 and S_2^2 = variances of the two group

n_1 and n_2 = number of participants in each of two groups

(iv) Kruskal-Wallis (H Test)

In this research, we apply Kruskal-Wallis test that is rank-based nonparametric test to compare the means rank between the groups and determines which means of those are statistically significantly different from each other. (Laerd, 2016). We adopted to find and compare the effect and relationships between the means of scores and factors.

$$H = \left[\frac{12}{n(n+1)} \times \sum_{j=1}^{c} \left(\frac{T_j^2}{n_j}\right)\right] - 3(n+1) \tag{1.4}$$

Where

n = sum of sample size for all samples

c = number of sample

T_j = sum of ranks in the j^{th} sample

n_j = size of the j^{th} sample

(v) One-way analysis of variance test (ANOVA)

In this research, we use one-way ANOVA to compare the means between the groups and determines which means of those are statistically significantly different from each other. (Laerd, 2016). We adopted to find and compare the effect and relationships between the means of scores and factors.

(vi) Multiple comparisons, Tukey's honestly significant difference (HSD)

Tukey's HSD test is a post-hoc test, which is performed after using Kruskal-Wallis (H Test). The purpose of Tukey's HSD test is to determine which sample groups differ. (Laerd, 2016).

$$Tukey's\ HSD \ = \bar{y}_i - \bar{y}_j \pm \frac{Q(1-\alpha_i r_i n_T - r)}{\sqrt{2}} s\sqrt{\frac{1}{n_i}} + \sqrt{\frac{1}{n_j}} \quad (1.5)$$

Where

$\bar{y}_i$ = sample means of i^{th} factor level

n_i = number of observations in level i

r = number of factor level

s = pooled standard deviation or sqrt(MSE)

n_T = total number of observations

α = probability of making a type 1 error

Q = (1 − α) percentile of the studentized range distribution with r number of factor levels and n_T - r degrees of freedom.

(vii) Cohen's *d* effect size

In this research, we adopted Cohen's *d* to measures the strength of the relationship between two variables on numeric scale (Sullivan & Feinn, 2012). There is formula to calculate its

$$d = \frac{\mu_1 - \mu_2}{\sqrt{(\sigma_1^2 - \sigma_2^2) \div 2}} \quad (1.6)$$

Where

μ_1 = Mean of sample 1

μ_2 = Mean of sample 2

σ_1 = Standard deviation of sample 1

σ_2 = Standard deviation of sample 2

Cohen's *d* measures either measure the sizes of differences or the sizes of associations. Cohen provided interpretation of effect sizes, revealing that d=0.2 represents a small effect size, d=0.5 indicates a medium effect size, d=0.8 indicates a large effect size, and d≥1.3 represents a very large effect size. It indicates that if difference of two groups' means is less than 0.2 standard deviations or more, the difference is negligible, although it is statistically significant. (Ferguson, 2012)

(viii) The epsilon-squared effect size

In this research, we adopted epsilon-squared to measures the strength of the relationship between two variables on non-parametric scale (Tomczak, 2014). There is formula to calculate its

$$E_R^2 = \frac{H}{(N^2-1) \div (N+1)} \qquad (1.7)$$

Where

H = the H value that obtained in the Kruskul-Wallis test

N = the total number of observations

E_R^2= coefficient assumes the value from 0 (indicating no relationship) to 1 (indicating perfect relationship)

The epsilon-squared effect size measures either measure the sizes of associations. Epsilon-squared interpretation of effect sizes, revealing that

E_R^2 = 0.00-0.01 represents a negligible effect size

0.01- <0.04 indicates a weak effect size

0.04- <0.16 indicates a moderate effect size

0.16- <0.36 indicates a relatively strong effect size

0.36- <0.64 indicates a strong effect size

0.64-1.00 indicates a very strong effect size (Rea & Parker, 1992)

(ix) Skewness

Due to degree of symmetry in the variable distribution, we adopted Skewness to evaluate the symmetric or skewed of the data distribution. if it looks the same to the left and right of the center point. There is formula to calculate its

$$g = \frac{\sum_{i=1}^{N}(X_i-\mu)^3 \div N}{\sigma^3} \qquad (1.8)$$

Where

μ = Mean of sample

N = Number of sample

σ = Standard deviation

Skewness is positive, provide that the data are skewed right or positively skewed that is the right tail of the data distribution is longer than the left tail. In the other hand, If Skewness is negative, the data are skewed left or negatively skewed that is the lift tail of the data distribution is longer than the right tail (Sheskin, 2012)

If skewness = 0, the data are perfectly symmetrical
If skewness is less than -1 of higher than +1, the distribution is highly skewed
If skewness is between -1 of higher than $-\frac{1}{2}$ or between +1 of higher than $+\frac{1}{2}$,the distribution is moderately skewed
If skewness is between $-\frac{1}{2}$ and $+\frac{1}{2}$,the distribution is approximately symmetric

(X) Kurtosis

Kurtosis is applied to measure the degree of tailedess in the variable distribution. The standard normal distribution has a kurtosis of zero. Moreover, positive kurtosis is a heavy-tailed distribution and negative kurtosis is a light tailed distribution. There is formula to calculate its

$$Kurtosis = \frac{\sum_{i=1}^{N}(Y_i-\mu)^4 \div N}{\sigma^4} - 3 \qquad (1.9)$$

Where

μ = Mean of sample

N = Number of sample

σ = Standard deviation

The normal distribution of Kurtosis is exactly 0. The distribution with Kurtosis ≈0 is named Mesokurtic. Moreover, The distribution with Kurtosis < 0 is named Platykurtic that the tails are shorter and thinner. Central peak is lower and broader. In addition, the distribution with

Kurtosis > 0 is named Leptokurtic that the tails are longer and fatter. Central peak is higher and sharper (Westfall, 2014)

(XI) Tests for Two Proportions

It examines sample size for hypothesis testing of the ratio or difference of two proportions. The test statistics analyzed by this procedure assume that the difference between the two proportions is zero (null hypothesis). The non-null case is discussed the difference between the two proportions is not zero. Results for two proportions testing using the Z-Test with pooled variance (Yates & Healy, 1994)

Hypothesis H0: P1 - P2 = 0

H1: P1 - P2 ≠ 0

$$p_0 = \frac{n_1 p_1 + n_2 p_2}{n_1 + n_2}$$

$$Z = \frac{p_1 + p_2}{\sqrt{p_0\,(1-p_0)(\frac{1}{n_1} - \frac{1}{n_2})}} \tag{1.10}$$

Where

n_1= Number of sample 1

n_2 = Number of sample 2

p_1= Proportions of sample 1

p_2= Proportions of sample 2

1.7. Significance and originality of the study

This research focuses on the education problem in a rural area. It was designed to the solves the problem arising in the education system. The result from this research is a new framework that provides the understanding of rural and urban education and finds the effective and suitable design of e-learning. Moreover, potential factors and features that can solve current education problem are proposed. The actual students' data is observed through field-testing method from 570 participants in Thai schools. Our proposed models are tested with actual field-testing data to represent the realistic process of learning.

In addition, there are two main contributions to distance learning education. Firstly, our model provides the guideline for teachers to manage their class efficiently and response the students' satisfaction. Secondly, our model provides the effective features and tools, which are suitable for students' behavior, and improves students' abilities in term of learning outcome and knowledge retention. Although our proposed model has carefully tested in overall e-learning perspectives, it might not cooperate with all students' behavior. Teachers supposed to adapt the tools and features of the model up to a class situation and each students' behavior. Thus, our study provides more advanced learning guideline than prior researches. Moreover, this framework can apply to solve learning problem in rural schools that face the same situation as Thailand.

There are several points that indicates our study different from other prior literature.

- Rather than testing on undergraduate students, we mainly focus on secondary school students who are in grade 7-10 (13-16 years old) and be in line with PISA test. We choose this average age because at this age young people in developing countries are nearing the end of compulsory education.
- Prior literatures examination indicates nominal amount of studies that incorporates distance learning in rural area. In this dissertation, we proposed MOOCs hybrid learning and education gamification model, to deal with both low-performing students and teacher lacking problem.
- In this study, we proposed the new model, called MOOCs hybrid learning which integrated MOOCs contents, Flipped learning and Active learning to fulfill each old model problems especially in students' motivation and knowledge retention.

1.8. Structure of the dissertation

This dissertation is organized into seven chapters. ***Chapter1***, the introduction provides the research background, research motivation, problem statement, research objective, research question, research design, significance and originality of the study, and overall structure of dissertation. The other chapters are detailed as follow.

Chapter 2 provides the summary of the related literature on education, the education model, e-learning model, and learning factors. The topics are reviewed to find the problem gaps and dependable sources for this study.

Chapter 3 describes the outline of research methodology and research activities to show the overall framework of research conduction and models comparison.

Chapter 4 investigates the design of the MOOCs hybrid learning model and analyzes the students' data obtained from rural and urban schools. The result of this chapter provides new models of e-learning and find the potential features and factors that positively affect to students' abilities.

Chapter 5 presents the effectiveness of educational gamification model, which is confirmed by rural and urban students test score. Moreover, this chapter also finds the factors that influence on learning outcome.

Chapter 6 summarizes all dissertation, highlights the results, and discusses practical the implication for e-learning. We also describe the contribution of e-learning and education to knowledge science.

CHAPTER 2
LITERATURE REVIEW

The main content of this chapter is to summarize the main literatures on education model, e-learning and learning theories. Literature reviews are classified into eight sections. Section 2.1 summarizes the education in Thailand. Section 2.2 presents the overall perspective of education model. Section 2.3 introduces flipped learning which is used in model design. Section 2.4 summarizes function of Massive Open Online Courses (MOOCs). Section 2.5 discusses about student-centered learning. Section 2.6 presents the features and statistical of gamification. Section 2.7 defines motivation and student satisfaction on e-learning. Section 2.8 presents learning retention. Section 2.9 introduces Keisey personality type

2.1. Education in Thailand

In Thailand, the basic educational system is divided into three levels. The first three years of school is called KG1-3 (3 years to 5 years old). Then, the primary or elementary school is called Prathom. It covers P1-6 (6 years to 11 years old). Lastly, secondary school is called Mattayomsuksa. It covers M1-6 (12 years to 18 years old) (Ministry of Education, 2013). There are three government agencies which are responsible for educational system development. Firstly, the Ministry of Education (MOE) is responsible for pre-school, primary, secondary, vocational and technical education. Secondly, the National Education Commission (NEC) is responsible for educational policies, planning, and research. Thirdly, the Ministry of University Affairs (MUA) manages the education in universities (Ministry of Education, 2013). Due to Thai education assessment, there have many indicators, which measure various achievement levels in every level of Thai education system. It can separate by three organizers. Firstly, accumulate grade point average (GPAX) is calculated by transforming the percentage of score and wage by the credit of each subject to accumulate grade point. Moreover, the range is between 1.00 and 4.00. This indicator is global standard and organizes by each school under the supervision of Ministry of Education. (Ministry of Education, 2013). Secondly, Ordinary National Educational Test (O-NET) is organizing by The National Institute of Educational

Testing Service (NIETS). O-NET tests on 3 levels, elementary school (grade 6), lower secondary school (grade 9) and upper secondary school (grade 12). It tests on 5 major subjects (e.g. Science, Mathematics, English, Thai, and Social). About two million students are tested every year. Moreover, NIETS conducts two tests for university admission are called the General Aptitude Test (GAT) and the Professional and Academic Aptitude (PAT) for all 12-grade students (NIETS, 2014). Third, Local Assessment System (LAS) is conducted by Office of the Basic Education Commission (OBEC). LAS tests on grade 2, grade 5, grade 8 and grade 11 students in 8 major subjects every year. Moreover, OBEC also conducts a test for grade 6 students is called National test (NT) which tests for evaluating the national standard same as O-NET. (NIETS, 2014). In conclusion, Thai education contains 6 assessments for 12 years of free education. In some reason, there are some overlapping of those tests such as grade 6 O-NET and NT.

According to Thai education problem, the Federal Rural Education Achievement Program (REAP) defines Rural and Low-Income School Program (RLIS) *"which school served by the district is defined as rural (population under 25,000) and 20% or more of the children served by the district are from families with incomes below the poverty line"*. Most of Thai rural school is Rural and Low-Income School (RLIS), which have less than 600 students with low family income. (Tangkitvanich, 2013). For students in the rural area, schools are their homes and communities. However, quality of Thai rural education has to improve with both skills and knowledge. One-third of 15-year-old Thai students cannot read and write and they do not understand the learning contents. (Napisara, 2016). Moreover, Thai rural schools also face several problems such as lack of instructor, infrastructure, and teaching materials. (Lathapipat, et al., 2015). In 2012, Thai government spent 4% of GDP in education spending. (TDRI, 2012). However, quality of Thai education is ranked lower than a country that spends less in terms of GDP (Singapore at 3.5% of GDP) (Suebnusorn & Chalamwong, 2013). Thailand has ranked the number eighth in the 11 ASEAN member countries that are lower than Cambodia and Vietnam (WEF, 2013). Moreover, The OECD's Programme for International Student Assessment (PISA) shows Thai students achieve some of the lowest academic scores in East Asia. (TDRI, 2012). Additionally, 1.6 million Thai children were unable to read or write (Ministry of education, 2013). In 2010, the Office of the Basic Education Commission tested the high school teachers in the subjects they have been teaching. From the results, Eighty-eight percent of the teachers failed the test in computer science while 86 percent of them failed in Biology (Ministry of Education, 2013).

2.2. Education model

The education has two forms; one is the teacher-led education model. The instructor has involved in every part of the class to engage with students. Out of class activities, students do their homework following the teacher's instruction. In the classroom, students participate in learning activities organized by the teacher such as lectures, group discussion, team projects, and group problem solving (Kearsley & Shneiderman, 1988). The other form is the student-led education model. The instructor has low involvement in the classroom. Students are free and flexible to learn the contents following the teacher's plan. (Kenny, 2013)

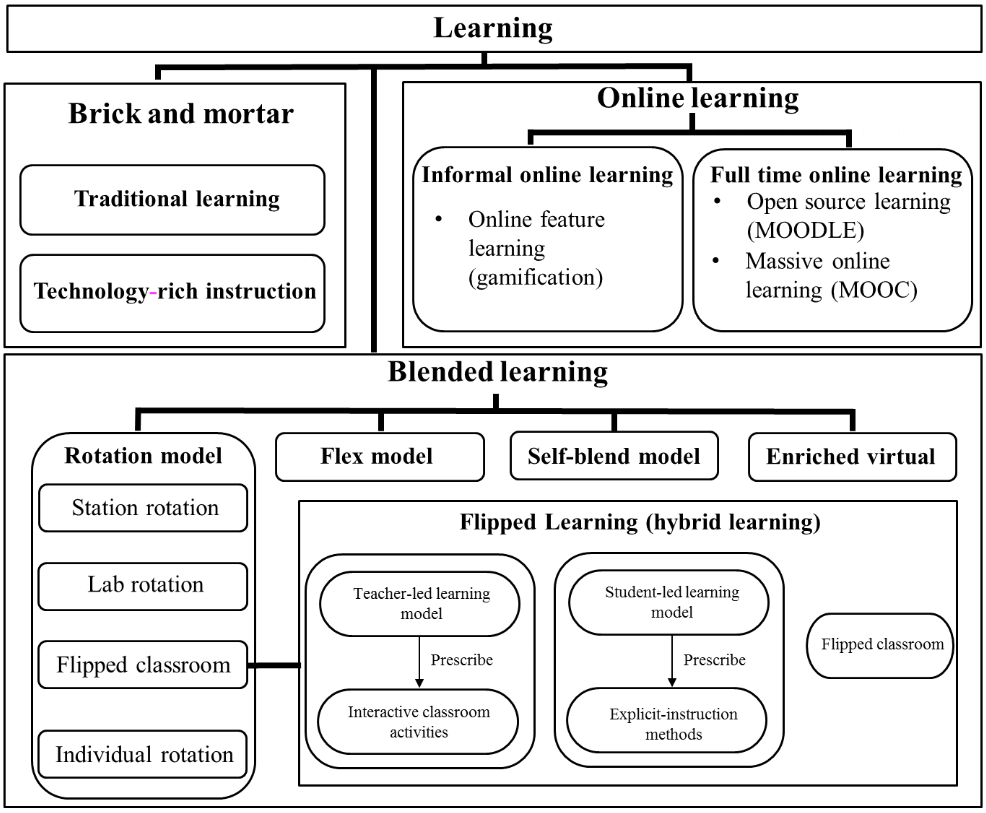


Figure. 2.1 Educational model

An educational model has divided into three parts. The first part, traditional instruction (brick and mortar learning) is an educational structure that focuses on face-to-face and teacher-led instruction. Instructions are based on lecture and assignment. Technology-rich instruction is a structure that combines the features of traditional instruction and online tools such as Internet devices and digital textbooks (Cynthia, 2014). The second part is online learning, which is an educational structure based on the student-led model. (Kenny, 2013) Students can learn the online content from their home or school. Due to informal online learning, students use online technology outside education program. For example, they obtain the learning content and exercise from educational gamification (Goodwin & Miller, 2013). Moreover, Full-time online learning is a structured education program. Teachers deliver contents through the online platform, so students can learn from their home or anywhere that they desire. This structure includes MOOCs and traditional e-learning tools (Moodle) (Martinez & Jagannathan, 2012). The third part is blended learning, which is the education program in which a student learns one part from online content and learns another part at school. Students have a freedom to control their time, place, and pace (Staker & Horn, 2012). This approach combines face-to-face instruction with online learning and provides positive results. Blended learning classes provide statistically better results than traditional education. (Meltem, 2015). This is promptly growing model not only increases the flexibility and freedom of learning experiences, but also provides teachers to act as the facilitators of learning.

Blended learning can divide to 4 models. Firstly, Rotation model is a program, which rotates in given subject. Students can rotate their class schedule, location, or content through learning activities such as small group or full-class instruction, peer tutoring, paper assignments, and group projects with at least one of these activities are learned via online. However, the method and activities vary from class to class following the teachers' perspective. (Christensen, et al., 2013). Secondly, Flex model, main learning content are provided online. Though teachers are in the room to support the class, students independently learn new material via online. The teachers provide face-to-face support through active learning such as group discussion, group projects, and peer tutoring. (Staker & Horn, 2012). Third, Self-blend or A la carte model gives students the chance to take classes more than offered class in school. Students learn additional contents through online learning while they attend a traditional classroom. The online courses are provided at either school or home. For example, a student can learn an online social course and take science in a traditional classroom. (Christensen, et al., 2013). Fourth, Enriched-virtual model provide whole school experience within one course. Students divide their time between traditional and online learning. Students learn the core contents in a classroom and then complete their homework online. In the other hand, online learning is the main tool when the students are located remotely. (Bailey, et al., 2013)

2.3. Flipped learning

According to flipped learning or inverted teaching, students obtain new contents outside the classroom, and use class time to participate the active learning through problem-solving, discussion, or debates (Berrett, 2012). This model responses to the idea that class time should use to encourage students to learn through active learning and interactive teaching techniques, rather than a traditional lecture (Cigman & Davis, 2009). New online technologies allows teachers to combine the virtual and physical learning spaces, including video lectures and interactive assessments, with classroom activities to motivate student creating their own experience through the online learning environment (Dziuban & Moskal, 2011). Due to the effectiveness of flipped model, Deslauriers, et al. (2011) implemented this model with a large physics lecture at the University of British Columbia. Students in the flipped class increased participated by 20%. Additionally, students in the flipped course do the better score more than twice compared to the control group on the exam. Ninety percent of participants enjoyed the interactive learning methods. In addition, a biology class at the University of Washington implemented a peer tutoring. They found much improvement in learning. Likewise, Berrett (2012) implemented a flipping learning for basic calculus course at the University of Michigan. Instructors provide the contents through exercises and then asked students to do the peers tutoring and present the discuss solutions.

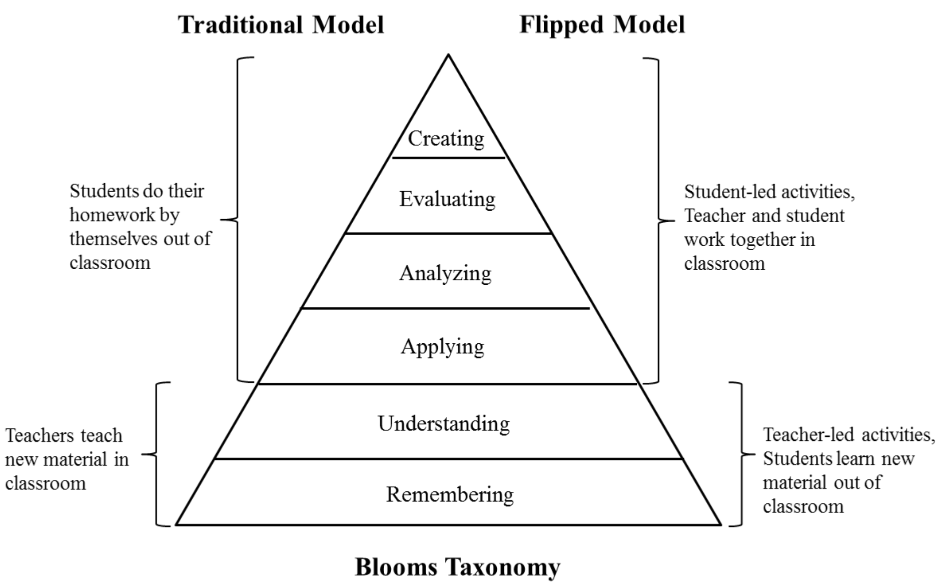


Figure. 2.2 Flipped model and Blooms Taxonomy (Adapted from Cynthia, 2014).

In terms of Bloom's revised taxonomy (Anderson, et al., 2000), students do the lower levels of cognitive work (gaining knowledge and comprehension) outside of class, and focus on the higher level of cognitive work (application, analysis, synthesis, and evaluation) in class (Cynthia, 2014). Before class time, students learn new materials from the online content. In the class time, students participate classroom discussion where the teacher becomes the supporter, not an instructor. Then students understanding are tested by group discussion, group problem solving and individual test. This model also improves educational outcome and its efficiency through data analytics and interactive lectures (Amirtha & Florence, 2015).

2.4. Massive open online course (MOOCs)

Massive open online course (MOOCs) is *"an online course aimed at unlimited participation and open access via the web*" (Bozkurt, et al., 2015). MOOC is new platform of online courses. It is designed to enroll a huge number of students at the same time. It also provides free enrollment or low cost for certificate courses to learn from open access contents and assessment. Students can control over place, pace, and time and learns from any device. MOOCs were first introduced in 2008 by Stephen Downes and George Siemens at the University of Manitoba, Canada and based on 'Connectivist' distributed peer learning model (Meltem, 2015). In 2011, MIT Open Course Ware (OCW) was established for MIT student who pays the tuition free. Then MIT alumni Slam Khan founded the Khan Academy to provide "*Free world-class education to anyone anywhere*". Then, Introduction to Artificial Intelligence course is offered by Sebastian Thrun of Stanford University and Andrew Ng, had an enrollment of over 160,000 participants (Sanchez & Luján, 2014). In 2012, Sebastian Thrun left the university and founded Udacity, which supported from Stanford. Andrew Ng also founded Coursera with the partner University, Princeton, University of Pennsylvania and Michigan. After that, MIT has also upgraded its open education and joined with Harvard to founded Edx (Amirtha & Florence, 2015). In 2013, edX was the first provider, which issues course certificates. They established XSeries program. Coursera also launched Specializations and Udacity launched Nanodegrees in 2014. (Shah, 2014). In addition, MOOC has two platforms. Firstly, xMOOCs is content-based MOOCs. It provides the content thought learning management platform of institutions (LMS). Secondly, cMOOCs is connectivist MOOCs. It developed by academics though open source web platform. MOOC courses are provided by various providers and universities such as Udacity (2 million students), MiriadaX (2 million students), edX (5 million students), and Coursera (15 million students). More than 20 million students have learned from MOOC (Shah, 2014).

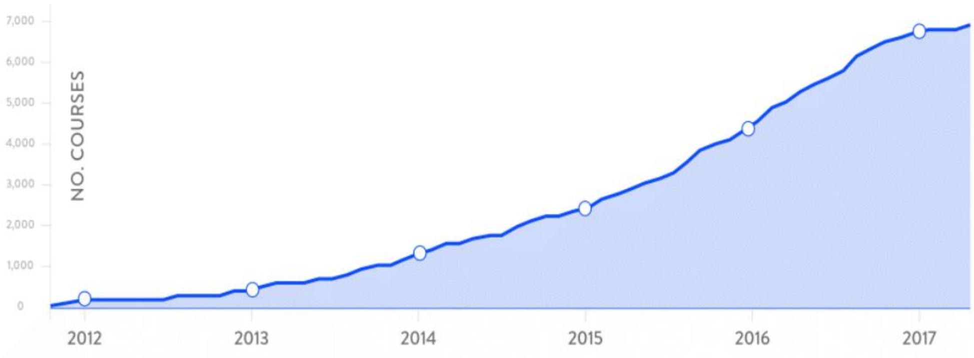


Figure. 2.3 Growth of MOOCs (Shah, 2016).

In 2015, Shah (2015) reports that Coursera, edX, and FutureLearn are the three largest MOOC providers in the world with 60% of all MOOCs users. They grew around 275% in 2015 and rapidly approaching the 35 million users. In the other hand, the growth rate for courses has slightly down from 100% in 2014 to 75% in 2015. By this growth rates, there will be around 7000 MOOCs courses, more than 700 universities, 40 providers and about 58 million students worldwide at the end of 2016 (Shah, 2016).

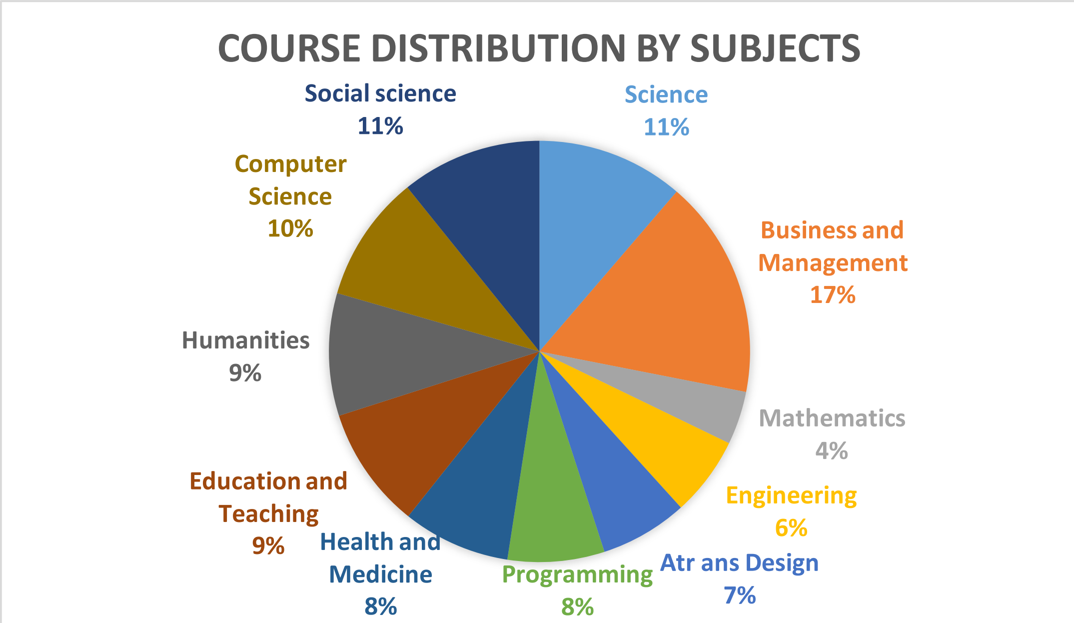


Figure. 2.4 Course distribution by subject (Shah, 2015)

In 2015, MOOC providers have increased in the percentage of courses focusing on technology and business. Computer Science and Programming courses grew more than 10%. Moreover, the growth of technical and business courses have decreased. However, there is still a balance between technical and non-technical courses in overall. (Shah, 2015). Despite MOOCs provide many benefits, they still have many problems for example, assessment for the massive students (Multiple choices), traditional design, satisfaction, and motivation. Moreover, MOOCs completion rate immersing is major problem. According to Jordan (2014) research, MOOCs have completion rate below 10% or around 3,700 completions per 50,000 enrollments. Moreover, over 525,000 students enrolled in 11 massive open online courses run by the University of Melbourne over two years, with 2.2 % of completion rate. (Kennedy, et al., 2010). These mean only MOOCs cannot allow enough motivation for the students to finish the course.

2.5. Student-centered learning (Active learning)

Due to student-centered model, the instructor provides low involvement of the class. Students have a freedom to learn the content, and instructors have various low involve activities to interact with their student. In this model, instructor acts like supporter in a classroom and provide the necessary resource for learners to create their own learning experience. The low involve strategies that can implement to the class such as answering and giving feedback via email or community forums, identifying students who are struggling with some concepts and providing a focus discussion on that content (Adam, et al, 2012). This model includes many learning theories such as peer tutoring, peer-assisted learning, problem- based learning, and collaborative learning. Additionally, active learning is one of the student-centered model that provides interactive learning activities such as exploring, analyzing, communicating, creating, and reflecting new knowledge. Students can create and share their content with classmate by blogs, video, and quizzes and they can share their work with the class and comment on one another's work. This model generates course concepts more excited and support students to explore their aspect to improve learning skills and develop a better understanding of student (Barkley, et al., 2005). Moreover, Just in Time Teaching (JiTT) is important tool of active learning activities. Instructors analyze student-performance information to understand which concepts students are struggling with and pinpoint students who are at risk. It can increase students' participation and fulfill the right knowledge to each student. It also gives feedback and adequate time to modify lectures (Adam, et al, 2012). Active learning is a new experience for some learners and instructor. Some students are not familiar with active learning or have a negative experience. Some special attention of teacher might be needed. (Barkley, et al., 2005).

2.6. Gamification

Gamification is *"the application of typical elements of game playing (rules of play, point scoring, and competition) to other areas of activity"* (Huotari & Hamari, 2012). It can create game experiences and designed behavior. This pattern also provides positively result and intrinsically motivation. (Ryan & Deci, 2000). It supports user engagement and increases social activities and interaction (Hamari, 2013). Gamification is socially interactive tools, which can drive strong behavioral change. Social gamification provides the better result in term of learning performance and increase learning retention. It increases learner's efficiency when combined with blended learning model (Marcos, 2016). Crawford (2003) defines a game as an activity that should have six characteristics. Firstly, fun, the activity should have interesting contents. Secondly, separate, it is restricted in time and place. Thirdly, uncertain, the goal of the activity is unpredictable. The fourth, non-productive, user does not obtain useful things. The fifth, rules, the activity should have rules that can separate the game world from real life. The sixth, fictitious, the activities provide awareness of a different reality. Due to the user side, all generations like to play games. The average age of gamers is 37 years old and they have been playing since 12 years old and most of the gamer is male (58%). In addition, Sixty-eight percent of parents believe that playing games provide mental education, and 54% believe that games help their children build the social connection. (Andriotis, 2014; Enders, 2013; Pappas, 2011). According to learners' preferences and model's effectiveness, the North America is the biggest market for gamification, followed by Europe. A survey conducted by TalentLMS (Andriotis, 2014), showed that 79% of the participants imply that they can be more effective and motivated if they learned in the game environment. Almost 89% of participants stated that a point and currency system would increase their learning engagement, and 82% were satisfied with multiple difficulty levels and exciting content. Due to the study that conducted by the University of Colorado (Enders, 2013), The results revealed that 14% of the participants have higher score in skill-based-knowledge tests, Eleven percent of them have higher score in terms of concrete knowledge, and 9% of them increased their retention rate. However, educational gamification can be problems when instructors and creators use it in an inappropriate way. Gamification will be more effective if it encourages specific behaviors to specific achievement. (Small, 2013). In addition, Duolingo is one of the popular educational language game. It is a self-learning teaching Web-base that teach students step-by-step through the well-organized tasks, generally based on translation (Krashen, 2013). Duolingo free online language-learning platform was introduced in 2012. In 2016, Duolingo offered 59 different language courses with more than 150 million users worldwide. (Duolingo, 2016). Vesselinov and Grego (2012) reported that the main factors for effective learning process were the learner's motivation and the initial knowledge. In addition, Duolingo English Test score have significantly correlated with the TOEFL iBT total scores, which show strong evidence for validity (Ye, 2014). In Africa, Jenkins and Melissa Monge worked on a pilot-test with 600 students and 15 teachers by using collaborative learning and Duolingo. The teachers become the supporter, helping the students become fluent in using Duolingo. Students could learn from other by peer tutoring and group work. (Schiller, 2015)

2.7. Motivation and student satisfaction on e-learning

Ryan & Deci (2000) define the motivation as *"having some reasons to do something"*, which can divided into intrinsically and extrinsically. There is extrinsically motivation, if the impulsion to perform some task is to receive the desired goal. On the other hand, people who is motivated intrinsically to perform the task by pure satisfaction and this motivation is often measured by interests and satisfaction (Wasko & Faraj, 2000). Wu (2010) define E-learning satisfaction as "*the sum of student feeling and attitude that results from aggregating all benefits* *of an e-learning environment".* Student satisfaction in e-learning can be evaluated based on first groups of factors. Firstly, student factors which are demographic and culture. There is some relation between cultures and learning that is reflected the learning preference. Additionally, the student satisfaction levels related to individual characteristics and students' age (So, 2009). The second group is design factors, which relate to interactivity. A learning environment in which social interaction and collaboration are an influence on positive learning outcomes (American Psychological Association, 1997). The third group of factors is instructor, which relates to instruction and teacher. The instructor is the main forecaster of course satisfaction and has a positive relation with students' performance. Student satisfaction also links to student performance and positively associated with course completion rate and grade-point average (GPA) (Bower & Kamata, 2000). The fourth group of factors is technical factors relate to technology. Technology accessing is one of the most important factors that influence student satisfaction. Students should be familiar with technology to accomplish the courses (Moore, J. C., 2009). The fifth group of factors is course factors, which are course categories and management. Administrative support is important for online learning students to access resources such as textbooks. (Moore, 2009).

2.8. Learning retention

Bahrick (1979) defines the leaning retention as "*having the information stored in long-term memory".* Some information can be retained for more than fifty years (Bahrick, 1984; Bahrick & Hall, 1991). Moreover, learning retention rate varies on different types of knowledge. There are four types of knowledge (e.g. recognition, cognition, recall and comprehension). Retention rate of recall knowledge was lower than the others (Bahrick, 1979). Allen et al. (1969) suggest that learners forgot average 2-20% of the content after one day. The learning method and practice time can make a significant difference for longer knowledge retention. For example, students who got five practice exercises forgot an average of 2%, while learners who received one exercise forgot an about 14%, and students who did not practice forgot approximately 22%. After one week, students forgot some contents between 0-70% depending on the learning method and students' age (Singh, et al., 1994). After one month, learners forgot 40-60% of the content (Bahrick, 1979). Even for meaningful content, long retention intervals (e.g. more than eight years later), learners forgot 80-95% of the contents. However, the retrieval task was easier than learning the new knowledge (Bahrick, & Phelps, 1987). Thus, the amount of knowledge that learner will forget varies depending on several factors such as the material type, motivation, learning method, learner’ prior knowledge, learning method, and practice time. (Thalheimer, 2010)

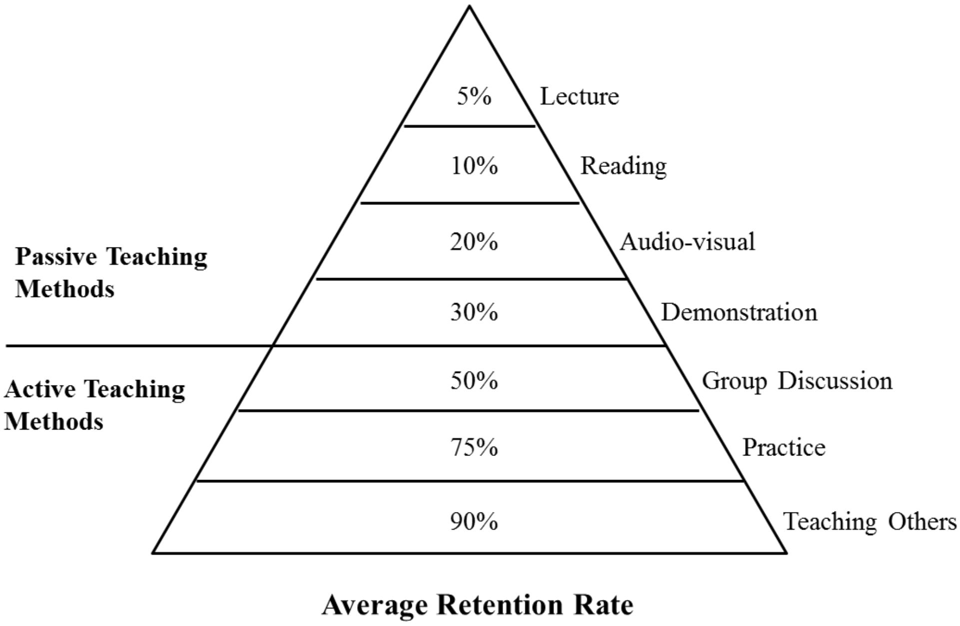


Figure 2.5 The learning Pyramid (Adapted form World Bank, 2016)

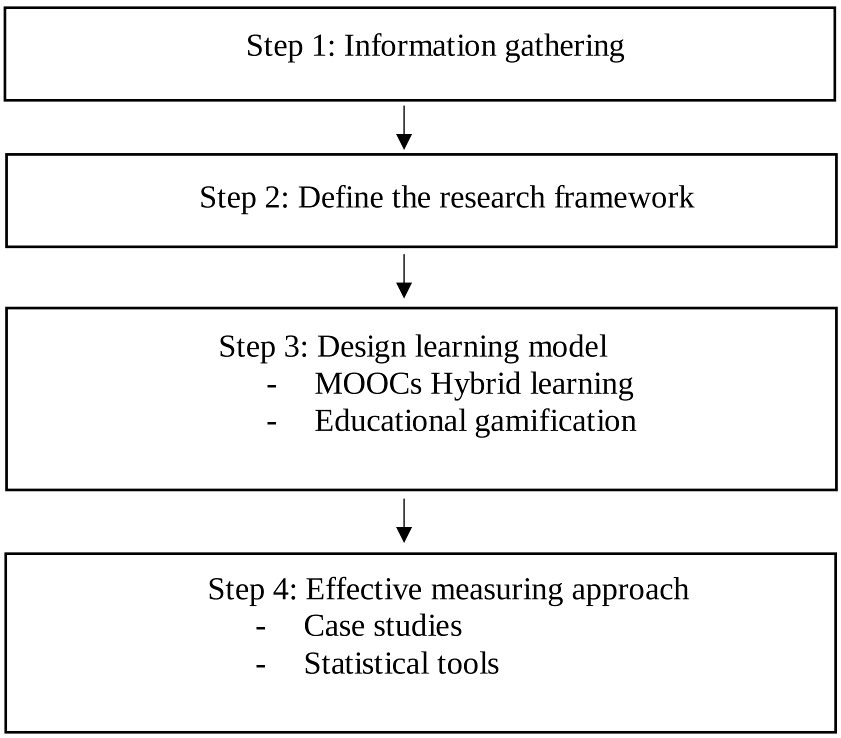
Due to Learning Pyramid from the National Training Laboratories (NTL) for Applied Behavioral Science, represents the average percentage of information retention rate from various activities. (Lalley & Miller, 2007) In the upper four (demonstration, audio-visual, reading, and Lecture) are passive learning. Learners learn from information that presents through verbal and sight such as listening, speaking and seeing. On the other hand, the bottom three (teach others, practice, and group discussion) are active learning. It provides purposeful learning experiences, such as hands-on or field experience. (Anderson, 2002). There are the difference in retention between passive and active methods. That is from extent of reflection and deep cognitive processing.

2.9. Personality type

The Keisey personality type is one of the factors that we use to find the relationship between learning outcome and retention in Chapter 5. The Keirsey Temperament Sorter (KTS) is "*a self-assessed personality questionnaire designed to analyze individual personalities and enable questionnaire takers to better understand each other"* (Keirsey, 1998). It is one of the most popular personality assessments in the world. The people's characteristic has identified by two characterizes. Firstly, communication that has divided to concrete and abstract communication. Concrete people talk about reality such as facts and figures but abstract people talk about ideas. They generally talk about the abstract ideas such as the theories. Secondly, the action that has divided to utilitarian and cooperative action. Utilitarian people always do the thing that works. They achieve their objectives as effectively as possible. Cooperative people do the thing that right. They act in a socially acceptable manner. They do the right thing with the acceptance of social rules. (Keirsey, 1998). Keirsey identified four basic temperaments: guardian, idealist, artisan, and rational. Each temperament has its own unique characteristics. Firstly, "guardians", speak about their duties, obey the laws, and follow the rules. Secondly, "idealists", try to act in good ethics and conscience. Thirdly, "artisans", mostly do the right thing that provides them a quick effective goal, even if they have to change the rules. Fourth, "rationalists" will talk about new problems and offer new solutions. They mostly do the effective way to achieve their goal. (Montgomery, 2002).

CHAPTER 3
RESEARCH METHODOLOGY

This chapter describes the outline of research methodology and shows the process of research conduction. Overall steps of research activities are summarized in Figure 3.1 and detail of each step is provided in Section 3.1. Moreover, the research methodology applied in this research includes (i) two case studies, which aims to address the problem and develop an efficient model to solve the current situation of rural and urban education. Moreover, finding the effectiveness of two models, and identify the significant factor that influences on learning outcome by using the statistical tools and satisfaction questionnaire. (ii) Compare significant factors between MOOCs hybrid learning and educational gamification model, which aims to find efficient features for improving students' ability on the e-learning platform.



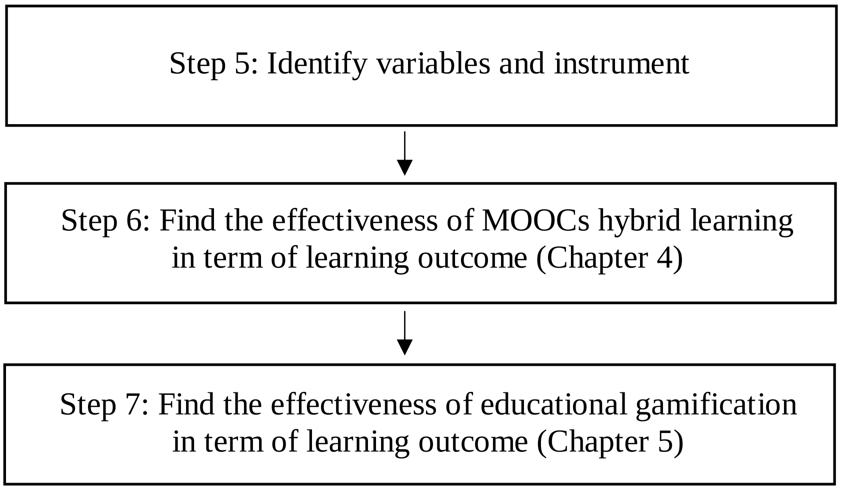


Figure. 3.1 Outline of research methodology

Effectiveness and suitability of e-learning models are the objectives of this dissertation. The learning outcome, knowledge retention, and e-learning factors are focused. Accordingly, the differences and components of two models are summarized in Table 3.1. The first model (Chapter 4) mainly focuses on MOOCs hybrids learning that integrates MOOCs content, Flipped learning, and active learning. On the other hand, educational gamification is the second model (Chapter 5), which combines gamification content, Flipped learning, and group discussion. These two models were created to solve the rural and urban education problem such as low-performing student, lack of teacher, and teaching materials. The main objectives of these two models are finding effectiveness in term of learning outcome by comparing the pre and post-test score (t-test). Moreover, sub-objectives are finding the influence of e-learning factors on learning outcome. Thus, two models share some similar methodology and objective while maintaining different factors based on the purpose of the study.

Table. 3.1
Outline of two models

Content	Chapter 4	Chapter 5
Model	MOOCs hybrid learning	Educational gamification
Model complements	MOOCs content, Flipped learning, and Active learning	Gamification content, Flipped learning, and Group activities
Objective	- To find Effectiveness in term of learning outcome - To find significant factor which affect earning outcome	
Participants	314 students in public school	251 students in public school
Statistical instruments	Effectiveness of model *Pre and Post test comparison (t-test), ANOVA test* Find the influence of factors on learning outcome *Kruskal-Wallis Test*	
Factors and features	Internal factors - *Academic achievement* Satisfaction factors - *Instructor* - *Course* - *Design* - *Technical* - *Focus group* Model features - *Focus group (JiTT)* Quizzes - *Online quizzes* - *In-video quizzes* - *Group quizzes* - *Flash quizzes* Social elements - *Forum discussion* - *Peer tutoring* Active learning - *Group activities*	Internal factors - *Academic achievement* Satisfaction Game learning factors - *Openness and acceptance* - *Personal and social skill* - *Game engagement* - *Emotion* - *Difficulty level and the story line* - *Time restriction* Learning time (hours per day) Social elements - *Group discussion* Keirsey Personality type - *Guardian* - *Artisan* - *Idealist* - *Rationalist*

	- *Pair activities* - *Individual activities*	

3.1. Research activities

Step 1 Information gathering

Step 1.1 Collecting the information

The data and information from various sources are observed to understand the background and current situation of e-learning and developing country schools. Many factors are focused for effective learning perspective.

Step 1.2 Classifying and summarizing prior literature

Effective of e-learning has been discussed over a few decades. Higher education e-learning is quite common as a tool to support learning in developed countries. A number of literatures are reviewed and classified into two main issues. The first issue focuses on effectiveness of models. The second issue studied factors that influence on effectiveness. The studied content and interesting findings from literature are summarized to acquire the overall studies and research limitation.

Step 2 Define the research framework

Step 2.1 Defining the research topic, problem statement, and objectives

Firstly, MOOCs hybrid learning and educational gamification are developed to answer the research question (i) Develop and design MOOCs hybrid learning features which sufficient and effective for developing countries' students. (ii) Find the factor that affects learning outcome. Secondly, the problem statements are defined to describe the current situation of e-learning method and education problem of the students in developing countries, which is the main scope of this study. Finally, the research objectives are set to find the suitable model and feature to solve education problem and provide the opportunity to students who cannot reach the standard education.

Step 3 Design learning model

MOOCs hybrid learning and educational gamification models are designed to deal with three education problems, which are classified as students, teachers, and infrastructure.

(i) MOOCs hybrid learning model is conducted to improve students' ability and experience on e-learning. This model is combined with flipped learning, MOOCs (teacher-centered model), and active learning (student-centered model) tools. Also, it collects students' data used to test the effectiveness of learning outcome. All developing detail will be described in Step 6.

(ii) Education gamification model is designed to improve students' motivation and ability. This model is combined with gamification content, flipped learning, and group discussion. Developing and examining the potential features will be described in Step 7.

Step 4 <u>Effective measuring approach</u>

The field test method was conducted as main research approaches to collect the students' data and scores. The objectives of field test are to observe students' behavior, collect personal data, test the effectiveness of models, and find the factors affecting on learning outcome. According to data analysis, is conducted using SPSS statistic tool. The paired *t*-test or dependent sample *t*-test, is a statistical tool that determines the difference of mean between two sets of data. The paired *t*-test is also applied for repeated-measures analysis and case-control observation. Due to the effectiveness of model and model features, paired t-test was used to compare the mean of score values before and after learning. (Pre and post-test). Test scores are dependent and continuous data that has approximately normally distributed. The pre-test was independent from post-test data collection. Additionally, Cohen's *d* provided interpretation of effect sizes. Cohen's *d* measures either measure the sizes of differences or the sizes of associations. In addition, rank-based nonparametric test like Kruskal-Wallis H test, applied to determine statistically significant differences between two or more independent groups. Refer to effective factors' measurement, data is ordinal scale that has more than two level in independent group. Each group have approximately same shape distributions. Kruskal-Wallis (H Test) was used to find relationships between scores improvement and factors. Moreover, Post Hoc test was conducted to analyse the subsequent effect. Moreover, Epsilon-squared (ε^2) provided interpretation of effect sizes. It measures the strength of the relationship between two variables on non-parametric scale

Step 5 Identify variables and instrument

This step describes the factors and features that are used in two proposed models. Some factors share the similar categories such as personal data (age, academic achievement, and past e-learning experience), social element (discussion, peer tutoring, and group activities), and satisfaction factors. In contrast, there are some different factors, quizzes, active learning, focus group (JiTT), and ground truthing are tested in MOOCs hybrid learning model. Moreover, game factors, self-element, learning time, and personality type are presented in Educational gamification. According to the contents, we apply MOOCs contents from Coursera (Coursera, 2015) by using a chemistry course on atoms and electronic structure from the University of Kentucky. In the other hand, the game contents were received from Duolingo (Duolingo, 2016). It was utilized by using a two-level (basic and intermediate)

Step 6 Find the effectiveness of MOOCs hybrid learning in term of learning outcome (Chapter 4)

This step involves testing the effectiveness of MOOCs hybrid learning model and find the factor that affects learning outcome to design the suitable e-learning model

Step 6.1 Create learning content and framework

6.1.1. MOOC content development and testing

In terms of primary data, the main methods are divided into two parts. Firstly, the steps of content testing and pattern of our MOOCs hybrid learning model (Coursera, 2015). The results from the first part (Figure 3.2) indicate the effectiveness of MOOCs content. The results of a pilot test were used to explore trust, reliability, and effectiveness of the content. After students learned and participated in the activities through our model's pattern (Figure 3.3), we pinpoint how effective or ineffective each tool of our MOOCs hybrid learning model is. This also helps to identify factors that affect our model's effectiveness. (Titie, et al., 2016)

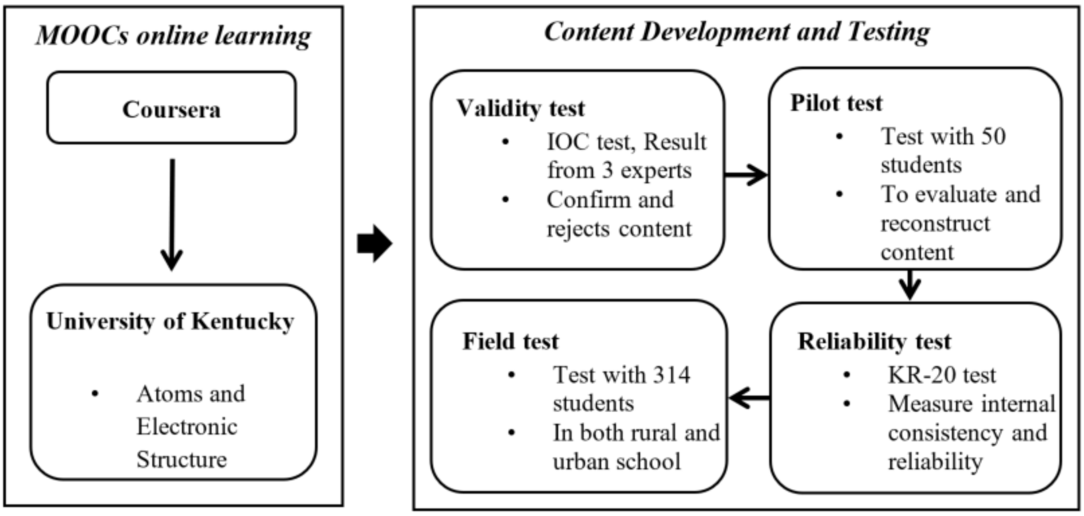


Figure 3.2 MOOC content development and testing

In Figure 3.2, the first section is devoted to the process of using MOOCs content. The purpose is to confirm the validity of the content. First, we used MOOCs from Coursera (Coursera, 2015) by using a chemistry course on atoms and electronic structure from the University of Kentucky. Chemistry course were chosen because students have never learned this content before. It is the effective way to measure actual learning process. This course consists of lecture videos approximately 10 minutes. Practice problems and answer sets are included that correspond with each lecture video. Second, we conducted a validity test using the Item Objective Congruence Index (IOC), which provides results from three experts in academic fields. The results of the validity test confirmed or rejected our set of exams. When the result was positive, we proceed by using that set of exams for a pilot test. We then conducted a pilot test on 50 students. Internal consistency and reliability were measured using the Kuder–Richardson Formula 20 test (KR-20, which aims to evaluate and reconstruct the exam from test results of a group of 50 students. After pilot testing, we conducted the actual pre-test in the form of field-testing. (Titie, et al., 2016)

6.1.2. MOOCs hybrid learning model

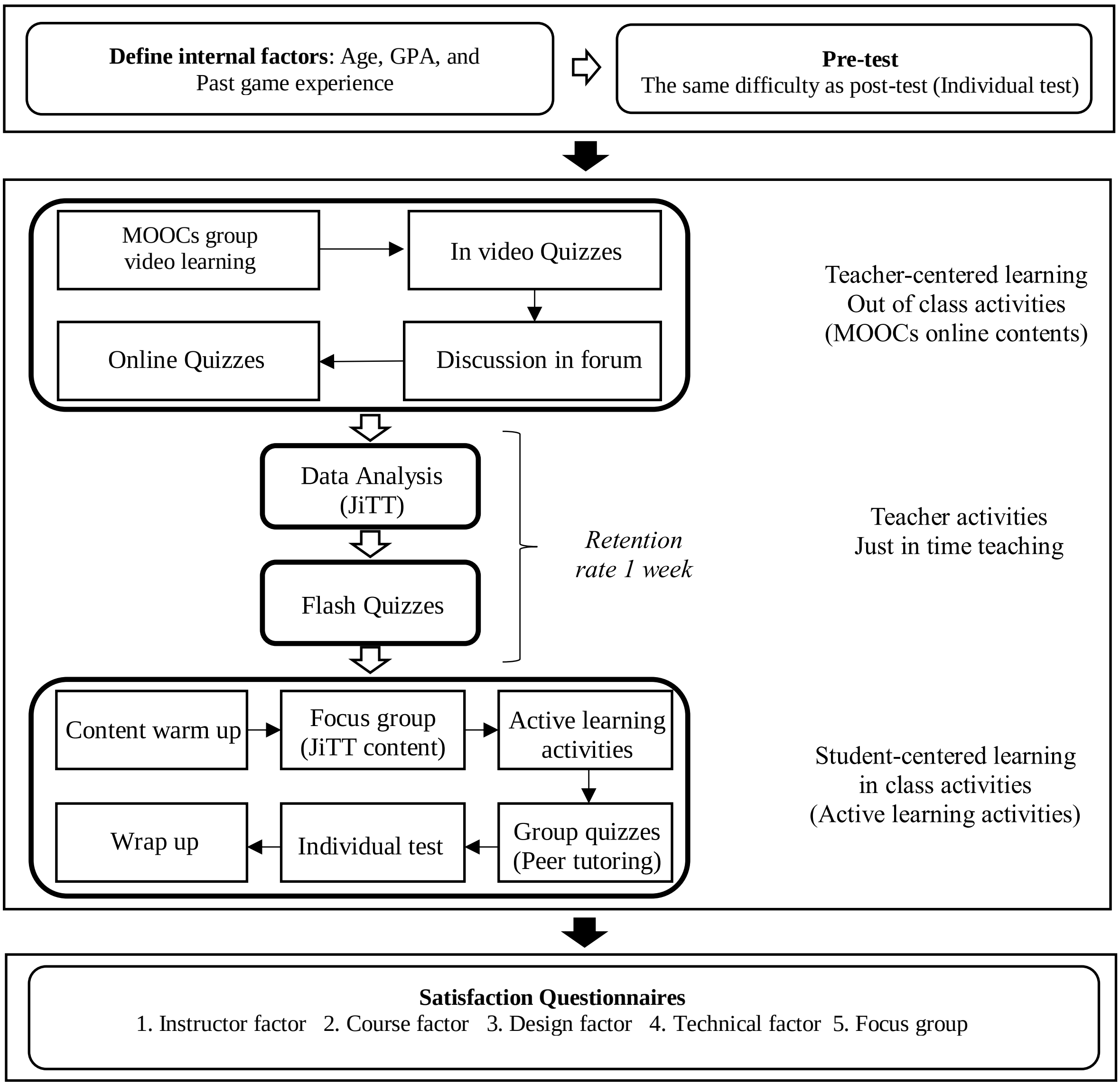


Figure 3.3 MOOCs hybrid learning model

The learning model we used in this study is a combination of the flipped learning model, MOOCs, and student-centered model (active learning), as shown in Figure 3.3. We adapted and used this model to design new learning processes. This framework combines three activity steps. The first step involves teacher-centered learning and out-of-class activities. Before receiving class content, students are tested using a pre-test and collected internal factor data. They then learn the chemistry content from Coursera, which provides free online learning. There are in-video quizzes that pop up while the teacher explains the content. After students have learned all contents, ten online quizzes are given to evaluate their understanding. Then students are tested by forum discussion to confirm their deep understanding of the content. In the second step, teacher activities are conducted. Teachers use student-performing data to understand which contents students are struggling with and focus on particular students who are at-risk and identified the risk group. After one week, students are tested through ten flash quiz questions that have the same difficulty as online quiz questions to determine the retention score and evaluate retained knowledge. The third step is student-centered learning through in-class activities. The teacher summarizes all content as a warm up session. After that, the teacher divides students into groups based on their knowledge and understanding, which were analyzed using the JiTT method. The teacher teaches different content to different groups to fulfill group lacking content. The students participate in three active learning activities. First, individual activities are conducted in which students solve problems in class and had a chance to ask questions to the teacher. Second, pair activities are conducted in which students work independently and discuss their thoughts and arguments with a partner. Then they have a wider discussion. Third, group activities (fishbowl discussion) are conducted starting from small groups of students sitting in a circle and engaging in a peer discussion with the remaining students sitting in outer circle and observing the discussion and taking notes so they can then discuss the interaction (Barkley, et al., 2005). After those steps, students are tested through group quizzes to evaluate the peer tutoring tools and individual quizzes to test their individual understanding. These quiz scores are counted as post-test scores. In the final step, peer evaluation is conducted in which students can assess and give scores to their fellow students. These activities can increase student social skill and build self-confidence (Adam, et al., 2012). We then used ground truthing to compare scores from the teacher and those from students (Peer evaluation). If they correlate, we can use them for peer evaluation. Finally, students fill out a satisfaction questionnaire. The questionnaire was written in Thai using a 3-point Likert scale: 1 = not agree, 2 = partly agree, 3 = agree. It consisted of 6 factors intended to measure intrinsic motivation (satisfaction) and their experience (ground truthing and focus group). First, satisfaction was measured based on four factors: instructor, course, design, and technical, following the study by Moore, 2009 and So, 2009. Second, e-learning experience was measured based on the personal experience after using our e-learning model. (Titie, et al., 2016)

Step 6.2 Identify the factors, features, and variable

After determine the learning framework, factors and features were proposed next. We propose four group factors; internal factors (GPA, Past e-learning experience, and Age), Satisfaction factors (focus group, instructor, design, technical, and course), social elements (Forum discussion and peer tutoring) and active learning activities (Group, pair, and individual activities). We find the effectiveness of these factors by using the t-test and Kruskal-Wallis (H Test)

Step 6.3 Participations and data collection

The data was collected using field testing methods at urban and rural school. According to MOOC hybrid learning model, 314 students were randomly selected. (154 from a public urban school in Bangkok province) and 160 from a public rural school in Suphanburi and chaiyaphum province). The students were in grades 7-10 (13-16 years old). Seventy-nine students were in grade 7, 80 in grade 8, 80 in grade 9, and 75 in grade 10. Out of the 314 respondents, 161 (51.27%) were male and 153 (48.72%) were female. The majority of students had a high (3.00-4.00) GPAX (33.43%) and medium (2.00-3.00) GPAX (33.43%), and 33.12% had a low (below 2.00).

Due to the student groups, participations were divided to 3 student groups. Control group, main contents were provided by traditional method (face to face instruction) and students participated in focus group and group activities. E-learning group, contents were provided by MOOCs video and educational gamification (E-learning). After that, students also participated in focus group and group activities. E-learning and motivation group, main contents were also provided by e-learning video and gamification. Student also participated in focus group and group activities. However, students in this group were motivated by some incentives (stationary, toy, and snack) together with extra scores from Science and English subject.

Furthermore, the data collections focus on rural and urban students separately. Students who study in each area are separated into 3 groups, referred to as control, e-learning, and e-learning and motivation group, respectively. Then in the same group, they are further divided into three group according to their GPA level (Low, medium, and high GPA)

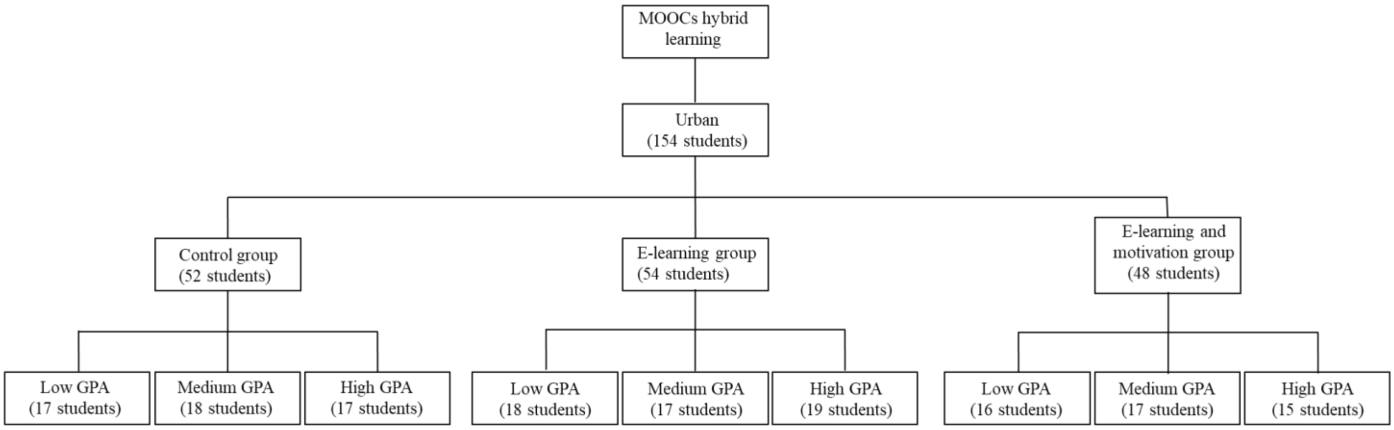


Figure 3.4 Number of students who participated MOOCs hybrid learning model in urban area

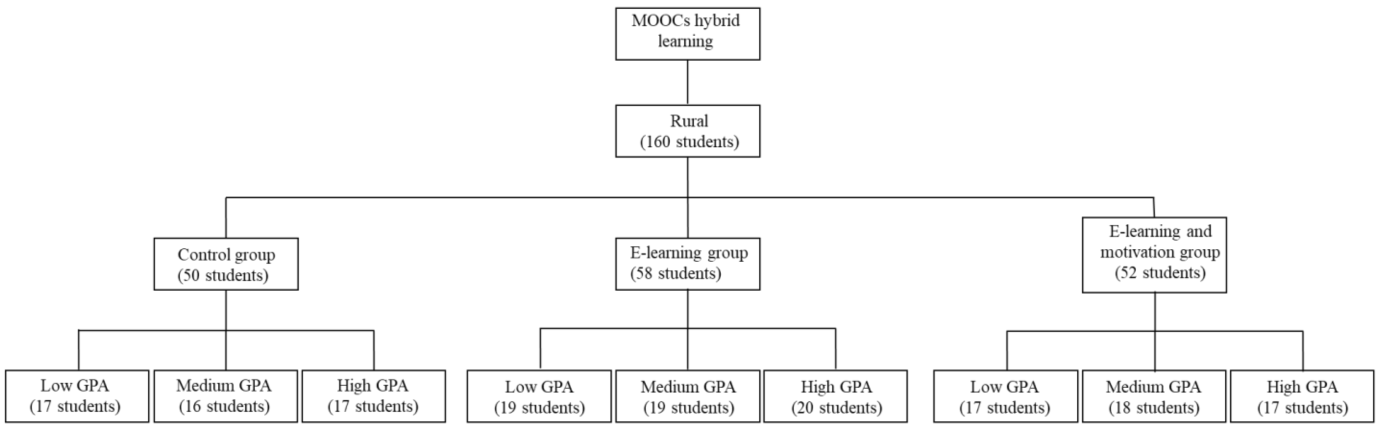


Figure 3.5 Number of students who participated MOOCs hybrid learning model in rural area

Step 6.4 Hypotheses and Data analysis

The main propose of this study was to investigate the suitable features and factor of MOOC hybrid learning model by taking into consideration two different areas (urban & rural). Researcher conducted three experiments. In the first experiment, researcher evaluated the effectiveness of MOOC hybrid learning model in improving learning by testing hypothesis H_1 (below). This experiment was carried out involving urban and rural students. Testing of different assumptions was carried out through pair t-test to determine the difference between pre and post-test scores

H_0: There is not a significant difference between pre and post-test scores

H_1: There is a significant difference between pre and post-test scores

H_0: There is not a significant difference between pre and post-test scores in a group of urban students

$H_{1.1}$: There is a significant difference between pre and post-test scores in a group of urban students

H_0: There is not a significant difference between pre and post-test scores in a group of rural students

$H_{1.2}$: There is a significant difference between pre and post-test scores in a group of rural students

Assumptions H_2–H_7 were tested in the second experiment to examine various relationships and how they influenced learning improvements (difference between pre and post-test scores), based on two factors, i.e., GPA (low, medium, and high GPA group) and satisfactory scores (instructor, course, design, technical, and focus group factor). Students were separated into two groups depending on whether they belonged to urban or rural groups. They were also tested on the chemistry subject. This section describes the Kruskal-Wallis test researcher conducted to analyze and find the relationships between improvements in scores and factors. Post hoc test was used to analyze subsequent effects. (Titie, et al., 2016)

H_0: The GPA does not have a significant effect on score improvement

H_2: The GPA has a significant effect on score improvement

H_0: Instructor factor does not have a significant effect on score improvement

H_3: Instructor factor has a significant effect on score improvement

H_0: Course factor does not have a significant effect on score improvement

H_4: Course factor has a significant effect on score improvement

H_0: Design factor does not have a significant effect on score improvement

H_5: Design factor has a significant effect on score improvement

H_0: Technical factor does not have a significant effect on score improvement
H_6: Technical factor has a significant effect on score improvement

H_0: Focus group factor do not have a significant effect on score improvement
H_7: Focus group factor has a significant effect on score improvement

In the third experiment, researcher tested hypotheses H_8-H_{12} (below) to determine the improvement and effectiveness of model features, i.e., MOOCs video (difference of pre-test and in-video quiz scores), discussion in forum (difference of in-video quiz and online quiz scores), retention rate (difference of online quiz and flash quiz scores), focus group (difference of flash quiz and individual activities scores), and group activities (difference of individual activities and post-test scores). In this section, testing of different assumptions was conducted through a paired t-test to determine the difference in scores.

H_0: There is not a significant difference between pre-test and in-video quiz scores
H_8: There is a significant difference between pre-test and in-video quiz scores

H_0: There is not a significant difference between pre-test and in-video quiz scores in a group of urban students
$H_{8.1}$: There is a significant difference between pre-test and in-video quiz scores in a group of urban students

H_0: There is not a significant difference between pre-test and in-video quiz scores in a group of rural students
$H_{8.2}$: There is a significant difference between pre-test and in-video quiz scores in a group of rural students

H_0: There is not a significant difference between in-video quiz and online quiz scores
H_9: There is a significant difference between in-video quiz and online quiz scores

H_0: There is not a significant difference between in-video quiz and online quiz scores in a group of urban students

$H_{9.1}$: There is a significant difference between in-video quiz and online quiz scores in a group of urban students

H_0: There is not a significant difference between in-video quiz and online quiz scores in a group of rural students
$H_{9.2}$: There is a significant difference between in-video quiz and online quiz scores in a group of rural students

H_0: There is not a significant difference between difference of online quiz and flash quiz scores
H_{10}: There is a significant difference between difference of online quiz and flash quiz scores

H_0: There is not a significant difference between online quiz and flash quiz scores in a group of urban students
$H_{10.1}$: There is a significant difference between online quiz and flash quiz scores in a group of urban students

H_0: There is not a significant difference between online quiz and flash quiz scores in a group of rural students
$H_{10.2}$: There is a significant difference between online quiz and flash quiz scores in a group of rural students

H_0: There is not a significant difference between difference of flash quiz and individual activities scores
H_{11}: There is a significant difference between difference of flash quiz and individual activities scores

H_0: There is not a significant difference between flash quiz and individual activities scores in a group of urban students
$H7_{11.1}$: There is a significant difference between flash quiz and individual activities scores in a group of urban students

H_0: There is not a significant difference between flash quiz and individual activities scores in a group of rural students

$H_{11.2}$: There is a significant difference between flash quiz and individual activities scores in a group of rural students

H_0: There is not a significant difference between difference of individual activities and post-test scores

H_{12}: There is a significant difference between difference of individual activities and post-test scores

H_0: There is not a significant difference between individual activities and post-test scores in a group of urban students

$H_{12.1}$: There is a significant difference between individual activities and post-test scores in a group of urban students

H_0: There is not a significant difference between individual activities and post-test scores in a group of rural students

$H_{12.2}$: There is a significant difference between individual activities and post-test scores in a group of rural students

Step 7 Find the effectiveness of educational gamification in term of learning outcome (Chapter 5)

This step involves the testing the effectiveness of educational gamification model and find the factors that influence on learning outcome to design the suitable model for developing countries students.

Step 7.1 Create learning content and framework

7.1.1. Gamification content development and testing

Refer to primary data, the main methods are divided into two parts: the processes and steps of content testing, utilizing Duolingo (Duolingo, 2016). The process (Figure 3.4) indicates statistical results that measure the effectiveness of the game content. We used the pilot test results in the figure 3.4 to explore the trust, reliability, and effectiveness issues. After the students had learned through the Duolingo program (Figure 3.5), the effectiveness of each educational gamification features had been determined. This also helped us to identify factors and features that affected the educational gamification effectiveness. Figure 3.5 focuses on the process of real data collection from 251 respondents emphasizing pre- and post-test results.

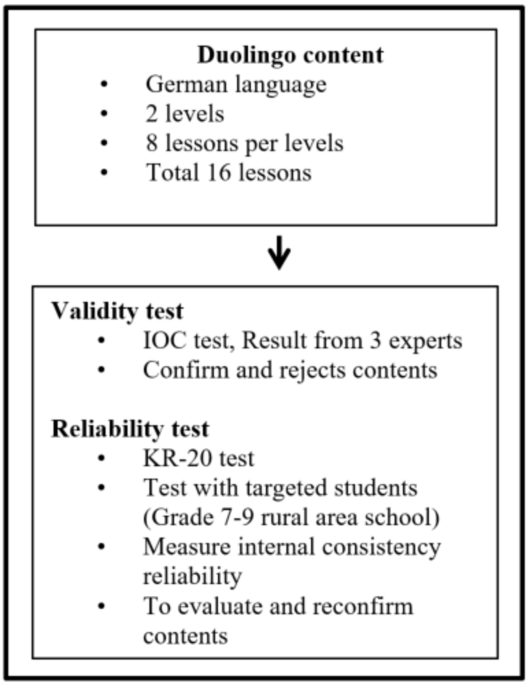


Figure 3.6 Gamification content development and testing

The first part of Figure 3.6 is devoted to the process of using Duolingo content, the purpose being to confirm the validity of the contents. The game content from Duolingo (Duolingo, 2016) was utilized by using a two-level (basic and intermediate) German course with eight lessons per level. The basic level comprised lessons titled Basic 1, Basic 2, Phrases, Account, Cases, Introductions, Food 1, and Animals 1. The intermediate level comprised lessons titled Plurals, Adjectives, Negatives, Questions 1, Clothing, and Nature 1. We choose German course because students have never learned this content before. It is the effective way to measure actual learning ability. This course consisted of interactive game activities that lasted approximately 10 to 15 minutes per lesson. We also conducted a validity test using the Item Objective Congruence Index (IOC). The IOC provides results from three experts in academic fields. The validity test results either confirmed or invalidated our test results. When we got a positive result, we proceeded by using that set of exams for our pilot test, performing pilot testing for 20 students. Internal consistency and reliability were measured by using the Kuder–Richardson Formula 20 test (KR-20) which aims to evaluate and reconstruct the exam.

After the pilot testing was completed, the real pre-test in the form of field-testing was performed

7.1.2. Educational gamification model

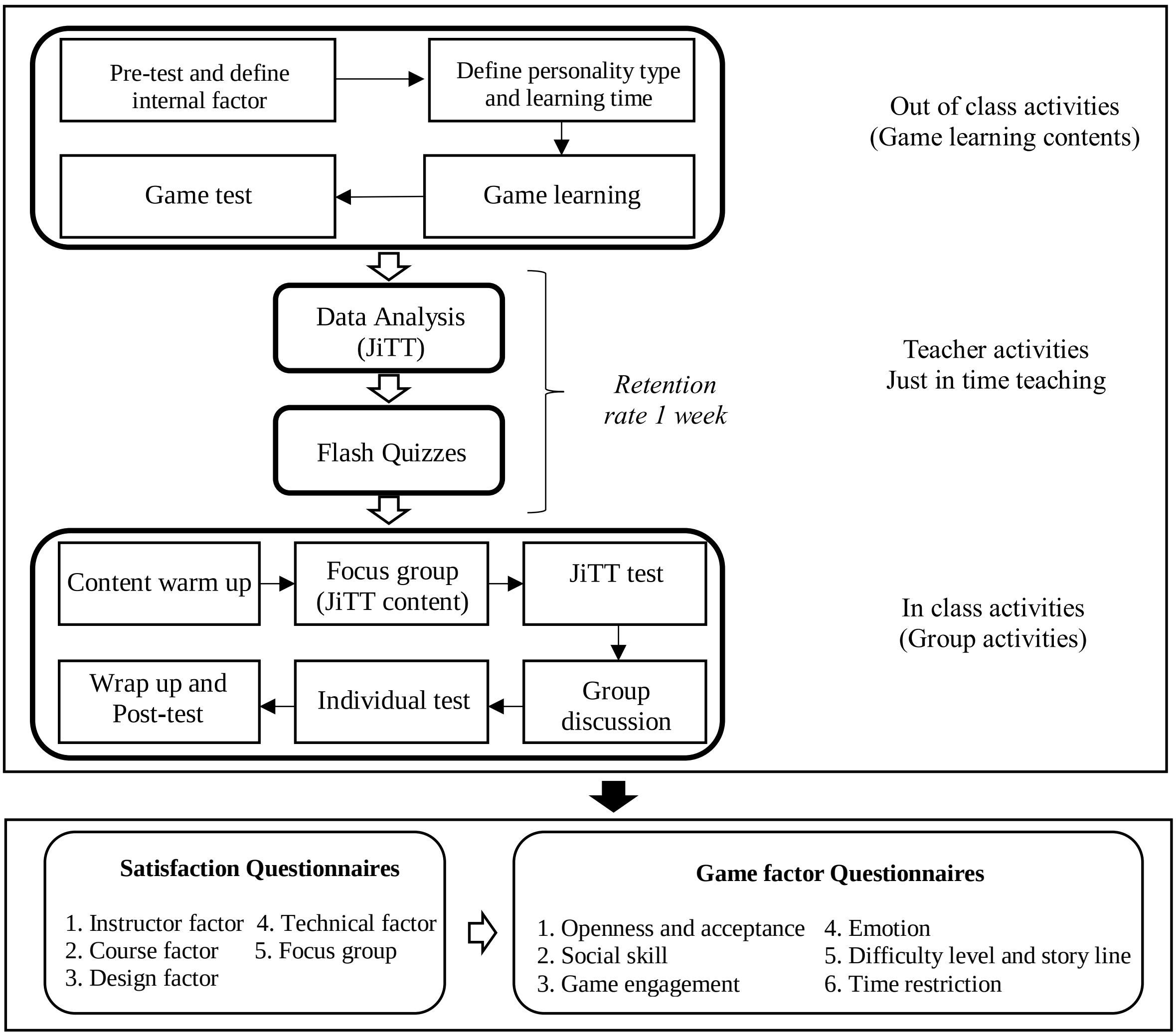


Figure 3.7 Educational gamification model

As Figure 3.7 shows, the gamification structure can be divided into five steps. First, internal factors and personality types are obtained. Student profiles are collected on the following items: Age (grades 7-10, students' age 13-16), GPA (below 2.00, 2.00-3.00, 3.00-4.00) (Ministry of Education, 2013), and Past game experience (never, sometimes, always play educational games). The students' personality types were identified through Keirsey's questionnaire, which pinpoints four basic temperaments: Artisan, Guardian, Rational, and Idealist (Keirsey, D., 1998). Second, students choose the German language and their daily study level: Casual - 15 mins/day, Regular - 30 mins/day, Serious - 45 mins/day, and Obsessed - 60 mins/day. In the third "Learning and testing" step, students answered 10 pre-test level questions. These were developed on the basis of Duolingo content, covering 16 lessons with two levels of difficulty (Duolingo, 2016). Both the pre and post-tests comprised three to five questions per level. In total, 10 questions were prepared. The post-test exam was eventually administered after the students had gone through the learning content and completed all the exercises. The level of difficulty was programmed to match that of the pre-test exam. After that, students played the basic level game, learning by themselves, and started group discussions with five students in each group to expand their mutual understanding. Then the basic level test was administered with 10 questions to evaluate their understanding. One week later, the students were given 10 warm up questions that had the same difficulty as those of the basic level test to determine their score retention and evaluate the amount of knowledge they had retained. The students started to learn intermediate level contents through the learning game and engaged in group discussions again. Finally, a post-test was conducted after the students had finished all the activities. We used a questionnaire to evaluate the game factors Satisfaction, Personal and social skills, Game engagement, Openness and acceptance, and Emotion combined with the self-elements of the game, that is, the level of difficulty and the story line, and the time restriction (Wendy & Dilip, 2013). The choices were evaluated on a three-point Likert scale (agree, partly agree, and disagree) to identify which factors the students felt were important for game learning. In order to analyze the effectiveness of gamification learning, the paired T-test method was utilized to compare the pre- and post-test score means, together with Kruskal-Wallis test is meant to find the effects and relationships between variables.

Step 7.2 <u>Identify the factors, features, and variable</u>

After determining the learning model, factors and features were examined. We propose five group factors; internal factors (GPA, age, and past e-learning experience), game learning factors (openness and acceptance, satisfaction, personal and social skill, game engagement, emotion, difficulty level and the story line, and time restriction), social elements (group discussion), learning time, and personality type (Guardian, Artisan, Idealist, and Rationalist). We find the effect of these factors by using the Kruskal-Wallis (H Test). It was used to find the relationships of factors on learning outcome.

Step 7.3 Participation and data collection

The data was collected using field testing methods at urban and rural school. Two-hundred fifty-one students were randomly selected. (128 from a public urban school in Bangkok province) and 123 from a public rural school in Suphanburi and chaiyaphum province). The students were in grades 7-10 (13-16 years old). Sixty-three students were in grade 7, 65 in grade 8, 63 in grade 9, and 60 in grade 10. Out of the 251 respondents, 127 (50.59%) were male and 124 (49.40%) were female. The majority of students had a high (3.00-4.00) GPAX (33.06%) and medium (2.00-3.00) GPAX (33.06%), and 33.86% had a low (below 2.00). Due to the student groups, participations were divided to 3 student groups; Control (learned by traditional method), E-learning (learned by MOOCs hybrid learning), and E-learning and motivation (learned by MOOCs hybrid learning with incentive and extra scores)

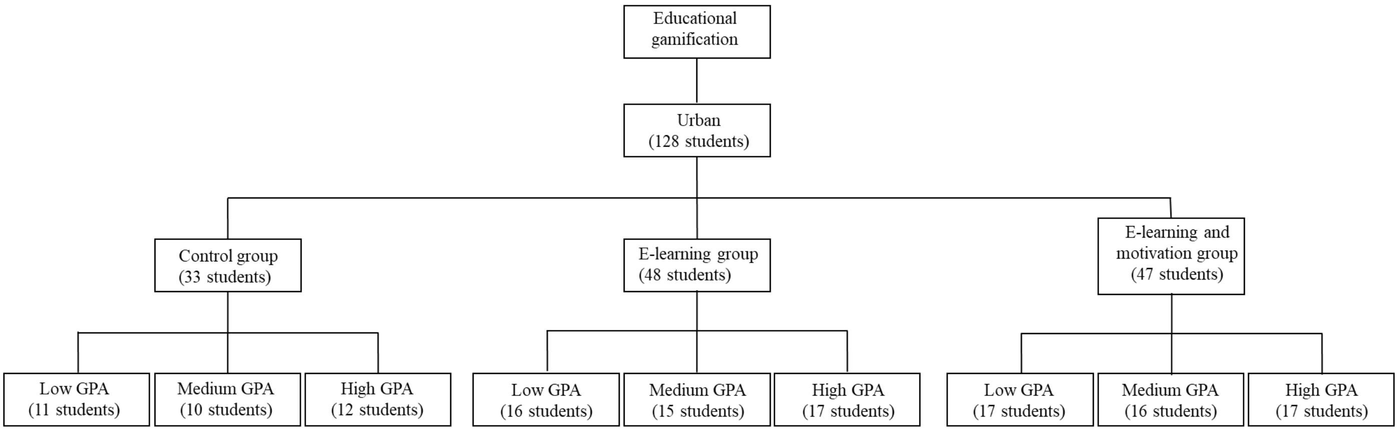


Figure 3.8 Number of students who participated Educational gamification model in urban area

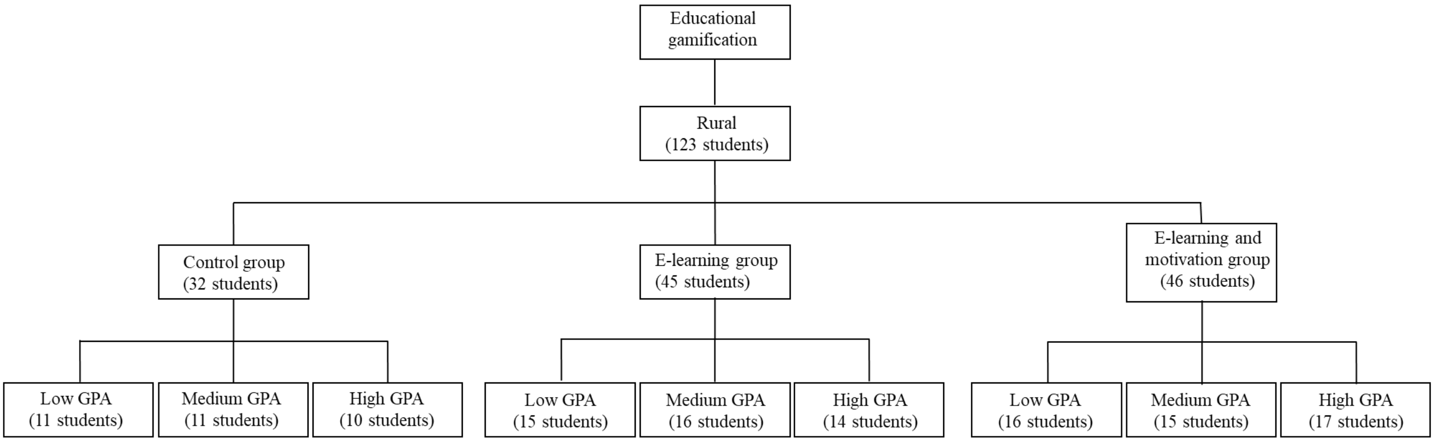


Figure 3.9 Number of students who participated Educational gamification model in rural area

Step 7.4 Hypotheses and Data analysis

Educational gamification was conducted as an experiment. In this experiment, the data analysis is divided into 3 sections. Firstly, measuring the effectiveness of learning outcome by paired t-test to determine the score difference between pre and post-test by testing hypothesis H_{13} (below). This experiment was carried out involving urban and rural students.

H_0: There is not a significant difference between pre and post-test scores

H_{13}: There is a significant difference between pre and post-test scores

H_0: There is not a significant difference between pre and post-test scores in a group of urban students

$H_{13.1}$: There is a significant difference between pre and post-test scores in a group of urban students

H_0: There is not a significant difference between pre and post-test scores in a group of rural students

$H_{13.2}$: There is a significant difference between pre and post-test scores in a group of rural students

In the second experiment, the testing of assumptions H_{14}-H_{23} are done to determine their relationships to and their influence on the learning improvement, on the basis of six factors: internal factors, game learning factors, self-elements, learning time, social elements and Keirsey personality type. In this section, we will show how we conducted Kruskal-Wallis Test to analyze and find the influence and relationship between score improvements (difference between pre- and post-test scores) and internal factors (Titie, et al., 2016)

H_0: The GPA does not have a significant effect on score improvement
H_{14}: The GPA has a significant effect on score improvement

H_0: The learning time does not have a significant effect on score improvement
H_{15}: The learning time has a significant effect on score improvement

H_0: Keirsey personality types do not have a significant effect on score improvement
H_{16}: Keirsey personality types have a significant effect on score improvement

H_0: The satisfaction does not have a significant effect on score improvement
H_{17}: The satisfaction has a significant effect on score improvement

H_0: The openness and acceptance factor do not have a significant effect on score improvement
H_{18}: The openness and acceptance factor have a significant effect on score improvement

H_0: Social skill factor does not have a significant effect on score improvement
H_{19}: Social skill factor has a significant effect on score improvement

H_0: The game engagement factor does not have a significant effect on score improvement
H_{20}: The game engagement factor has a significant effect on score improvement

H_0: The emotional factor does not have a significant effect on score improvement
H_{21}: The emotional factor has a significant effect on score improvement

H_0: The difficulty level and the story line do not have a significant effect on score improvement

H_{22}: The difficulty level and the story line have a significant effect on score improvement

H_0: The time restriction does not have a significant effect on score improvement

H_{23}: The time restriction has a significant effect on score improvement

In the third experiment, researcher tested hypotheses H_{24}-H_{27} (below) to determine the improvement and effectiveness of model features, i.e., game learning (difference of pre-test and game test), learning retention (difference of game test and flash quiz score), focus group (difference of flash quiz and JiTT test), and group activities (difference of JiTT test and individual test score). In this section, testing of different assumptions was conducted through a paired t-test to determine the difference in scores.

H_0: There is not a significant difference between pre-test and game test scores

H_{24}: There is a significant difference between pre-test and game test scores

H_0: There is not a significant difference between pre-test and game test scores in a group of urban students

$H_{24.1}$: There is a significant difference between pre-test and game test scores in a group of urban students

H_0: There is not a significant difference between pre-test and game test scores in a group of rural students

$H_{24.2}$: There is a significant difference between pre-test and game test scores in a group of rural students

H_0: There is not a significant difference between game test and flash quiz scores

H_{25}: There is a significant difference between game test and flash quiz scores

H_0: There is not a significant difference between game test and flash quiz scores in a group of urban students

$H_{25.1}$: There is a significant difference between game test and flash quiz scores in a group of urban students

H_0: There is not a significant difference between game test and flash quiz scores in a group of rural students
$H_{25.2}$: There is a significant difference between game test and flash quiz scores in a group of rural students

H_0: There is not a significant difference between difference of flash quiz and JiTT test score
H_{26}: There is a significant difference between difference of flash quiz and JiTT test score

H_0: There is not a significant difference between flash quiz and JiTT test score in a group of urban students
$H_{26.1}$: There is a significant difference between flash quiz and JiTT test score in a group of urban students

H_0: There is not a significant difference between flash quiz and JiTT test score in a group of rural students
$H_{26.2}$: There is a significant difference between flash quiz and JiTT test score in a group of rural students

H_0: There is not a significant difference between difference of JiTT test and Individual test scores
H_{27}: There is a significant difference between difference of JiTT test and Individual test scores

H_0: There is not a significant difference between JiTT test and Individual test scores in a group of urban students
$H_{27.1}$: There is a significant difference between JiTT test and Individual test scores in a group of urban students

H_0: There is not a significant difference between JiTT test and Individual test scores in a group of rural students

$H_{27.2}$: There is a significant difference between JiTT test and Individual test scores in a group of rural students

CHAPTER 4
MOOC HYBRID LEARNING MODEL

This chapter incorporates with MOOCs hybrid learning model. Massive online open courses (MOOCS), flipped learning, and active learning have become major tools to support the learning process. The main objective is developing a MOOC hybrid learning model that is effective and suitable in both rural and urban areas. This model was designed to solve less experience and insufficient number of teachers in schools. We also identify the internal factors that affect the learning process. The case study of MOOCs hybrid learning was developed to simulate the effectives in term of learning outcome. We collected data from 314 secondary students (grades 7-10) in a public school in urban and rural Thailand. From the results, the design which integrated MOOCs, flipped learning, and active learning are shown effective in developing countries schools. In addition, group activities, such as peer tutoring and forum discussions, significantly improve learning outcome. Moreover, the effectiveness of learning outcome is confirmed in a case study and tested through the statistical experiments.

4.1. Introduction

The user of e-learning has increased all around the world. The traditional teaching style has been adapted to blended learning and full e-learning mode. A student can learn in their own place, pace, and time. This is the good opportunity for developing countries students who do not have an opportunity to reach high standard education. Several new models were developed in distance learning such as Massive online open courses (MOOCs), flipped learning, and active learning These models have been successfully filling the equality gap in education (Vicki, 2014). However, these new e-learning approaches have been designed mainly for education in developed countries, which have their own learning style and culture. For developing countries education, there lack teachers in rural schools, and they must teach many subjects, including those in which they have low experience. In addition, most rural students are low-performing students in Rural and Low-Income Schools (RLISs). For these reasons, MOOCs hybrid learning was created to solve these specific problems and provide the effective learning method for low-performing students in the rural area.

In this chapter, we developed MOOCs hybrid learning model that integrates MOOCs as content, students learned at home or in their leisure time and active learning activities that contribute to group discussion and applying their knowledge to complete their assignments. This model also includes various learning theories such as collaborative learning, peer tutoring, collaborative, and problem-based learning. Moreover, collaborative learning is one of the most effective methods for instruction (Foley & Donnell, 2006). Students work in teams for the same goal. They are encouraged to support each other and charged for their own and the group's work (Bowen, et al., 2012). Peer tutoring and peer-assisted can help students acquire knowledge and skills through active helping with matched companions. Examples of these tools are forum discussion, peer-to-peer exchanges, and deeper engagement with the course content. These factors will help students obtain a deeper understanding of their lessons (Crouch & Mazur, 2001).

4.2 Learning content and framework

4.2.1. MOOC content development and testing

Due to primary data, the main methods are divided into two parts. Firstly, the steps of content testing and pattern of our MOOCs hybrid learning model. Applying MOOCs from Coursera (Coursera, 2015) by using a chemistry course on atoms and electronic structure from the University of Kentucky. Chemistry course were chosen because students have never learned this content before. It is the effective way to measure actual learning process. This course consists of lecture videos approximately 10 minutes. Practice problems and answer sets are included that correspond with each lecture video. Second, conducting a validity test using the Item Objective Congruence Index (IOC), which provides results from three experts in academic fields. The results of the validity test confirmed or rejected our set of exams. When the result was positive, we proceed by using that set of exams for a pilot test. We then conducted a pilot test on 50 students. Internal consistency and reliability were measured using the Kuder–Richardson Formula 20 test (KR-20, which aims to evaluate and reconstruct the exam from test results of a group of 50 students. After pilot testing, we conducted the actual pre-test in the form of field-testing. (Titie, et al., 2016)

4.2.2. MOOCs hybrid learning model

The learning model we used in this study is a combination of the flipped learning model, MOOCs, and student-centered model (active learning), as shown in Figure 4.1. We adapted and used this model to design new learning processes. This framework combines three activity steps. The first step involves teacher-centered learning and out-of-class activities. Before receiving class content, students are tested using a pre-test and collected internal factor data. They then learn the chemistry content from Coursera, which provides free online learning. There are in-video quizzes that pop up while the teacher explains the content. After students have learned all contents, ten online quizzes are given to evaluate their understanding. Then students are tested by forum discussion to confirm their deep understanding of the content. In the second step, teacher activities are conducted. Teachers use student-performing data to understand which contents students are struggling with and focus on particular students who are at-risk and identified the risk group. After one week, students are tested through ten flash quiz questions that have the same difficulty as online quiz questions to determine the retention score and evaluate retained knowledge. The third step is student-centered learning through in-class activities. The teacher summarizes all content as a warm up session. After that, the teacher divides students into groups based on their knowledge and understanding, which were analyzed using the JiTT method. The teacher teaches different content to different groups to fulfill group lacking content. The students participate in three active learning activities. First, individual activities are conducted in which students solve problems in class and had a chance to ask questions to the teacher. Second, pair activities are conducted in which students work independently and discuss their thoughts and arguments with a partner. Then they have a wider discussion. Third, group activities (fishbowl discussion) are conducted starting from small groups of students sitting in a circle and engaging in a peer discussion with the remaining students sitting in outer circle and observing the discussion and taking notes so they can then discuss the interaction (Barkley, et al., 2005). After those steps, students are tested through group quizzes to evaluate the peer tutoring tools and individual quizzes to test their individual understanding. These quiz scores are counted as post-test scores. In the final step, peer evaluation is conducted in which students can assess and give scores to their fellow students. These activities can increase student social skill and build self-confidence (Adam, et al., 2012). We then used ground truthing to compare scores from the teacher and those from students (Peer evaluation). If they correlate, we can use them for peer evaluation. Finally, students fill out a satisfaction questionnaire. The questionnaire was written in Thai using a 3-point Likert scale:

1 = not agree, 2 = partly agree, 3 = agree. It consisted of 6 factors intended to measure intrinsic motivation (satisfaction) and their experience (focus group). First, satisfaction was measured based on four factors: instructor, course, design, and technical, following the study by Moore, 2009 and So, 2009. Second, e-learning experience was measured based on the personal experience after using our e-learning model. (Titie, et al., 2016)

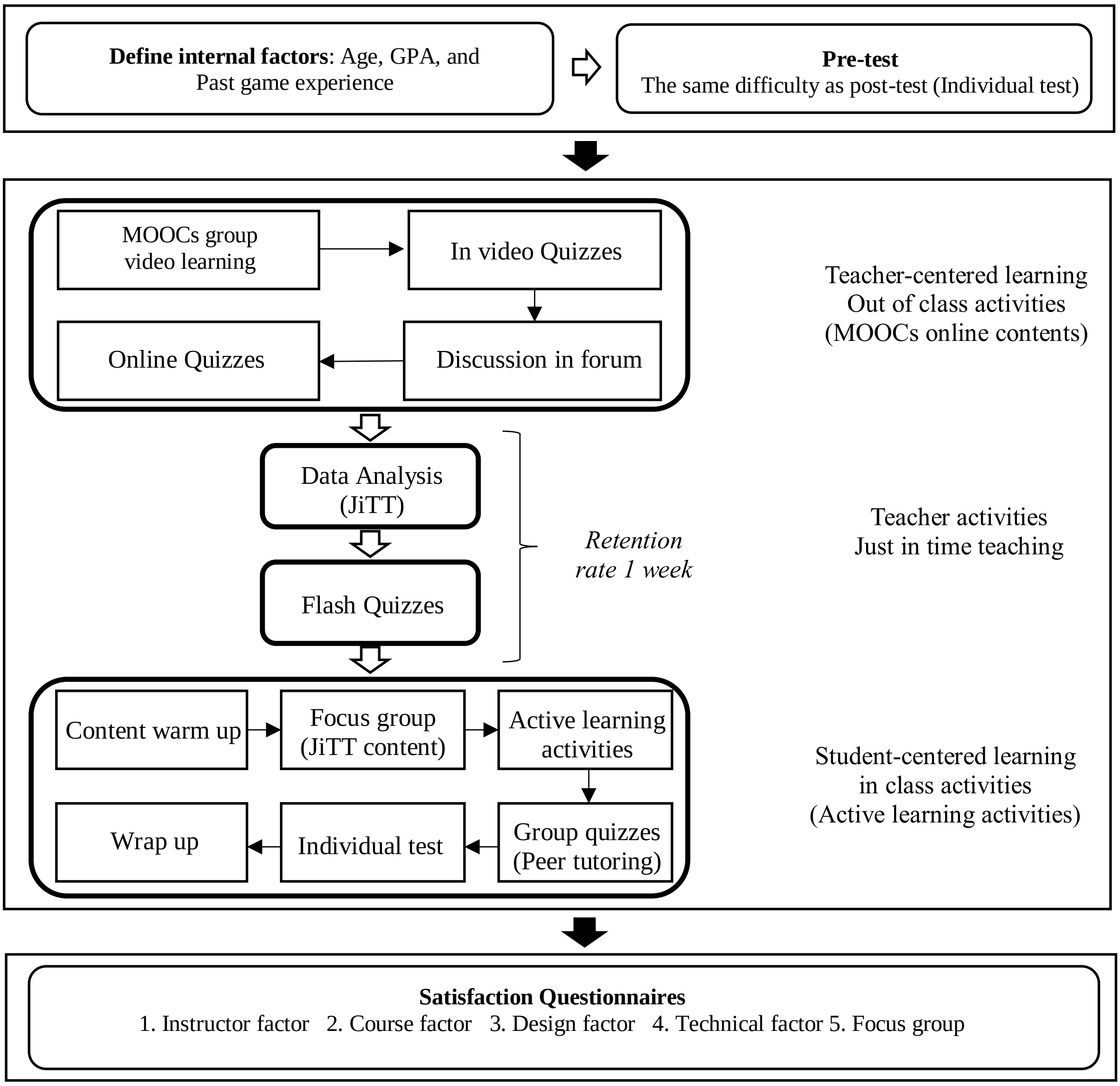


Figure 4.1 MOOCs hybrid learning model

4.2.3. Identify the factors, features, and variable

After determine the learning framework, factors and features were proposed next. We propose four group factors; internal factors GPA, Satisfaction factors (focus group, instructor, design, technical, and course), social elements (Forum discussion and peer tutoring) and active learning activities (Group, pair, and individual activities). We find the effectiveness of these factors by using the t-test and Kruskal-Wallis (H Test)

4.2.4. Participations and data collection

The data was collected using field testing methods at urban and rural school. According to MOOC hybrid learning model, 314 students were randomly selected. (154 from a public urban school in Bangkok province and 160 from a public rural school in chaiyaphum province). The students were in grades 7-10 (13-16 years old). Seventy-nine students were in grade 7, 80 in grade 8, 80 in grade 9, and 75 in grade 10. Out of the 314 respondents, 161 (51.27%) were male and 153 (48.72%) were female. The majority of students had a high (3.00-4.00) GPAX (33.43%) and medium (2.00-3.00) GPAX (33.43%), and 33.12% had a low (below 2.00).
Due to the student groups, participations were divided to 3 student groups. Control group, main contents were provided by traditional method (face to face instruction) and students participated in focus group and group activities. E-learning group, contents were provided by MOOCs video and educational gamification (E-learning). After that, students also participated in focus group and group activities. E-learning and motivation group, main contents were also provided by e-learning video and gamification. Student also participated in focus group and group activities. However, students in this group were motivated by some incentives (stationary, toy, and snack) together with extra scores from Science and English subject.
Furthermore, the data collections focus on rural and urban students separately. Students who study in each area are separated into 3 groups, referred to as control, e-learning, and e-learning and motivation group, respectively. Then in the same group, they are further divided into three group according to their GPA level (Low, medium, and high GPA)

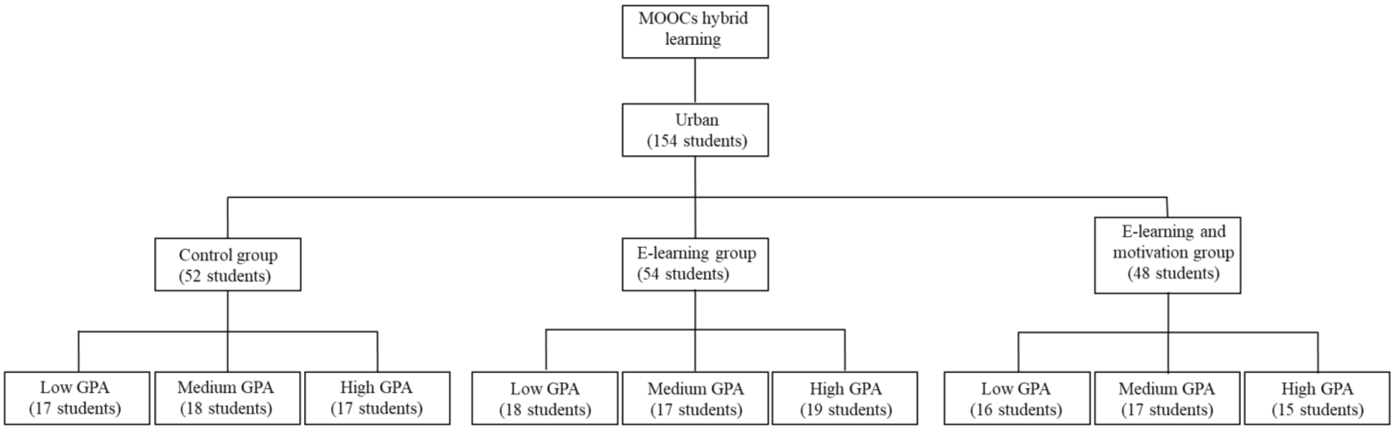


Figure 4.2 Number of students who participated MOOCs hybrid learning model in urban area

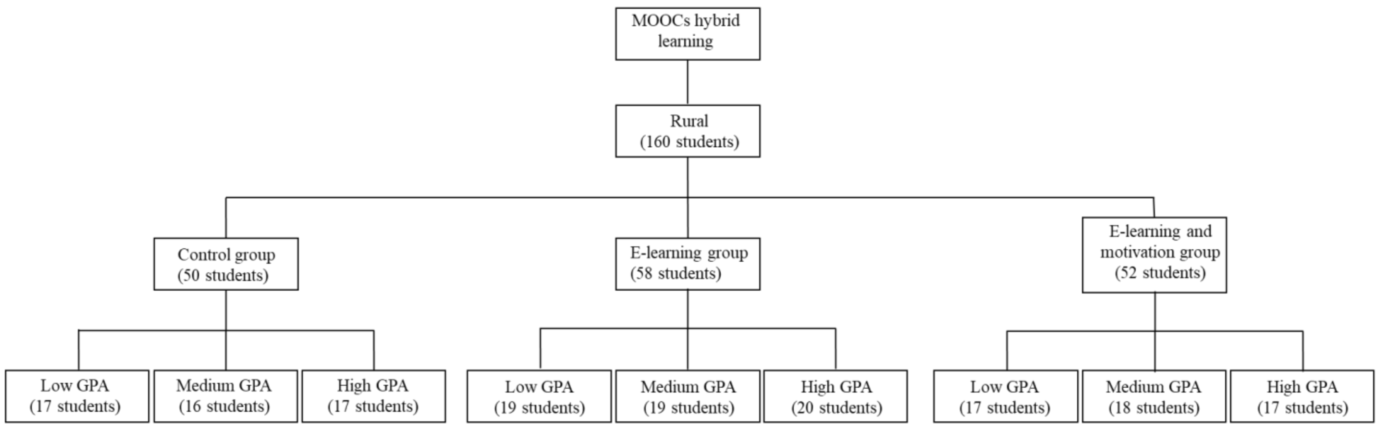


Figure 4.3 Number of students who participated MOOCs hybrid learning model in rural area

4.3. Data analysis

Testing of hypothesis were conducting using a pair *t*-test to determine whether the data are significantly different from each other. In addition, ANOVA was used to analyze the differences among 3 group means (control, e-learning, and e-learning and motivation groups). Tukey's honest significant different (HSD) test was used to analyze subsequent effects. It compares all possible pairs of means that are significantly different from each other. The analyses focus on rural and urban students separately. Students who study in each area are divided into three group according to their GPA level. Then in the same GPA level, they are further separate into 3 groups, referred to as control, e-learning, and e-learning and motivation group, respectively.

4.3.1 Pre and Post-test Analysis

4.3.1.1 Effectiveness of model

The overall analysis on the difference between pre and post-test score is done by employing the Paired *t*-test, Cohen's *d* effect size, Skewness, Kurtosis, and ANOVA. Refer to Figure 4.4, the difference between pre and post-test score distribution is approximately symmetrical negative skewed (Skewness= -0.19). This means most students have positive improvement after learning from MOOCs hybrid learning model. Moreover, Kurtosis distribution (0.18) is Leptokurtic that the tails are longer and fatter. Additionally, Cohen provided interpretation of effect sizes, revealing that d = 5.85 represents a very large effect size. The difference between pre and post-test score is very large. As Table 4.1 shown, Hypothesis H_1, the null hypothesis was rejected. There is a significant difference between pre and post-test scores at a level of 0.01 (t-value = -77.84).

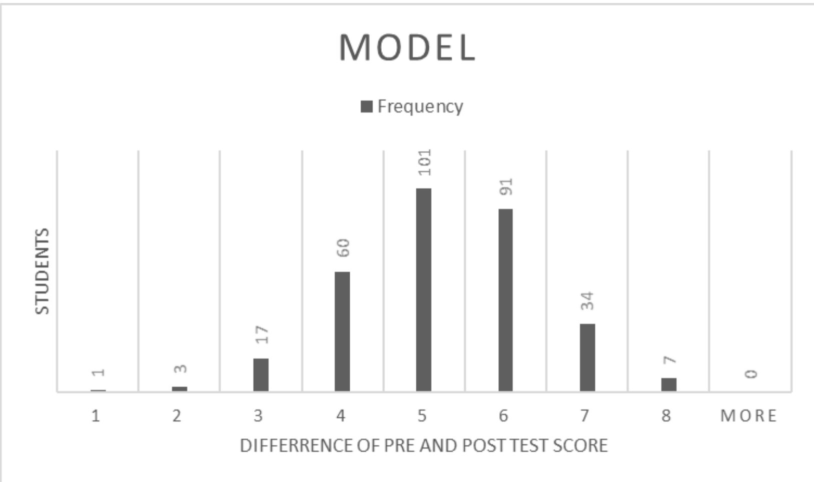


Figure 4.4 Difference of pre and post test scores in MOOC hybrid learning model histogram

From Figure 4.5, In urban area, the difference between pre and post-test score distribution is approximately symmetrical negative skewed (Skewness= -0.22). This means most students have positive improvement after learning from MOOCs hybrid learning model.

Moreover, Kurtosis distribution (-0.18) is Platykurtic that the tails are shorter and thinner. Most of students have the approximately average scores. In addition, Cohen provided interpretation of effect sizes, revealing that d = 5.94 represents a very large effect size. The difference between pre and post-test score is very large. As Table 4.1 shown, Hypothesis $H_{1.1}$, the null hypothesis was rejected. There is a significant difference between pre and post-test scores in a group of urban students at a level of 0.01 (t-value = -53.27)

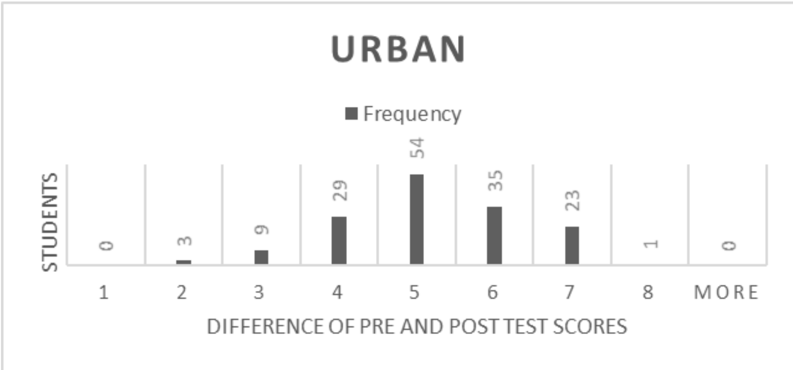


Figure 4.5 Difference of pre and post test scores in urban area histogram

From Figure 4.6, In rural area, the difference between pre and post-test score distribution is approximately symmetrical negative skewed (Skewness= -0.16). This means most students have positive improvement after learning from MOOCs hybrid learning model. Moreover, Kurtosis distribution (0.59) is Leptokurtic that the tails are longer and fatter. Additionally. Cohen provided interpretation of effect sizes, revealing that d = 5.76 represents a very large effect size. The difference between pre and post-test score is very large. As Table 4.1 shown, Hypothesis $H_{1.2}$, the null hypothesis was rejected. There is a significant difference between pre and post-test scores in a group of rural students at a level of 0.01 (t-value = -56.74)

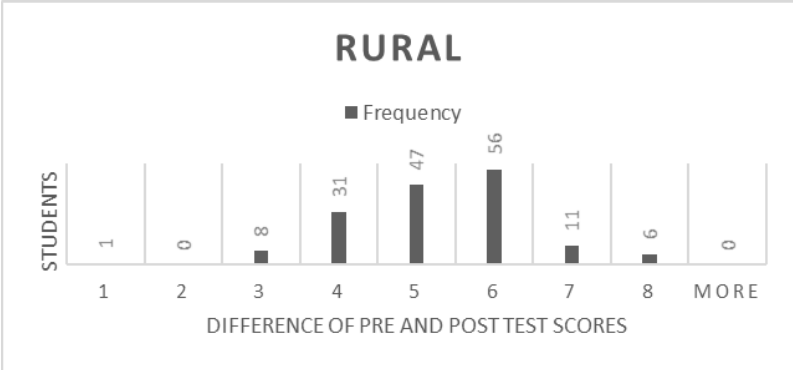


Figure 4.6 Difference of pre and post test scores in rural area histogram

Table 4.1 Results of t-test for difference between pre and post-test scores

Group	**Pre-test score**			**Post-test score**			***t*-value**
	N	***M***	**SD**	***N***	***M***	**SD**	
All students	314	2.13	0.82	314	7.36	0.96	-77.84**
Urban student	154	2.24	0.79	154	7.42	0.94	-53.27**
Rural student	160	2.01	0.83	160	7.30	0.98	-56.74**

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation

Table 4.2 Results of difference between pre and post-test scores of all students

Group	**Pre-test score**			**Post-test score**			**Difference between means**		
	N	M_1	SD_1	***N***	M_2	SD_2	M_2-M_1 *[95% CI]*	***t*-value**	***d***
Control	102	2.02	0.78	102	6.58	0.82	4.55 [4.33, 4.78]	-40.71**	5.6
E-learning	112	2.23	0.83	112	7.47	0.74	5.24 [5.07, 5.41]	-60.76**	6.6
E-learning and Motivation	100	2.12	0.83	100	8.03	0.74	5.91 [5.68, 6.13]	-51.53**	7.5

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

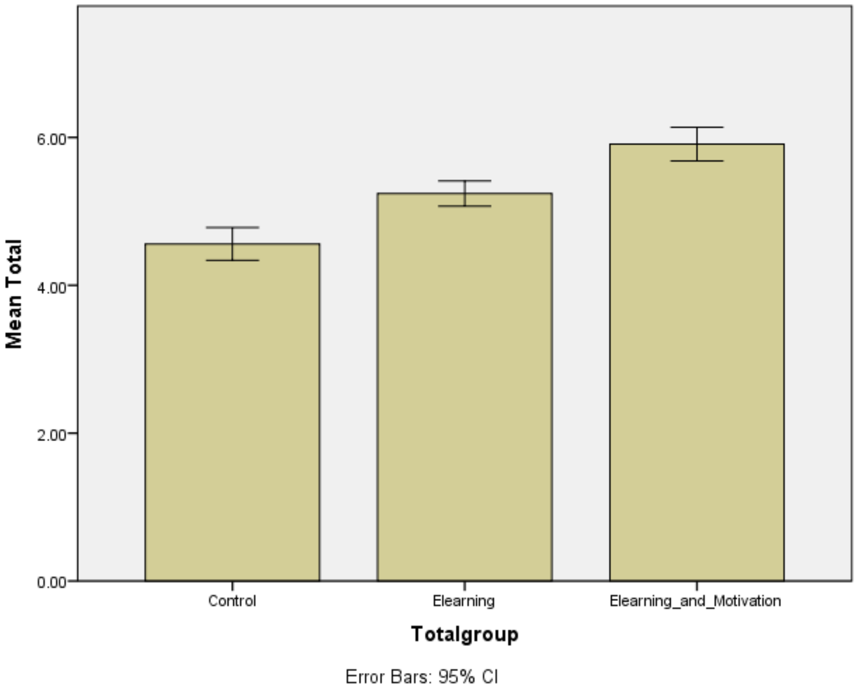


Figure 4.7 Results of difference between pre and post-test scores of all students

For all students control group, the mean score for post-test scores (*M*=6.58, *SD*=0.82) was higher than the mean score for pre-test scores (*M*=2.02, *SD*=0.78). The observed difference between means was 4.55, 95% CI [4.33, 4.78], *t* (100) = -40.71, *p*<.001. Cohen's d effect size between the independent and dependent variable was *d*=5.6, and this represents a very large effect size. Due to e-learning group, the mean score for post-test scores (*M*=7.47, *SD*=0.74) was higher than the mean score for pre-test scores (*M*=2.23, *SD*=0.83). The difference between means was 5.24, 95% CI [5.07, 5.41], *t* (110) = -60.76, *p*<.001. Cohen's d effect size represents a very large effect size (*d*=5.6). Refer to e-learning and motivation group, the mean score for post-test scores (*M*=8.03, *SD*=0.74) was higher than the mean score for pre-test scores (*M*=2.12, *SD*=0.83). The difference between means was 5.91, 95% CI [5.68, 6.13], *t* (98) = -51.53, *p*<.001. Cohen's d effect size was 7.5. The difference between pre and post-test score is very large.

Table 4.3 Results of difference between pre and post-test scores of urban students

Group	Pre-test score			Post-test score			Difference between means		
	N	M_1	SD_1	***N***	M_2	SD_2	M_2-M_1 [95% CI]	***t*-value**	***d***
Control	52	2.26	0.74	52	6.76	0.85	4.50 [4.19, 4.80]	-29.19**	6.0
E-learning	54	2.27	0.87	54	7.53	0.79	5.25 [4.96, 5.55]	-35.62**	6.3
E-learning and Motivation	48	2.18	0.76	48	8.02	0.72	5.83 [5.52, 6.14]	-38.14**	7.8

*p<0.05, ***p*<*0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

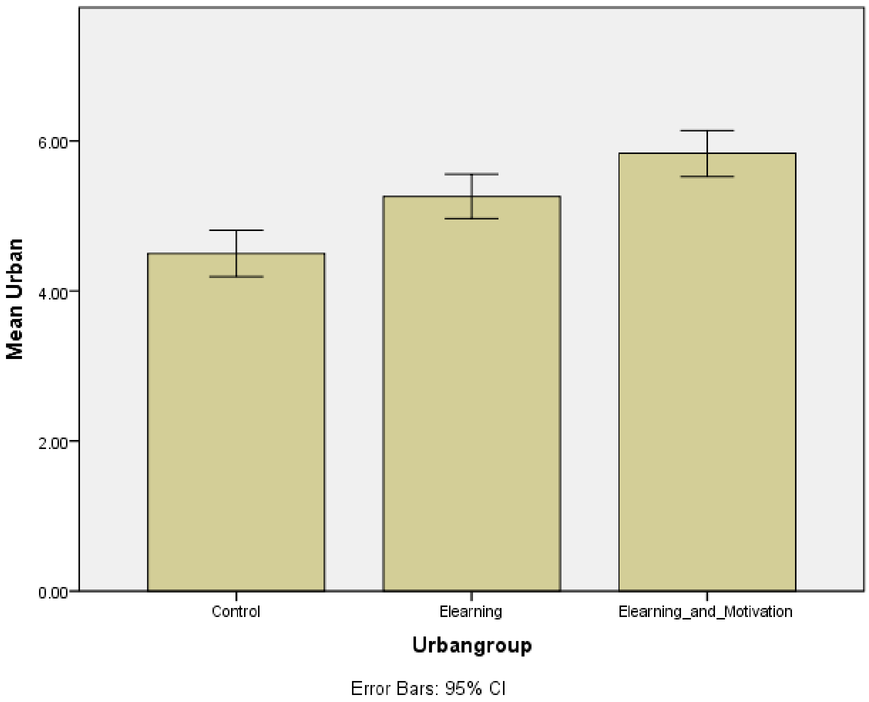


Figure 4.8 Results of difference between pre and post-test scores of urban students

Due to all students control group, the mean score for post-test scores (*M*=6.76, *SD*=0.85) was higher than the mean score for pre-test scores (*M*=2.06, *SD*=0.74). The observed difference between means was 4.50, 95% CI [4.19, 4.80], *t* (50) = -29.19, *p*<.001. Cohen's d effect size between the independent and dependent variable was *d*=6. The difference between pre and post-test score is very large. Due to e-learning group, the mean score for post-test scores (*M*=7.53, *SD*=0.79) was higher than the mean score for pre-test scores (*M*=2.27, *SD*=0.87). The difference between means was 5.25, 95% CI [4.96, 5.55], *t* (52) = -35.62, *p*<.001. Cohen's d effect size represents a very large effect size (*d*=6.3). Refer to e-learning and motivation group, the mean score for post-test scores (*M*=8.02, *SD*=0.72) was higher than the mean score for pre-test scores (*M*=2.18, *SD*=0.76). The difference between means was 5.83, 95% CI [5.52, 6.14], *t* (46) = -38.14, *p*<.001. Cohen's d effect size was 7.8. This represents a very large effect size.

Table 4.4 Results of difference between pre and post-test scores of rural students

Group	Pre-test score			Post-test score			Difference between means		
	N	***M_1***	***SD_1***	***N***	***M_2***	***SD_2***	***M_2-M_1* [95% CI]**	***t*-value**	***d***
Control	50	1.78	0.76	50	6.40	0.75	4.62 [4.29, 4.94]	-28.19**	6.1
E-learning	58	2.18	0.80	58	7.41	0.70	5.22 [5.03, 5.41]	-54.76**	6.9
E-learning and Motivation	52	2.05	0.89	52	8.03	0.76	5.98 [5.63, 6.32]	-35.10**	7.2

*p<0.05, ***p<0.01, M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

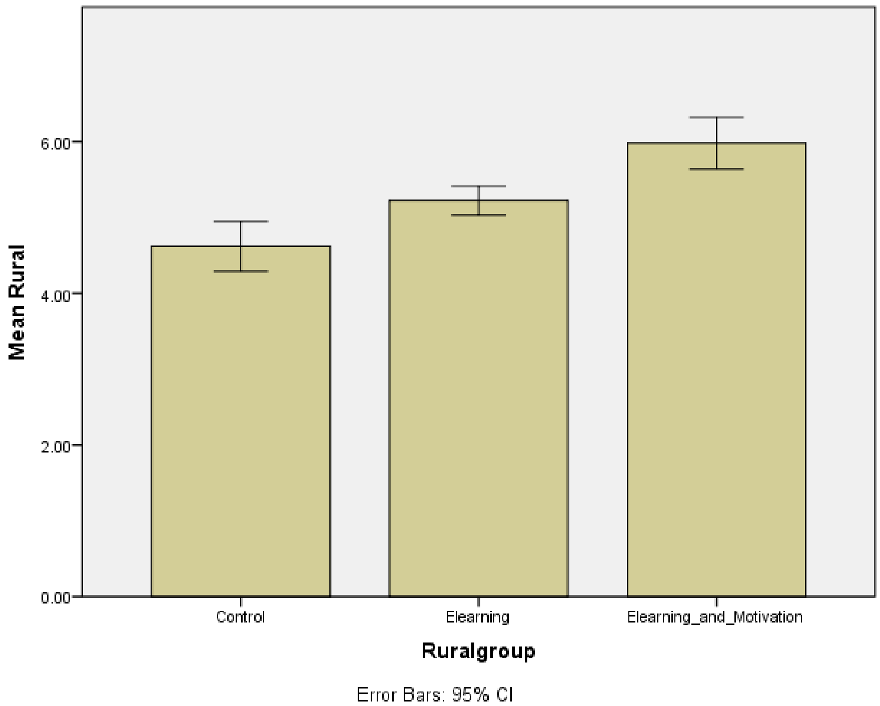


Figure 4.9 Results of difference between pre and post-test scores of rural students

According to all students control group, the mean score for post-test scores (*M*=6.40, *SD*=0.75) was higher than the mean score for pre-test scores (*M*=1.78, *SD*=0.76). The difference between means was 4.62, 95% CI [4.29, 4.94], t (48) = -28.19, p<.001. Cohen's d effect size between the independent and dependent variable was d=6.1, and this represents a very large effect size. Due to e-learning group, the mean score for post-test scores (*M*=7.41, *SD*=0.76) was higher than the mean score for pre-test scores (*M*=2.05, *SD*=0.89). The difference between means was 5.22, 95% CI [5.03, 5.41], t (56) = -54.76, p<.001. Cohen's d effect size represents a very large effect size (d=6.9). Refer to e-learning and motivation group, the mean score for post-test scores (*M*=8.03, *SD*=0.76) was higher than the mean score for pre-test scores (*M*=2.05, *SD*=0.89). The difference between means was 5.98, 95% CI [5.63, 6.32], t (50) = -35.10, p<.001. Cohen's d effect size was 7.2. The difference between pre and post-test score is very large.

The model can apply to both rural and urban area. The mean scores improve from 2.13 (Pre-test mean) to 7.36 (Post-test mean). The mean increases about 245%. The improvement of rural mean score (263%) is greater than urban mean score (231%). In urban area, e-learning and motivation group shows the best performance for all GPA levels. Similarly, in the rural area, e-learning group and e-learning and motivation group provide much improvement than control group for medium and high GPA students. However, low GPA students, the three group (e-learning and motivation, e-learning, and control group) provide the same learning improvement. MOOCs hybrid learning model shows the same improvement as traditional teaching (control group) for the rural low GPA students. This mean e-learning model can apply and help teacher to teach various subjects in the same standard as traditional teaching.

4.3.1.2 Academic achievement (GPA)

From Table 4.5, the overall analysis on score improvement is done by employing the Kruskal-Wallis Test. From hypothesis H_2, the null hypothesis was rejected. GPA have a significant effect on score improvement at a level of 0.01 ($\chi^2(2) = 16.28$). Additionally. Epsilon square (ε^2) provided interpretation of effect sizes, indicate that ε^2 = 0.05 represents moderate effect size. GPA have moderate influence on score improvement. Furthermore, high GPA groups have a significantly higher mean (Mean = 5.00) of their difference in pre and post- test scores than medium GPA (Mean = 5.24) and low GPA group (Mean = 5.45).

4.3.1.3 Satisfactory factors

As Table 4.5 shown, satisfactory factors are divided into 5 factors (instructor, course, design, technical, and focus group factor) Refer to H_3, the null hypothesis was rejected. Instructor factor has a significant effect on score improvement at a level of 0.01 ($\chi^2(2)$ = 154.58). Additionally. Epsilon square (ε^2) provided interpretation of effect sizes, indicate that ε^2 = 0.49 represents strong effect size. Instructor factor has strong influence on score improvement. Moreover, high GPA groups have a significantly higher mean (Mean = 5.93) of their difference in pre and post- test scores than medium GPA (Mean = 4.81) and low GPA group (Mean = 3.80). From H_4, the null hypothesis was accepted. Course factor does not have a significant effect on score improvement at a level of 0.19 ($\chi^2(2)$ = 3.25). Additionally. Epsilon square (ε^2) provided interpretation of effect sizes, indicate that ε^2 = 0.01 represents negligible effect size. Course factor has negligible impact on score improvement. Testing of H_5, the null hypothesis was rejected. Design factor will have a significant effect on score improvement at a level of 0.01 ($\chi^2(2)$ = 48.72). Additionally. Epsilon square (ε^2) provided interpretation of effect sizes, indicate that ε^2 = 0.15 represents moderate effect size. Design factor has moderate influence on score improvement. Furthermore, high GPA groups have a significantly higher mean (Mean = 5.60) of their difference in pre and post- test scores than medium GPA (Mean = 4.90) and low GPA group (Mean = 4.35). Due to H_6, the null hypothesis was accepted. Technical factor will not have a significant effect on score improvement at a level of 0.44 ($\chi^2(2)$ =1.61). Additionally. Epsilon square (ε2) provided interpretation of effect sizes, indicate that ε^2 = 0.005 represents negligible effect size. Technical factor has negligible influence on score improvement. Testing of H_7, the null hypothesis was rejected. Focus group factor will have a significant influence on score improvement at a level of 0.01 ($\chi^2(2)$ = 147.78). Additionally. Epsilon square (ε^2) provided interpretation of effect sizes, indicate that ε^2 = 0.47 represents strong effect size. Focus group factor has strong influence on score improvement. Moreover, high GPA groups have a significantly higher mean (Mean = 5.88) of their difference in pre and post- test scores than medium GPA (Mean = 4.87) and low GPA group (Mean = 3.77).

From the result, GPA is a significant factor that is influence on learning outcome for both urban and rural areas. Students will get more learning improvement, if they get high GPA. GPA is one of indicators that can predict the learning outcome. According to satisfaction factors, instructor, design, and focus group factors provide the strong influence with learning outcome. It means professional instructor, computer interface, and focus group activities are important factors. E-learning model creator should concern when design new e-learning model

Table 4.5 Results of Kruskal-Wallis Test for GPA and Satisfactory factors that effect on score improvement

Factors	**Factors**			**Score improvement**				
	N	***M***	***SD***	***N***	***MR***	***SD***	***df***	**Chi-Square**
GPA	314	2.00	0.81	314	5.23	1.19	2	16.28**
Low GPA				104	173.11	0.10		
Medium GPA				105	156.85	0.11		
High GPA				105	142.69	0.12		
Satisfaction								
Instructor factors	314	2.35	0.76	314	5.23	1.19	2	154.58**
Disagree				56	54.37	0.11		
Partly agree				90	121.88	0.08		
Agree				168	210.96	0.06		
Course factors	314	2.29	0.77	314	5.23	1.19	2	3.25
Disagree				62	162.48	0.16		
Partly agree				97	144.17	0.12		
Agree				155	163.85	0.09		
Design factors	314	2.44	0.70	314	5.23	1.19	2	48.72**
Disagree				40	92.56	0.18		
Partly agree				95	131.62	0.10		
Agree				179	185.75	0.08		
Technical factors	314	2.15	0.79	314	5.23	1.19	2	1.61
Disagree				79	161.01	0.13		
Partly agree				108	163.77	0.10		
Agree				127	149.98	0.10		
Focus group factors	314	2.37	0.77	314	5.23	1.19	2	147.78**
Disagree				58	52.71			
Partly agree				81	126.40			
Agree				175	206.63			

*p<0.05, ***p<0.01*, *M* =Mean, *MR* =Mean Rank, *SD* = Standard deviation, *df* = Degree of freedom

4.3.2 Effectiveness of model features Analysis

Effectiveness of model features were conducted using a pair *t*-test to define whether the score is significantly different from each other. Moreover, the effectiveness index (EI) was used to find improvements in learning potential in terms of percentages.

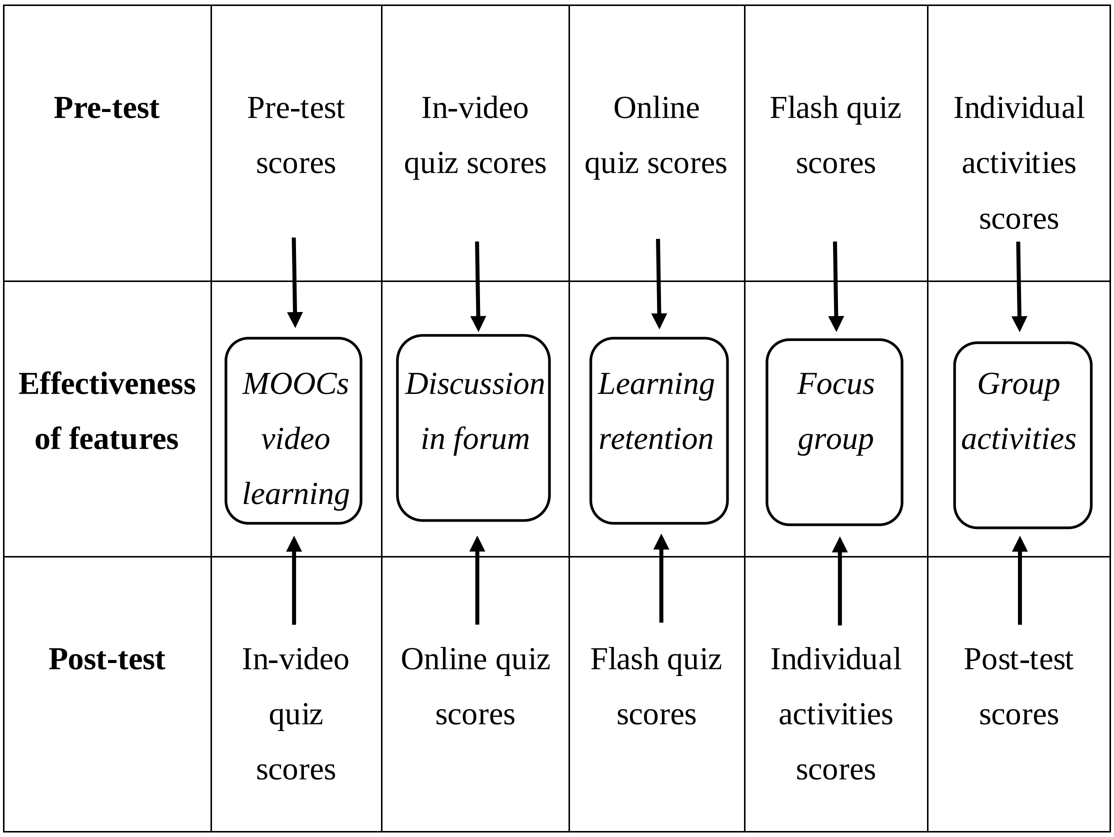


Figure 4.10 Model features charts

4.3.2.1 Difference between pre-test and in-video quiz score (MOOCs video learning)

The overall analysis on the difference between pre and post-test score is done by employing the Paired *t*-test, Cohen's *d* effect size, Skewness, and Kurtosis. From Figure 4.9, the difference between pre-test and in-video quiz scores distribution is approximately symmetrical skewed (Skewness= 0.1). Moreover, Kurtosis distribution (-0.06) is Platykurtic that the tails are shorter and thinner. Most of students have the approximately average scores. Additionally, Cohen provided interpretation of effect sizes, revealing that d = 1.5 represents a very large effect size. The difference between pre-test and in-video quiz scores is very large. As Table 4.3 shown, Testing H_8, the null hypothesis was rejected. There is a significant difference between pre-test and in-video quiz scores at a level of 0.01 (t-value = -21.51).

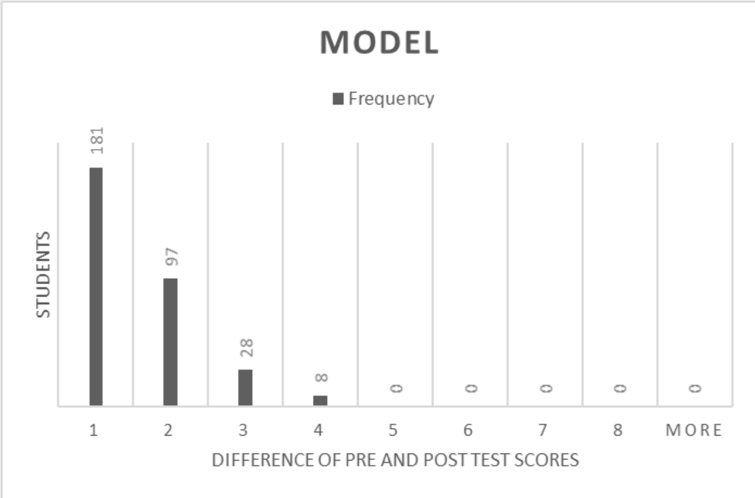


Figure 4.11 Difference of pre-test and in-video quiz scores in MOOC hybrid learning model histogram

From Figure 4.12, In urban area, the difference between pre-test and in-video quiz scores distribution is approximately symmetrical negative skewed (Skewness= -0.11). This means most students have positive improvement after learning from MOOCs hybrid learning model. Moreover, Kurtosis distribution (-0.06) is Platykurtic that the tails are shorter and thinner. Most of students have the approximately average scores. In addition, Cohen provided interpretation of effect sizes, revealing that d = 1.4 represents a very large effect size. The difference between pre-test and in-video quiz scores is very large. Hypothesis $H_{8.1}$, the null hypothesis was rejected. There is a significant difference between pre-test and in-video quiz scores in a group of urban students at a level of 0.01 (t-value = -14.06)

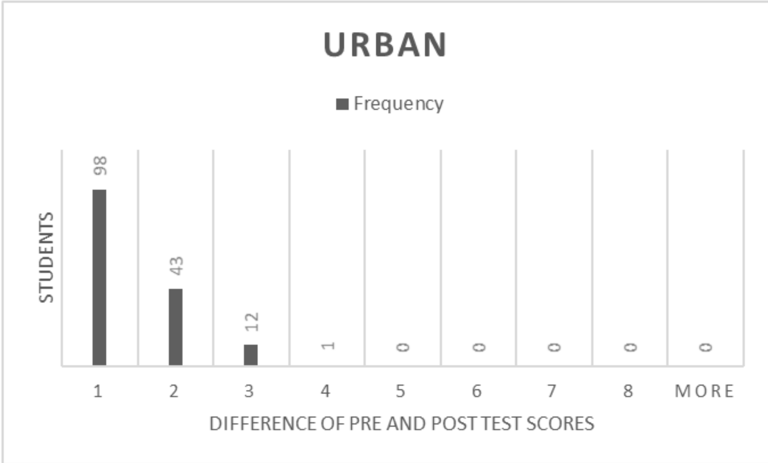


Figure 4.12 Difference of pre-test and in-video quiz scores in urban area histogram

From Figure 4.13, In rural area, the difference between pre-test and in-video quiz scores distribution is approximately symmetrical skewed (Skewness= 0.23). Moreover, Kurtosis distribution (-0.21) is Platykurtic that the tails are shorter and thinner. In addition, Cohen provided interpretation of effect sizes, revealing that d = 1.62 represents a very large effect size. The difference between pre-test and in-video quiz scores is very large. Hypothesis $H_{8.2}$, the null hypothesis was rejected. There is a significant difference between pre-test and in-video quiz scores in a group of rural students at a level of 0.01 (t-value = -16.48)

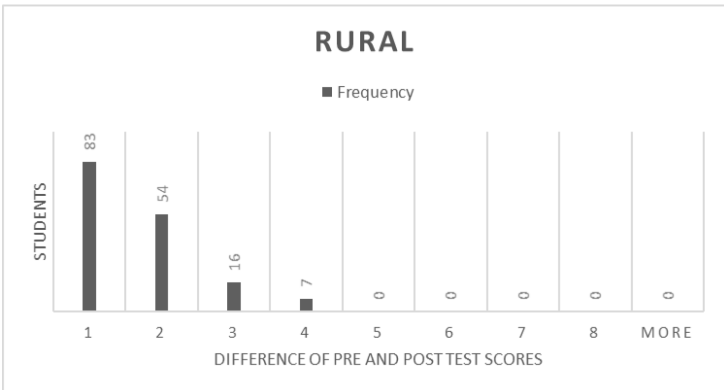


Figure 4.13 Difference of pre-test and in-video quiz scores in rural area histogram

Table 4.6 Results of difference between Pre-test and In-video quiz scores of all students

Group	Pre-test score			In-video quiz scores			Difference between means		
	N	M_1	SD_1	***N***	M_2	SD_2	M_2-M_1 [95% CI]	*t*-value	*d*
Control	102	2.02	0.78	102	2.96	0.78	0.93 [0.74, 1.12]	-9.72**	1.2
E-learning	112	2.27	0.85	112	3.42	0.80	1.15 [0.96, 1.33]	-13.80**	1.3
E-learning and Motivation	100	2.12	0.83	100	3.87	0.81	1.75[1.52, 1.97]	-15.22**	2.1

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

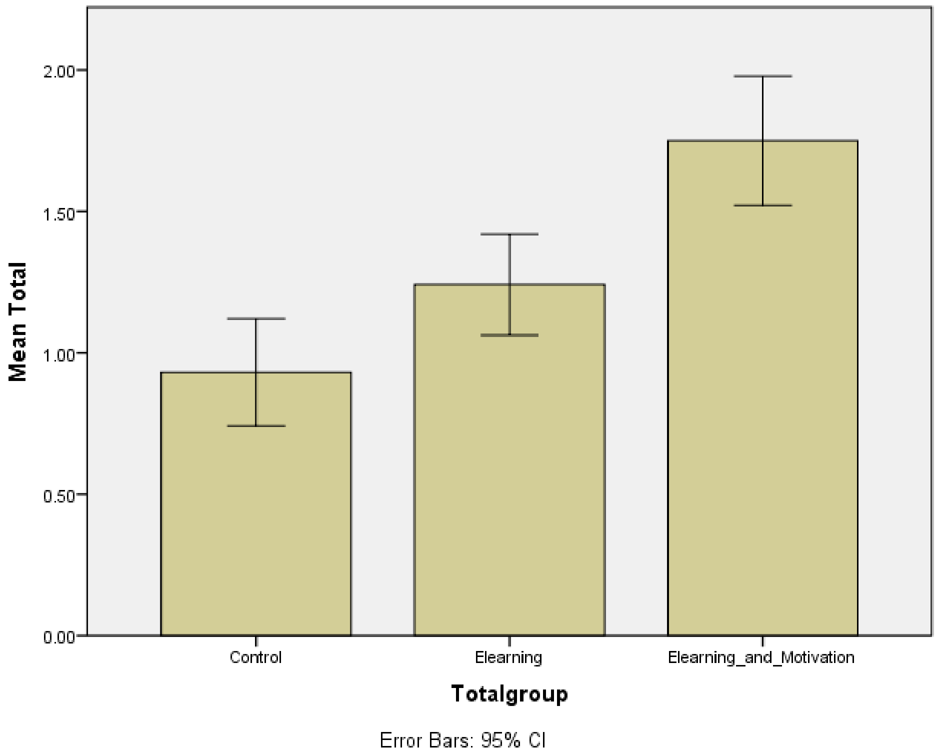


Figure 4.14 Results of difference between Pre-test and In-video quiz scores of all students

For all students control group, the mean score for In-video quiz scores (*M*=2.96, *SD*=0.78) was higher than the mean score for pre-test scores (*M*=2.02, *SD*=0.78). The observed difference between means was 0.93, 95% CI [0.74, 1.12], *t* (100) = -9.72, *p*<.001. Cohen's d effect size between the independent and dependent variable was *d*=1.2, and this represents a medium effect size. Due to e-learning group, the mean score for In-video quiz scores (*M*=3.42, *SD*=0.80) was higher than the mean score for pre-test scores (*M*=2.27, *SD*=0.85). The difference between means was 1.15, 95% CI [0.96, 1.33], *t* (110) = -13.80, *p*<.001. Cohen's d effect size represents a very large effect size (*d*=1.3). Refer to e-learning and motivation group, the mean score for In-video quiz scores (*M*=3.87, *SD*=0.81) was higher than the mean score for pre-test scores (*M*=2.12, *SD*=0.83). The difference between means was 1.75, 95% CI [1.52, 1.97], *t* (98) = -15.22, *p*<.001. Cohen's d effect size was 2.1. The difference between Pre-test and In-video quiz scores is very large.

Table 4.7 Results of difference between Pre-test and In-video quiz scores of urban students

Group	**Pre-test score**			**In-video quiz scores**			**Difference between means**		
	N	***M_1***	***SD_1***	***N***	***M_2***	***SD_2***	***M_2-M_1 [95% CI]***	***t*-value**	***d***
Control	52	2.25	0.75	52	3.04	0.82	0.79 [0.48, 1.10]	-5.71**	1.0
E-learning	54	2.25	0.91	54	3.17	0.82	1.16 [0.91, 1.42]	-8.62**	1.0
E-learning and Motivation	48	2.18	0.76	48	3.79	0.77	1.60[1.32, 1.88]	-11.55**	2.1

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

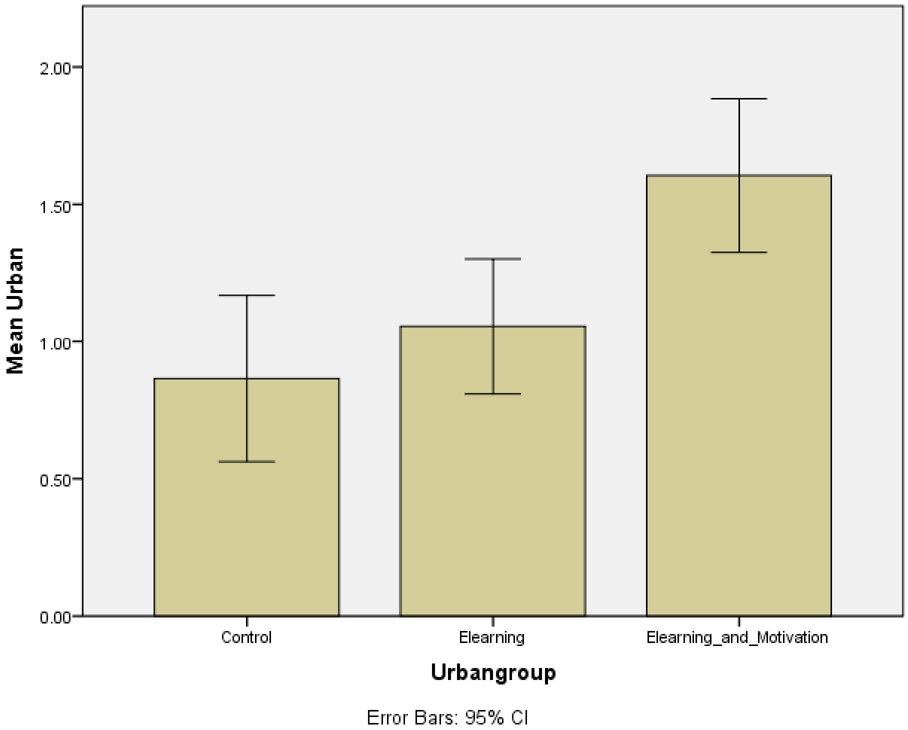


Figure 4.15 Results of difference between Pre-test and In-video quiz scores of urban students

For all students control group, the mean score for In-video quiz scores (*M*=3.04, *SD*=0.82) was higher than the mean score for pre-test scores (*M*=2.25, *SD*=0.75). The observed difference between means was 0.79, 95% CI [0.48, 1.10], *t* (50) = -5.71, *p*<.001. Cohen's d effect size between the independent and dependent variable was *d*=1, and this represents a medium effect size. Due to e-learning group, the mean score for In-video quiz scores (*M*=3.17, *SD*=0.82) was higher than the mean score for pre-test scores (*M*=2.25, *SD*=0.91). The difference between means was 1.16, 95% CI [0.91, 1.42], *t* (52) = -8.62, *p*<.001. Cohen's d effect size represents a medium effect size (*d*=1). Refer to e-learning and motivation group, the mean score for In-video quiz scores (*M*=3.79, *SD*=0.77) was higher than the mean score for pre-test scores (*M*=2.18, *SD*=0.76). The difference between means was 1.60, 95% CI [1.32, 1.88], *t* (46) = -11.55, *p*<.001. Cohen's d effect size was 2.1. The difference between Pre-test and In-video quiz scores is very large.

Table 4.8 Results of difference between Pre-test and In-video quiz scores of rural students

Group	Pre-test score			In-video quiz scores			Difference between means		
	N	***M_1***	***SD_1***	***N***	***M_2***	***SD_2***	***M_2-M_1 [95% CI]***	***t*-value**	***d***
Control	50	1.78	0.76	50	2.78	0.76	1.00 [0.76, 1.23]	-8.48**	1.3
E-learning	58	2.28	0.80	58	3.58	0.81	1.30 [1.02, 1.57]	-11.05**	1.6
E-learning and Motivation	52	2.08	0.89	52	3.94	0.84	1.86[1.49, 2.22]	-10.50**	2.1

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

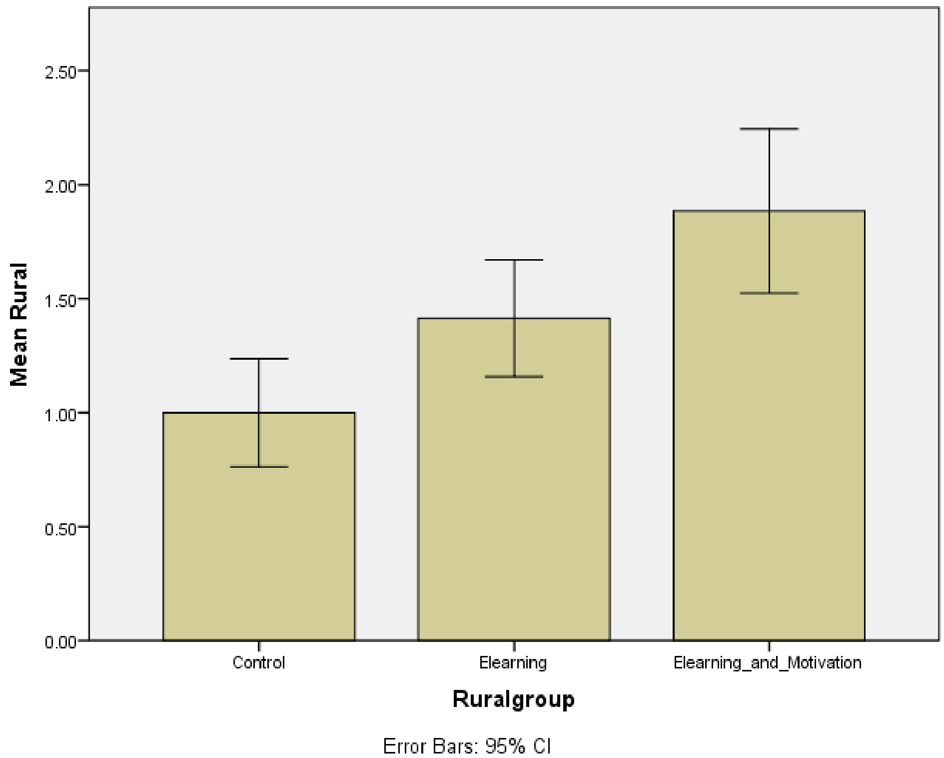


Figure 4.16 Results of difference between Pre-test and In-video quiz scores of rural students

For all students control group, the mean score for In-video quiz scores (*M*=2.78, *SD*=0.76) was higher than the mean score for pre-test scores (*M*=1.78, *SD*=0.76). The observed difference between means was 1.00, 95% CI [0.76, 1.23], *t* (48) = -8.48, *p*<.001. Cohen's d effect size between the independent and dependent variable was *d*=1.3, and this represents a very large effect size. Due to e-learning group, the mean score for In-video quiz scores (*M*=3.58, *SD*=0.81) was higher than the mean score for pre-test scores (*M*=2.08, *SD*=0.89). The difference between means was 1.30, 95% CI [1.02, 1.57], *t* (56) = -11.05, *p*<.001. Cohen's d effect size represents a very large effect size (*d*=1.6). Refer to e-learning and motivation group, the mean score for In-video quiz scores (*M*=3.94, *SD*=0.84) was higher than the mean score for pre-test scores (*M*=2.08, *SD*=0.89). The difference between means was 1.86, 95% CI [1.49, 2.22], *t* (50) = -10.50, *p*<.001. Cohen's d effect size was 2.1. The difference between Pre-test and In-video quiz scores is very large.

The model can apply to both rural and urban area. The mean scores improve from 2.13 (Pre-test mean) to 7.36 (Post-test mean). The mean increases about 245%. The improvement of rural mean score (263%) is greater than urban mean score (231%). In urban area, e-learning and motivation group shows the best performance for all GPA levels. Similarly, in the rural area, e-learning group and e-learning and motivation group provide much improvement than control group for medium and high GPA students. However, low GPA students, the three group (e-learning and motivation, e-learning, and control group) provide the same learning improvement. MOOCs hybrid learning model shows the same improvement as traditional teaching (control group) for the rural low GPA students. This mean e-learning model can apply and help teacher to teach various subjects in the same standard as traditional teaching.

4.2.2.2 Difference between in-video quiz and online quiz score (Discussion in forum)

The overall analysis on the difference between in-video quiz and online quiz score is done by employing the Paired *t*-test, Cohen's *d* effect size, Skewness, and Kurtosis. Refer to Figure 4.45, the difference between in-video quiz and online quiz score distribution is perfectly symmetric (Skewness= 0.01). Moreover, Kurtosis distribution (0.1) is Leptokurtic that the tails are longer and fatter. Additionally, Cohen provided interpretation of effect sizes, revealing that *d* = 2 represents a very large effect size. The difference between in-video quiz and online quiz score is very large. Testing H_9, the null hypothesis was rejected. There is a significant difference between pre-test and in-video quiz scores at a level of 0.01 (t-value = -30.38).

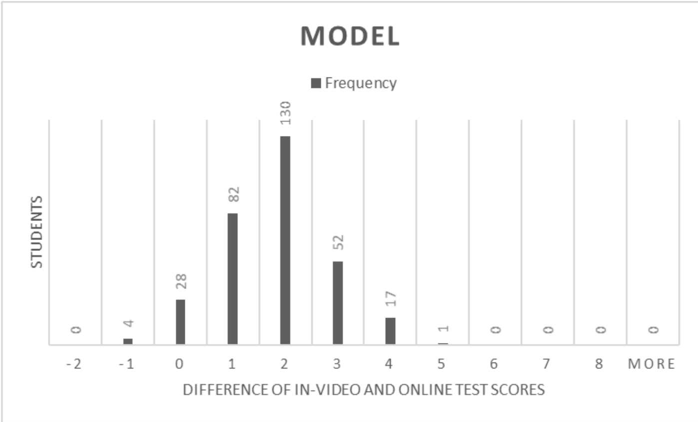


Figure 4.17 Difference of in-video quiz and online quiz score in MOOC hybrid learning model histogram

From Figure 4.18, In urban area, the difference between in-video quiz and online quiz score distribution is perfectly symmetric (Skewness= -0.004). Moreover, Kurtosis distribution (0.19) is Leptokurtic that the tails are longer and fatter. In addition, Cohen provided interpretation of effect sizes, revealing that d = 2.1 represents a very large effect size. The difference between in-video quiz and online quiz score is very large. Hypothesis $H_{9.1}$, the null hypothesis was rejected. There is a significant difference between in-video quiz and online quiz score in a group of urban students at a level of 0.01 (t-value = -20.19).

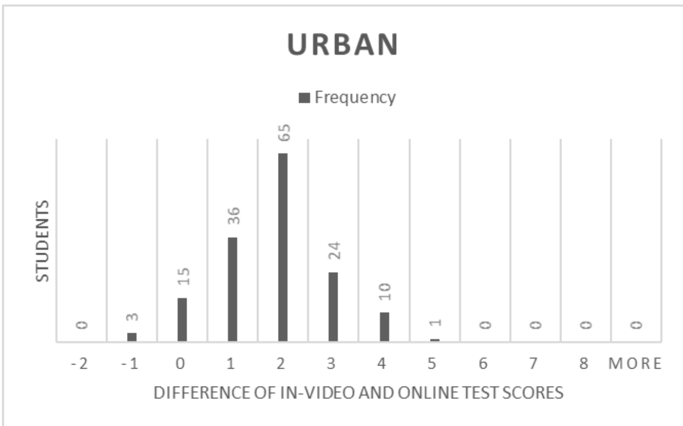


Figure 4.18 Difference of in-video quiz and online quiz score in urban area histogram

From Figure 4.19, In rural area, the difference between in-video quiz and online quiz score distribution is perfectly symmetric (Skewness= 0.03). Moreover, Kurtosis distribution (-0.08) is perfectly symmetric. Additionally. Cohen provided interpretation of effect sizes, revealing that *d* = 1.91 represents a very large effect size. The difference between in-video quiz and online quiz score is very large. Hypothesis $H_{9.2}$, the null hypothesis was rejected. There is a significant difference between in-video quiz and online quiz score in a group of rural students at a level of 0.01 (t-value = -22.89).

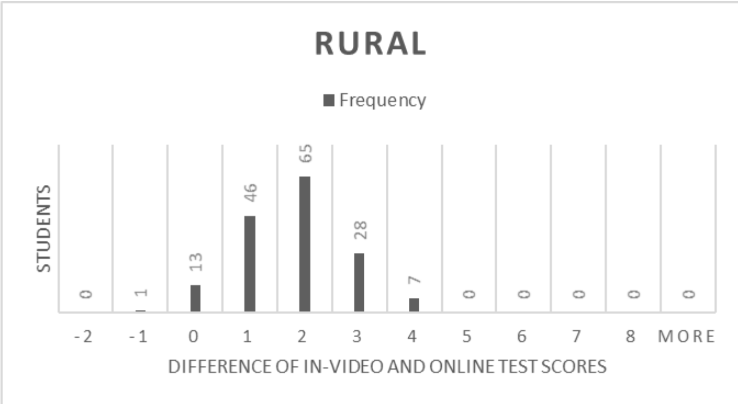


Figure 4.19 Difference of in-video quiz and online quiz score in rural area histogram

Table 4.9 Results of difference between In-video quiz and Online quiz scores of all students

Group	**In-video quiz score**			**Online quiz scores**			**Difference between means**		
	N	***M_1***	***SD_1***	***N***	***M_2***	***SD_2***	***M_2-M_1 [95% CI]***	***t*-value**	***d***
Control	102	2.95	0.83	102	4.76	0.85	1.81 [1.62, 1.99]	-19.68**	2.1
E-learning	112	3.42	0.80	112	5.07	0.83	1.82 [1.58, 2.05]	-16.65**	2.0
E-learning and Motivation	100	3.87	0.81	100	5.69	0.83	1.82[1.60, 2.03]	-16.75**	2.2

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

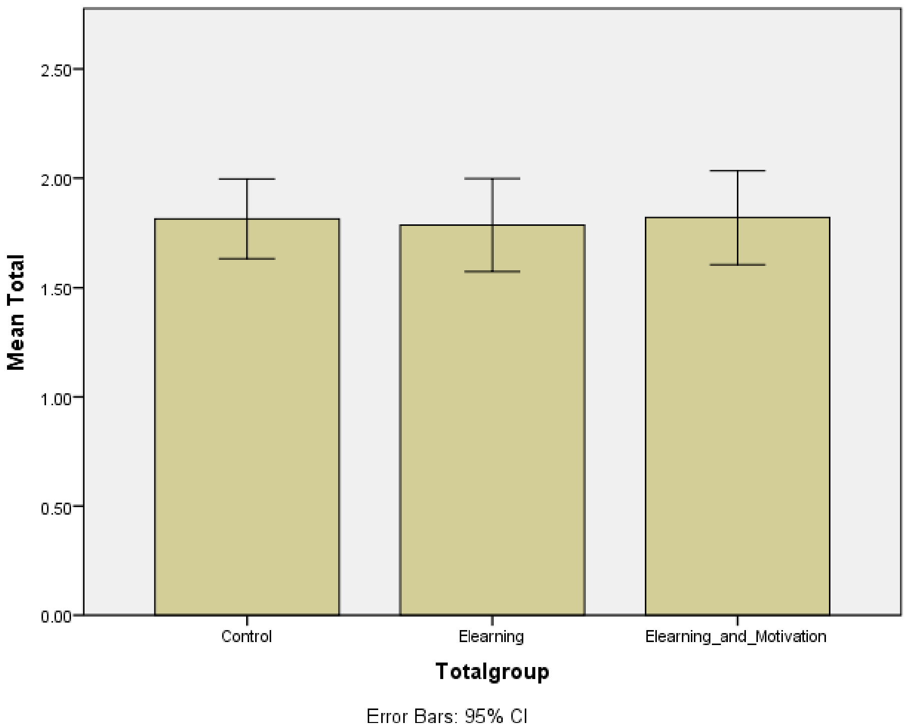


Figure 4.20 Results of difference between In-video quiz and Online quiz scores of all students

For all students control group, the mean score for Online quiz scores (*M*=4.76, *SD*=0.85) was higher than the mean score for In-video quiz (*M*=2.95, *SD*=0.83). The observed difference between means was 1.81, 95% CI [1.62, 1.99], *t* (100) = -19.68, *p*<.001. Cohen's d effect size between the independent and dependent variable was *d*=2.1, and this represents a very large effect size. Due to e-learning group, the mean score for Online quiz scores (*M*=5.07, *SD*=0.83) was higher than the mean score for In-video quiz (*M*=3.42, *SD*=0.80). The difference between means was 1.82, 95% CI [1.58, 2.05], *t* (110) = -16.65, *p*<.001. Cohen's d effect size represents a very large effect size (*d*=2.0). Refer to e-learning and motivation group, the mean score for Online quiz scores (*M*=5.69, *SD*=0.83) was higher than the mean score for In-video quiz (*M*=3.87, *SD*=0.81). The difference between means was 1.82, 95% CI [1.60, 2.03], *t* (98) = -16.75, *p*<.001. Cohen's d effect size was 2.2. The difference between In-video quiz and Online quiz scores is very large.

Table 4.10 Results of difference between In-video quiz and Online quiz scores of urban students

Group	In-video quiz score			Online quiz scores			Difference between means		
	N	M_1	SD_1	*N*	M_2	SD_2	M_2-M_1 [95% CI]	*t*-value	*d*
Control	52	3.04	0.82	52	5.02	0.78	1.97[1.69, 2.26]	-13.79**	2.4
E-learning	54	3.41	0.82	54	5.16	0.88	1.75[1.36, 2.13]	-10.27**	2.0
E-learning and Motivation	48	3.79	0.77	48	5.58	0.84	1.79 [1.47, 2.10]	-11.38**	2.2

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

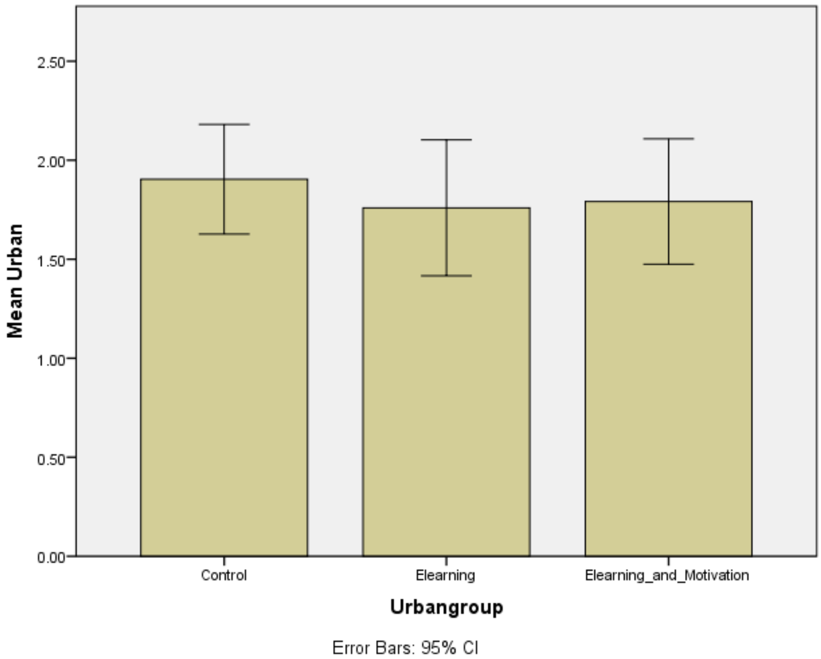


Figure 4.21 Results of difference between In-video quiz and Online quiz scores of urban students

For all students control group, the mean score for Online quiz scores (*M*=5.02, *SD*=0.78) was higher than the mean score for In-video quiz scores (*M*=3.04, *SD*=0.82). The observed difference between means was 1.97, 95% CI [1.69, 2.26], *t* (50) = -13.79, *p*<.001. Cohen's d effect size between the independent and dependent variable was *d*=2.4, and this represents a very large effect size. Due to e-learning group, the mean score for Online quiz scores (*M*=5.16, *SD*=0.88) was higher than the mean score for In-video quiz scores (*M*=3.41, *SD*=0.82). The difference between means was 1.75, 95% CI [1.36, 2.13], *t* (52) = -10.27,

p<.001. Cohen's d effect size represents a very large effect size (d=2.0). Refer to e-learning and motivation group, the mean score for Online quiz scores (M=5.58, SD=0.84) was higher than the mean score for In-video quiz scores (M=3.79, SD=0.77). The difference between means was 1.79, 95% CI [1.47, 2.10], t (46) = -11.38, p<.001. Cohen's d effect size was 2.2. The difference between In-video quiz and Online quiz scores is very large.

Table 4.11 Results of difference between In-video quiz and Online quiz scores of rural students

Group	In-video quiz score			Online quiz scores			Difference between means		
	N	M_1	SD_1	N	M_2	SD_2	M_2-M_1 [95% CI]	t-value	d
Control	50	2.78	0.76	50	4.50	0.83	1.72 [1.47, 1.96]	-14.17**	2.1
E-learning	58	3.58	0.81	58	5.42	0.73	1.84 [1.53, 2.14]	-13.56**	2.3
E-learning and Motivation	52	3.94	0.84	52	5.78	0.81	1.84[1.52, 2.15]	-12.19**	2.2

*$p<0.05$, **$p<0.01$, M =Mean, SD = standard deviation, CI = Confidence interval; d = Cohen's d effect size

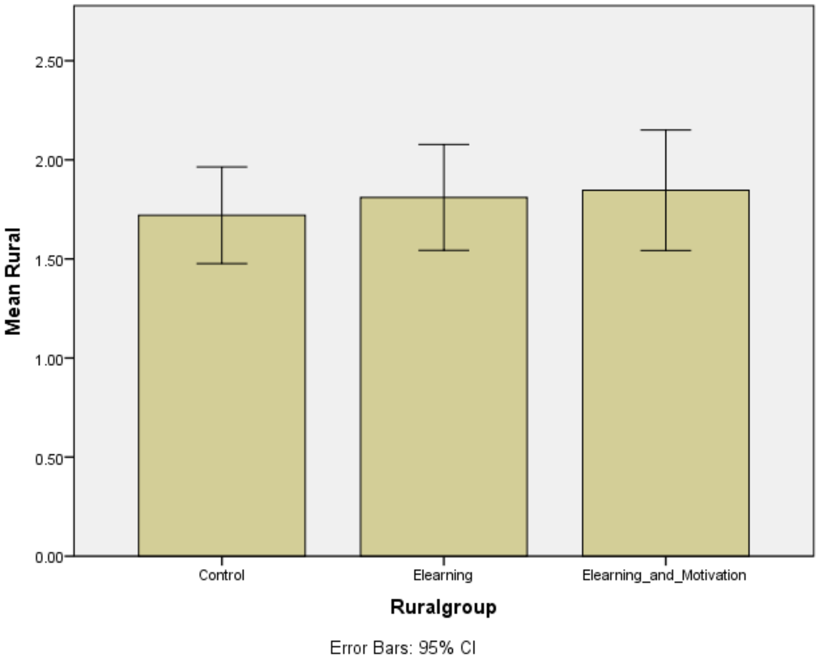


Figure 4.22 Results of difference between In-video quiz and Online quiz scores of rural students

For all students control group, the mean score for Online quiz scores (*M*=4.50, *SD*=0.83) was higher than the mean score for In-video quiz scores (*M*=2.78, *SD*=0.76). The observed difference between means was 1.72, 95% CI [1.47, 1.98], *t* (48) = -14.17, *p*<.001. Cohen's d effect size between the independent and dependent variable was *d*=2.1, and this represents a very large effect size. Due to e-learning group, the mean score for Online quiz scores (*M*=5.42, *SD*=0.73) was higher than the mean score for In-video quiz scores (*M*=3.94, *SD*=0.84). The difference between means was 1.84, 95% CI [1.53, 2.14], *t* (56) = -13.56, *p*<.001. Cohen's d effect size represents a very large effect size (*d*=2.3). Refer to e-learning and motivation group, the mean score for Online quiz scores (*M*=5.78, *SD*=0.81) was higher than the mean score for In-video quiz scores (*M*=3.94, *SD*=0.84). The difference between means was 1.84, 95% CI [1.52, 2.15], *t* (50) = -12.19, *p*<.001. Cohen's d effect size was 2.2. The difference between In-video quiz and Online quiz scores is very large.

Discussion in forum is the effective tool which can apply to both rural and urban area. The mean scores improve from 3.43 (in-video quiz mean) to 5.23 (online quiz mean). The mean increases about 52%. The improvement of urban mean score (54%) is greater than rural mean score (49%). In urban area, control and e-learning group shows the equal improvement for low and medium GPA levels. For example, low GPA, mean of control and e-learning group improve 30% but e-learning and motivation group improves only 28%. Discussion in forum can apply and help students to gain more knowledge for both traditional teaching and e-learning method. Moreover, in the rural area, e-learning and motivation group shows much improving for low and high GPA levels. For instance, low GPA, mean of e-learning and motivation group improves 33% but control group improves only 20%

4.3.2.3 Difference between online quiz and flash quiz score (Learning retention)

The overall analysis on the difference between online quiz and flash quiz score is done by employing the Paired *t*-test, Cohen's *d* effect size, Skewness, and Kurtosis. Refer to Figure 4.67, the difference between online quiz and flash quiz score distribution is perfectly symmetric (Skewness= 0.07). Moreover, Kurtosis distribution (-0.42) is Platykurtic that the tails are shorter and thinner. Most of students have the approximately average scores. Additionally, Cohen provided interpretation of effect sizes, revealing that *d* = 3.48 represents a very large effect size. The difference between online quiz and flash quiz score is very large. Testing H_{10}, the null hypothesis was rejected. There is a significant difference between online quiz and flash quiz scores at a level of 0.01 (t-value = -22.31).

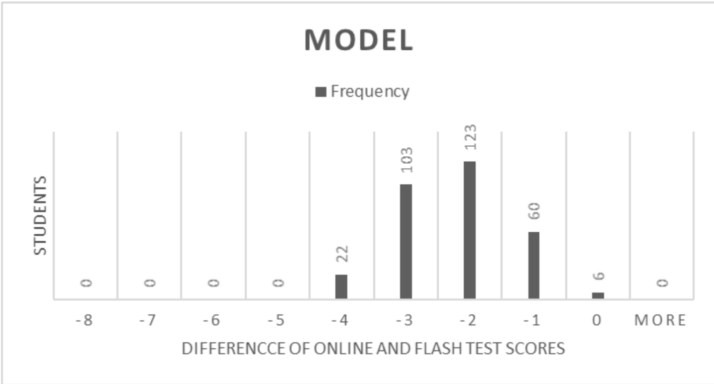


Figure 4.23 Difference of online quiz and flash quiz score in MOOC hybrid learning model histogram

From Figure 4.24, In urban area, the difference between online quiz and flash quiz scores distribution is moderately negative skewed (Skewness= -0.62). Moreover, Kurtosis distribution (-0.25) is Platykurtic that the tails are shorter and thinner. In addition, Cohen provided interpretation of effect sizes, revealing that *d* = 1.13 represents a large effect size. The difference between online quiz and flash quiz scores is large. Hypothesis $H_{10.1}$, the null hypothesis was rejected. There is a significant difference between online quiz and flash quiz scores in a group of urban students at a level of 0.01(t-value = -13.32)

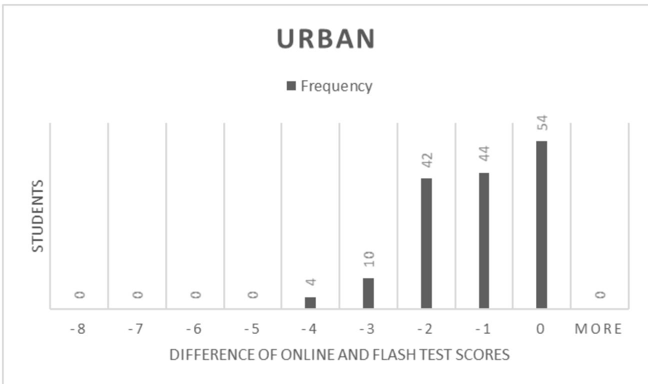


Figure 4.24 Difference of online quiz and flash quiz scores in urban area histogram

From Figure 4.25, In rural area, the difference between online quiz and flash quiz scores distribution is perfectly symmetric (Skewness= -0.08). Moreover, Kurtosis distribution (-0.55) is Platykurtic that the tails are shorter and thinner. Additionally. Cohen provided interpretation of effect sizes, revealing that *d* = 1.42 represents a very large effect size. The difference between online quiz and flash quiz scores is very large. Hypothesis $H_{10.2}$, the null hypothesis was rejected. There is a significant difference between online quiz and flash quiz scores in a group of rural students at a level of 0.01 (*t*-value = -18.72).

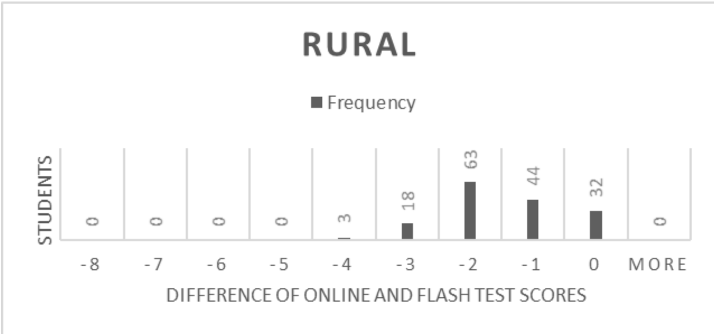


Figure 4.25 Difference of online quiz and flash quiz scores in rural area histogram

Table 4.12 Results of difference between Online quiz scores and Flash quiz scores of all students

Group	Online quiz scores			Flash quiz scores			Difference between means		
	N	M_1	SD_1	***N***	M_2	SD_2	M_2-M_1 *[95% CI]*	***t*-value**	***d***
Control	102	4.76	0.85	102	3.02	0.82	-1.74 [-1.93, -1.54]	17.91**	2.0
E-learning	112	5.07	0.83	112	4.05	0.89	-1.19 [-1.37, -1.00]	14.06**	1.1
E-learning and Motivation	100	5.69	0.83	100	4.83	0.84	-0.86[-1.05, -0.66]	8.90**	1.0

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

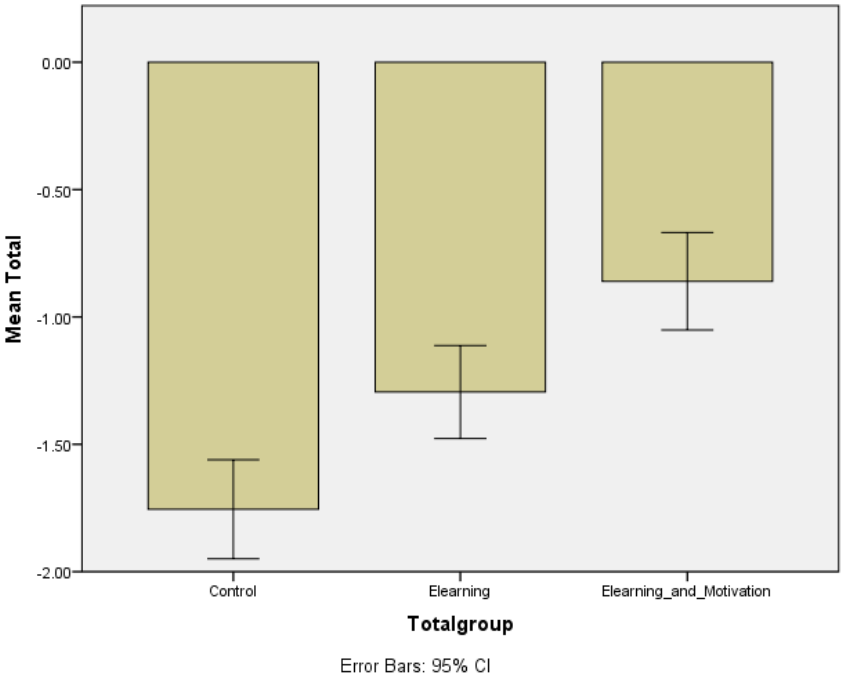


Figure 4.26 Results of difference between Online quiz scores and Flash quiz scores of all students

For all students control group, the mean score for Flash quiz scores (*M*=3.02, *SD*=0.82) was lower than the mean score for Online quiz scores (*M*=4.76, *SD*=0.85). The observed difference between means was -1.74, 95% CI [-1.93, -1.54], t (100) =17.91, p<.001. Cohen's d effect size between the independent and dependent variable was d=2.0, and this represents a very large effect size. Due to e-learning group, the mean score for Flash quiz scores (*M*=4.05, *SD*=0.89) was lower than the mean score for Online quiz scores (*M*=5.07, *SD*=0.83). The difference between means was -1.19, 95% CI [-1.37, -1.00], t (110) = 14.06, p<.001. Cohen's d effect size represents a medium effect size (d=1.1). Refer to e-learning and motivation group, the mean score for Flash quiz scores (*M*=4.83, *SD*=0.84) was lower than the mean score for Online quiz scores (*M*=5.69, *SD*=0.83). The difference between means was -0.86, 95% CI [-1.05, -0.66], t (98) = -0.86, p<.001. Cohen's d effect size was 1.0. The difference between Online quiz scores and Flash quiz scores is medium.

Table 4.13 Results of difference between Online quiz scores and Flash quiz scores of urban students

Group	Online quiz scores			Flash quiz scores			Difference between means		
	N	M_1	SD_1	*N*	M_2	SD_2	M_2-M_1 [95% CI]	*t*-value	*d*
Control	52	5.02	0.78	52	3.29	0.78	-1.72 [-2.02, -1.43]	12.29**	2.2
E-learning	54	5.16	0.88	54	4.18	0.86	-0.97 [-1.25, -0.70]	7.72**	1.1
E-learning and Motivation	48	5.58	0.84	48	4.97	0.83	-0.60 [-0.84, -0.35]	4.96**	0.7

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

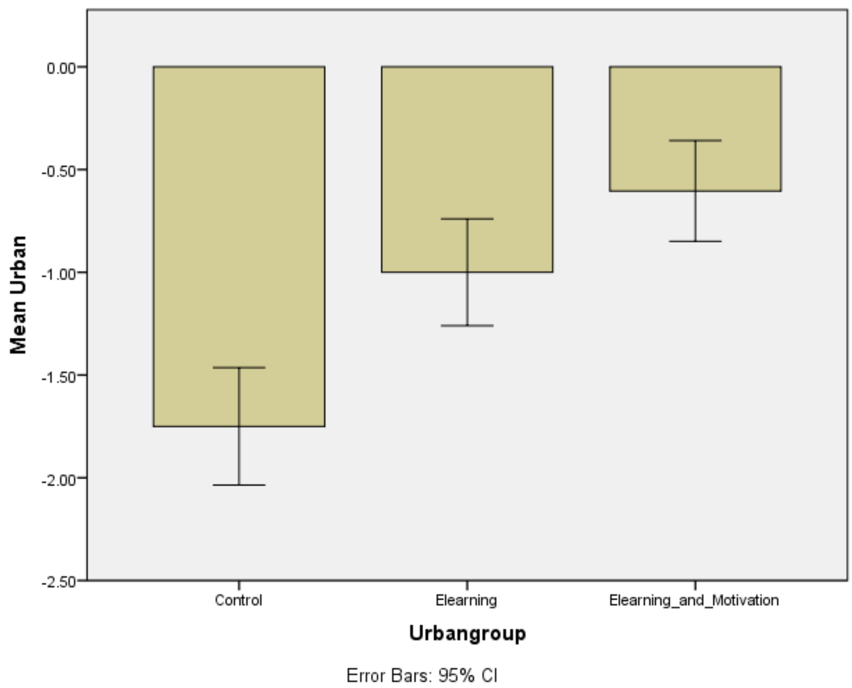


Figure 4.27 Results of difference between Online quiz scores and Flash quiz scores of urban students

For all students control group, the mean score for Flash quiz scores (*M*=3.29, *SD*=0.78) was lower than the mean score for Online quiz scores (*M*=5.02, *SD*=0.78). The observed difference between means was -1.72, 95% CI [-2.02, -1.43], *t* (50) =12.29, *p*<.001. Cohen's d effect size between the independent and dependent variable was *d*=2.2, and this represents a very large effect size. Due to e-learning group, the mean score for Flash quiz scores (*M*=4.18, *SD*=0.86) was lower than the mean score for Online quiz scores (*M*=5.16, *SD*=0.88). The difference between means was -0.97, 95% CI [-1.25, -0.70], *t* (52) = 7.72, *p*<.001. Cohen's d effect size represents a medium effect size (*d*=1.1). Refer to e-learning and motivation group, the mean score for Flash quiz scores (*M*=4.97, *SD*=0.83) was lower than the mean score for Online quiz scores (*M*=5.58, *SD*=0.84). The difference between means was -0.60, 95% CI [-0.84, -0.35], *t* (46) = 4.96, *p*<.001. Cohen's d effect size was 0.7. The difference between Online quiz scores and Flash quiz scores is medium.

Table 4.14 Results of difference between Online quiz scores and Flash quiz scores of rural students

Group	**Online quiz scores**			**Flash quiz scores**			**Difference between means**		
	N	M_1	SD_1	***N***	M_2	SD_2	M_2-M_1 *[95% CI]*	***t*-value**	***d***
Control	50	4.50	0.83	50	2.74	0.63	-1.76 [-2.03, -1.48]	12.96**	2.3
E-learning	58	5.42	0.73	58	3.92	0.89	-1.50 [-1.77, -1.22]	12.99**	1.8
E-learning and Motivation	52	5.78	0.81	52	4.72	0.80	-1.06 [-1.32, -0.79]	7.78**	1.3

*p<0.05, ***p<0.01, M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

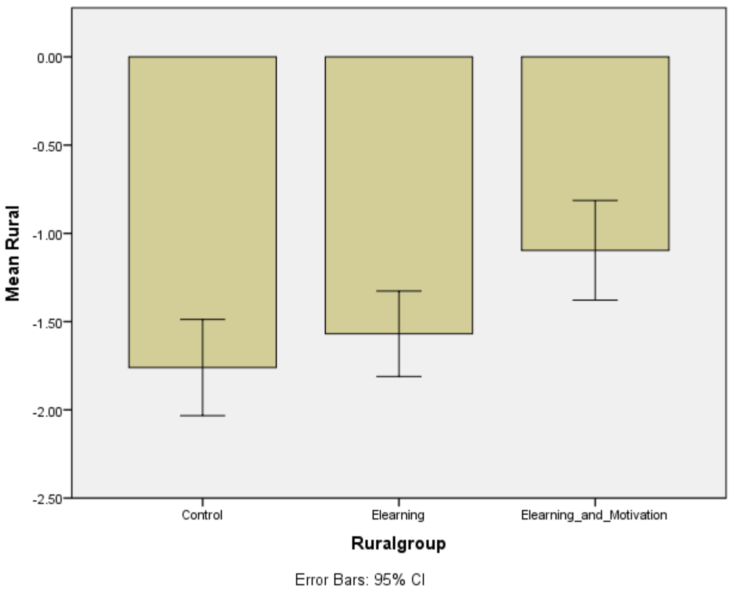


Figure 4.28 Results of difference between Online quiz scores and Flash quiz scores of rural students

For all students control group, the mean score for Flash quiz scores (*M*=2.74, *SD*=0.63) was lower than the mean score for Online quiz scores (*M*=4.50, *SD*=0.83). The observed difference between means was -1.76, 95% CI [-2.03, -1.48], *t* (48) =12.96, *p*<.001. Cohen's d effect size between the independent and dependent variable was *d*=2.3, and this represents a very large effect size. Due to e-learning group, the mean score for Flash quiz scores (*M*=3.92, *SD*=0.89) was lower than the mean score for Online quiz scores (*M*=5.42, *SD*=0.73). The difference between means was -1.50, 95% CI [-1.77, -1.22], *t* (56) = 12.99, *p*<.001. Cohen's d effect size represents a medium effect size (*d*=1.8). Refer to e-learning and motivation group, the mean score for Flash quiz scores (*M*=4.72, *SD*=0.80) was lower than the mean score for Online quiz scores (*M*=5.78, *SD*=0.81). The difference between means was -1.06, 95% CI [-1.32, -0.79], *t* (50) = 7.78, *p*<.001. Cohen's d effect size was 1.3. The difference between Online quiz scores and Flash quiz scores is medium.

After one week, students forgot some contents. They forgot about 24% of the total contents. The mean scores reduce from 5.23 (online quiz mean) to 3.93 (flash quiz mean). The decrease of rural mean score (28%) is greater than urban mean score (21%). In urban area, e-learning and motivation group can retain students' knowledge better than other methods for all GPA levels. For instance, low GPA, mean of control e-learning and motivation group reduce only 11%. On the other hand, control group reduce 38%. Furthermore, in the rural area, e-learning and motivation group shows less reducing in mean for medium and high GPA levels. However, low GPA, control group can retain students' knowledge better than other groups. Traditional teaching which is face to face instruction plays the important role in learning retention for rural low GPA students.

4.3.2.4 Difference between flash quiz and individual activities scores (Focus group)

The overall analysis on the difference between flash quiz and individual activities score is done by employing the Paired *t*-test, Cohen's *d* effect size, Skewness, and Kurtosis. Refer to Figure 4.87, the difference between flash quiz and individual activities score distribution is perfectly symmetric (Skewness= 0.07). Moreover, Kurtosis distribution (-0.40) is Platykurtic that the tails are shorter and thinner. Additionally, Cohen provided interpretation of effect sizes, revealing that *d* = 1.4 represents a very large effect size. The difference between flash quiz and individual activities score is very large. Testing H11, the null hypothesis was rejected. There is a significant difference between flash quiz and individual activities scores at a level of 0.01 (t-value = -26.35).

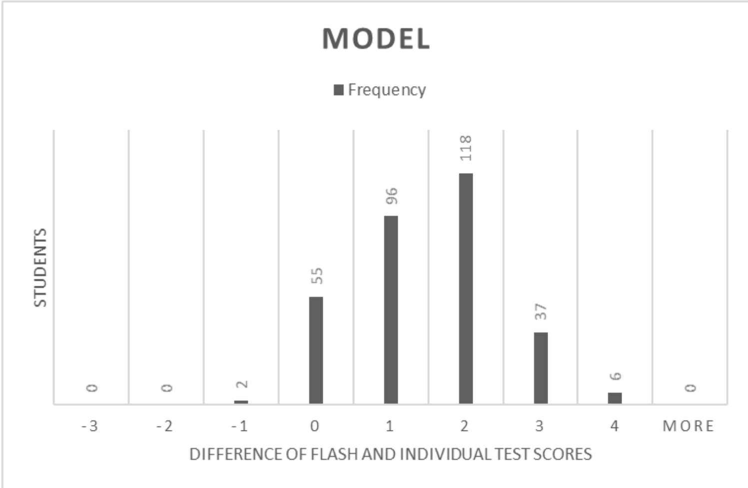


Figure 4.29 Difference of flash quiz and individual activities score in MOOC hybrid learning model histogram

From Figure 4.30, in urban area, the difference between flash quiz and individual activities score distribution is approximately symmetric positive skewed (Skewness= 0.10). Moreover, Kurtosis distribution (-0.51) is Platykurtic that the tails are shorter and thinner. In addition, Cohen provided interpretation of effect sizes, revealing that d = 1.26 represents a very large effect size. The difference between flash quiz and individual activities score is very large. Hypothesis $H_{11.1}$, the null hypothesis was rejected. There is a significant difference between flash quiz and individual activities score in a group of urban students at a level of 0.01 (t-value = -16.06).

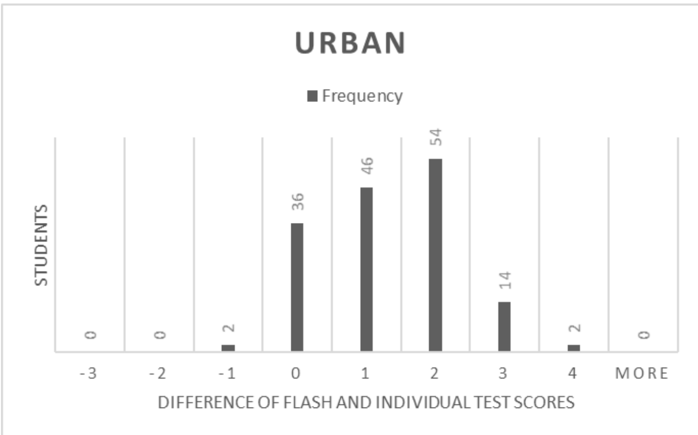


Figure 4.30 Difference of flash quiz and individual activities score in urban area histogram

From Figure 4.31, In rural area, the difference between flash quiz and individual activities score distribution is approximately symmetric positive skewed (Skewness= 0.10).

Moreover, Kurtosis distribution (-0.30) is Platykurtic that the tails are shorter and thinner. Additionally. Cohen provided interpretation of effect sizes, revealing that *d* = 1.53 represents a very large effect size. The difference between flash quiz and individual activities score is very large. Hypothesis $H_{11.2}$, the null hypothesis was rejected. There is a significant difference between flash quiz and individual activities score in a group of rural students at a level of 0.01 (t-value = -21.79).

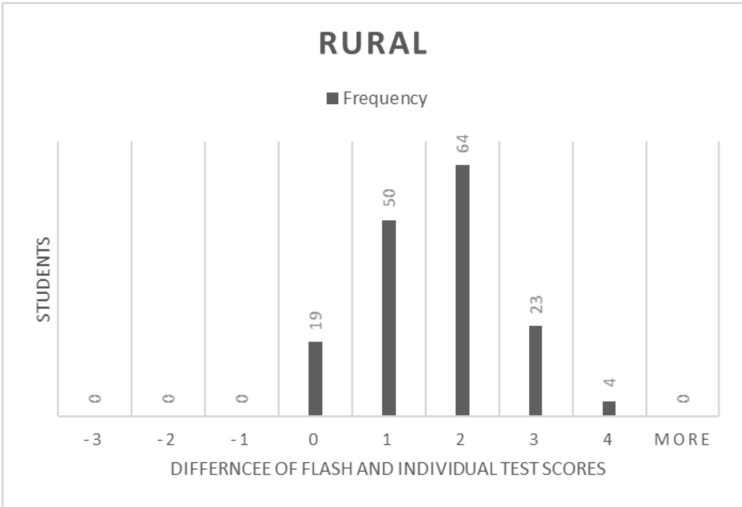


Figure 4.31 Difference of flash quiz and individual activities score in rural area histogram

Table 4.15 Results of difference between Flash quiz and Individual quiz scores of all students

Group	Flash quiz scores			Individual quiz scores			Difference between means		
	N	***M_1***	***SD_1***	***N***	***M_2***	***SD_2***	***M_2-M_1 [95% CI]***	***t*-value**	***d***
Control	102	3.02	0.82	102	4.70	0.83	1.68 [1.50, 1.85]	-19.38**	2.0
E-learning	112	4.05	0.89	112	5.75	0.84	1.70 [1.21, 1.64]	-14.67**	1.6
E-learning and Motivation	100	4.83	0.84	100	6.56	0.82	1.73 [1.01, 1.38]	-13.18**	1.4

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

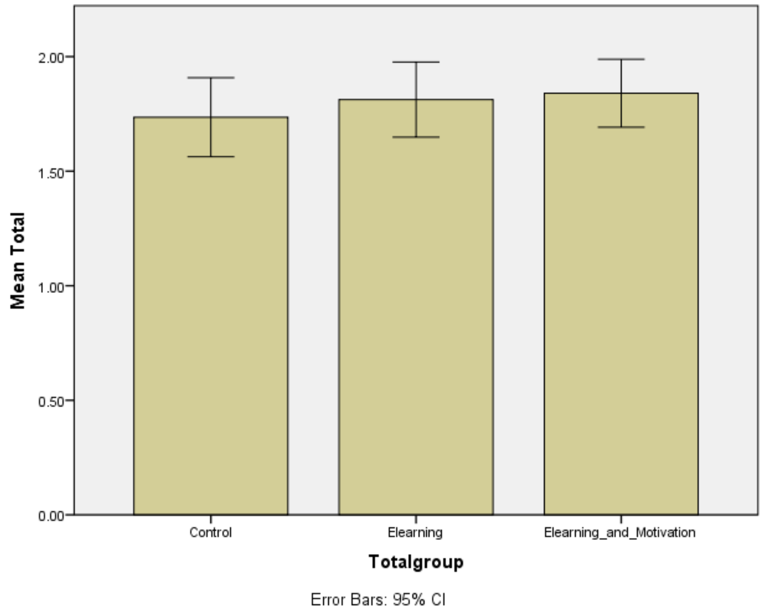


Figure 4.32 Results of difference between Flash quiz and Individual quiz scores of all students

For all students control group, the mean score for Individual quiz scores (*M*=4.70, *SD*=0.83) was higher than the mean score for Flash quiz scores (*M*=3.02, *SD*=0.82). The observed difference between means was 1.68, 95% CI [1.50, 1.85], t (100) = -19.38, p<.001. Cohen's d effect size between the independent and dependent variable was d=2.0, and this represents a very large effect size. Due to e-learning group, the mean score for Individual quiz scores (*M*=5.75, *SD*=0.84) was higher than the mean score for Flash quiz scores (*M*=4.05, *SD*=0.89). The difference between means was 1.70, 95% CI [1.21, 1.64], t (110) = -14.67, p<.001. Cohen's d effect size represents a very large effect size (d=1.6). Refer to e-learning and motivation group, the mean score for Individual quiz scores (*M*=6.56, *SD*=0.82) was higher than the mean score for Flash quiz scores (*M*=4.83, *SD*=0.84). The difference between means was 1.73, 95% CI [1.01, 1.38], t (98) = -13.18, p<.001. Cohen's d effect size was 1.4. The difference between Flash quiz and Individual quiz scores is very large.

Table 4.16 Results of difference between Flash quiz and Individual quiz scores of urban students

Group	**Flash quiz scores**			**Individual quiz scores**			**Difference between means**		
	N	***M_1***	***SD_1***	***N***	***M_2***	***SD_2***	***M_2-M_1 [95% CI]***	***t*-value**	***d***
Control	52	3.29	0.78	52	4.85	0.87	1.56 [1.30, 1.81]	-12.91**	1.8
E-learning	54	4.18	0.86	54	5.6	0.87	1.42 [0.91, 1.54]	-12.88**	1.8
E-learning and Motivation	48	4.97	0.83	48	6.59	0.86	1.62 [0.69, 1.22]	-13.20**	1.9

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

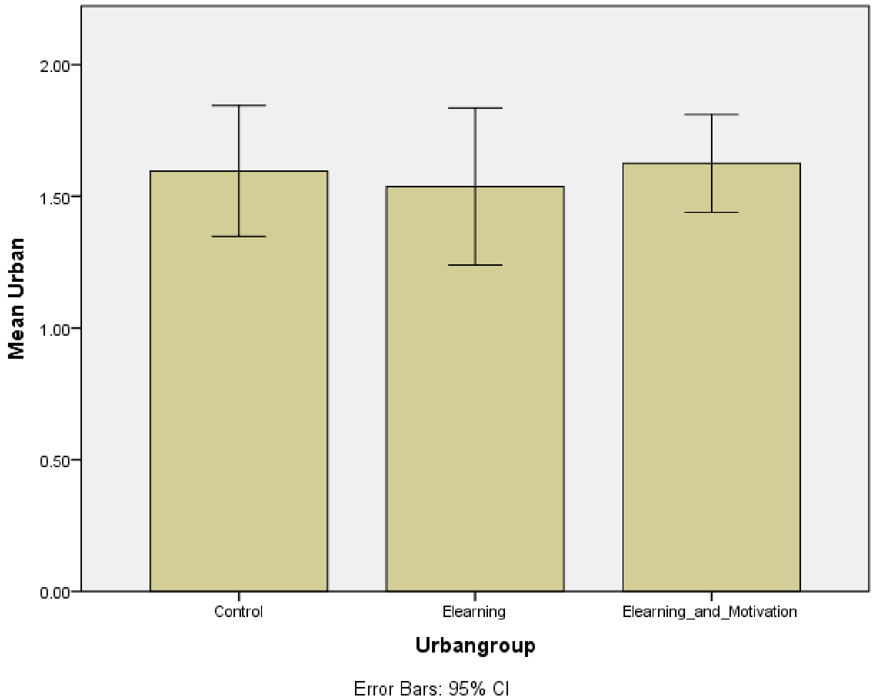


Figure 4.33 Results of difference between Flash quiz and Individual quiz scores of urban students

For all students control group, the mean score for Individual quiz scores (*M*=4.85, *SD*=0.87) was higher than the mean score for Flash quiz scores (*M*=3.29, *SD*=0.78). The observed difference between means was 1.56, 95% CI [1.30, 1.81], *t* (50) = -12.91, *p*<.001. Cohen's d effect size between the independent and dependent variable was *d*=1.8, and this represents a very large effect size. Due to e-learning group, the mean score for Individual quiz scores (*M*=5.60, *SD*=0.87) was higher than the mean score for Flash quiz scores (*M*=4.18, *SD*=0.86). The difference between means was 1.42, 95% CI [0.91, 1.54], *t* (52) = -12.88, *p*<.001. Cohen's d effect size represents a very large effect size (*d*=1.8). Refer to e-learning and motivation group, the mean score for Individual quiz scores (*M*=6.59, *SD*=0.86) was higher than the mean score for Flash quiz scores (*M*=4.97, *SD*=0.83). The difference between means was 1.62, 95% CI [0.69, 1.22], *t* (46) = -13.20, *p*<.001. Cohen's d effect size was 1.9. The difference between Flash quiz and Individual quiz scores is very large.

Table 4.17 Results of difference between Flash quiz and Individual quiz scores of rural students

Group	Flash quiz scores			Individual quiz scores			Difference between means		
	N	M_1	SD_1	***N***	M_2	SD_2	M_2-M_1 [95% CI]	***t*-value**	***d***
Control	50	2.74	0.63	50	4.52	0.73	1.78 [1.53, 2.02]	-14.56**	2.6
E-learning	58	3.92	0.89	58	5.74	0.86	1.82 [1.31, 1.92]	-15.05**	2.6
E-learning and Motivation	52	4.72	0.80	52	6.61	0.78	1.89 [1.15, 1.60]	-15.69**	2.7

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

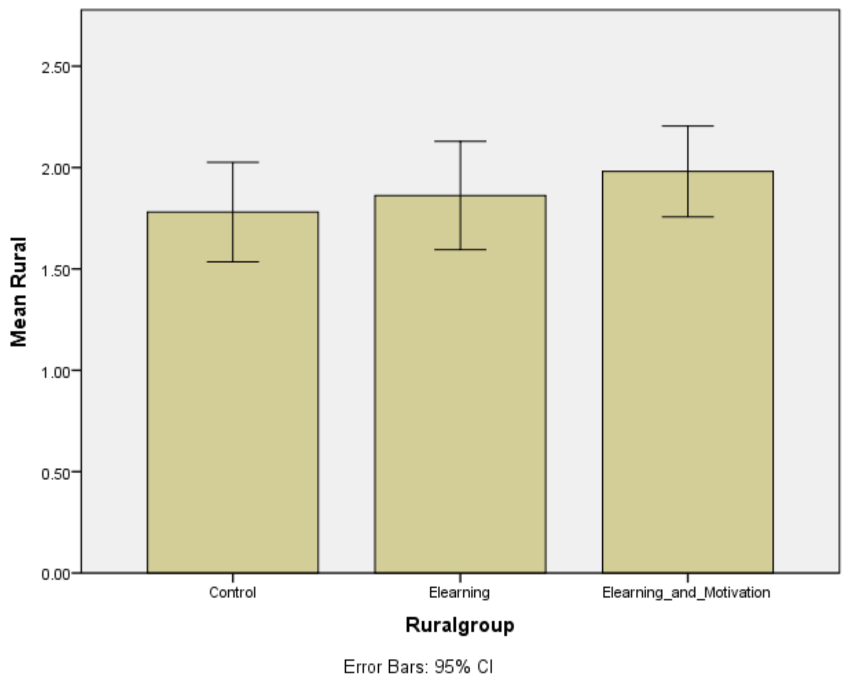


Figure 4.34 Results of difference between Flash quiz and Individual quiz scores of rural students

For all students control group, the mean score for Individual quiz scores (*M*=4.52, *SD*=0.73) was higher than the mean score for Flash quiz scores (*M*=2.74, *SD*=0.63). The observed difference between means was 1.78, 95% CI [1.53, 2.02], *t* (48) = -14.56, *p*<.001. Cohen's d effect size between the independent and dependent variable was *d*=2.6, and this represents a very large effect size. Due to e-learning group, the mean score for Individual quiz scores (*M*=5.74, *SD*=0.86) was higher than the mean score for Flash quiz scores (*M*=3.92, *SD*=0.89). The difference between means was 1.82, 95% CI [1.31, 1.92], *t* (56) = -15.05, *p*<.001. Cohen's d effect size represents a very large effect size (*d*=2.6). Refer to e-learning and motivation group, the mean score for Individual quiz scores (*M*=6.61, *SD*=0.78) was higher than the mean score for Flash quiz scores (*M*=4.72, *SD*=0.80). The difference between means was 1.89, 95% CI [1.15, 1.60], *t* (50) = -15.69, *p*<.001. Cohen's d effect size was 2.7. The difference between Flash quiz and Individual quiz scores is very large.

Focus group is the potential tool which can apply to both rural and urban area. The mean scores improve from 3.93 (flash quiz mean) to 5.41 (individual activities mean). The mean increases about 37%. The improvement of rural mean score (43%) is greater than urban mean score (32%). In urban area, control and e-learning group shows the best improvement for low GPA levels. For example, low GPA, mean of e-learning and motivation group improve 27% but control group improves only 22%. Similarly, in the rural area, e-learning and motivation group shows much improving for low GPA levels. For instance, low GPA, mean of e-learning and motivation group improves 27% but control group improves only 23%. In addition, e-learning provide more effectiveness for medium and high GPA levels

4.3.2.5 Difference between individual activities and post-test score (Group activities)

The overall analysis on the difference between individual activities and post-test score is done by employing the Paired *t*-test, Cohen's *d* effect size, Skewness, and Kurtosis. Refer to Figure 4.108, the difference between individual activities and post-test score distribution is approximately symmetric positive skewed (Skewness= 0.23). Moreover, Kurtosis distribution (-0.37) is Platykurtic that the tails are shorter and thinner. Additionally, Cohen provided interpretation of effect sizes, revealing that *d* = 2 represents a very large effect size. The difference between individual activities and post-test score is very large. Testing H_{12}, the null hypothesis was rejected. there is a significant difference between individual activities and post-test score at a level of 0.01 (t-value = -31.54).

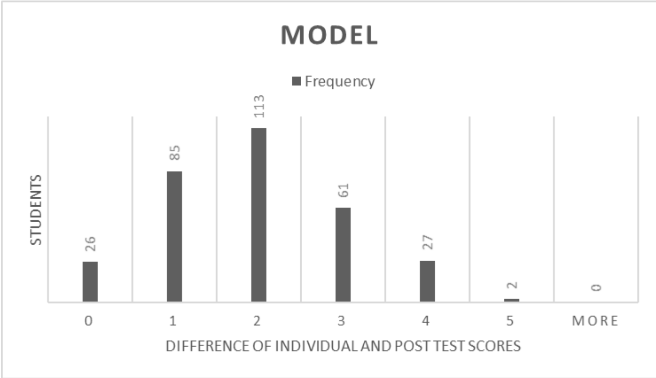


Figure 4.35 Difference of individual activities and post-test score in MOOC hybrid learning model histogram

From Figure 4.36, In urban area, the difference between individual activities and post-test score distribution is approximately symmetric positive skewed (Skewness= -0.62). Moreover, Kurtosis distribution (-0.31) is Platykurtic that the tails are shorter and thinner. In addition, Cohen provided interpretation of effect sizes, revealing that d = 2.13 represents a large effect size. The difference between individual activities and post-test score is large. Hypothesis $H_{12.1}$, the null hypothesis was rejected. There is a significant difference between individual activities and post-test score in a group of urban students at a level of 0.01(t-value = -22.55)

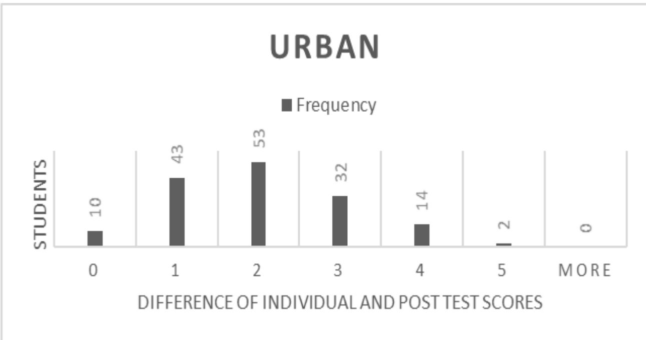


Figure 4.36 Difference of individual activities and post-test score in urban area histogram

From Figure 4.37, In rural area, the difference between individual activities and post-test score distribution is approximately symmetric positive skewed (Skewness= 0.14). Moreover, Kurtosis distribution (-0.47) is Platykurtic that the tails are shorter and thinner. Additionally. Cohen provided interpretation of effect sizes, revealing that d = 1.9 represents a very large effect size. The difference between individual activities and post-test score is very large. Hypothesis $H_{12.2}$, the null hypothesis was rejected. There is a significant difference between individual activities and post-test score in a group of rural students at a level of 0.01 (t-value = -22.07).

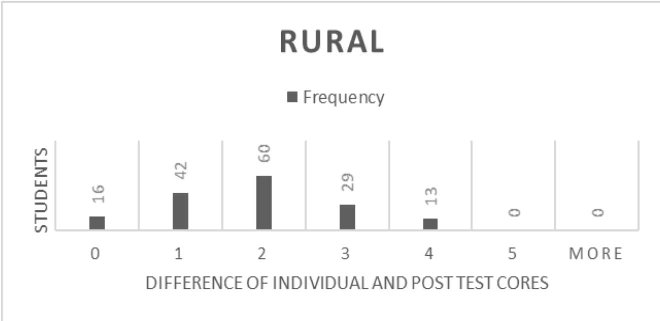


Figure 4.37 Difference of individual activities and post-test score in rural area histogram

Table 4.18 Results of difference between Individual quiz and post test scores of all students

Group	Individual quiz scores			Post test scores			Difference between means		
	N	***M₁***	***SD₁***	***N***	***M₂***	***SD₂***	***M₂-M₁ [95% CI]***	***t*-value**	***d***
Control	102	4.70	0.83	102	6.59	0.82	1.89 [1.66, 2.11]	-17.11**	2.2
E-learning	112	5.57	0.84	112	7.49	0.74	1.92 [1.79, 2.22]	-19.68**	2.5
E-learning and Motivation	100	6.03	0.82	100	8.03	0.74	2.00 [1.77, 2.22]	-17.72**	2.5

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

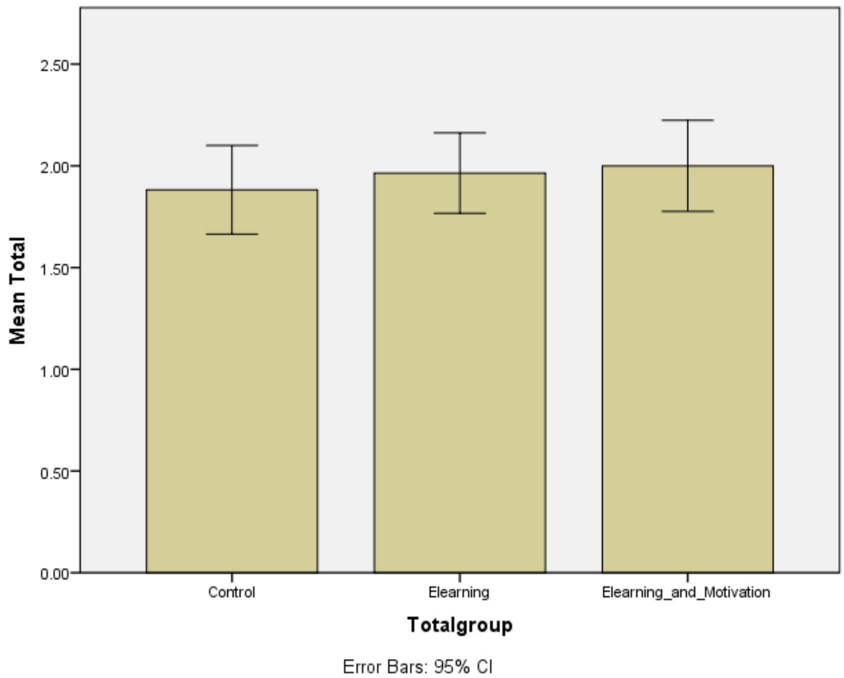


Figure 4.38 Results of difference between Individual quiz and post test scores of all students

For all students control group, the mean score for post-test scores (*M*=6.59, *SD*=0.82) was higher than the mean score for Individual quiz scores (*M*=4.70, *SD*=0.83). The observed difference between means was 1.89, 95% CI [1.66, 2.11], *t* (100) = -17.11, *p*<.001. Cohen's d effect size between the independent and dependent variable was *d*=2.2, and this represents a very large effect size. Due to e-learning group, the mean score for post-test scores (*M*=7.49, *SD*=0.74) was higher than the mean score for Individual quiz scores (*M*=5.57, *SD*=0.84). The difference between means was 1.92, 95% CI [1.79, 2.22], *t* (110) = -19.68, *p*<.001. Cohen's d effect size represents a very large effect size (*d*=2.2). Refer to e-learning and motivation group, the mean score for post-test scores (*M*=8.03, *SD*=0.74) was higher than the mean score for Individual quiz scores (*M*=6.03, *SD*=0.82). The difference between means was 2.00, 95% CI [1.77, 2.22], *t* (98) = -17.72, *p*<.001. Cohen's d effect size was 2.5. The difference between Individual quiz and post test scores is very large.

Table 4.19 Results of difference between Individual quiz and post test scores of urban students

Group	Individual quiz scores			Post test scores			Difference between means		
	N	M_1	SD_1	*N*	M_2	SD_2	M_2-M_1 [95% CI]	*t*-value	*d*
Control	52	4.85	0.87	52	6.79	0.87	1.94 [1.61, 2.26]	-12.39**	2.2
E-learning	54	5.42	0.87	54	7.62	0.73	2.20 [1.90, 2.51]	-14.38**	2.7
E-learning and Motivation	48	5.94	0.86	48	8.02	0.72	2.08 [1.74, 2.42]	-12.21**	2.6

*p<0.05, ***p*<0.01, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

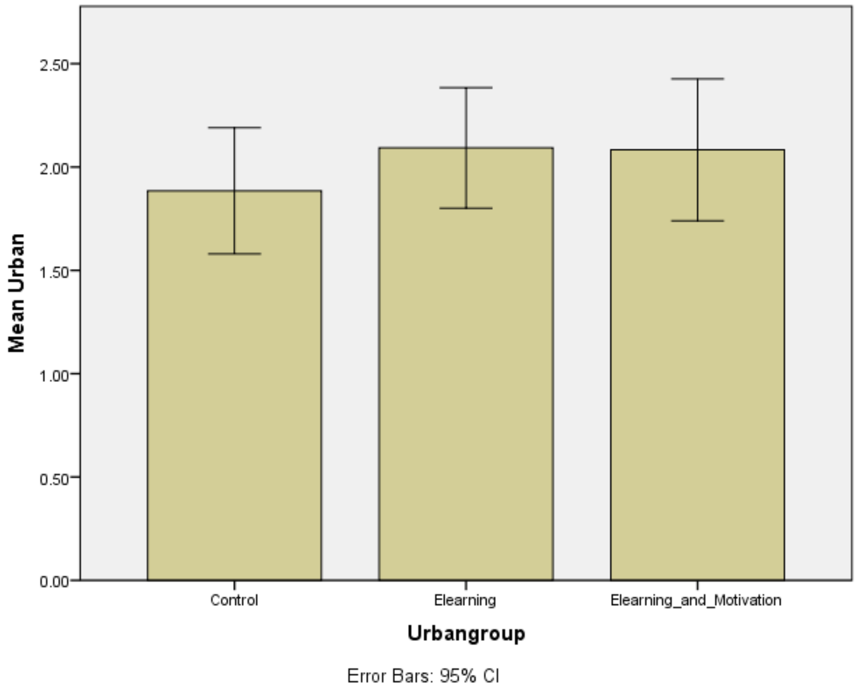


Figure 4.39 Results of difference between Individual quiz and post test scores of urban students

For all students control group, the mean score for post-test scores (*M*=6.79, *SD*=0.87) was higher than the mean score for Individual quiz scores (*M*=4.85, *SD*=0.87). The observed difference between means was 1.94, 95% CI [1.61, 2.26], *t* (50) = -12.39, *p*<.001. Cohen's d effect size between the independent and dependent variable was *d*=2.2, and this represents a very large effect size. Due to e-learning group, the mean score for post-test scores (*M*=7.62, *SD*=0.73) was higher than the mean score for Individual quiz scores (*M*=5.42, *SD*=0.87). The difference between means was 2.20, 95% CI [1.90, 2.51], *t* (52) = -14.38, *p*<.001. Cohen's d effect size represents a very large effect size (*d*=2.7). Refer to e-learning and motivation group, the mean score for post-test scores (*M*=8.02, *SD*=0.72) was higher than the mean score for Individual quiz scores (*M*=5.94, *SD*=0.86). The difference between means was 2.08, 95% CI [1.74, 2.42], *t* (46) = -12.21, *p*<.001. Cohen's d effect size was 2.6. The difference between Individual quiz and post test scores is very large.

Table 4.20 Results of difference between Individual quiz and post test scores of rural students

Group	Individual quiz scores			Post test scores			Difference between means		
	N	M_1	SD_1	*N*	M_2	SD_2	M_2-M_1 [95% CI]	*t*-value	*d*
Control	50	4.52	0.73	50	6.40	0.75	1.88 [1.55, 2.20]	-11.69**	2.5
E-learning	58	5.54	0.86	58	7.46	0.67	1.92 [1.62, 2.21]	-13.51**	2.4
E-learning and Motivation	52	6.1	0.78	52	8.04	0.78	1.94 [1.62, 2.25]	-13.81**	2.4

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

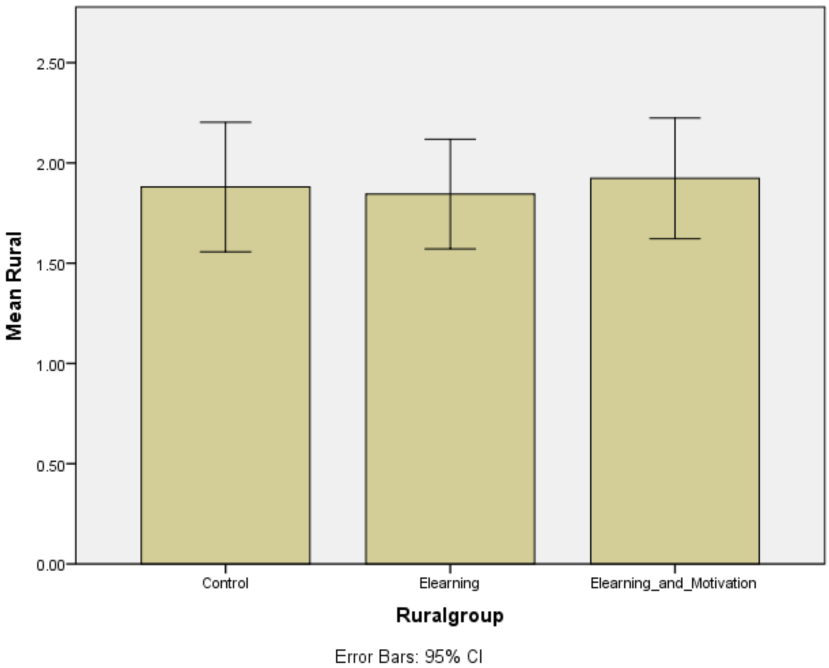


Figure 4.40 Results of difference between Individual quiz and post test scores of rural students

For all students control group, the mean score for post-test scores (*M*=6.40, *SD*=0.75) was higher than the mean score for Individual quiz scores (*M*=4.52, *SD*=0.73). The observed difference between means was 1.88, 95% CI [1.55, 2.20], *t* (48) = -11.69, *p*<.001. Cohen's d effect size between the independent and dependent variable was *d*=2.5, and this represents a very large effect size. Due to e-learning group, the mean score for post-test scores (*M*=7.46, *SD*=0.67) was higher than the mean score for Individual quiz scores (*M*=5.54, *SD*=0.86). The difference between means was 1.92, 95% CI [1.62, 2.21], *t* (56) = -13.51, *p*<.001. Cohen's d effect size represents a very large effect size (*d*=2.4). Refer to e-learning and motivation group, the mean score for post-test scores (*M*=8.04, *SD*=0.78) was higher than the mean score for Individual quiz scores (*M*=6.10, *SD*=0.78). The difference between means was 1.94, 95% CI [1.62, 2.25], *t* (50) = -13.81, *p*<.001. Cohen's d effect size was 2.4. The difference between Individual quiz and post test scores is very large.

Group activities is the effective tool which can apply to both rural and urban area. The mean scores improve from 5.41 (individual activities mean) to 7.36 (Post-test mean). The mean increases about 36%. The improvement of urban mean score (37%) is greater than rural mean score (34%). In urban area, e-learning group shows the best improvement for low GPA levels. For example, low GPA, mean of e-learning group improve 55% but control group improves only 48%. Moreover, e-learning and motivation group provides the best performance for medium and high GPA levels. Similarly, in the rural area, e-learning group shows much improving for low GPA levels. For instance, low GPA, mean of e-learning group improves 50% but control group improves only 44%. In addition, e-learning and motivation group provides more effectiveness for medium and high GPA levels.

Table 4.21 Results of *t*-test for effectiveness of model features

Group	**Pre-test score**			**In-video quiz scores**			***t*-value**
	N	***M***	**SD**	***N***	***M***	**SD**	
All students	314	2.13	0.82	314	3.43	0.89	-21.51**
Urban student	154	2.24	0.79	154	3.40	0.86	-14.06**
Rural student	160	2.01	0.83	160	3.45	0.93	-16.48**
Group	**In-video quiz scores**			**Online quiz scores**			***t*-value**
	N	***M***	**SD**	***N***	***M***	**SD**	
All students	314	3.43	0.89	314	5.23	0.90	-30.38**
Urban student	154	3.40	0.86	154	5.22	0.86	-20.19**
Rural student	160	3.45	0.93	160	5.25	0.94	-22.89**
Group	**Online quiz scores**			**Flash quiz scores**			***t*-value**
	N	***M***	**SD**	***N***	***M***	**SD**	
All students	314	5.23	0.90	314	3.93	1.12	-22.31**
Urban student	154	5.22	0.86	154	4.09	1.11	-13.32**
Rural student	160	5.25	0.94	160	3.77	1.12	-18.72**
Group	**Flash quiz scores**			**Individual activities scores**			***t*-value**
	N	***M***	**SD**	***N***	***M***	**SD**	
All students	314	3.93	1.12	314	5.41	0.98	-26.35**
Urban student	154	4.09	1.11	154	5.40	0.95	-16.06**
Rural student	160	3.77	1.12	160	5.41	1.01	-21.79**
Group	**Individual activities scores**			**Post-test score**			***t*-value**
	N	***M***	**SD**	***N***	***M***	**SD**	
All students	314	5.41	0.98	314	7.36	0.96	-31.54**
Urban student	154	5.40	0.95	154	7.42	0.94	-22.55**
Rural student	160	5.41	1.01	160	7.30	0.98	-22.07**

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation

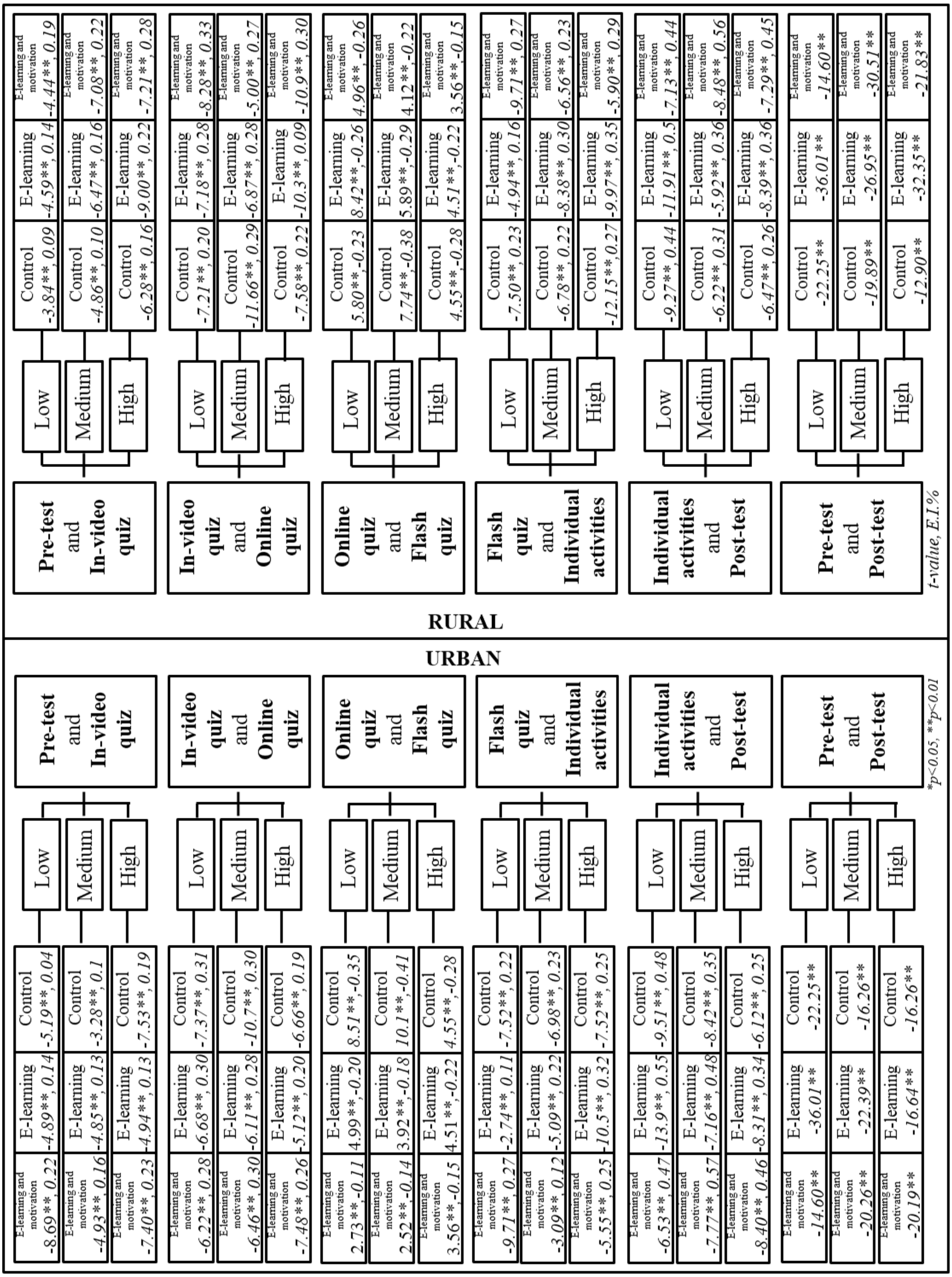


Figure 4.41 Results of t-test for effectiveness of model feature

4.4. Findings and discussion

4.4.1. Results

Our MOOC hybrid learning model, designed by combining MOOCs, flipped learning, and active learning, is effective for students in rural and urban schools. It results in the overall aspect of improvement in the learning process (statistically significant difference between pre and post-test scores). The learning improvement of rural students are greater than urban students. In urban area, MOOCs hybrid learning model shows the best performance for all GPA levels. Similarly, in the rural area, this model provides much improvement than traditional teaching for medium and high GPA students. However, MOOCs hybrid learning model shows the same improvement as traditional teaching (control group) for the rural low GPA students. This model can apply to support teacher to teach various subjects in the same standard as traditional teaching.

The internal factors of GPA have a significantly effect on learning outcome for both urban and rural areas. If students got high GPA, they tend to receive good scores of e-learning. GPA is one of indicators that can predict the learning outcome. According to learning outcome and satisfaction, Satisfaction has positive correlation with learning outcome especially for 3 factors (Instructor, design, and focus group factor). These factors provide the strong relationship with learning outcome. It means professional instructor, computer interface, and focus group activities are important factors. If students satisfy with these factors, they tend to have better learning

Next, MOOCs video learning have a significantly effect improving learning outcome for both areas. The rural group shows much improvement in score than urban group. Similarly, forum discussions improved learning outcome. This factor will help students gain a deeper understanding of their lessons. Focus group is also the potential tool which can apply to both rural and urban area. However, the rural group shows greater improvement than urban group. Due to group activities and peer tutoring improved scores for all students. Even more, group activities affect to all academic group. Students can do better if they can discuss problems together. This kind of social activity should be integrated into every learning model.

Regarding retention, students forgot some content after one week and forgot about 24% of the content. Rural students can retain their knowledge better than urban students. In urban area, MOOC hybrid learning model can retain students' knowledge better than other methods for all GPA levels. Furthermore, in the rural area, MOOC hybrid learning model can retain students' knowledge better than traditional teaching for medium and high GPA levels. However, Traditional teaching plays the important role in learning retention for rural low GPA students. Teachers should refresh their memory by using content warm-up sessions to summarize the content before the next class.

4.4.2. Effective MOOCs hybrid learning model

The Effective MOOCs hybrid learning model has been evaluated by case study and statistical experiments. This model is a combination of the flipped learning model, MOOCs, and student-centered model (active learning), as shown in Figure 4.4. This model combines four activity steps; (i) Teacher-centered learning, (ii) Teacher activities, (iii) Student-centered learning, and (iv) Extrinsically motivation evaluation.

(i) The first step incorporates with teacher-centered learning and out-of-class activities. In the beginning, teacher should collect internal factor data such as age, and academic achievement (GPA). Teacher then tests students with a pre-test exam to estimate students' ability and plan the teaching contents. After that, students learn from MOOCs group video learning, which provides online learning contents, in-video quizzes that pop up while the teacher explains the content. After students have learned all contents, online quizzes are provided to evaluate their understanding. Then students discuss the contents in forum discussion to exchange their opinion and confirm their deep understanding of the content.

(ii) In the second step, teacher activities, Teachers analyze student-performance to understand students struggling and also identified the risk group that need special attention. Teacher can use Just in Time Teaching (JiTT) to modify the contents and give specific content to each risk student group. After one week, students are tested by flash quiz questions that is the same difficulty as online quiz questions to determine the retention score and evaluate retained knowledge.

(iii) The third step is student-centered learning through in-class activities. The teacher summarizes all content in warm up session. After that, the teacher divides students into groups based on students' score from in-video, online, flash quizzes, and forum discussion. Teacher teaches specific contents to each group. After fulfill all lacking content, students participate group active learning activities. Firstly, pair activities, students work independently and discuss their thoughts and arguments with a partner. Secondly, group activities are conducted starting from small groups of students and discussion with each other in either same or another group. Teacher observes their discussion and try to measure students' performance. After those steps, students are tested by group quizzes using peer tutoring technique. High-performing students will help their friend to explain difficult contents. Moreover, individual quizzes test their individual understanding and count as post-test scores.

(iv) In the final step, satisfaction evaluation is conducted in which students can assess and give scores for their satisfaction in student, instructor, course, and design factors. These activities can measure their extrinsically motivation.

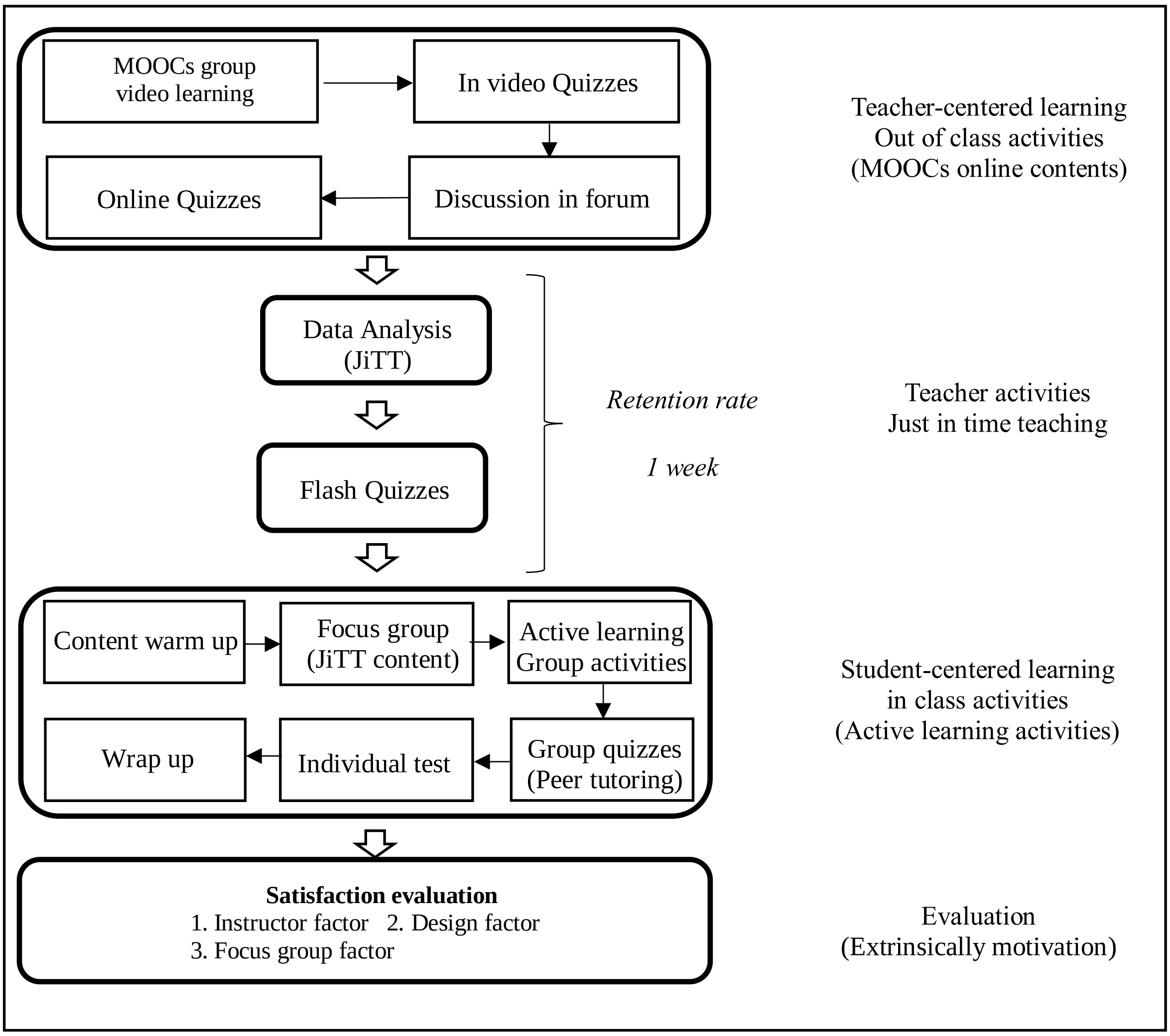


Figure 4.40 Effective MOOCs hybrid learning model

4.4.3. Discussion and conclusion

In rural, there are many RLIS schools. Most students are low potential students with low GPA and they do not have an opportunity to reach high standard education because they live in poverty and learn with unskilled teachers. Small rural schools lack teachers, teaching materials, and infrastructure. Most teachers have to teach many subjects, including those in which they have no experience. MOOC hybrid learning model is considered as the effective educational tool that can solve rural and low-performing students. This model is combined with flipped learning, MOOCs (teacher-centered model), and active learning (student-centered model) tools.

Most rural students got low GPA grade. They are low potential students and get a hard time to understand the contents, and some are slow to grasp the knowledge. Our result showed that any GPA grade students improve their learning using our model. This is meaningful especially, in rural education. This model is designed with interactive interface and step by step instructions. Students can understand the content easily and get immediate feedback from the teacher and their classmates in the discussion forum. Video playback options integrated within video quiz tool, are used for repeating the contents and check their understanding. Due to flipped learning, student can learn from MOOCs video lectures out of class time. They have freedom to choose their place, pace, and time. Some students are afraid to ask teacher in class. Peer tutoring and JiTT help them with private time for discussing with their classmate or teacher. Most students do not deeply understand the contents. They cannot recall the knowledge after one week. Repeating content tools such as video play-back options, content warm up, and wrap up, help them to recall and brush up their cognition. More practice time will provide more memory ability. Form our result, student satisfactions provide a strong link to learning ability. Students are satisfied with MOOCs video learning that are taught by professional instructors worldwide with standardly designed contents.

Lack of teachers, teaching materials, experience, and evaluation tools are the biggest problems in rural education. High standard video presentation, teaching support features, and high- quality materials are provided in this model. Teachers needed time to understand all the processes and tools. However, they were satisfied with students' improvement. MOOC video lectures help low-skilled teachers teach various kinds of subjects to students and identify risk groups. Teachers tracked students' performance before class and taught tailored content individually. Active learning enabled the teachers to focus on their students instead of class handling. They participated directly in student group activity and used peer tutoring with low-performing students. Moreover, teachers can make use of social elements to compensate their lack of education experience. Students can help one another. Our results showed that social elements, such as forum discussions, peer tutoring, and group activities will help students gain a deeper understanding through the exchange of their thoughts and opinions. Moreover, social activities seem to be effective for students by forcing them to work together and participate in peer tutoring. They can help students to absorb more knowledge and retain it for a longer time.

In the remote area, infrastructure and equipment are another important problem when applying this model. Internet access and computers are still required to apply our model. In some rural areas where schools do not have enough equipment, the non-interactive mode with video presentations is possible, but some tools are not usable such as the interactive feedback or JiTT method. Teachers can track and measure students' ability by the paper-based system. In future, the technological device will be affordable by the economy of scale. Internet connection is transferred from the mobile signal and public Wi-Fi. This model will play the important role in distance education. Moreover, rural students also lack computer literacy. These are a major barrier for rural students. Many online learners lack self-motivation and fall behind. The teacher can use MOOCs video as teaching material to teach students step by step. The students should practice with the computer at least once a week in computer class.

In sum, our MOOC hybrid learning model can improve students' learning processes and increase their learning retention and will be a solution to education problems in rural areas, not only in Thailand but also in other developing countries.

CHAPTER 5
EDUCATIONAL GAMIFICATION

This chapter incorporates with the effectiveness of educational gamification. Educational gamification is a potential educational model to deliver meaningful learning experiences to a learner. It can help learners practice real-life situations in the better learning environment. This chapter investigates the effectiveness of educational gamification in term of learning outcome and retention. In addition, finding the important factors that influence student abilities, considering language learning. We apply the Duolingo game to investigate and identify the effectiveness for urban and rural students. The survey is conducted from 251 secondary students (grades 7-10) in urban and rural public school in Thailand. The results show that an educational gamification model is effective for urban and rural schools and can adapt to solve educational problems in developing countries. We also found that group activities, academic achievement and learning time significantly improve students' learning ability. Personality type and most of the game learning factors are also positively affect learning ability. Moreover, the effectiveness of learning outcome is confirmed in a case study and tested by the statistical experiments.

5.1. Introduction

Due to the emergence of the Internet, Educational technology is created to supports distance education through online learning. E-learning offers a lot of efficient compared to brick and mortar teaching method. (Rosenberg, 2006). However, there are several problems that need to be solved to make e-learning effective such as technical issues and computer literacy. Many rural school lack necessary e-learning equipment such as highly efficient devices and Internet connections that are required for online courses. Recently, several new approaches have established in the education sector. One of these is gamification. Educational gamification is a model that has high potential for improving students' ability and motivation. It motivates students to learn from standard contents with an interactive game interface and allows teachers to be facilitators and assistants in the classroom. (Huotari & Hamari, 2012).

In this chapter, we aim to examine the effectiveness of an educational gamification model that is suitable and effective for urban and rural students and finds potential features that have influence on student ability. At the same time, it aims to identify the factors that influence the learning process. The answers it provides will not only provide a new solution to solve education problems in Thailand but will also make it possible to solve the educational problem for students in developing countries.

5.2. Learning content and framework

5.2.1. Gamification content development and testing

According to primary data, the main methods are divided into two parts: the processes and steps of content testing is devoted to the process of using Duolingo content, the purpose being to confirm the validity of the contents. The game content from Duolingo (Duolingo, 2016) was utilized by using a two-level (basic and intermediate) German course with eight lessons per level. The basic level comprised lessons titled Basic 1, Basic 2, Phrases, Account, Cases, Introductions, Food 1, and Animals 1. The intermediate level comprised lessons titled Plurals, Adjectives, Negatives, Questions 1, Clothing, and Nature 1. We choose German course because students have never learned this content before. It is the effective way to measure actual learning ability. This course consisted of interactive game activities that lasted approximately 10 to 15 minutes per lesson. We also conducted a validity test using the Item Objective Congruence Index (IOC). The IOC provides results from three experts in academic fields. The validity test results either confirmed or invalidated our test results. When we got a positive result, we proceeded by using that set of exams for our pilot test, performing pilot testing for 20 students. Internal consistency and reliability were measured by using the Kuder–Richardson Formula 20 test (KR-20) which aims to evaluate and reconstruct the exam. After the pilot testing was completed, the real pre-test in the form of field-testing was performed

5.2.2. Educational gamification model

As Figure 5.1 shows, the gamification structure can be divided into five steps. First, internal factors and personality types are obtained. Student profiles are collected on the following items: GPA (below 2.00, 2.00-3.00, 3.00-4.00) (Ministry of Education, 2013). The students’ personality types were identified through Keirsey’s questionnaire, which pinpoints four basic temperaments: Artisan, Guardian, Rational, and Idealist (Keirsey, D., 1998). Second, students choose the German language and their daily study level: Casual - 15 mins/day, Regular - 30 mins/day, Serious - 45 mins/day, and Obsessed - 60 mins/day. In the third “Learning and testing” step, students answered 10 pre-test level questions. These were developed on the basis of Duolingo content, covering 16 lessons with two levels of difficulty (Duolingo, 2016). Both the pre and post-tests comprised three to five questions per level. In total, 10 questions were prepared. The post-test exam was eventually administered after the students had gone through the learning content and completed all the exercises. The level of difficulty was programmed to match that of the pre-test exam. After that, students played the basic level game, learning by themselves, and started group discussions with five students in each group to expand their mutual understanding. Then the basic level test was administered with 10 questions to evaluate their understanding. One week later, the students were given 10 warm up questions that had the same difficulty as those of the basic level test to determine their score retention and evaluate the amount of knowledge they had retained. The students started to learn intermediate level contents through the learning game and engaged in group discussions again. Finally, a post-test was conducted after the students had finished all the activities. We used a questionnaire to evaluate the game factors Satisfaction, Personal and social skills, Game engagement, Openness and acceptance, and Emotion combined with the self-elements of the game, that is, the level of difficulty and the story line, and the time restriction (Wendy & Dilip, 2013). The choices were evaluated on a three-point Likert scale (agree, partly agree, and disagree) to identify which factors the students felt were important for game learning. In order to analyze the effectiveness of gamification learning, the paired T-test method was utilized to compare the pre- and post-test score means, together with Kruskal-Wallis test is meant to find the effects and relationships between variables.

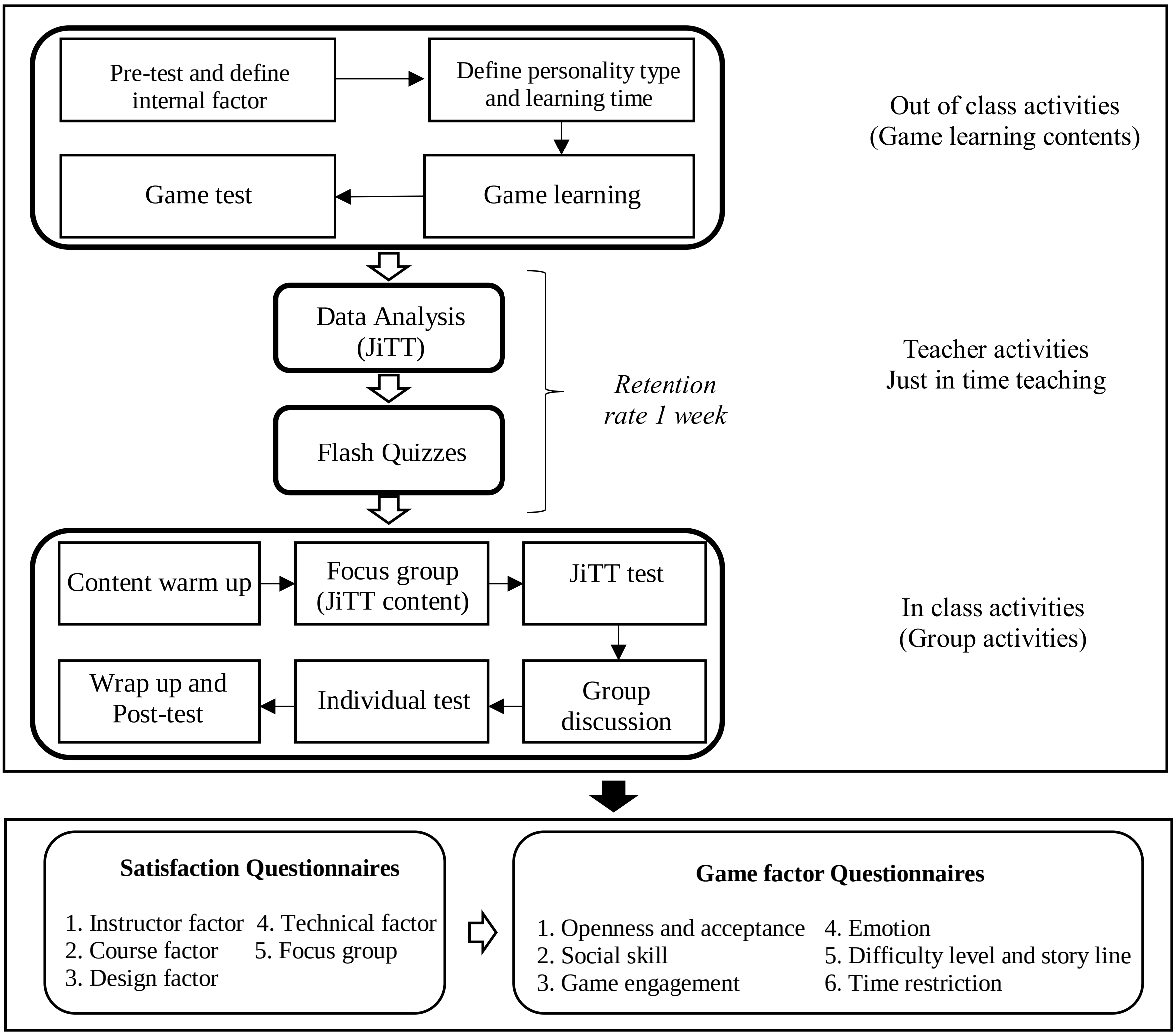


Figure 5.1 Educational gamification model

5.2.2. Identify the factors, features, and variable

After determining the learning model, factors and features were examined. We propose five group factors; internal factors (GPA, age, and past e-learning experience), game learning factors (openness and acceptance, satisfaction, personal and social skill, game engagement, emotion, difficulty level and the story line, and time restriction), social elements (group discussion), learning time, and personality type (Guardian, Artisan, Idealist, and Rationalist). We find the effect of these factors by using the Kruskal-Wallis (H Test). It was used to find the relationships of factors on learning outcome.

5.2.3. Participation and data collection

The data was collected using field testing methods at urban and rural school. Two-hundred fifty-one students were randomly selected. (128 from a public urban school in Bangkok province) and 123 from a public rural school in chaiyaphum province). The students were in grades 7-10 (13-16 years old). Sixty-three students were in grade 7, 65 in grade 8, 63 in grade 9, and 60 in grade 10. Out of the 251 respondents, 127 (50.59%) were male and 124 (49.40%) were female. The majority of students had a high (3.00-4.00) GPAX (33.06%) and medium (2.00-3.00) GPAX (33.06%), and 33.86% had a low (below 2.00). Due to the student groups, participations were divided to 3 student groups; Control (learned by traditional method), E-learning (learned by educational gamification), and E-learning and motivation (learned by educational gamification with incentive and extra scores)

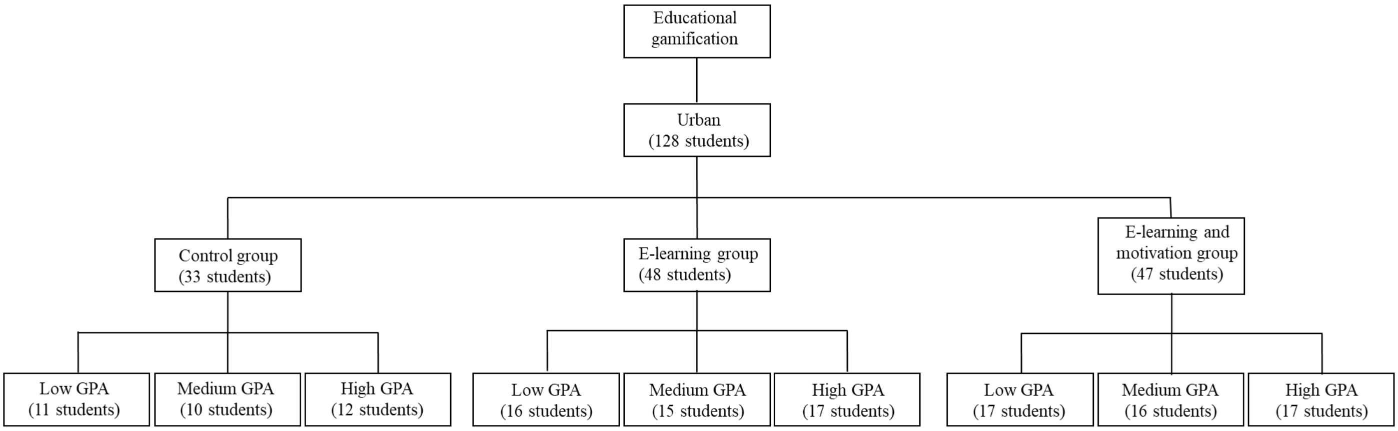


Figure 5.2 Number of students who participated Educational gamification model in urban a

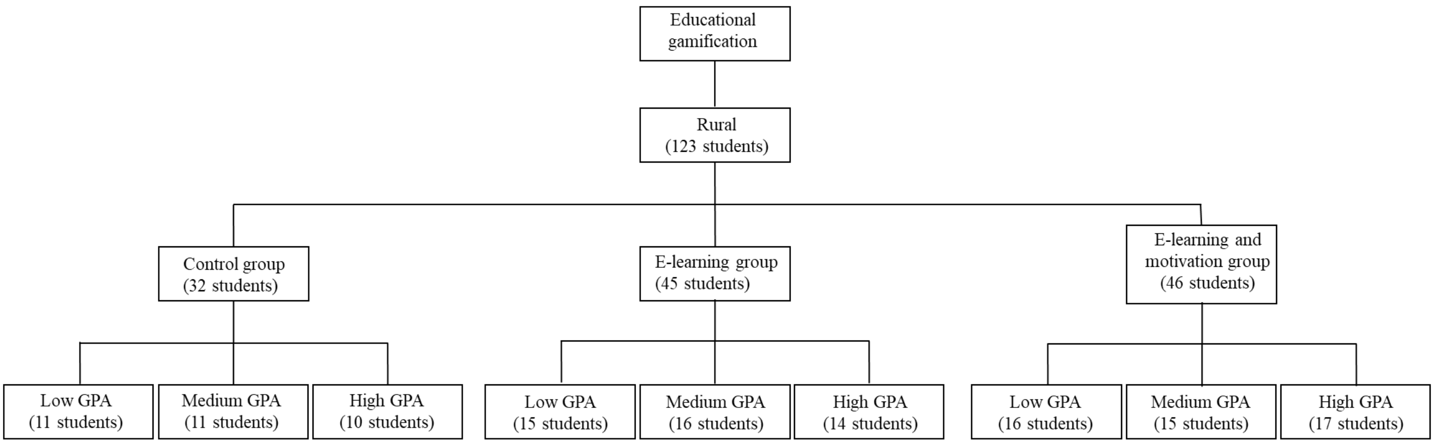


Figure 5.3 Number of students who participated Educational gamification model in rural area

5.3. Data analysis

Testing of hypothesis were conducting using a pair *t*-test to determine whether the data are significantly different from each other. In addition, Analysis of variance (ANOVA) was used to analyze the differences among 3 group means (control, e-learning, and e-learning and motivation groups). Tukey's honest significant different (HSD) test was used to analyze subsequent effects. It compares all possible pairs of means that are significantly different from each other. The analyses focus on rural and urban students separately. Students who study in each area are divided into three group according to their GPA level. Then in the same GPA level, they are further separate into 3 groups, referred to as control, e-learning, and e-learning and motivation group, respectively.

5.3.1 Pre and Post-test Analysis

5.3.1.1 Effectiveness of model

The overall analysis on the difference between pre and post-test score is done by employing the Paired *t*-test, Cohen's *d* effect size, Skewness, Kurtosis, and ANOVA. Refer to Figure 5.4, the difference between pre and post-test score distribution is approximately symmetrical positive skewed (Skewness= 0.20). Moreover, Kurtosis distribution (-0.55) is Platykurtic that the tails are shorter and thinner. Additionally, Cohen provided interpretation of effect sizes, revealing that d = 3.95 represents a very large effect size. The difference between pre and post-test score is very large., Hypothesis H_{13}, the null hypothesis was rejected. There is a significant difference between pre and post-test scores at a level of 0.01 (t-value = -47.61).

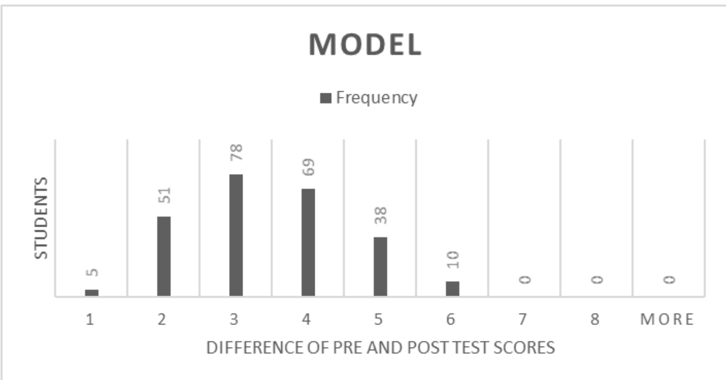


Figure 5.4 Difference of pre and post test scores in MOOC hybrid learning model histogram

From Figure 5.5, In urban area, the difference between pre and post-test score distribution is approximately symmetrical positive skewed (Skewness= 0.17). Moreover, Kurtosis distribution (-0.58) is Platykurtic that the tails are shorter and thinner. Most of students have the approximately average scores. In addition, Cohen provided interpretation of effect sizes, revealing that d = 3.92 represents a very large effect size. The difference between pre and post-test score is very large. Hypothesis $H_{13.1}$, the null hypothesis was rejected. There is a significant difference between pre and post-test scores in a group of urban students at a level of 0.01 (t-value = -33.14)

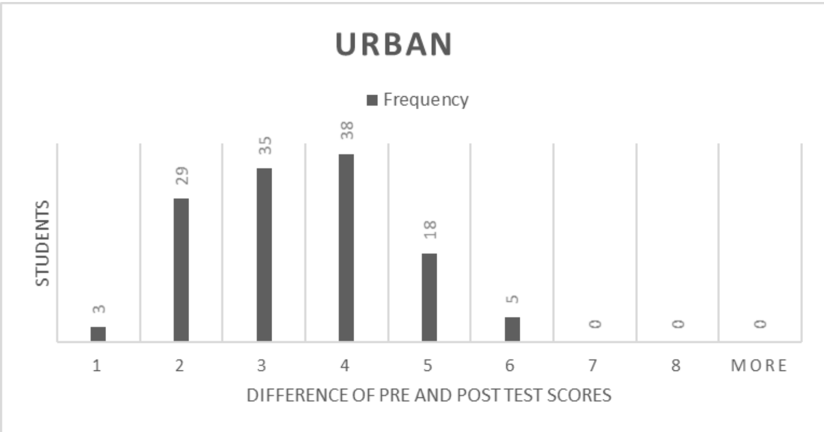


Figure 5.5 Difference of pre and post test scores in urban area histogram

From Figure 5.6, In rural area, the difference between pre and post-test score distribution is approximately symmetrical positive skewed (Skewness= 0.25). Moreover, Kurtosis distribution (-0.5) is Platykurtic that the tails are shorter and thinner. Additionally. Cohen provided interpretation of effect sizes, revealing that d = 3.97 represents a very large effect size. The difference between pre and post-test score is very large. As Table 5.1 shown, Hypothesis $H_{13.2}$, the null hypothesis was rejected. There is a significant difference between pre and post-test scores in a group of rural students at a level of 0.01 (t-value = -34.12).

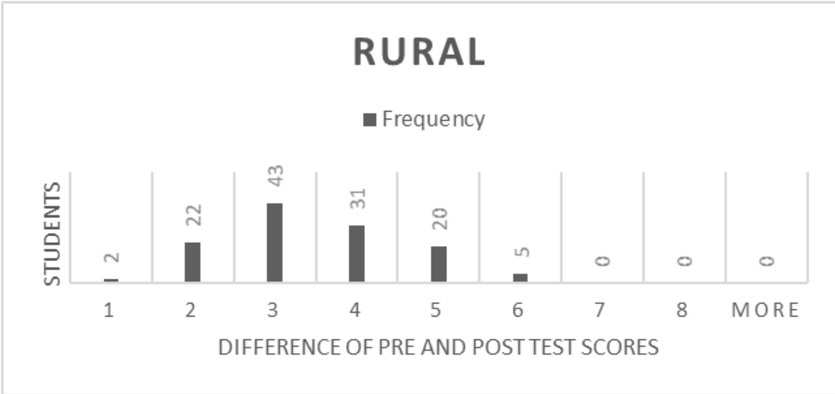


Figure 5.6 Difference of pre and post test scores in rural area histogram

Table 5.1 Results of t-test for difference between pre and post-test scores

Group	**Pre-test score**			**Post-test score**			***t*-value**
	N	***M***	**SD**	***N***	***M***	**SD**	
All students	251	2.16	0.79	251	5.62	0.94	-47.61**
Urban student	128	2.17	0.78	128	5.60	0.95	-33.14**
Rural student	123	2.15	0.79	123	5.64	0.95	-34.12**

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation

Table 5.2 Results of difference between pre and post-test scores of all students

Group	**Pre test scores**			**Post test scores**			**Difference between means**		
	N	M_1	SD_1	***N***	M_2	SD_2	M_2-M_1 *[95% CI]*	***t*-value**	***d***
Control	85	2.03	0.75	85	5.49	1.00	3.46 [3.27, 3.78]	-25.13**	3.8
E-learning	83	2.12	0.72	83	5.90	0.96	3.78 [3.10, 3.59]	-26.98**	3.9
E-learning and Motivation	83	2.34	0.87	83	6.16	0.84	3.82 [3.21, 3.72]	-27.21**	4.0

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

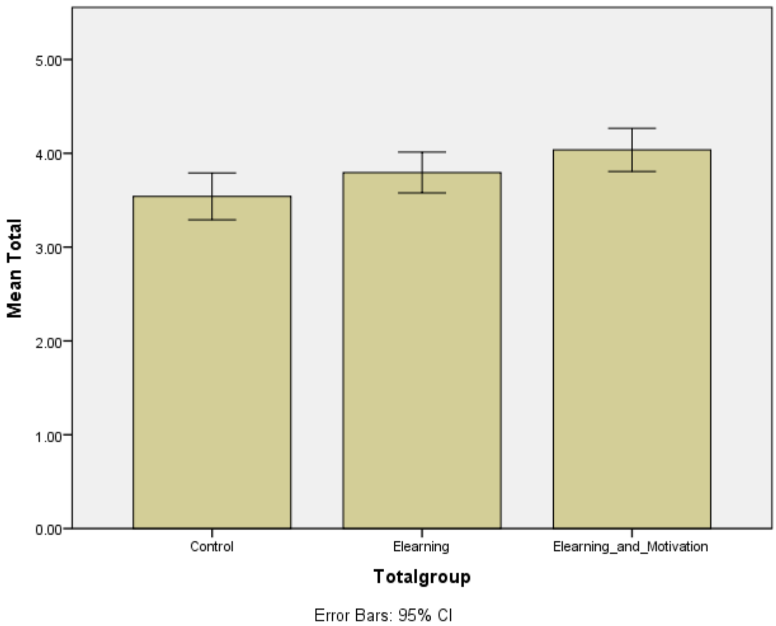


Figure 5.7 Results of difference between pre and post-test scores of all students

For all students control group, the mean score for post-test scores (*M*=5.49, *SD*=1.00) was higher than the mean score for pre-test scores (*M*=2.03, *SD*=0.75). The observed difference between means was 3.46, 95% CI [3.27, 3.78], *t* (83) = -25.13, *p*<.001. Cohen's d effect size between the independent and dependent variable was *d*=3.8, and this represents a very large effect size. Due to e-learning group, the mean score for post-test scores (*M*=5.90, *SD*=0.96) was higher than the mean score for pre-test scores (*M*=2.12, *SD*=0.72). The difference between means was 3.78, 95% CI [3.10, 3.59], *t* (81) = -26.98, *p*<.001. Cohen's d effect size represents a very large effect size (*d*=3.9). Refer to e-learning and motivation group, the mean score for post-test scores (*M*=6.16, *SD*=0.84) was higher than the mean score for pre-test scores (*M*=2.34, *SD*=0.87). The difference between means was 3.82, 95% CI [3.21, 3.72], *t* (81) = -27.21, *p*<.001. Cohen's d effect size was 4.0. The difference between pre and post-test score is very large.

Table 5.3 Results of difference between pre and post-test scores of urban students

Group	**Pre test scores**			**Post test scores**			**Difference between means**		
	N	M_1	SD_1	***N***	M_2	SD_2	M_2-M_1 *[95% CI]*	***t*-value**	***d***
Control	43	2.04	0.77	43	5.57	1.02	3.53 [3.16, 3.91]	-19.73**	3.9
E-learning	41	2.12	0.71	41	5.74	0.94	3.62 [2.92, 3.61]	-19.89**	3.9
E-learning and Motivation	44	2.39	0.86	44	6.34	0.84	3.95 [2.93, 3.7]	-20.64**	3.9

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

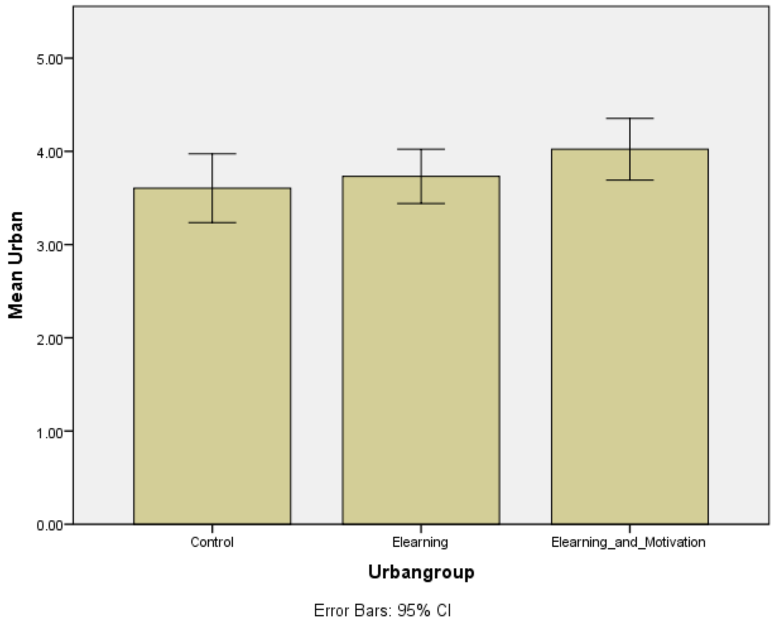


Figure 5.8 Results of difference between pre and post-test scores of urban students

For all students control group, the mean score for post-test scores (*M*=5.57, *SD*=1.02) was higher than the mean score for pre-test scores (*M*=2.04, *SD*=0.77). The observed difference between means was 3.53, 95% CI [3.16, 3.91], *t* (41) = -19.73, *p*<.001. Cohen's d effect size between the independent and dependent variable was *d*=3.9, and this represents a very large effect size. Due to e-learning group, the mean score for post-test scores (*M*=5.74, *SD*=0.94) was higher than the mean score for pre-test scores (*M*=2.12, *SD*=0.71). The difference between means was 3.62, 95% CI [2.92, 3.61], *t* (110) = -19.89, *p*<.001. Cohen's d effect size represents a very large effect size (*d*=3.9). Refer to e-learning and motivation group, the mean score for post-test scores (*M*=6.34, *SD*=0.84) was higher than the mean score for pre-test scores (*M*=2.39, *SD*=0.86). The difference between means was 3.95, 95% CI [2.93, 3.7], *t* (42) = -20.64, *p*<.001. Cohen's d effect size was 3.9. The difference between pre and post-test score is very large.

Table 5.4 Results of difference between pre and post-test scores of rural students

Group	Pre test scores			Post test scores			Difference between means		
	N	***M_1***	***SD_1***	***N***	***M_2***	***SD_2***	***M_2-M_1 [95% CI]***	***t*-value**	***d***
Control	42	2.02	0.77	42	5.43	0.94	3.41 [3.04, 3.77]	-19.91**	3.9
E-learning	42	2.15	0.74	42	5.48	0.96	3.33 [2.97, 3.69]	-18.96**	3.8
E-learning and Motivation	39	2.33	0.89	39	5.89	0.85	3.56 [3.20, 3.92]	-19.88**	4.0

*p<0.05, ***p<0.01, M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

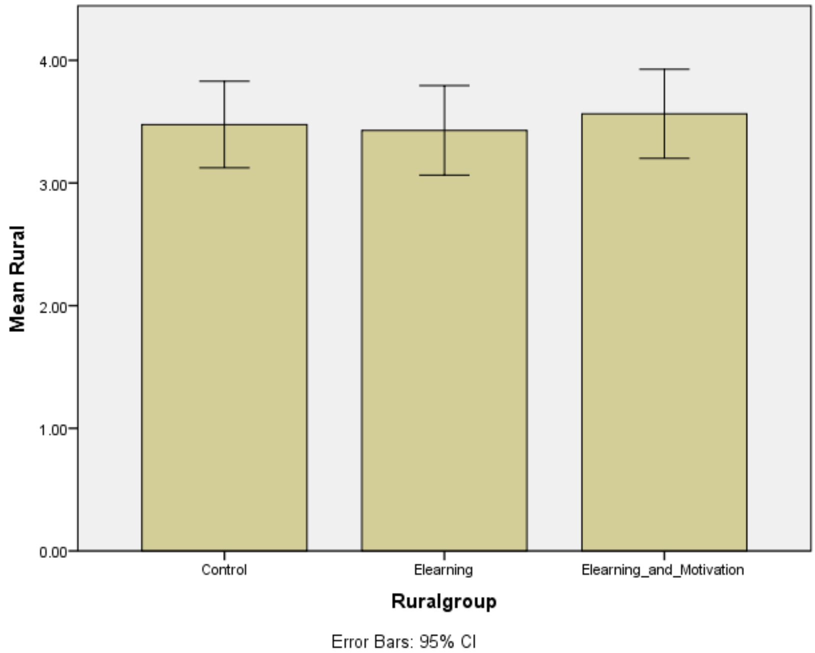


Figure 5.9 Results of difference between pre and post-test scores of rural students

For all students control group, the mean score for post-test scores (*M*=5.43, *SD*=0.94) was higher than the mean score for pre-test scores (*M*=2.02, *SD*=0.77). The observed difference between means was 3.41, 95% CI [3.04, 3.77], *t* (40) = -19.91, *p*<.001. Cohen's d effect size between the independent and dependent variable was *d*=3.9, and this represents a very large effect size. Due to e-learning group, the mean score for post-test scores (*M*=5.48, *SD*=0.96) was higher than the mean score for pre-test scores (*M*=2.15, *SD*=0.74). The difference between means was 3.33, 95% CI [2.97, 3.69], *t* (40) = -18.96, *p*<.001. Cohen's d effect size represents a very large effect size (*d*=3.8). Refer to e-learning and motivation group, the mean score for post-test scores (*M*=5.89, *SD*=0.85) was higher than the mean score for pre-test scores (*M*=2.33, *SD*=0.89). The difference between means was 3.56, 95% CI [3.20, 3.92], *t* (37) = -19.88, *p*<.001. Cohen's d effect size was 4.00. The difference between pre and post-test score is very large.

The gamification model can apply to both rural and urban area. The mean scores improve from 2.16 (Pre-test mean) to 5.62 (Post-test mean). The mean increases about 160%. The improvement of rural mean score (162%) is greater than urban mean score (158%). In the urban area, e-learning and motivation group provide much improvement than control group for low and high GPA students. Moreover, e-learning group shows the best performance among three groups (e-learning and motivation, e-learning, and control group) for medium GPA students. In rural area, e-learning and motivation group shows the best performance for all GPA levels. This model can apply and help teacher to teach various subjects for the higher standard than traditional teaching (control group).

5.3.1.2 Academic achievement (GPA)

From table 5.5, the overall analysis on score improvement is done by employing the Kruskal-Wallis Test. From hypothesis H_{14}, the null hypothesis was rejected. GPA have a significant effect on score improvement at a level of 0.03 ($\chi^2(2) = 17.58$). Additionally. Epsilon square (ε^2) provided interpretation of effect sizes, indicate that $\varepsilon^2 = 0.07$ represents moderate effect size. GPA have moderate influence on score improvement. Furthermore, high GPA groups have a significantly higher mean (Mean = 3.90) of their difference in pre and post- test scores than medium GPA (Mean = 3.26) and low GPA group (Mean = 3.07).

5.3.1.3 Learning time

Due to table 5.5, from hypothesis H_{15}, the null hypothesis was rejected. Learning time have a significant effect on score improvement at a level of 0.01 ($\chi^2(2) = 116.33$). Additionally. Epsilon square (ε^2) provided interpretation of effect sizes, indicate that $\varepsilon^2 = 0.46$ represents strong effect size. Learning time have strong influence on score improvement. Moreover, obsessed group (60 mins per day) have a significantly higher mean (Mean = 4.43) of their difference in pre and post- test scores than regular group (30 mins per day) (Mean = 3.29) and serious group (45 mins per day) (Mean = 5.45) than casual group (15 mins per day) (Mean = 2.83) respectively.

5.3.1.4 Personality type

Due to table 5.5, Hypothesis H_{16}, the null hypothesis was rejected. Personality type have a significant effect on score improvement at a level of 0.01 ($\chi^2(2) = 89.63$). Additionally. Epsilon square (ε^2) provided interpretation of effect sizes, indicate that $\varepsilon^2 = 0.35$ represents relatively strong effect size. Personality type have relatively strong influence on score improvement. Furthermore, artisan (Mean = 4.23) and rational group (Mean = 4.12) have a significantly higher mean of their difference in pre and post- test scores than guardian (Mean = 3.20) and idealist group (Mean = 2.54).

5.3.1.5 Satisfaction

Refer to table 5.5, Hypothesis H_{17}, the null hypothesis was rejected. Satisfaction have a significant effect on score improvement at a level of 0.01 ($\chi^2(2) = 49.30$). Additionally. Epsilon square (ε^2) provided interpretation of effect sizes, indicate that $\varepsilon^2 = 0.19$ represents relatively strong effect size. Satisfaction has relatively strong influence on score improvement. In addition, students who satisfy with gamification model (Mean = 3.75) have a significantly higher mean of their difference in pre and post- test scores than students who partly satisfy (Mean = 2.70) and not satisfy with gamification model (Mean = 2.33).

From the result, GPA and satisfaction are a significant factor that are influence on learning outcome for both urban and rural areas. Students will get more learning improvement, if they get high GPA and satisfaction. According to learning time, students who spend 60 mins per day for game learning, provide the best performance among others (15, 30, 45 mins per day). However, students who spend 30 or 45 mins per day, get the same improvement on learning outcome. Similarly, personality types provide the influence on learning outcome.

Artisan and rational group can learn and receive the game contents better than guardian and idealist group.

5.3.1.6 Gamification factors

From table 5.5, gamification factors have divided into 6 factors (openness and acceptance, social skill, game engagement, emotion, difficulty level and storyline, and time restriction)

Refer to H_{18}, the null hypothesis was rejected. Openness and acceptance factor will have a significant effect on score improvement at a level of 0.01 ($\chi^2(2) = 15.97$). Additionally. Epsilon square (ε^2) provided interpretation of effect sizes, indicate that $\varepsilon^2 = 0.06$ represents moderate effect size. Openness and acceptance factor have moderate influence on score improvement. Students who prefer to learn by educational gamification as my primary contents (Mean = 3.69) have a significantly higher mean of their difference in pre and post- test scores than students who partly prefer (Mean = 3.19) and not prefer to learn by gamification model (Mean = 2.87). Due to H_{19}, the null hypothesis was rejected. Social skill factor will have a significant effect on score improvement at a level of 0.01 ($\chi^2(2) = 29.92$). Additionally. Epsilon square (ε^2) provided interpretation of effect sizes, indicate that $\varepsilon^2 = 0.11$ represents moderate effect size. Social skill factor has moderate influence on score improvement. Students who agree that educational gamification improves their social skill. (Mean = 3.81) have a significantly higher mean of their difference in pre and post- test scores than students who partly agree (Mean = 3.16) and disagree (Mean = 2.93). According to H_{20}, the null hypothesis was accepted. Game engagement factor does not have a significant effect on score improvement at a level of 0.19 ($\chi^2(2) = 3.22$). Additionally. Epsilon square (ε^2) provided interpretation of effect sizes, indicate that $\varepsilon^2 = 0.01$ represents negligible effect size. Game engagement factor has negligible influence on score improvement. Due to H_{21}, the null hypothesis was accepted. Emotion factor does not have a significant effect on score improvement at a level of 0.065 ($\chi^2(2) = 5.45$). From hypothesis H_{22}, the null hypothesis was rejected. Additionally. Epsilon square (ε^2) provided interpretation of effect sizes, indicate that $\varepsilon^2 = 0.02$ represents weak effect size. Emotion factor has weak influence on score improvement. Difficulty level and storyline factor will have a significant effect on score improvement at a level of 0.01 ($\chi^2(2) = 13.79$). Additionally. Epsilon square (ε^2) provided interpretation of effect sizes, indicate that $\varepsilon^2 = 0.05$ represents moderate effect size. Difficulty level and storyline factor has moderate influence on score improvement. Furthermore, students who agree that difficulty level and storyline motivate them to learn more on gamification (Mean = 3.68) have a significantly higher mean of their difference in pre and post- test scores than students who partly agree (Mean = 3.23) and disagree (Mean = 2.93). According to H_{23}, the null hypothesis was accepted. Time restriction factor will not have a significant effect on score improvement at a level of 0.56 ($\chi^2(2) = 1.14$). Additionally. Epsilon square (ε^2) provided interpretation of effect sizes, indicate that $\varepsilon^2 = 0.004$ represents negligible effect size. Time restriction factor has negligible influence on score improvement.

Gamification factors influence on learning outcome for both urban and rural areas. Openness and acceptance, social skill, and difficulty level and storyline factors provide the strong influence with learning outcome. These factors can motivate students to learn and receive the learning contents more on gamification.

Table 5.5 Results of Kruskal-Wallis Test for GPA, learning time, personality type, satisfaction, and gamification factors that effect on score improvement

Factors	**Factors**			**Score improvement**				
	N	***M***	***SD***	***N***	***MR***	***SD***	***df***	**Chi-Square**
GPA	251	1.99	0.81	251	3.45	1.14	2	17.58*
Low GPA				85	129.69	0.12		
Medium GPA				83	119.52	0.12		
High GPA				83	128.69	0.12		
Learning time	251	2.64	1.16	251	3.45	1.14	2	116.33**
15 mins/day				60	58.35	0.11		
30 mins/day				49	119.46	0.12		
45 mins/day				61	117.80	0.10		
60 mins/day				81	186.24	0.09		
Personality type	251	2.62	1.18	251	3.45	1.14	2	89.63**
Guardian				62	67.99	0.12		
Artisan				55	174.31	0.13		
Idealist				50	168.29	0.15		
Rationalists				84	112.01	0.08		
Satisfaction	251	2.67	0.58	251	3.45	1.14	2	49.30**
				15	58.57	0.23		

Disagree								
Partly agree				51	79.01	0.11		
Agree				185	144.42	0.08		
Game factor								
Openness	251	2.48	0.66	251	3.45	1.14	2	15.97**
Disagree				24	89.92	0.20		
Partly agree				82	111.22	0.10		
Agree				145	140.33	0.10		
Social skill	251	2.28	0.84	251	3.45	1.14	2	29.92**
Disagree				63	93.10	0.12		
Partly agree				54	110.86	0.12		
Agree				134	147.57	0.10		
Game engagement	251	2.44	0.68	251	3.45	1.14	2	3.22
Disagree				28	115.34	0.25		
Partly agree				83	137.01	0.11		
Agree				140	121.61	0.09		
Emotion	251	2.24	0.81	251	3.45	1.14	2	5.45
Disagree				59	137.59	0.14		
Partly agree				72	134.43	0.13		
Agree				120	115.24	0.10		
Difficulty level	251	2.45	0.69	251	3.45	1.14	2	13.79*
Disagree				30	92.07	0.20		
Partly agree				78	115.12	0.11		
Agree				143	139.05	0.09		
Time restriction	251	2.31	0.72	314	3.45	1.14	2	1.14
Disagree				38	117.18	0.17		
Partly agree				96	131.10	0.12		
Agree				117	124.68	0.10		

*p<0.05, ***p<0.01*, *M* =Mean, *MR* =Mean Rank, *SD* = Standard deviation, *df* = Degree of freedom

5.3.2 Effectiveness of model features Analysis

Effectiveness of model features were conducted using a paired *t*-test to define whether the data are significantly different from each other. Moreover, the effectiveness index (EI) was used to find improvements in learning potential in terms of percentages.

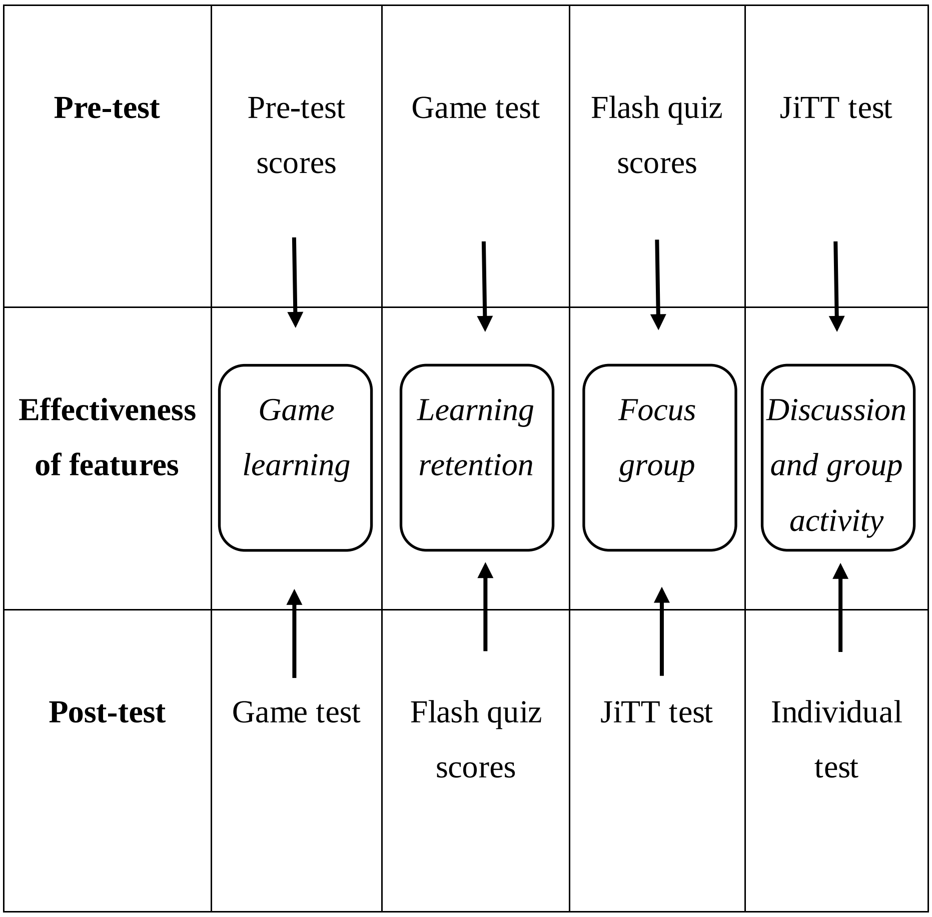


Figure 5.10 Model features charts

5.3.2.1 Difference between pre-test and game test (Game learning)

The overall analysis on the difference between pre-test and game test score is done by employing the Paired *t*-test, Cohen's *d* effect size, Skewness, and Kurtosis. Refer to Figure 5.9, the difference between pre-test and game test score distribution is approximately symmetric positive skewed (Skewness= 0.28). Moreover, Kurtosis distribution (-0.28) is Platykurtic that the tails are shorter and thinner. Additionally, Cohen provided interpretation of effect sizes, revealing that d = 1.45 represents a very large effect size. The difference between pre-test and game test score is very large. Testing H_{24}, the null hypothesis was rejected. There is a significant difference between pre-test and game test score at a level of 0.01 (t-value = -20.79). Moreover, there is a significant difference between pre-test and game test score in a model

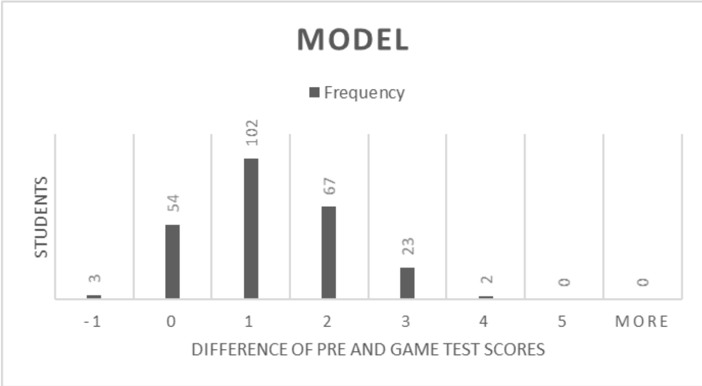


Figure 5.11 Difference of pre-test and game test score in MOOC hybrid learning model histogram

From Figure 5.12, in urban area, the difference between pre-test and game test score distribution is approximately symmetric positive skewed (Skewness= 0.35). Moreover, Kurtosis distribution (-0.44) is Platykurtic that the tails are shorter and thinner. In addition, Cohen provided interpretation of effect sizes, revealing that d = 1.4 represents a very large effect size. The difference between pre-test and game test score is very large. Hypothesis $H_{24.1}$, the null hypothesis was rejected. There is a significant difference between pre-test and game test score in a group of urban students at a level of 0.01 (t-value = -13.68).

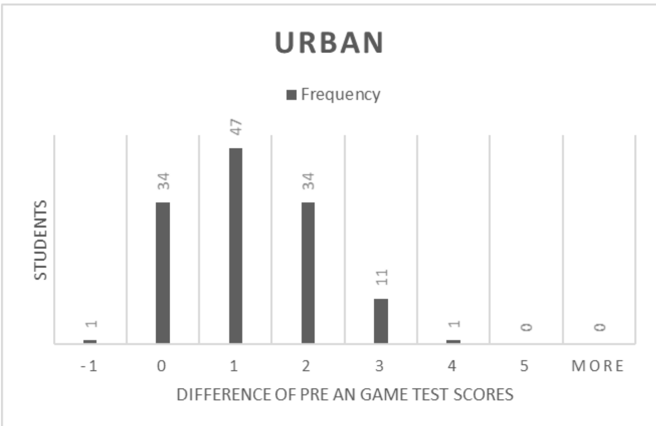


Figure 5.12 Difference of pre-test and game test score in urban area histogram

From Figure 5.13, in rural area, the difference between pre-test and game test score distribution is approximately symmetric positive skewed (Skewness= 0.31). Moreover, Kurtosis distribution (-0.11) is Platykurtic that the tails are shorter and thinner. Additionally. Cohen provided interpretation of effect sizes, revealing that d = 1.5 represents a very large effect size. The difference between pre-test and game test score is very large. Hypothesis $H_{24.2}$, the null hypothesis was rejected. There is a significant difference between pre-test and game test score in a group of rural students at a level of 0.01 (t-value = -15.27).

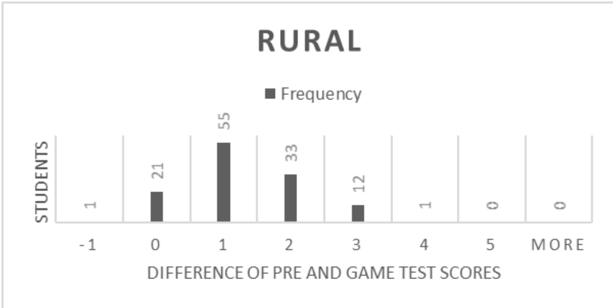


Figure 5.13 Difference of pre-test and game test score in rural area histogram

Table 5.6 Results of difference between Pre test and Game test scores of all students

Group	Pre test scores			Game test scores			Difference between means		
	N	M_1	SD_1	***N***	M_2	SD_2	M_2-M_1 *[95% CI]*	***t*-value**	***d***
Control	85	2.03	0.75	85	3.26	1.01	1.25 [1.03, 1.46]	-11.30**	1.3
E-learning	83	2.12	0.72	83	3.21	0.79	1.09 [0.89, 1.30]	-10.57**	1.4
E-learning and Motivation	83	2.34	0.87	83	3.72	0.80	1.37 [1.17, 1.57]	-13.80**	1.6

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

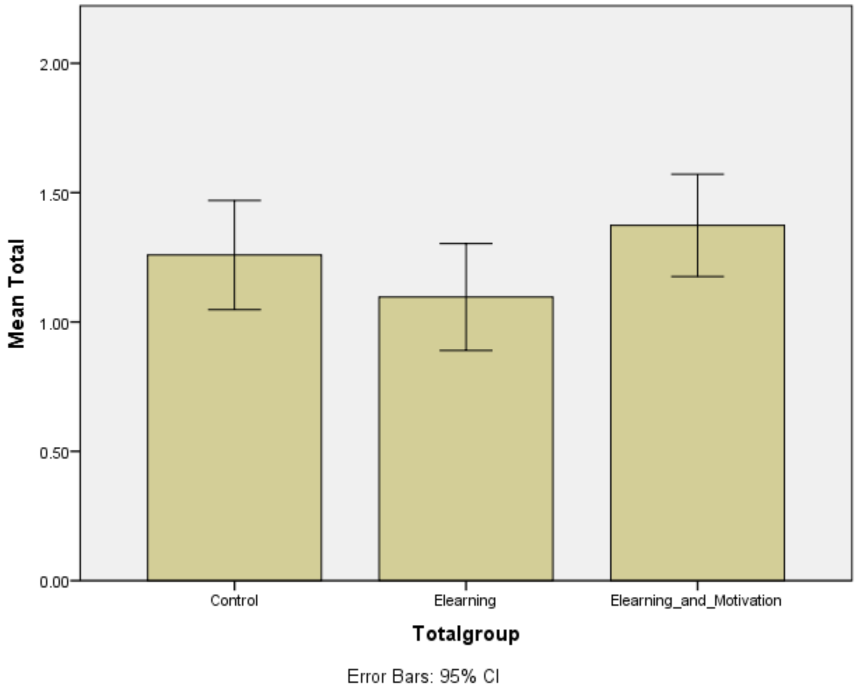


Figure 5.14 Results of difference between Pre-test and Game test scores of all students

For all students control group, the mean score for Game test scores (*M*=3.26, *SD*=1.01) was higher than the mean score for pre-test scores (*M*=2.03, *SD*=0.75). The observed difference between means was 1.25, 95% CI [1.03, 1.46], *t* (83) = -11.30, *p*<.001. Cohen's d effect size between the independent and dependent variable was *d*=1.3, and this represents a very large effect size. Due to e-learning group, the mean score for Game test scores (*M*=3.21, *SD*=0.79) was higher than the mean score for pre-test scores (*M*=2.12, *SD*=0.72). The difference between means was 1.09, 95% CI [0.89, 1.30], *t* (81) = -10.57, *p*<.001. Cohen's d effect size represents a very large effect size (*d*=1.4). Refer to e-learning and motivation group, the mean score for Game test scores (*M*=3.72, *SD*=0.80) was higher than the mean score for pre-test scores (*M*=2.34, *SD*=0.87). The difference between means was 1.37, 95% CI [1.17, 1.57], *t* (81) = -13.80, *p*<.001. Cohen's d effect size was 1.6. The difference between Pre-test and Game test scores is very large.

Table 5.7 Results of difference between Pre test and Game test scores of urban students

Group	Pre test scores			Game test scores			Difference between means		
	N	M_1	SD_1	*N*	M_2	SD_2	M_2-M_1 [95% CI]	*t*-value	*d*
Control	43	2.04	0.77	43	3.26	0.97	1.21 [0.89, 1.53]	-8.11**	1.3
E-learning	41	2.12	0.71	41	3.19	0.81	1.07 [0.76, 1.38]	-6.97**	1.4
E-learning and Motivation	44	2.39	0.86	44	3.58	0.86	1.19 [0.88, 1.50]	-8.46**	1.3

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

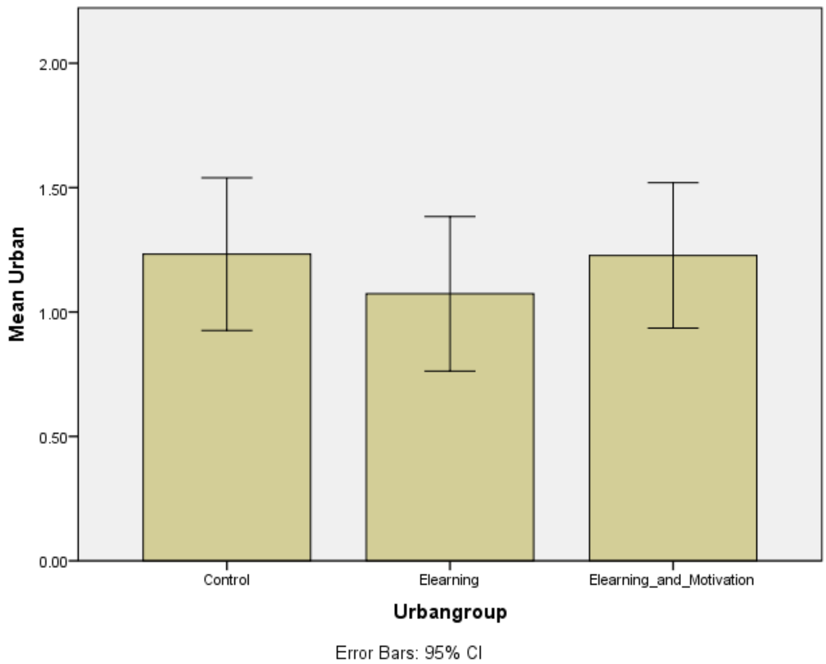


Figure 5.15 Results of difference between Pre test and Game test scores of urban students

For all students control group, the mean score for Game test scores (*M*=3.26, *SD*=0.97) was higher than the mean score for pre-test scores (*M*=2.04, *SD*=0.77). The observed difference between means was 1.21, 95% CI [0.89, 1.53], *t* (41) = -8.11, *p*<.001. Cohen's d effect size between the independent and dependent variable was *d*=1.3, and this represents a very large effect size. Due to e-learning group, the mean score for Game test scores (*M*=3.19, *SD*=0.81) was higher than the mean score for pre-test scores (*M*=2.12, *SD*=0.71). The difference between means was 1.07, 95% CI [0.76, 1.38], *t* (39) = -6.97, *p*<.001. Cohen's d effect size represents a very large effect size (*d*=1.4). Refer to e-learning and motivation group, the mean score for Game test scores (*M*=3.58, *SD*=0.86) was higher than the mean score for pre-test scores (*M*=2.39, *SD*=0.86). The difference between means was 1.19, 95% CI [0.88, 1.50], t (42) = -8.46, p<.001. Cohen's d effect size was 1.3. The difference between Pre-test and Game test scores is very large.

Table 5.8 Results of difference between Pre test and Game test scores of rural students

Group	**Pre test scores**			**Game test scores**			**Difference between means**		
	N	M_1	SD_1	***N***	M_2	SD_2	M_2-M_1 **[95% CI]**	***t*-value**	***d***
Control	42	2.02	0.77	42	3.20	1.05	1.20 [0.88, 1.52]	-7.77**	1.2
E-learning	42	2.15	0.74	42	3.23	0.77	1.07 [0.79, 1.35]	-7.91**	1.4
E-learning and Motivation	39	2.33	0.89	39	3.87	0.73	1.53 [1.27, 1.80]	-11.68**	1.8

*p<0.05, ***p<0.01, M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

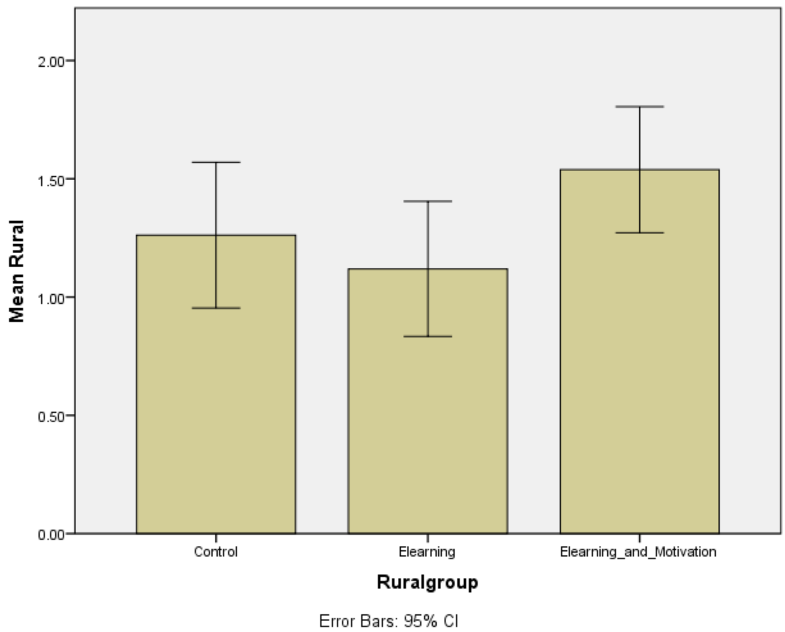


Figure 5.16 Results of difference between Pre test and Game test scores of rural students

For all students control group, the mean score for Game test scores (M=3.20, SD=1.05) was higher than the mean score for pre-test scores (M=2.02, SD=0.77). The observed difference between means was 1.20, 95% CI [0.88, 1.52], t (40) = -7.77, p<.001. Cohen's d effect size between the independent and dependent variable was d=1.2, and this represents a very large effect size. Due to e-learning group, the mean score for Game test scores (M=3.23, SD=0.77) was higher than the mean score for pre-test scores (M=2.15, SD=0.74). The difference between means was 1.07, 95% CI [0.79, 1.35], t (39) = -7.91, p<.001. Cohen's d effect size represents a very large effect size (d=1.4). Refer to e-learning and motivation group, the mean score for Game test scores (M=3.87, SD=0.73) was higher than the mean score for pre-test scores (M=2.333, SD=0.89). The difference between means was 1.53, 95% CI [1.27, 1.80], t (37) = -11.68, p<.001. Cohen's d effect size was 1.8. The difference between Pre-test and Game test scores is very large.

In urban area, e-learning and motivation, and e-learning group can retain students' knowledge better than control group in high and low GPA levels, respectively. For example, low GPA, mean of e-learning group reduce only 6%. Although, control group reduce 10%. However, control group shows less reducing in mean for medium GPA levels. Furthermore, in rural area, e-learning and motivation group can retain students' knowledge better than other methods for all GPA levels. For instance, low GPA, mean of e-learning and motivation group reduce only 8%. On the other hand, control group reduce 12%. E-learning and motivation, and e-learning method play the important role in learning retention for most of GPA level.

5.3.2.2 Difference between game test and flash quiz score (Learning retention)

The overall analysis on the difference between game test and flash quiz score is done by employing the Paired *t*-test, Cohen's *d* effect size, Skewness, and Kurtosis. Refer to Figure 5.44, the difference between game test and flash quiz score distribution is moderately negative skewed (Skewness=-0.64). Moreover, Kurtosis distribution (0.59) is Leptokurtic that the tails are longer and fatter. Additionally, Cohen provided interpretation of effect sizes, revealing that *d* = 0.71 represents a medium effect size. The difference between game test and flash quiz score is very large. Testing H_{25}, the null hypothesis was rejected. There is a significant difference between game test and flash quiz score at a level of 0.01 (t-value = 14.92). Moreover, there is a significant difference between game test and flash quiz score

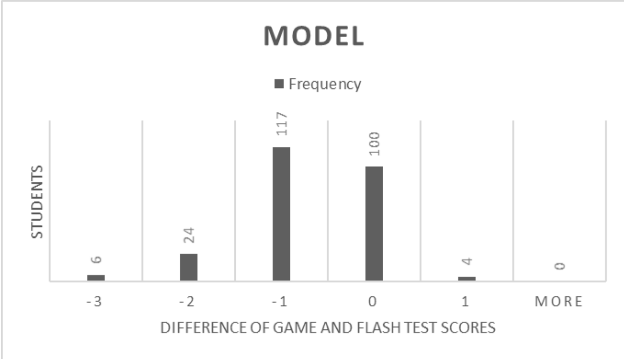


Figure 5.17 Difference of game test and flash quiz score in MOOC hybrid learning model histogram

From Figure 5.18, In urban area, the difference between game test and flash quiz score distribution is approximately symmetrical negative skewed (Skewness= -0.40). Moreover, Kurtosis distribution (0.40) is Leptokurtic that the tails are longer and fatter. In addition, Cohen provided interpretation of effect sizes, revealing that *d* = 0.63 represents a medium effect size. The difference between game test and flash quiz score is medium. Hypothesis $H_{25.1}$, the null hypothesis was rejected. There is a significant difference between game test and flash quiz score in a group of urban students at a level of 0.01 (t-value = 9.99).

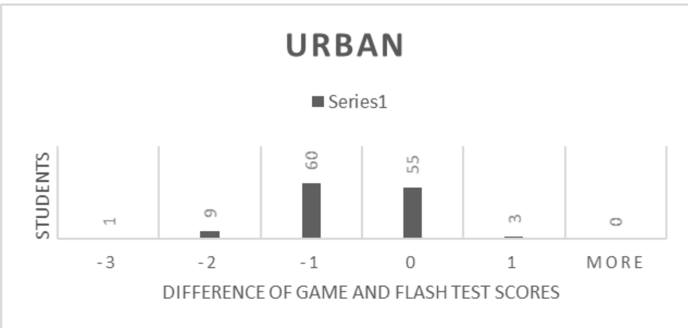


Figure 5.18 Difference of game test and flash quiz score in urban area histogram

From Figure 5.19, In rural area, the difference between game test and flash quiz score distribution is moderately negative skewed (Skewness= -0.72). Moreover, Kurtosis distribution (0.37) is Leptokurtic that the tails are longer and fatter. Additionally. Cohen provided interpretation of effect sizes, revealing that *d* = 0.78 represents a large effect size. The difference between game test and flash quiz score is large. Hypothesis $H_{25.2}$, the null hypothesis was rejected. There is a significant difference between game test and flash quiz score in a group of rural students at a level of 0.01 (t-value = 10.80).

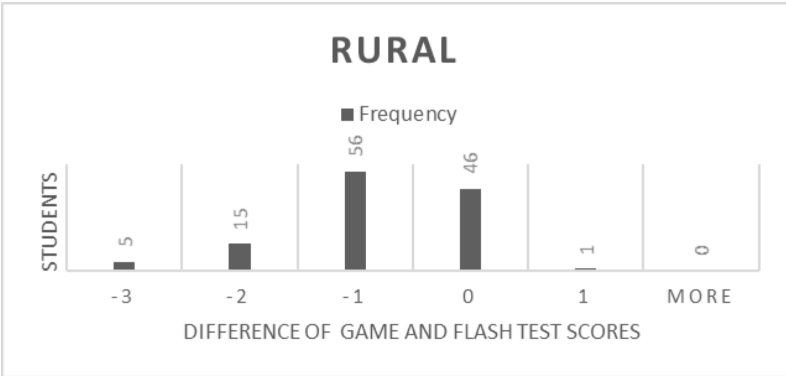


Figure 5.19 Difference of game test and flash quiz score in rural area histogram

Table 5.9 Results of difference between Game test and flash quiz scores of all students

Group	Game test scores			Flash quiz scores			Difference between means		
	N	***M₁***	***SD₁***	***N***	***M₂***	***SD₂***	***M₂-M₁ [95% CI]***	***t*-value**	***d***
Control	85	3.26	1.01	85	2.53	1.11	-0.75 [-0.91, -0.60]	9.21**	0.6
E-learning	83	3.21	0.79	83	2.42	0.93	-0.79 [-0.98, -0.60]	8.36**	0.9
E-learning and Motivation	83	3.72	0.80	83	3.13	1.02	-0.59 [-0.73, -0.44]	7.89**	0.6

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

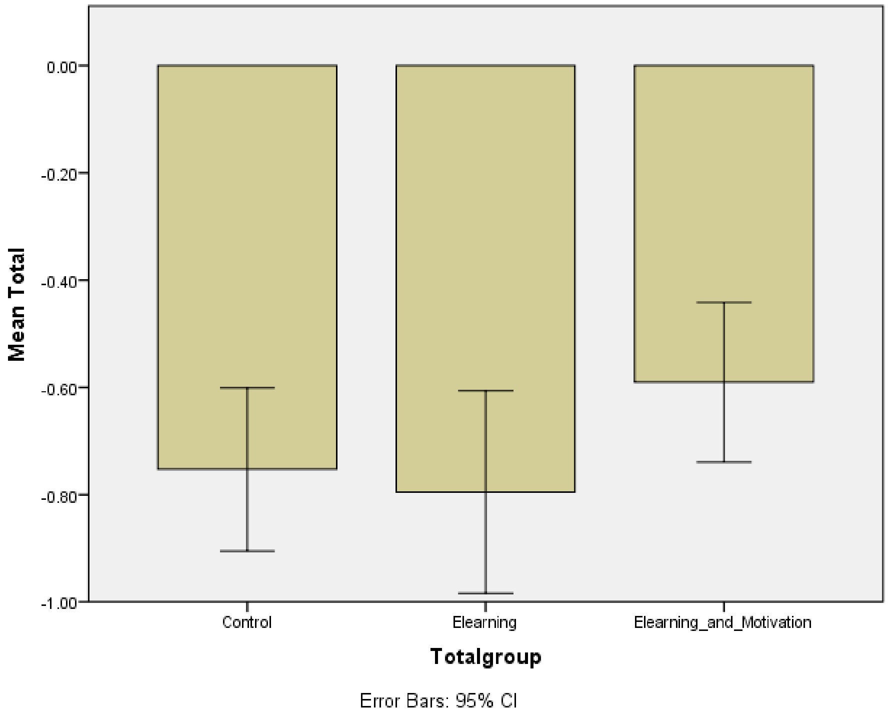


Figure 5.20 Results of difference between Game test and flash quiz scores of all students

For all students control group, the mean score for flash quiz scores (*M*=2.53, *SD*=1.11) was lower than the mean score for Game test scores (*M*=3.26, *SD*=1.01). The observed difference between means was -0.75, 95% CI [-0.91, -0.60], t (83) = 9.21, p<.001. Cohen's d effect size between the independent and dependent variable was d=0.6, and this represents a medium effect size. Due to e-learning group, the mean score for flash quiz scores (*M*=2.42, *SD*=0.93) was lower than the mean score for Game test scores (*M*=3.21, *SD*=0.79). The difference between means was -0.79, 95% CI [-0.98, -0.60], t (81) = 8.36, p<.001. Cohen's d effect size represents a medium effect size (d=0.9). Refer to e-learning and motivation group, the mean score for flash quiz scores (*M*=3.13, *SD*=1.02) was lower than the mean score for Game test scores (*M*=3.72, *SD*=0.80). The difference between means was -0.59, 95% CI [-0.73, -0.44], t (81) = 7.89, p<.001. Cohen's d effect size was 0.6. The difference between pre and post-test score is medium.

Table 5.10 Results of difference between Game test and flash quiz scores of urban students

Group	Game test scores			Flash quiz scores			Difference between means		
	N	M_1	SD_1	***N***	M_2	SD_2	M_2-M_1 [95% CI]	***t*-value**	***d***
Control	43	3.26	0.97	43	2.60	1.18	-0.65 [-0.89, -0.41]	5.92**	0.6
E-learning	41	3.19	0.81	41	2.63	0.82	-0.56 [-0.78, -0.33]	5.06**	0.6
E-learning and Motivation	44	3.58	0.86	44	3.00	1.04	-0.58 [-0.77, -0.39]	6.42**	0.6

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

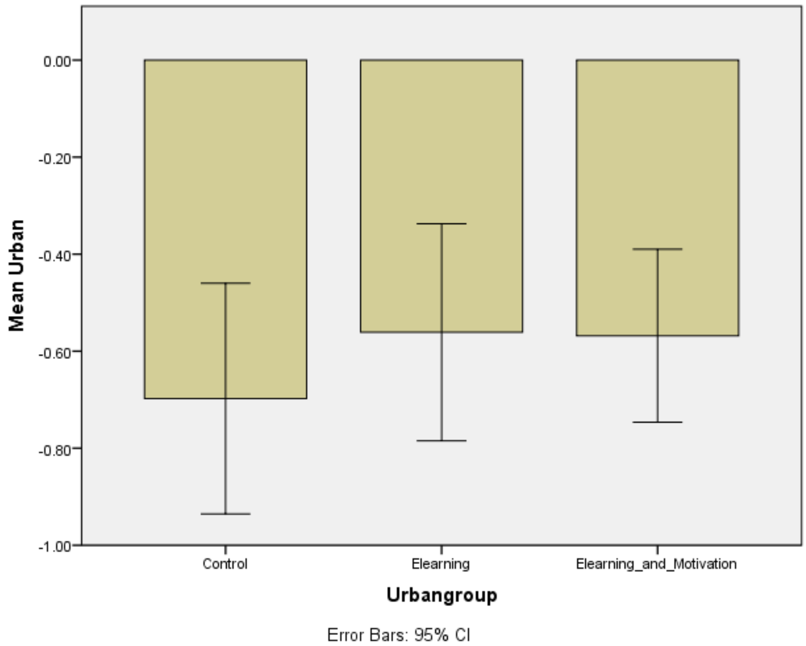


Figure 5.21 Results of difference between Game test and flash quiz scores of urban students

For all students control group, the mean score for flash quiz scores (*M*=2.60, *SD*=1.18) was lower than the mean score for Game test scores (*M*=3.26, *SD*=0.97). The observed difference between means was -0.65, 95% CI [-0.89, -0.41], *t* (41) = 5.92, *p*<.001. Cohen's d effect size between the independent and dependent variable was *d*=0.6, and this represents a medium effect size. Due to e-learning group, the mean score for flash quiz scores (*M*=2.62, *SD*=0.82) was lower than the mean score for Game test scores (*M*=3.19, *SD*=0.81). The difference between means was -0.56, 95% CI [-0.78, -0.33], t (39) = 5.06, p<.001. Cohen's d effect size represents a medium effect size (d=0.6). Refer to e-learning and motivation group, the mean score for flash quiz scores (M=3.00, SD=1.04) was lower than the mean score for Game test scores (M=3.58, SD=0.86). The difference between means was -0.58, 95% CI [-0.77, -0.39], t (42) = 6.42, p<.001. Cohen's d effect size was 0.6. The difference between pre and post-test score is medium.

Table 5.11 Results of difference between Game test and flash quiz scores of rural students

Group	Game test scores			Flash quiz scores			Difference between means		
	N	M_1	SD_1	N	M_2	SD_2	M_2-M_1 [95% CI]	t-value	d
Control	42	3.20	1.05	42	2.41	1.01	-0.82 [-1.02, -0.61]	7.13**	0.7
E-learning	42	3.23	0.77	42	2.15	0.93	-1.07 [-1.38, -0.76]	6.98**	1.2
E-learning and Motivation	39	3.87	0.73	39	3.25	1.01	-0.61 [-0.86, -0.36]	4.91**	0.7

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

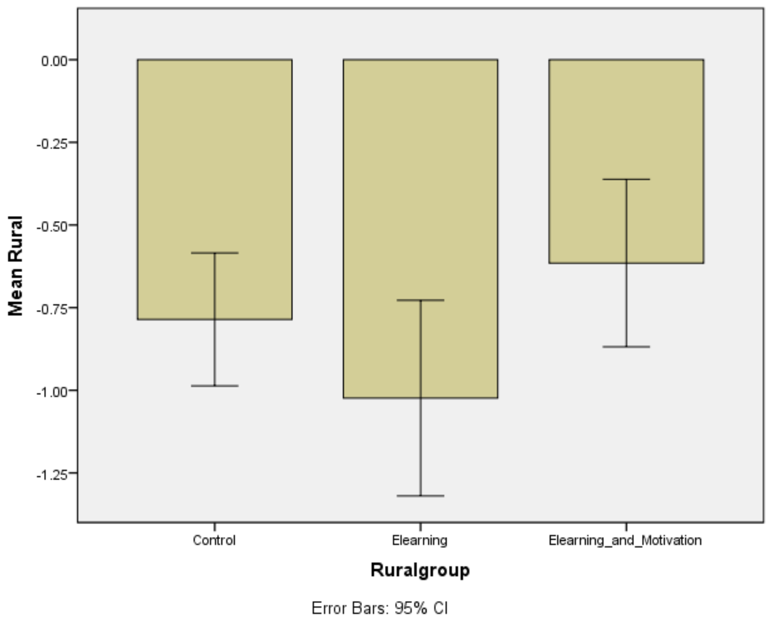


Figure 5.22 Results of difference between Game test and flash quiz scores of rural students

For all students control group, the mean score for flash quiz scores (M=2.41, SD=1.01) was lower than the mean score for Game test scores (M=3.20, SD=1.05). The observed difference between means was -0.82, 95% CI [-1.02, -0.61], t (39) = 7.13, p<.001. Cohen's d effect size between the independent and dependent variable was d=0.7, and this represents a medium effect size. Due to e-learning group, the mean score for flash quiz scores (M=2.15, SD=0.93) was lower than the mean score for Game test scores (M=3.23, SD=0.77). The difference between means was -1.07, 95% CI [-1.38, -0.76], t (39) = 6.98, p<.001. Cohen's d effect size represents a medium effect size (d=1.2). Refer to e-learning and motivation group, the mean score for flash quiz scores (M=3.25, SD=1.01) was lower than the mean score for Game test scores (M=3.87, SD=0.73). The difference between means was -0.61, 95% CI [-0.86, -0.36], t (37) = 4.91, p<.001. Cohen's d effect size was 0.7. The difference between pre and post-test score is medium.

In urban area, e-learning and motivation, and e-learning group can retain students' knowledge better than control group in high and low GPA levels, respectively. For example, low GPA, mean of e-learning group reduce only 6%. Although, control group reduce 10%. However, control group shows less reducing in mean for medium GPA levels. Furthermore, in rural area, e-learning and motivation group can retain students' knowledge better than other methods for all GPA levels. For instance, low GPA, mean of e-learning and motivation group reduce only 8%. On the other hand, control group reduce 12%. E-learning and motivation, and e-learning method play the important role in learning retention for most of GPA level.

5.3.2.3 Difference between flash quiz and JiTT test (Focus group)

The overall analysis on the difference between flash quiz and JiTT test score is done by employing the Paired *t*-test, Cohen's *d* effect size, Skewness, and Kurtosis. Refer to Figure 5.65, the difference between flash quiz and JiTT test score distribution is approximately symmetrical negative skewed (Skewness= -0.17). Moreover, Kurtosis distribution (0.26) is Leptokurtic that the tails are longer and fatter. Additionally, Cohen provided interpretation of effect sizes, revealing that d = 1.56 represents a very large effect size. The difference between flash quiz and JiTT test scoreis very large. From Table 5.3, Testing H_{26}, the null hypothesis was rejected. There is a significant difference between flash quiz and JiTT test at a level of 0.01 (t-value = -19.77). Moreover, there is a significant difference between flash quiz and JiTT test.

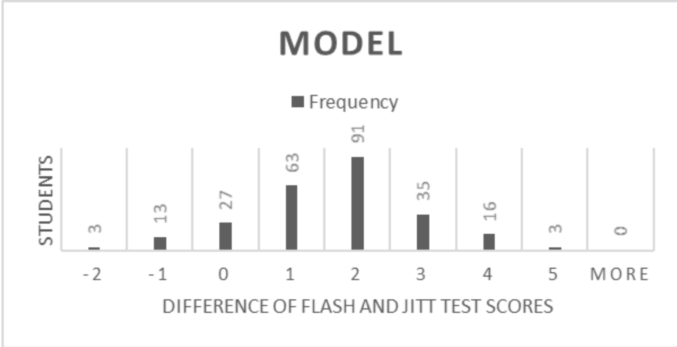


Figure 5.23 Difference of flash quiz and JiTT test score in MOOC hybrid learning model histogram

From Figure 5.24, in urban area, the difference between flash quiz and JiTT test score distribution is approximately symmetrical negative skewed (Skewness= -0.33). Moreover, Kurtosis distribution (-0.06) is perfectly symmetric. In addition, Cohen provided interpretation of effect sizes, revealing that *d* = 1.54 represents a very large effect size. The difference between flash quiz and JiTT test score is very large. Hypothesis $H_{26.1}$, the null hypothesis was rejected. There is a significant difference between flash quiz and JiTT test score in a group of urban students at a level of 0.01 (*t*-value = -13.03).

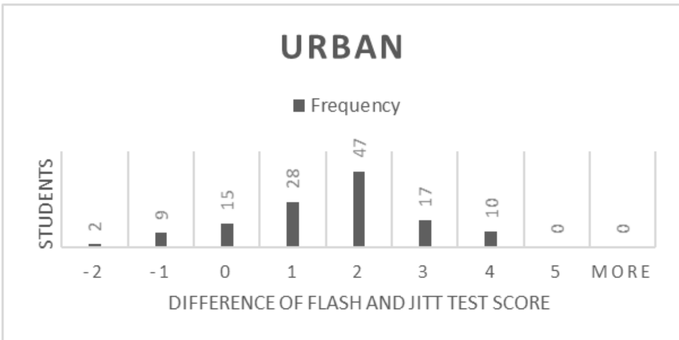


Figure 5.24 Difference of flash quiz and JiTT test score in urban area histogram

From Figure 5.25, in rural area, the difference between flash quiz and JiTT test score distribution is perfectly symmetric (Skewness= 0.07). Moreover, Kurtosis distribution (0.63) is Leptokurtic that the tails are longer and fatter. Additionally. Cohen provided interpretation of effect sizes, revealing that *d* = 1.57 represents a very large effect size. The difference between flash quiz and JiTT test score is very large. Hypothesis $H_{26.2}$, the null hypothesis was rejected. There is a significant difference between flash quiz and JiTT test score in a group of rural students at a level of 0.01 (t-value = -15.03).

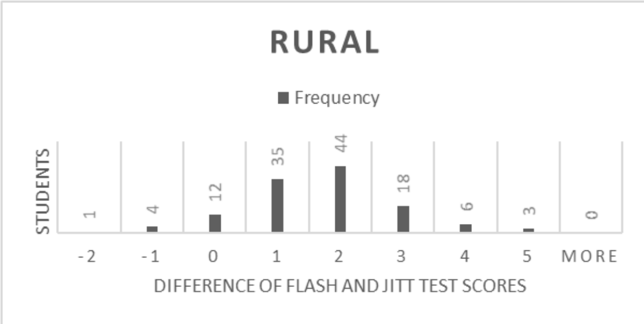


Figure 5.25 Difference of flash quiz and JiTT test score in rural area histogram

Table 5.12 Results of difference between Flash quiz and JiTT test score of all students

Group	**Flash quiz scores**			**JiTT test score**			**Difference between means**		
	N	M_1	SD_1	***N***	M_2	SD_2	M_2-M_1 [95% CI]	***t*-value**	***d***
Control	85	2.53	1.11	85	4.30	0.95	1.77 [1.50, 2.03]	-13.55**	1.7
E-learning	83	2.42	0.93	83	4.27	1.09	1.85 [1.55, 2.15]	-12.24**	1.8
E-learning and Motivation	83	3.13	1.02	83	5.05	1.01	1.92 [0.97, 1.52]	-13.07**	1.7

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

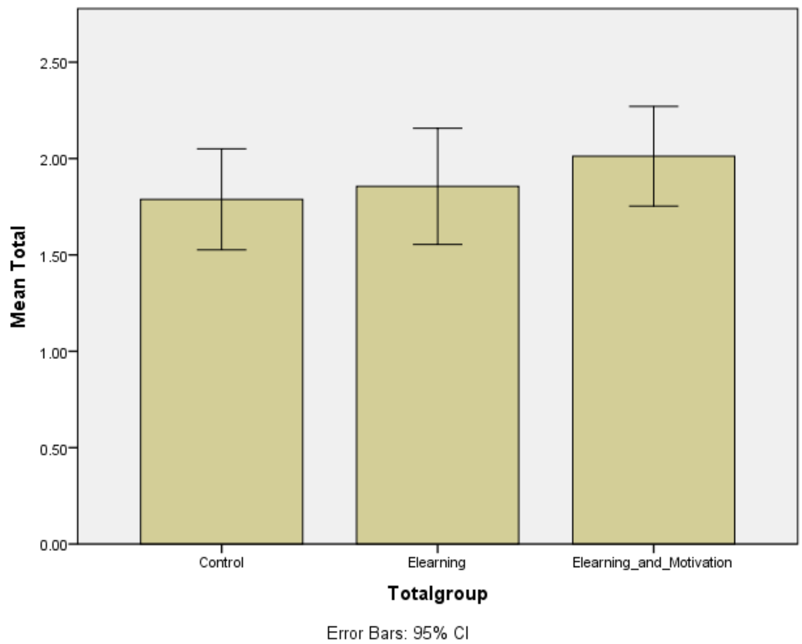


Figure 5.26 Results of difference between Flash quiz and JiTT test score of all students

For all students control group, the mean score for JiTT test score (*M*=4.30, *SD*=0.95) was higher than the mean score for Flash quiz scores (*M*=2.53, *SD*=1.11). The observed difference between means was 1.77, 95% CI [1.50, 2.03], *t* (83) = -13.55, *p*<.001. Cohen's d effect size between the independent and dependent variable was *d*=1.7, and this represents a very large effect size. Due to e-learning group, the mean score for JiTT test score (*M*=4.27, *SD*=1.09) was higher than the mean score for Flash quiz scores (*M*=2.42, *SD*=0.93). The difference between means was 1.85, 95% CI [1.55, 2.15], *t* (81) = -12.24, *p*<.001. Cohen's d effect size represents a very large effect size (*d*=1.8). Refer to e-learning and motivation group, the mean score for JiTT test score (*M*=5.05, *SD*=1.01) was higher than the mean score for Flash quiz scores (*M*=3.13, *SD*=1.02). The difference between means was 1.92, 95% CI [0.97, 1.52], *t* (81) = -13.07, *p*<.001. Cohen's d effect size was 1.7. The difference between pre and post-test score is very large.

Table 5.13 Results of difference between Flash quiz and JiTT test score of urban students

Group	Flash quiz scores			JiTT test score			Difference between means		
	N	M_1	SD_1	*N*	M_2	SD_2	M_2-M_1 [95% CI]	*t*-value	*d*
Control	43	2.60	1.18	43	4.31	0.87	1.70 [1.28, 2.12]	-13.55**	1.6
E-learning	41	2.63	0.82	41	4.31	1.08	1.68 [1.23, 2.13]	-12.24**	1.7
E-learning and Motivation	44	3.00	1.04	44	5.23	1.02	2.23 [0.86, 1.68]	-14.07**	1.8

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

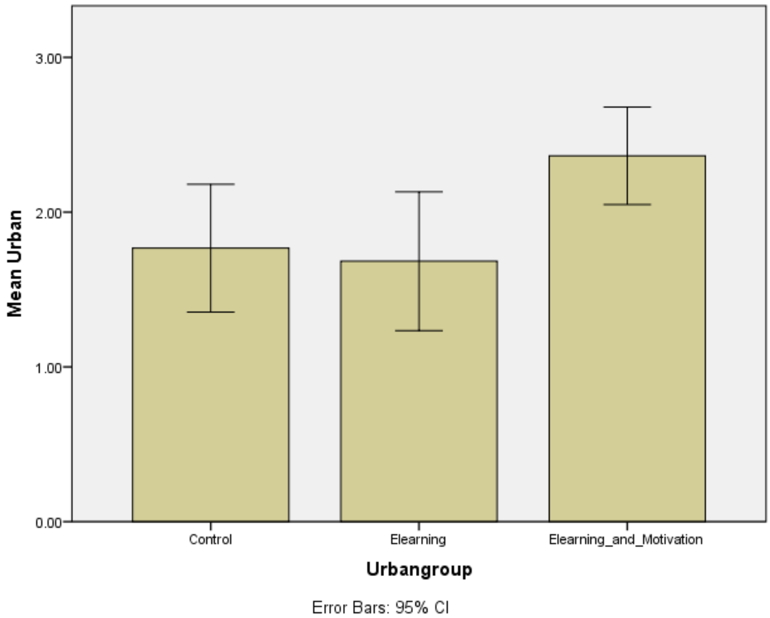


Figure 5.27 Results of difference between Flash quiz and JiTT test score of urban students

For all students control group, the mean score for JiTT test score (*M*=4.31, *SD*=0.87) was higher than the mean score for Flash quiz scores (*M*=2.60, *SD*=1.18). The observed difference between means was 1.70, 95% CI [1.28, 2.12], *t* (41) = -13.55, *p*<.001. Cohen's d effect size between the independent and dependent variable was *d*=1.6, and this represents a very large effect size. Due to e-learning group, the mean score for JiTT test score (*M*=4.31, *SD*=1.02) was higher than the mean score for Flash quiz scores (*M*=2.63, *SD*=0.82). The difference between means was 1.68, 95% CI [1.23, 2.13], *t* (39) = -12.24, *p*<.001. Cohen's d effect size represents a very large effect size (*d*=1.7). Refer to e-learning and motivation group, the mean score for JiTT test score (*M*=5.23, *SD*=1.02) was higher than the mean score for Flash quiz scores (*M*=3.00, *SD*=1.04). The difference between means was 2.23, 95% CI [0.86, 1.68], *t* (42) = -14.07, *p*<.001. Cohen's d effect size was 1.8. The difference between pre and post-test score is very large.

Table 5.14 Results of difference between Flash quiz and JiTT test score of rural students

Group	**Flash quiz scores**			**JiTT test score**			**Difference between means**		
	N	M_1	SD_1	***N***	M_2	SD_2	M_2-M_1 [95% CI]	***t*-value**	***d***
Control	42	2.41	1.01	42	4.25	1.04	1.84 [1.53, 2.15]	-10.78**	1.7
E-learning	42	2.15	0.93	42	4.15	1.11	2.00 [1.58, 2.41]	-9.83**	1.9
E-learning and Motivation	39	3.25	1.01	39	5.48	0.99	2.23 [0.85, 1.66]	-10.27**	1.8

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

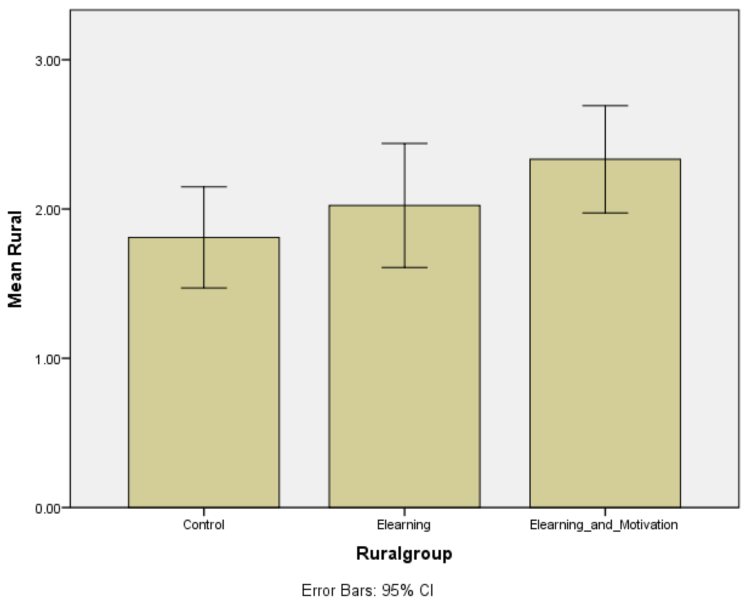


Figure 5.28 Results of difference between Flash quiz and JiTT test score of rural students

For all students control group, the mean score for JiTT test score (*M*=4.25, *SD*=1.04) was higher than the mean score for Flash quiz scores (*M*=2.41, *SD*=1.01). The observed difference between means was 1.84, 95% CI [1.53, 2.15], *t* (39) = -10.78, *p*<.001. Cohen's d effect size between the independent and dependent variable was *d*=1.7, and this represents a very large effect size. Due to e-learning group, the mean score for JiTT test score (*M*=4.15, *SD*=1.11) was higher than the mean score for Flash quiz scores (*M*=2.15, *SD*=0.93). The difference between means was 2.00, 95% CI [1.58, 2.41], *t* (40) = -9.83, *p*<.001. Cohen's d effect size represents a very large effect size (*d*=1.9). Refer to e-learning and motivation group, the mean score for JiTT test score (*M*=5.48, *SD*=0.99) was higher than the mean score for Flash quiz scores (*M*=3.25, *SD*=1.01). The difference between means was 2.23, 95% CI [0.85, 1.66], *t* (37) = -10.27, *p*<.001. Cohen's d effect size was 1.8. The difference between pre and post-test score is very large.

Focus group is the potential tool which can apply to both rural and urban area. The mean scores improve from 2.69 (flash quiz mean) to 4.33 (JiTT test mean). The mean increases about 60%. The improvement of rural mean score (64%) is greater than urban mean score (56%). In urban area, e-learning and motivation, and e-learning group show more improvement than control group for low and medium GPA levels, respectively. For instance, low GPA, mean of e-learning group improve 24% but control group improves only 22%. However, control group shows much improvement in mean for high GPA levels. Moreover, in the rural area, e-learning and motivation group shows much improving for low and medium GPA levels. For instance, low GPA, mean of e-learning and motivation group improves 26% but control group improves only 18%. Nevertheless, control group shows much improvement in mean for high GPA levels. From both area, e-learning methods show the effectiveness for low and medium GPA levels but control group shows much improvements for high GPA levels.

5.3.2.4 Difference between JiTT test and individual test score (Group activities)

The overall analysis on the difference between JiTT test and individual test score is done by employing the Paired *t*-test, Cohen's *d* effect size, Skewness, and Kurtosis. Refer to Figure 5.86, the difference between JiTT test and individual test score distribution is moderately positive skewed (Skewness=0.66). Moreover, Kurtosis distribution (-0.17) is Platykurtic that the tails are shorter and thinner. Additionally, Cohen provided interpretation of effect sizes, revealing that *d* = 1.05 represents a large effect size. The difference between JiTT test and individual test score is large. Testing H_{27}, the null hypothesis was rejected. There is a significant difference between JiTT test and individual test score at a level of 0.01 (t-value = -16.03). Moreover, there is a significant difference between JiTT test and individual test score

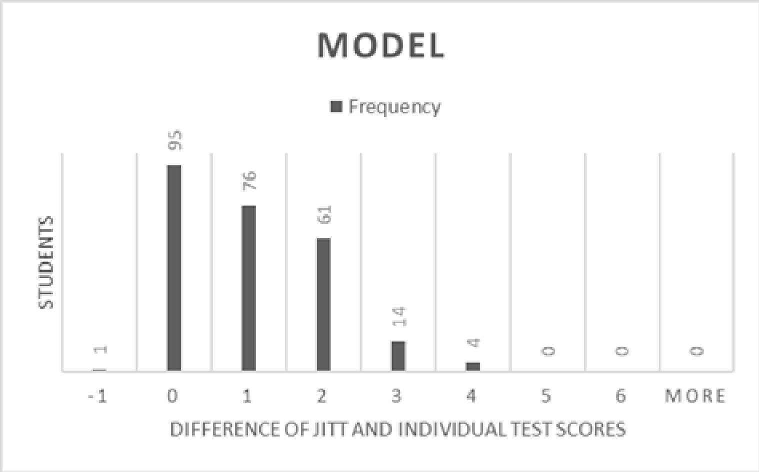


Figure 5.29 Difference of JiTT test and individual test score in MOOC hybrid learning model histogram

From Figure 5.30, In urban area, the difference between JiTT test and individual test score distribution is approximately symmetrical positive skewed (Skewness= 0.52). Moreover, Kurtosis distribution (-0.40) is Platykurtic that the tails are shorter and thinner. In addition, Cohen provided interpretation of effect sizes, revealing that *d* = 1.06 represents a large effect size. The difference between JiTT test and individual test score is large. Hypothesis $H_{27.1}$, the null hypothesis was rejected. There is a significant difference between JiTT test and individual test score in a group of urban students at a level of 0.01 (t-value = -11.72)

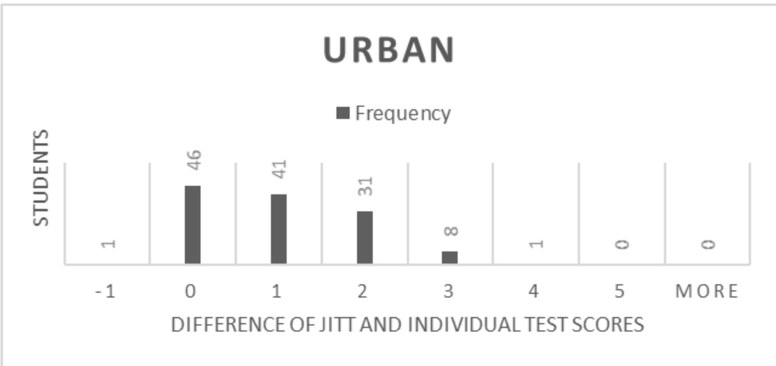


Figure 5.30 Difference of JiTT test and individual test score in urban area histogram

From Figure 5.31, In rural area, the difference between JiTT test and individual test score distribution is moderately positive skewed (Skewness= 0.78). Moreover, Kurtosis distribution (0.04) is Leptokurtic that the tails are longer and fatter. Additionally. Cohen provided interpretation of effect sizes, revealing that *d* = 1.05 represents a large effect size. The difference between JiTT test and individual test score is large. Hypothesis $H_{27.2}$, the null hypothesis was rejected. There is a significant difference between JiTT test and individual test score in a group of rural students at a level of 0.01 (t-value = -10.92).

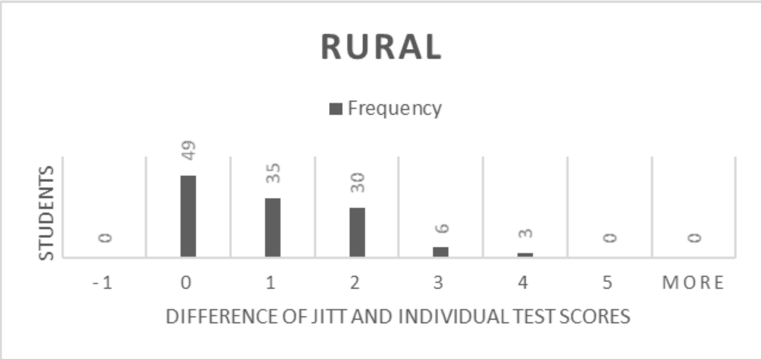


Figure 5.31 Difference of JiTT test and individual test score in rural area histogram

Table 5.15 Results of difference between JiTT test and Individual test score of all students

Group	JiTT test score			Individual test scores			Difference between means		
	N	***M_1***	***SD_1***	***N***	***M_2***	***SD_2***	***M_2-M_1 [95% CI]***	***t*-value**	***d***
Control	85	4.30	0.95	85	5.39	0.89	1.09 [0.89, 1.30]	-10.60**	1.1
E-learning	83	4.27	1.09	83	5.33	0.88	1.06 [0.82, 1.29]	-8.98**	1.0
E-learning and Motivation	83	5.05	1.01	83	5.28	0.90	1.10 [0.68, 1.12]	-9.89**	1.1

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

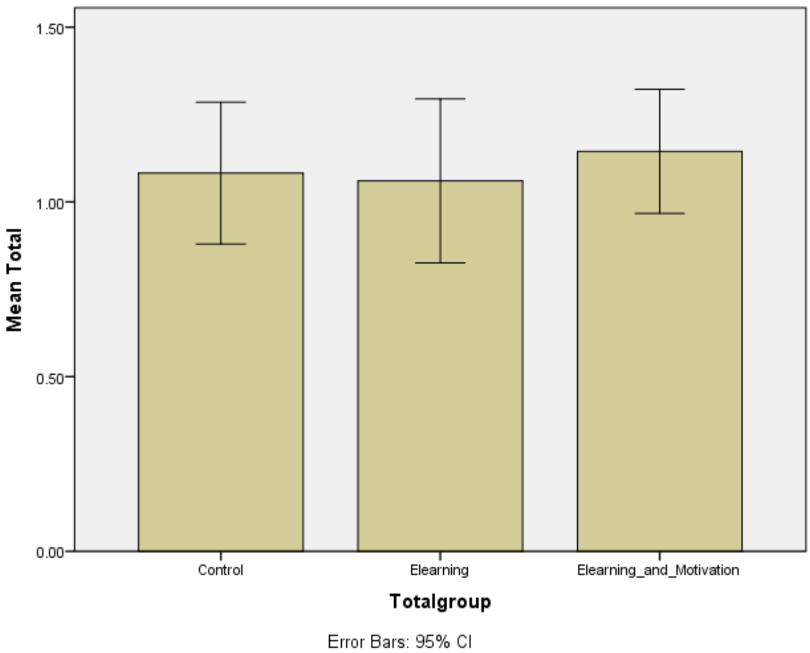


Figure 5.32 Results of difference between JiTT test and Individual test score of all students

For all students control group, the mean score for Individual test score (*M*=5.39, *SD*=0.89) was higher than the mean score for JiTT test scores (*M*=4.30, *SD*=0.95). The observed difference between means was 1.09, 95% CI [0.89, 1.30], *t* (83) = -10.60, *p*<.001. Cohen's d effect size between the independent and dependent variable was *d*=1.1, and this represents a medium effect size. Due to e-learning group, the mean score for Individual test score (*M*=5.33, *SD*=0.88) was higher than the mean score for JiTT test scores (*M*=4.27, *SD*=1.09). The difference between means was 1.09, 95% CI [0.82, 1.29], *t* (81) = -8.98, *p*<.001. Cohen's d effect size represents a medium size (*d*=1.0). Refer to e-learning and motivation group, the mean score for Individual test score (*M*=5.28, *SD*=0.90) was higher than the mean score for JiTT test scores (*M*=5.05, *SD*=1.01). The difference between means was 1.10, 95% CI [0.68, 1.12], *t* (81) = -9.89, *p*<.001. Cohen's d effect size was 1.1. The difference between pre and post-test score is medium.

Table 5.16 Results of difference between JiTT test and Individual test score of urban students

Group	JiTT test score			Individual test scores			Difference between means		
	N	*M₁*	*SD₁*	*N*	*M₂*	*SD₂*	*M₂-M₁ [95% CI]*	*t*-value	*d*
Control	43	4.31	0.87	43	5.39	0.86	1.07 [0.77, 1.36]	-7.78**	1.2
E-learning	41	4.31	1.08	41	5.31	0.90	1.00 [0.67, 1.32]	-6.24**	1.0
E-learning and Motivation	44	5.23	1.02	44	5.24	0.96	1.10 [0.64, 1.30]	-7.86**	1.3

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

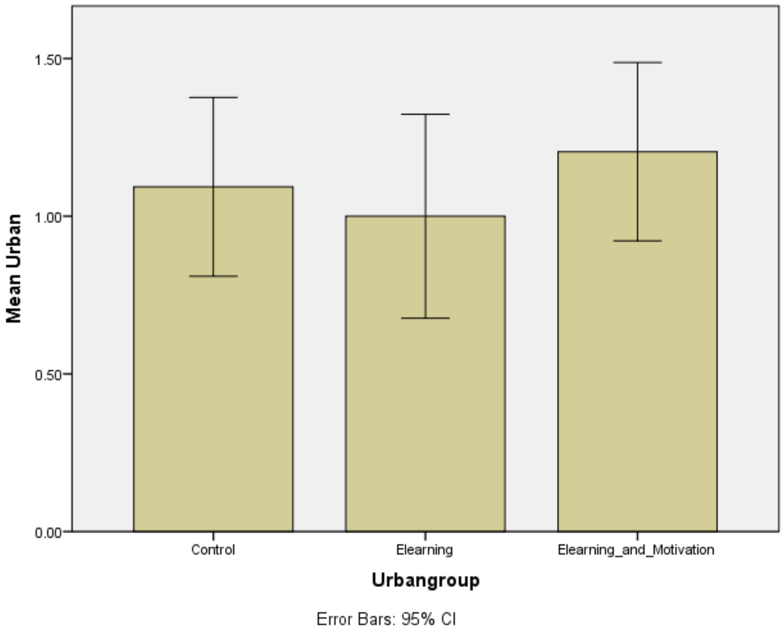


Figure 5.33 Results of difference between JiTT test and Individual test score of urban students

For all students control group, the mean score for Individual test score (M=5.39, SD=0.86) was higher than the mean score for JiTT test scores (M=4.31, SD=0.87). The observed difference between means was 1.07, 95% CI [0.77, 1.36], t (41) = -7.78, p<.001. Cohen's d effect size between the independent and dependent variable was d=1.2, and this represents a medium effect size. Due to e-learning group, the mean score for Individual test score (M=5.31, SD=0.90) was higher than the mean score for JiTT test scores (M=4.31, SD=1.08). The difference between means was 1.00, 95% CI [0.67, 1.32], t (39) = -6.24, p<.001. Cohen's d effect size represents a medium size (d=1.0). Refer to e-learning and motivation group, the mean score for Individual test score (M=5.24, SD=0.96) was higher than the mean score for JiTT test scores (M=5.23, SD=1.02). The difference between means was 1.10, 95% CI [0.64, 1.30], t (42) = -7.86, p<.001. Cohen's d effect size was 1.3. The difference between pre and post-test score is very large.

Table 5.17 Results of difference between JiTT test and Individual test score of rural students

Group	**JiTT test score**			**Individual test scores**			**Difference between means**		
	N	***M_1***	***SD_1***	***N***	***M_2***	***SD_2***	***M_2-M_1 [95% CI]***	***t*-value**	***d***
Control	42	4.25	1.04	42	5.33	0.92	1.07 [0.75, 1.39]	-7.13**	1.0
E-learning	42	4.15	1.11	42	5.35	0.90	1.20 [0.83, 1.57]	-6.41**	1.1
E-learning and Motivation	39	4.14	0.99	39	5.35	0.84	1.21 [0.52, 1.16]	-7.35**	1.1

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation, CI = Confidence interval; *d* = Cohen's d effect size

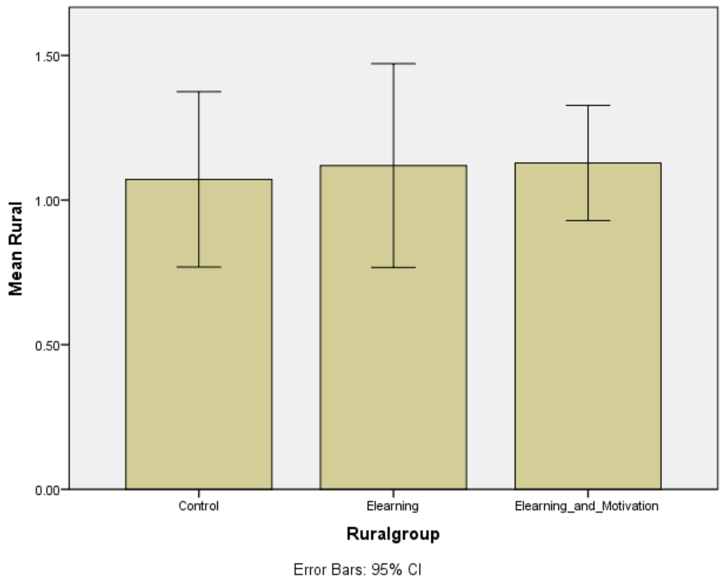


Figure 5.34 Results of difference between JiTT test and Individual test score of rural students

For all students control group, the mean score for Individual test score (M=5.33, SD=0.92) was higher than the mean score for JiTT test scores (M=4.25, SD=1.04). The observed difference between means was 1.07, 95% CI [0.75, 1.39], t (40) = -7.13, p<.001. Cohen's d effect size between the independent and dependent variable was d=1.0, and this represents a medium effect size. Due to e-learning group, the mean score for Individual test score (M=5.35, SD=0.90) was higher than the mean score for JiTT test scores (M=4.15, SD=1.11). The difference between means was 1.20, 95% CI [0.83, 1.57], t (40) = -6.41, p<.001. Cohen's d effect size represents a medium size (d=1.1). Refer to e-learning and motivation group, the mean score for Individual test score (M=5.35, SD=0.84) was higher than the mean score for JiTT test scores (M=4.14, SD=0.99). The difference between means was 1.31, 95% CI [0.52, 1.16], t (37) = -7.35, p<.001. Cohen's d effect size was 1.1. The difference between pre and post-test score is medium.

Surprisingly, in urban areas, control group shows the best improvement for all GPA levels. For example, low GPA, mean of control group improve 23% but e-learning and motivation group improves only 19%. Similarly, in the rural area, control group shows much improving for low and medium GPA levels. For instance, low GPA, mean of control group improves 26% but e-learning and motivation group improves 13%. However, high GPA, mean of e-learning group improves 18% which is higher than control group (15%).

Table 5.18 Results of *t*-test for effectiveness of model features

Group	Pre-test score			Game test scores			*t*-value
	N	***M***	**SD**	***N***	***M***	**SD**	
All students	251	2.16	0.79	251	3.40	0.89	-20.79**
Urban student	128	2.17	0.78	128	3.35	0.88	-13.68**
Rural student	123	2.15	0.79	123	3.44	0.91	-15.27**
Group	**Game test scores**			**Flash quiz scores**			***t*-value**
	N	***M***	**SD**	***N***	***M***	**SD**	
All students	251	3.40	0.89	251	2.69	1.07	14.92**
Urban student	128	3.35	0.88	128	2.75	1.02	9.99**
Rural student	123	3.44	0.91	123	2.64	1.11	10.80**
Group	**Flash quiz scores**			**JiTT test score**			***t*-value**
	N	***M***	**SD**	***N***	***M***	**SD**	
All students	251	2.69	1.07	251	4.33	1.02	19.77**
Urban student	128	2.75	1.02	128	4.31	0.99	-13.03**
Rural student	123	2.64	1.11	123	4.34	1.05	15.03**
Group	**JiTT test score**			**Individual test scores**			***t*-value**
	N	***M***	**SD**	***N***	***M***	**SD**	
All students	251	4.33	1.02	251	5.34	0.89	-16.03**
Urban student	128	4.31	0.99	128	5.32	0.91	-11.72**
Rural student	123	4.34	1.05	123	5.36	0.87	-10.92**

*p<0.05, ***p<0.01*, *M* =Mean, *SD* = standard deviation

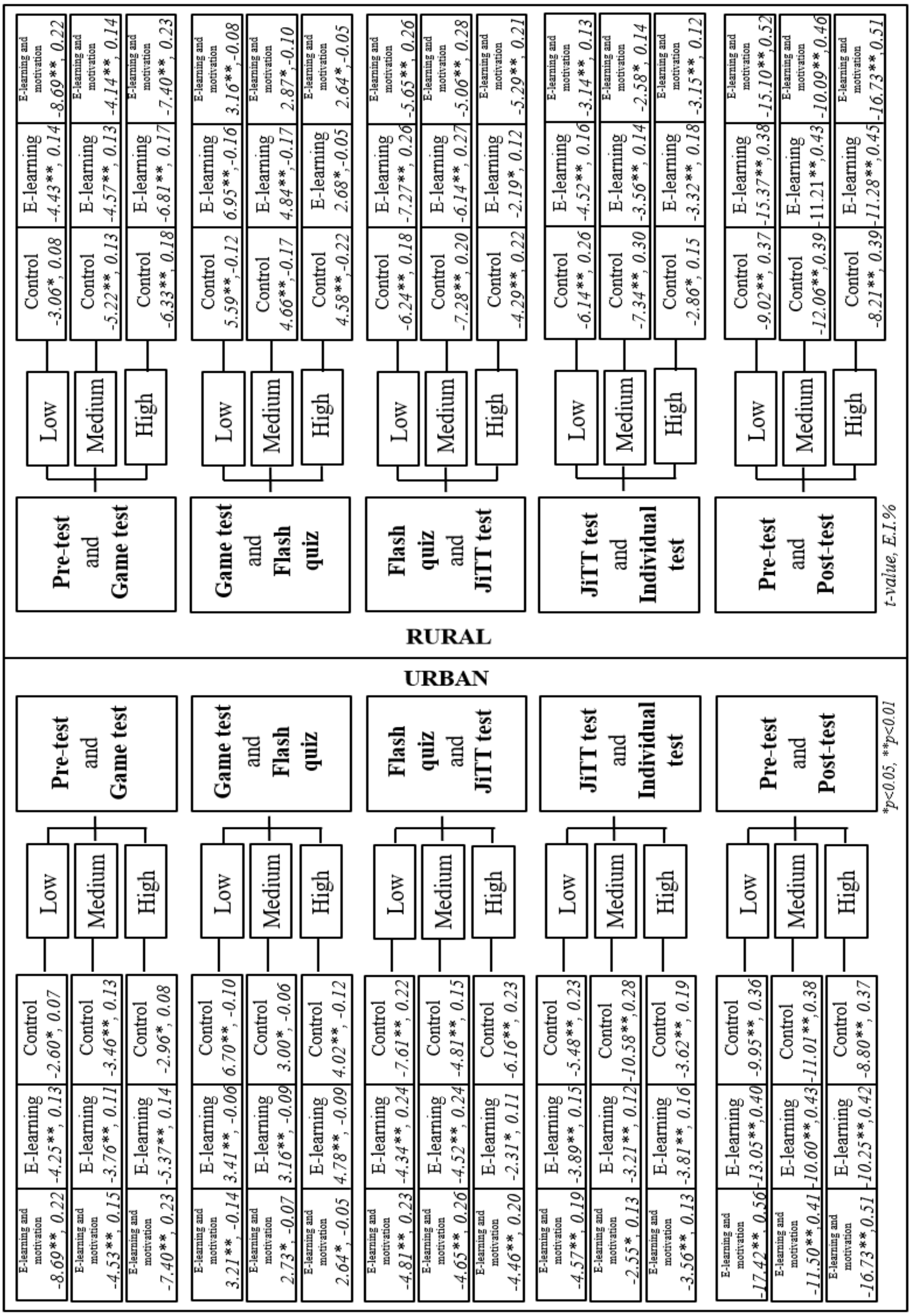


Figure 5.35 Results of t-test for effectiveness of model features

5.4. Discussion and conclusion

5.4.1. Results

Educational gamification model, designed by combining gamification, flipped learning, and active learning, is effective for students in rural and urban schools. The learning improvement of rural students are greater than urban students. In urban area, educational gamification model shows the best performance for all GPA levels. Similarly, in the rural area, this model provides much improvement than traditional teaching for all academic students. This model can apply and help teacher to teach various subjects for the higher standard than traditional teaching (control group)

The internal factors of GPA and satisfaction have a significantly effect on learning outcome for both urban and rural areas. Students will get more learning improvement, if they get high GPA and satisfaction. GPA and satisfaction are good indicators that can predict the learning outcome. Furthermore, learning time, students who spend 60 mins per day for game learning, provide the best performance among others (15, 30, 45 mins per day). However, students who spend 30 or 45 mins per day, get the same improvement on learning outcome. Similarly, personality types provide the influence on learning outcome. Artisan and rational group can learn and receive the learning contents better than guardian and idealist group.

Gamification factors influence on learning outcome for both urban and rural areas. Openness and acceptance, social skill, and difficulty level and storyline factors provide the strong influence with learning outcome. These factors can motivate students to learn and receive the learning contents more on gamification.

Furthermore, Game learning have a significantly effect improving learning outcome for both areas. The learning improvement of rural group is greater than urban group. Similarly, focus group is also the potential tool which can apply to both rural and urban area. However, the rural group shows greater improvement than urban group. This factor will help students fulfill the lacking contents from the game learning and gain a deeper understanding of their lessons. According to group activities and peer tutoring improved scores for rural and urban students. Even more, group activities affect to all academic group. Surprisingly, the learning improvement of urban group is equal with rural group. Students can gain more knowledge if they can discuss and solve problems together. High potential students will be tutoring to low potential students who embarrass to ask the teacher. Social activities are a high potential tool that should be integrated into every learning models.

Regarding retention, students forgot some content after one week and forgot about 20% of the content. Urban students can retain their knowledge better than rural students. In urban area, educational gamification model can retain students' knowledge better than other control group for high and low GPA levels. Furthermore, in the rural area, this model can retain students' knowledge better than traditional teaching for all GPA levels. After some time, teachers should review the core contents by using content warm-up sessions before teaching the new materials.

5.4.2. Discussion

The results we obtained in our present study suggest that educational gamification has very good potential as a way to solve education problem. It can help low skilled teachers teach various kinds of subjects to students. It can also enable students to work and learn independently at their own pace, place and time. Using this tool, teachers become companions and supporter, helping students to learn collaboratively with their classmates.

In the study we conducted, most rural students got low GPA grades. They were low potential students who had a hard time understanding the teaching contents, and some of them were very slow in their ability to grasp the knowledge that the teachers were trying to impart to them. The results we obtained with the educational gamification model we propose suggest that the model enables students to improve their learning abilities, regardless of their age.

We designed this model through the use of an interactive game interface that takes the students' educational level and the storyline into consideration. We are confident that it enables students to easily understand the teaching contents and get immediate feedback from the program. If students choose wrong answers, thus indicating that they did not understand the contents correctly, the program will repeat the same content with another example and check their understanding again. Most rural students do not deeply understand the contents and rarely recall the knowledge they have learned after the class is over. However, after one week of using our educational gamification model, they forgot only 20% of the contents they had learned. This rate is quite impressive when compared to that obtained from other e-learning models such as the one reported by Singh et al. in 1994. In the same survey, however, Singh et al. reported that age affects learning retention and that younger students are more likely to forget teaching contents. This is because elder students have developed a high ability to concentrate and thus are better able to retain the knowledge they have absorbed than younger students. The model we propose enables students to concentrate on content and try to reach new achievements for the next levels by motivating them with interactive game mechanisms such as level, story line, and time restriction. In this way, they are able to measure their progress in each learning stage and compare it with that of their classmates. These tools force them to get more absorbed in the proceedings and get more practice time, which forces them to increase their memory ability and learning retention. The results we obtained show that there is a correlation between students' learning ability and the degree of satisfaction they are able to get while learning. They were satisfied with the educational gamification procedure that taught them standard designed contents with interactive game activities. It appears that if they are satisfied with the game interface they will be able to concentrate on contents, and that this will affect their ability to learn and retain knowledge (Wu, et al, 2010). Group discussions and social skills are social elements that will help students gain a deeper understanding through exchanges of thoughts and opinions. They can help students absorb more knowledge and retain it for a longer time. Though some students tend to be afraid to ask teachers questions in class, participating in group discussions can help them overcome this tendency. In this regard, a gamification environment that allows for social interaction and collaboration can also lead to positive learning outcomes (Carr, 2000). In such an environment, for students to improve their scores they should spend at least 45-60 minutes per day (15 minutes per game, 3-4 games per day). In 1969 Allen et al. suggested that more practice time would be effective in helping students to improve their learning and retention abilities. If one considers Keirsey personality type, students in all groups can improve their learning ability but rationalist and artisan students do better than others because they have strategic talent and can work independently. Gamification is only effective when it encourages specific behaviors (Small, 2013).

In Thailand, the biggest problems in rural education are a lack of well qualified and experienced teachers and teaching materials. The model we propose aims to overcome these deficiencies by providing high quality materials and teaching support features. Teachers needed time to understand all the processes and tools it provides, but they were satisfied with the improvement the students achieved in using it. The educational gamification process helps low skilled teachers teach various kinds of subjects. Through group discussions and focus group they enable them to focus on individual students instead of trying to "handle" the class as a whole. For example, they are able to participate directly in student group activities and focus group session. They can also make use of social elements to compensate for their lack of education experience. Furthermore, students can use it to help one another. The social activities and game mechanisms the model provides seem to be effective for students by allowing them to work together, helping them to absorb more knowledge and retain it for a longer time.

However, problems remain in applying the model, including infrastructure and equipment. There is a greater need for Internet accessibility and computers, which hopefully will become more affordable in the future through economic developments. For example, it will become possible to transfer Internet connections from mobile signals and public WiFi hotspots. This will enable the model to help rural students reach a standard education level and solve the problem of educating low-performing students in remote areas.

5.4.3. Conclusion

Educational gamification is an important educational tool for improving students' ability. However, it is quite difficult to apply this tool because it requires expensive equipment such as computers, mobile phones, and tablets. Presently this is a huge barrier for students and schools in remote areas. In the future, hopefully, technological devices will become more affordable and gamification tools will play an increasingly important role in education. The study results we obtained showed that factors such as satisfaction, openness and acceptance, social skills, and level of difficulty and story line had an effect on learning ability. Another key factor in improving students' learning ability and memory was the amount of time they spent using the program per day. Social elements such as group discussion help students gain more understanding by helping them to explore their diverse perspectives and improve their communication skills. With respect to Keirsey personality type, rationalists and artisans group improve more than others in terms of learning ability. Therefore, an educational gamification model can improve students' ability to learn, increase their learning retention, and provide a solution to solving education problems in rural areas where there are low potential students. Teachers can use it to teach subjects they are not particularly skilled in and students can use it to learn by themselves and ask the teacher when they need any advice.

CHAPTER 6
CONCLUSION AND IMPLICATIONS

6.1. Conclusion

In recent years, e-learning tends to be core tool to support the learning process. Although the Internet increases the quality of communication and connection, distance learning still requires the effective model to support and design a better learning process to fit each students' learning style. Massive online open courses (MOOCS), flipped learning, active learning, and gamification are the main approaches to fulfill the equality gap in education. These new models have been designed for students in leading education countries to support their own culture. However, a massive problem occurs when these technologies are applied to other countries. Especially in rural area which lack of teacher and teaching material. Moreover, most rural students are the low-performing student, who have to study in Rural and Low-Income Schools (RLISs). They do not have the opportunity to reach the standard education. Developing MOOCs hybrid learning and educational gamification model to reduce the number of low-performing students are an effective way to enhance an education system.

In this research, we analyze the rural education problems by focusing on three main issues; student, teacher, and infrastructure. We developed MOOCs hybrid learning and educational gamification model, which is a combination of MOOCs contents, flipped learning, active learning, and gamification to improve students' abilities (learning outcome). Students learn new material from MOOCs and gamification contents outside of class then use class time to assimilating knowledge through problem-solving, peer tutoring, group discussion, and group activities. These are the main features of models that are superior to current educational model that used in distance learning. After implemented our proposed model, we expect the improving of students 'abilities and satisfaction.

To achieve research objective, the field test was conducted to collect student's data and behavior (As presented in Chapter 4 and 5). Then, two models were compared to find the effectiveness and suitability for each group of students, demonstrated as below. The interesting findings are summary as following.

- Chapter 4: This chapter investigates the design of the MOOCs hybrid learning model and analyses the students' data obtained from urban and rural schools. Moreover, we identify the factors and features that affect learning outcome. From the result, our proposed model is effective in term of learning outcome. Refer to the learning outcome, MOOCs video learning and focus group (JiTT) significantly improved scores. Moreover, group activities, such as peer tutoring, group discussion, and forum discussions, help students gain a deeper understanding of their lessons. Satisfaction positively affects learning outcome. Regarding memory and attention, students forgot some content after one week and forgot about 20% of the content
- Chapter 5: This chapter presents the effectiveness of education gamification model, which are tested by urban and rural students. Moreover, this chapter also finds the factors that influence on learning outcome. By examining the result, educational gamification model enables students to improve their learning abilities. After one week of using this model, students forgot only 30% of the contents that they had learned. In addition, interactive game mechanisms such as difficulty level, story line, and social skill, enables students to concentrate on contents and try to reach new achievements. Group discussions will help students gain a deeper understanding through exchanges of thoughts and opinions. Results also show a link between students' learning ability and the degree of satisfaction they are able to get while learning. More learning time would be effective in helping students to improve their learning abilities. Due to Keirsey personality type, students in all groups can improve their learning ability but rationalist and artisan students do better than the others because they have strategic talent and can work independently.

6.1.1 Learning effectiveness comparison

Due to learning effectiveness, sub effect of two model were tested regarding three groups; low, medium, and high- potential students and three methods; control, e-learning, and e-learning and motivation. In order to test the ability of each model, pair t-test was used to compare the mean value of pre and post-test score to determine whether the data are significantly different from each other. The difference of mean and percentage change are applied to compare their effectiveness.

From table 6.1 describes learning effectiveness of MOOCs hybrid learning model. E-learning and motivation method shows much improvement in mean score than control and e-learning method for all group (low, medium and high potential students) in both rural and urban area. MOOCs will display the highest performance in combination with e-learning and motivation method.

Table 6.1 Learning effectiveness comparison of MOOCs hybrid learning model

Academic achievement	MOOCs hybrid learning					
	Urban area			Rural area		
	Control	E-learning	E-learning and motivation	Control	E-learning	E-learning and motivation
Low	**5.06** (233%) *(2.17, 7.23)*	**5.67** (262%) *(2.16, 7.77)*	**5.9** (295%) *(2.00, 7.93)*	**5.22** (330%) *(1.58, 6.82)*	**5.20** (225%) *(2.31, 7.52)*	**5.71** (263%) *(2.17, 7.88)*
Medium	**4.39** (197%) *(2.22, 6.61)*	**5.5** (246%) *(2.23, 7.70)*	**5.82** (254%) *(2.29, 8.11)*	**4.44** (264%) *(1.68, 6.12)*	**5.15** (233%) *(2.21, 7.36)*	**6.16** (308%) *(2.00, 8.16)*
High	**4.00** (165%) *(2.41, 6.47)*	**4.75** (197%) *(2.40, 7.15)*	**5.80** (256%) *(2.26, 8.00)*	**4.15** (202%) *(2.05, 6.23)*	**5.30** (258%) *(2.05, 7.35)*	**6.05** (302%) *(2.00, 8.05)*

Mean different
(% change)
(Pre-test mean, Post-test mean)

From table 6.2 describes learning effectiveness of educational gamification model. According to low academic achievement group, e-learning and motivation method shows much improvement in mean score than other methods in urban school. However, e-learning method shows the same improvement as control group in rural area. Educational gamification model shows good performance when apply it with motivation for urban students. However, for rural student, this model should be only exercise or supporting contents. Moreover, medium academic achievement group, e-learning method shows much improvement in mean score than other methods in urban school. Meanwhile, e-learning and motivation method display much improvement than other methods in rural area. Urban student can learn from this model without any motivation or incentive. However, this model shows better performance when apply with motivation for rural students. Furthermore, high academic achievement group, e-learning and motivation method shows much improvement in mean score than other methods in both areas.

Table 6.2 Learning effectiveness comparison of Educational gamification model

Academic achievement	**Educational gamification**					
	Urban area			**Rural area**		
	Control	E-learning	E-learning and motivation	Control	E-learning	E-learning and motivation
Low	**3.00** (165%) *(1.81, 4.81)*	**3.12** (138%) *(2.25, .5.37)*	**4.50** (225%) *(2.00, 6.50)*	**3.09** (174%) *(1.72, 4.81)*	**3.00** (132%) *(2.26, 5.26)*	**3.40** (170%) *(2.00, 5.40)*
Medium	**3.20** (200%) *(1.60, 4.80)*	**2.86** (254%) *(2.20, 5.06)*	**3.19** (134%) *(2.37, 5.56)*	**3.36** (218%) *(1.54, 4.90)*	**3.37** (149%) *(2.25, 5.62)*	**3.53** (147%) *(2.40, 5.93)*
High	**2.85** (118%) *(2.41, 5.21)*	**3.20** (132%) *(2.41, 5.61)*	**4.00** (176%) *(2.26, 6.26)*	**3.00** (125%) *(2.40, 5.40)*	**3.50** (148%) *(2.35, 5.85)*	**4.00** (181%) *(2.20, 6.20)*

Mean different
(% change)
(Pre-test mean, Post-test mean)

6.1.2 Two models' factors comparison

According to the effective factors of both models, four similar factors and features are applied in both MOOC hybrid learning and educational gamification model. Firstly, social factor is one of the effective factors that requires students to exchanges the knowledge and a deeper engagement with the course content. It forces students to work in teams toward the attainment of some goal and help them to explore diverse perspectives. Moreover, it also improves student communication skills and develops a better understanding of student. Many social features are used in this research for example; peer tutoring, group activities, and group discussion. However, only group discussion was applied in both models. Next, focus group and JiTT help students with private time for discussing with their teacher. Teacher can find the lacking contents and fulfil them on time. Thirdly, student satisfaction is the intrinsically motivation, which integrates student feeling, and attitude from aggregating all benefits of an e-learning environment. Finally, academic achievement (GPA) is an internal factor which can identify the previous knowledge of students. Results from 570 participants in both models indicate that group discussion, focus group, student satisfaction, and academic achievement are the important factors that have positive relationship with learning outcome. Students who have high score in these factors, will have a high learning outcome.

6.1.3 Model features effectiveness comparison

Due to main teaching content, MOOCs video learning and game learning show the best performance when combine with motivation and some incentive for all group (low, medium and high potential students) in both rural and urban area. Due to MOOCs hybrid learning model, the total mean scores of post-tests increase about 245% from the pre-test. The improvement of rural mean score (263%) is greater than urban mean score (231%). According to educational gamification model, the total mean scores of post-tests increase about 160% from the pre-test. The improvement of rural mean score (162%) is greater than urban mean score (158%). These two models can improve learning abilities. However, applying e-learning with rural area shows better improvement that urban. Rural students can concentrate on e-learning content longer than urban students by cause of incentives which can motivate them to learn.

MOOCs video learning and game learning are suitable to use as the main teaching material for hybrid learning model. In MOOCs video learning, the total mean scores of post-tests increase about 61% from the pre-test. The improvement of rural mean score (72%) is greater than urban mean score (55%). Similarly, in game learning, the total mean scores of post-tests increase about 57% from the pre-test. The improvement of rural mean score (60%) is greater than urban mean score (54%). In line with the model effectiveness, two content provided tools are more effective when apply them in rural area.

Refer to focus group, MOOCs focus group displays better performance when apply with e-learning or e-learning and motivation method for all academic group in all areas. The mean score increases about 37%. The improvement of rural mean score (43%) is greater than urban mean score (32%). Similarly, in gamification focus group, the total mean increases about 60%. The improvement of rural mean score (64%) is greater than urban mean score (56%). Moreover, gamification focus group shows good performance when apply with e-learning or e-learning and motivation method for low and medium group but it is not effective for high group in all areas. This feature can apply to most of academic group except high group because this group has high learning ability. They can understand the contents by themselves without focusing suggestion from teacher.

According to group activity, MOOC group activity shows better performance when apply with e-learning or e-learning and motivation method for all academic group in all areas. The total mean score increases about 36%. The improvement of urban mean score (37%) is greater than rural mean score (34%). Furthermore, gamification group activities pre-test means scores increase about 23% from post-test. The improvement of urban mean score (23%) is equal with rural mean score (23%). Moreover, gamification group activity is not effective for all academic group in urban area. However, it is only effective for medium and high academic group in rural area. This tool is more suitable applying with rural students.

Regarding learning retention, MOOCs and gamification can retain the knowledge longer when apply with e-learning or e-learning and motivation method for all academic group in all areas, except low academic group in rural area. In MOOCs hybrid learning, students forgot about 24% of the total contents after one week. The decrease of rural mean score (28%) is greater than urban mean score (21%). Refer to educational gamification, students forgot only 20% of the total contents. Similarly, the decrease of rural mean score (23%) is greater than urban mean score (17%). From two model, urban students can retain their knowledge better than rural students.

6.1.4 Model framework

As Table 6.1 shows the MOOCs hybrid learning effective tools which are suitable for low-performing students in rural area. MOOCs hybrid learning model combines three activities. Firstly, out-of-class activities, students learn the content from MOOCs contents, which can improve 19% of mean score (the different of pre and post-test mean scores) but traditional method (face to face instruction) improves only 9%. Then students are tested by online quizzes and forum discussion to confirm their understanding. Forum discussion tools mean scores improve 33%. However, traditional teaching improves only 20%. In teacher activities, teachers use student-performance data to analyze the lacking contents. After one week, students forgot some contents. Traditional teaching can retain students' knowledge better than e-learning method. MOOCs hybrid learning model has less potential to retain students' knowledge. Thus, contents summary sessions should integrate with the model in both before and after the teacher activities section. In class activities, teacher use the focus group tool to fulfill students' lacking contents. This tool improves 27% of mean score but traditional teaching method improves only 23%. After those steps, students participate in group activities which can improve 50% of mean score. Although, traditional teaching method improves only 44%. In the final step, individual quiz and satisfaction evaluation are conducted to measure the effectiveness of learning outcome and students' satisfaction respectively.

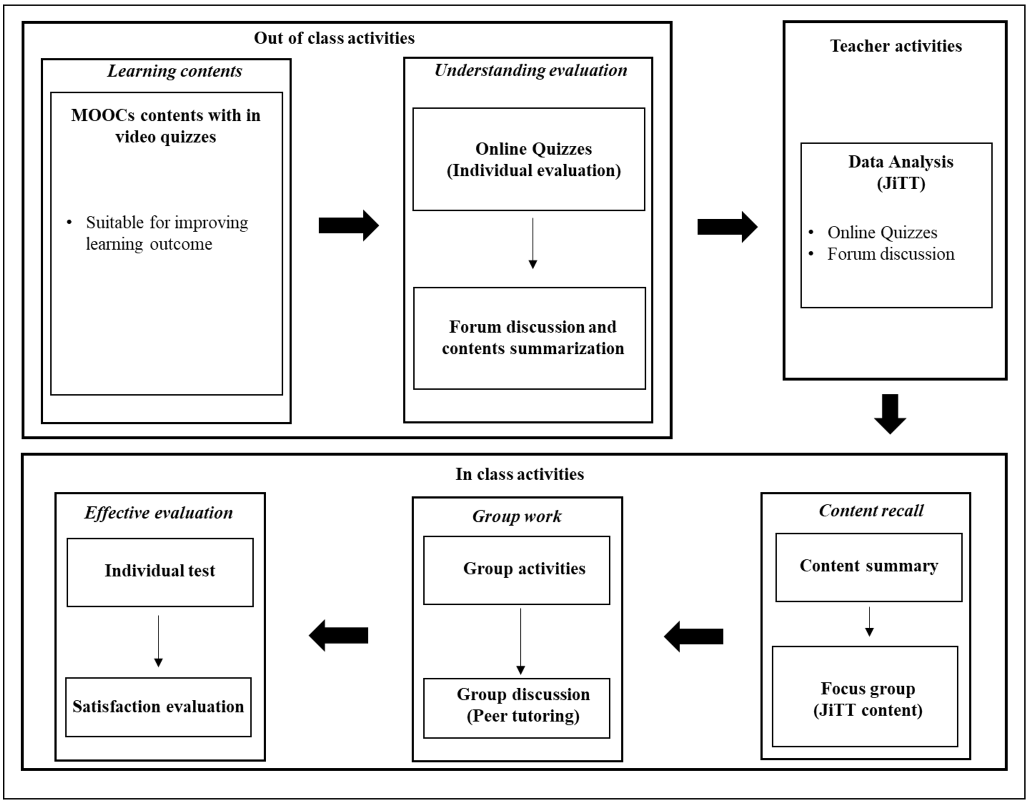


Figure 6.1 MOOCs hybrid model which is suitable for low-performing students in rural area

From Table 6.2 shows the educational gamification effective tools which are suitable for low-performing students in rural area. Similarly, educational gamification model combines three activities. In out-of-class activities, students learn the content from game learning, which can improve 48% of mean scores but control group which has learned contents from face to face method improves only 22%. After that, students are tested by game test to measure their individual understanding. Then, teacher summarize the contents. In teacher activities, teachers use student-performance data to analyze students' abilities. After one week, students forgot some contents. E-learning method can retain students' knowledge better than traditional teaching method. E-learning method reduce only 8% of mean score. On the other hand, traditional teaching method reduce 12%. In class activities, teacher again summarize the contents and use the focus group tool to fulfill students' lacking contents. This tool improves 26% of mean score but traditional teaching method improves only 18%. Then, students participate in group activities. Surprisingly these activities do not effective for low-performing students in rural area. Traditional teaching method improves 26% but e-learning method improves only 13%. Finally, individual quiz and satisfaction evaluation are tested to evaluate learning outcome and students' satisfaction.

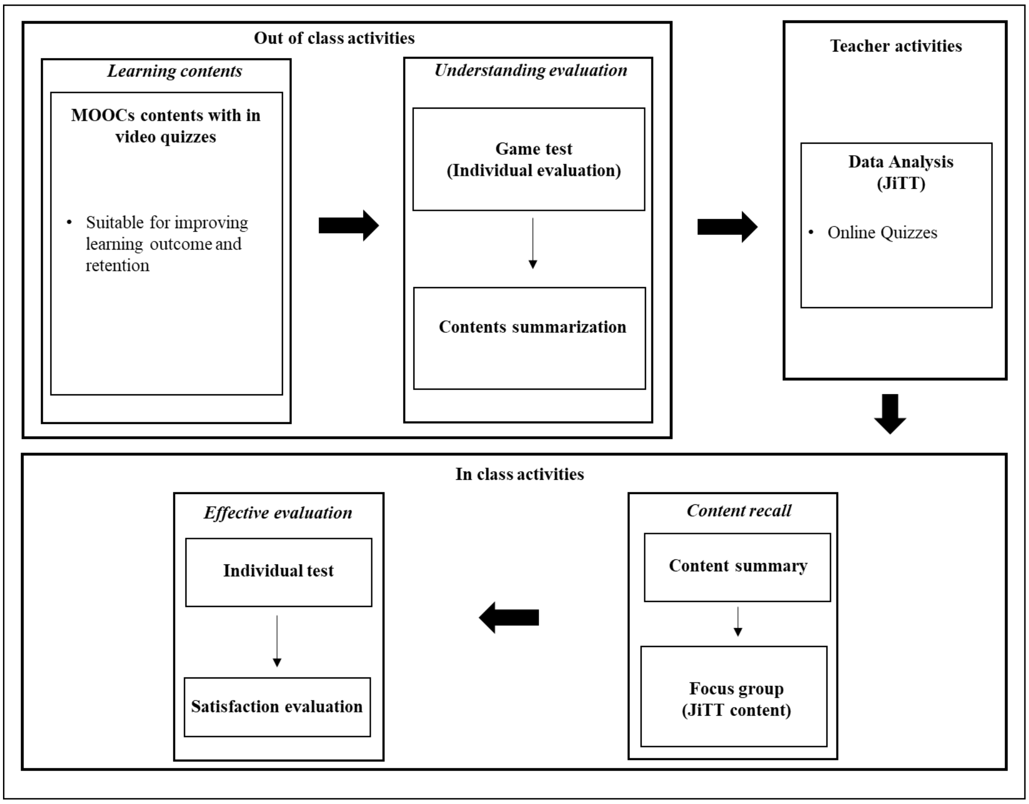


Figure 6.2 Educational gamification model which is suitable for low-performing students in rural area

This research provides effective model to enhance the understanding of students' behavior and rural education problem (student, teacher, and infrastructure problem). This model can promote a new perspective of e-learning that improves learning outcome, knowledge retention, and students' satisfaction especially of low-performing students in rural area.

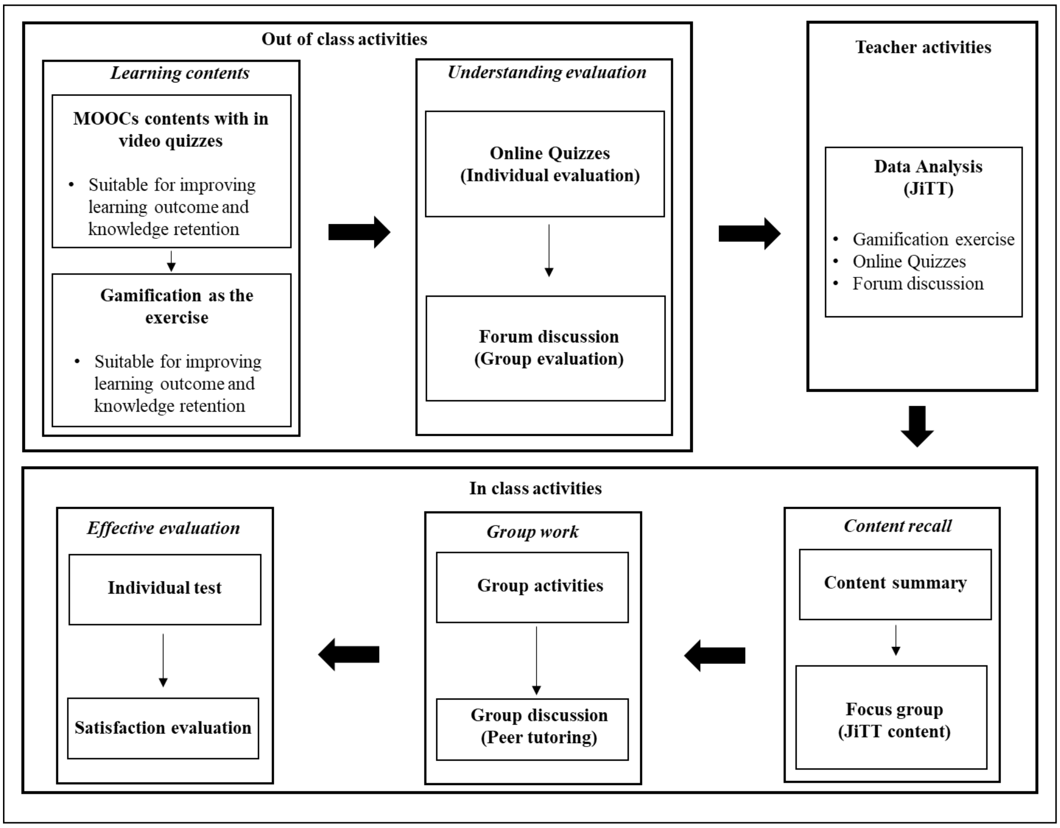


Figure 6.3 MOOCs and gamification hybrid model

According to Figure 6.3, this framework combines the advantage of MOOCs hybrid learning and educational gamification model. This framework contains three activities. The first activities involve teacher-centered learning and out-of-class activities. Before receiving class content, students are tested using a pre-test to collect personal data. They then learn the content from MOOCs contents, which provides free online learning. There are in-video quizzes that pop up while the teacher explains the content. After students have learned all contents, gamification exercises are given to emphasize their knowledge. Gamification feature is considered suitable for improving learning outcome. Then students are tested by forum discussion to confirm their deep understanding of the content. In the second activities, teacher activities are conducted. Teachers use student-performance data from gamification exercises, online quizzes and forum discussion to understand students' lacking contents and identified the risk group. The third activities are student-centered learning through in-class activities. The teacher summarizes all content as a warm up session. After that, the teacher divides students into groups based on their lacking contents. The teacher teaches different contents in each group to fulfill group. Then, students participate group learning activities. Then they have a wider discussion and discuss the interaction. After those steps, students are tested through group discussion to evaluate the peer tutoring tools. Individual quiz tests their individual understanding. This test is counted as post-test scores. In the final step, satisfaction evaluation is conducted in which students can assess and give scores for their satisfaction. (Titie, et al., 2016)

6.1.5 Effective e-learning framework

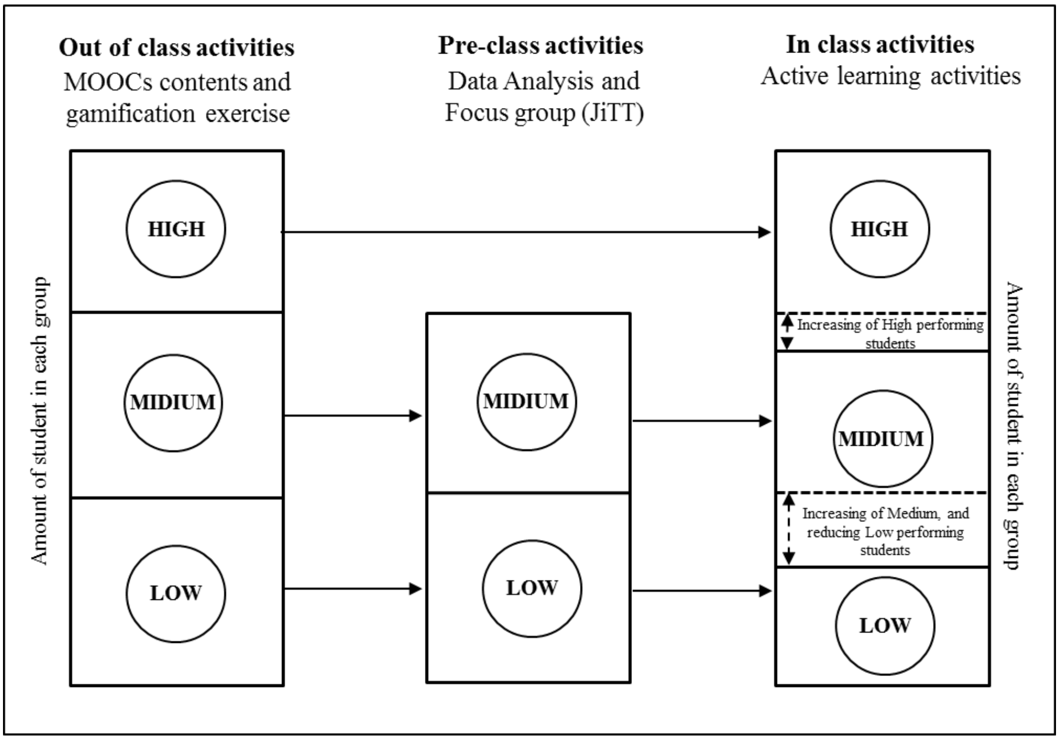


Figure 6.4 Effective e-learning framework

From effective e-learning framework, the first activities involve out-of-class activities. All groups of students are provided with learning contents from MOOC contents and gamification exercise. The second activities are pre-class activities. Teachers use student-performance data to analyze struggling concepts and pinpoint particular students who are more at-risk and identified the risk group. Teachers focus on medium and low performing group. For high performing students, they can learn by themselves with the interactive model features. Therefore, high group might skip the pre-class activities, if there are not enough teachers. Due to table 6.3, the number of students who have score excess mean score of urban high performing group, increase 10 students after learning only from the out of class activities, compare to 8 students for low group even, they have learnt from both out and pre class activities. In the same result as rural area, the number of students who have score excess mean score of rural high performing group, increase 4 students after learning only from the out of class activities compare to 4 students for low group which have learnt from both out and pre class activities. Moreover, learning contents are based on their knowledge and understanding, which were analyzed using the JiTT method. The teacher teaches different content to different groups to fulfill group lacking content. After students learned from focus group activity, the amount of High and Medium performing students is increased, but Low group are reduced. Thus, they are ready to participate in Active learning activities (the third activities).

The difference between pre-test and post-test proportions of students who have score excess mean score of three learning methods, is done by employing the tests for two proportions (Z-test) (Yates & Healy, 1994) to examine sample size for hypothesis testing of the ratio or difference of two proportions.

H_0: The difference between pre-test and post-test proportions is zero

H_1: The difference between pre-test and post-test proportions is not zero

In urban, the number of high, medium, low performing students who have score excess mean score of e-learning and motivation method are increased as shown in Table 6.3; Low group increasing 16%, Medium group increasing 6.2%, and high group increasing 21%, respectively. However, low (z-value = 5.35) and high group (z-value = 8.36) are two groups which are significant difference between pre and post-test proportions. In rural, the number of low groups did not increase but medium group has increase 1.9% and high group has increase 7.7%. Thus, they are ready to participate in Active learning activities (the third activities). After students learned from active learning activity, in urban, the number of medium performing students who have score excess mean score of e-learning and motivation method, are increased 8.3%. Meanwhile, high and low group do not increase. In rural, the number of high, medium, low performing students are increased; Low group increasing 7.7%, Medium group increasing 21.2%, and high group increasing 7.7%. However, only medium group are significant difference between pre and post-test proportions. (z-value = 8.5)

Table 6.3 Number of students who have score excess mean score of e-learning and motivation method (MOOCs hybrid learning)

Academic achievement	Number of students									
	Urban area (Total 48 students)					**Rural area** (Total 52 students)				
	Pre-test (Mean= 2.2)	After learn from Focus group (Mean=6.2)	**z-value (% change)**	After learn from Group activity (Mean=8.1)	**z-value (% change)**	Pre-test (Mean= 3)	After learn from Focus group (Mean=6.4)	**z-value (% change)**	After learn from Group activity (Mean=8.1)	**z-value (% change)**
Low	3 (6.25%)	11 (22.9%)	**5.35* (+16%)**	11 (22.9%)	**0 (0%)**	7 (13.4%)	7 (13.4%)	**0 (0%)**	11 (21.1%)	**1.07 (+7.7%)**
Medium	6 (12.5%)	9 (18.7%)	**0.71 (+6.2%)**	13 (27%)	**0.94 (+8.3%)**	2 (3.8%)	3 (5.7%)	**0.21 (+1.9%)**	14 (26.9%)	**8.5** (+21.2%)**
High	2 (4.1%)	12 (25%)	**8.36** (+21%)**	12 (25%)	**0 (0%)**	5 (9.6%)	9 (17.3%)	**1.32 (+7.7%)**	13 (25%)	**0.94 (7.7%)**

Number of student (% of all sample) *p<0.05, ***p<0.01*

From Table 6.4, after students learned from MOOCs focus group activity, in urban, the number of high, medium, low performing students who have score excess mean score of e-learning method, are increased; low group increasing 3.7%, medium group increasing 5.5%, and high group increasing 5.6%, respectively. In rural, the number of low groups increase 12%, medium group increasing 8.6%, and high group has increase 13%. However, low (z-value = 2.65) and high group (z-value = 3.86) are significant difference between pre and post-test proportions. Then, they participate in Active learning activities. After students learned from active learning activities, in urban, the number low and high group increasing 7.4%. Meanwhile, medium group does not increase. In rural, the number of high, medium, low performing students are increased; Low group increasing 5.2%, Medium group increasing 10.4%, and high group increasing 5.3%.

Table 6.4 Number of students who have score excess mean score of e-learning method (MOOCs hybrid learning)

Academic achievement	**Number of students**									
	Urban area (Total 54 students)					**Rural area** (Total 58 students)				
	Pre-test (Mean= 2.2)	After learn from Focus group (Mean=5.4)	**Z-value (% change)**	After learn from Group activity (Mean=7.5)	**Z-value (% change)**	Pre-test (Mean= 2.1)	After learn from Focus group (Mean=5.5)	**Z-value (% change)**	After learn from Group activity (Mean=7.4)	**Z-value (% change)**
Low	5 (9.2%)	7 (12.9%)	**1.1 (+3.7%)**	11 (20.3%)	**1.06 (+7.4%)**	8 (13.7%)	15 (25.8%)	**2.65* (+12%)**	18 (31%)	**0.38 (+5.2%)**
Medium	6 (11.1%)	9 (16.6%)	**0.69 (+5.5%)**	9 (16.6%)	**0 (0%)**	7 (12%)	12 (20.6%)	**1.57 (+8.6%)**	18 (31%)	**1.16 (+10.4%)**
High	9 (16.6%)	12 (22.2%)	**0.52 (+5.6%)**	16 (29.6%)	**0.7 (+7.4%)**	6 (10.3%)	14 (24%)	**3.86* (+13%)**	17 (29.3%)	**0.39 (+5.3%)**

Number of student *p<0.05, ***p<0.01*
(% of all sample)

Refer to Table 6.5, after students learned from MOOCs focus group activity, in urban, the number of high, medium, low performing students who have score excess mean score of control method (traditional teaching), are increased; low group increasing 1.9%, medium group increasing 11%, and high group increasing 11%, respectively. However, medium (z-value = 2.65) and high group (z-value = 2.22) are only two groups that are significant difference between pre and post-test proportions. In rural, the number of low groups does not increase. However, medium group increasing 3.4%, and high group has increase 5.2%. Then, they participate in Active learning activities. After students learned from active learning activities, in urban, the number low group are increased 16%, medium and high group increasing 3.7%, and 1% respectively. However, only low group are significant difference between pre and post-test proportions. (z-value = 4.26). In rural, the number of high, medium, low performing students are increased; Low group increasing 3.4%, Medium group increasing 1.8%, and high group increasing 3.4%.

Table 6.5 Number of students who have score excess mean score of control group (MOOCs hybrid learning)

Academic achievement	**Number of students**									
	Urban area (Total 54 students)					**Rural area** (Total 58 students)				
	Pre-test (Mean= 2.2)	After learn from Focus group (Mean=4.8)	**Z-value (% change)**	After learn from Group activity (Mean=6.7)	**Z-value (% change)**	Pre-test (Mean= 1.7)	After learn from Focus group (Mean=4.5)	**Z-value (% change)**	After learn from Group activity (Mean=6.4)	**Z-value (% change)**
Low	7 (12.9%)	8 (14.8%)	**0.78 (+1.9%)**	17 (31.4%)	**4.26* (+16%)**	9 (15.5%)	9 (15.5%)	**0 (0%)**	11 (18.9%)	**0.25 (+3.4%)**
Medium	5 (9.2%)	11 (20.3%)	**2.65* (+11%)**	13 (24%)	**0.21 (+3.7%)**	10 (17.2%)	12 (20.6%)	**0.23 (+3.4%)**	13 (22.4%)	**0.05 (+1.8%)**
High	7 (12.9%)	13 (24%)	**2.22* (+11%)**	14 (25%)	**0.05 (+1%)**	10 (17.2%)	13 (22.4%)	**0.50 (+5.2%)**	15 (25.8%)	**0.26 (+3.4%)**

Number of student *p<0.05, ***p<0.01*
(% of all sample)

Regarding to Table 6.6, after students learned from gamification focus group activity, in urban, the number of high, medium, low performing students who have score excess mean score of e-learning and motivation method, are increased; low group increasing 17%, medium and high group are increase 12%. Moreover, low (z-value = 2.7), medium (z-value = 2.64), and high group (z-value = 2.64) also are significant difference between pre and post-test proportions. In rural, the number of high, medium, low performing students are increased; Low group increasing 21%, Medium group increasing 13%, and high group increasing 13%. In line with urban area, low (z-value = 7.5), medium (z-value = 2.48), and high group (z-value = 2.48) are significant difference between pre and post-test proportions. Then, they participate in Active learning activities. After students learned from active learning activities, in urban, the number medium and high group increasing 4.2%, and 2.1% respectively. Meanwhile, low group does not increase. In rural, the number of high, medium, low performing students are increased; Low group increasing 4%, Medium group increasing 4%, and high group increasing only 2%.

Table 6.6 Number of students who have score excess mean score of e-learning and motivation method (Educational gamification)

Academic achievement	**Number of students**									
	Urban area (Total 47 students)					**Rural area** (Total 46 students)				
	Pre-test (Mean= 2.2)	After learn from Focus group (Mean=4.8)	**Z-value (% change)**	After learn from Group activity (Mean=5.6)	**Z-value (% change)**	Pre-test (Mean= 2.2)	After learn from Focus group (Mean=5)	**Z-value (% change)**	After learn from Group activity (Mean=5.6)	**Z-value (% change)**
Low	3 (6.3%)	8 (17%)	**2.7* (+10%)**	8 (17%)	**0 (0%)**	3 (6.5%)	13 (28%)	**7.5** (+21%)**	15 (32%)	**0.2 (+4%)**
Medium	6 (12.7%)	12 (25.5%)	**2.64* (+12%)**	14 (29.7%)	**0.27 (+4.2%)**	6 (13%)	12 (26%)	**2.48* (+13%)**	14 (30%)	**0.2 (+4%)**
High	6 (12.7%)	12 (25.5%)	**2.64* (+12%)**	13 (27.6%)	**0.08 (+2.1%)**	6 (13%)	12 (26%)	**2.48* (+13%)**	13 (28%)	**0.05 (+2%)**

Number of student *p<0.05, ***p<0.01*
(% of all sample)

Regarding to Table 6.7, after students learned from gamification focus group activity, in urban, the number of high, medium, low performing students who have score excess mean score of e-learning method, are increased; low group increasing 6.2%, medium group 4.1%, and high group 6.3%. In rural, the number of low group does not increase However, medium and high group increase only 2%. Then, they participate in Active learning activities. After students learned from active learning activities, in urban, the number low, and medium group increasing 14%, and 6.3% respectively. Meanwhile, high group does not increase. In rural, the number of high, medium, low performing students are increased; Low group increasing 15%, Medium group increasing 9%, and high group increasing 11%. However, only low group are significant difference between pre and post-test proportions. (z-value = 3.55)

Table 6.7 Number of students who have score excess mean score of e-learning method (Educational gamification)

Academic achievement	Number of students									
	Urban area (Total 48 students)					Rural area (Total 45 students)				
	Pre-test (Mean= 2.2)	After learn from Focus group (Mean=4.2)	**Z-value (% change)**	After learn from Group activity (Mean=5.1)	**Z-value (% change)**	Pre-test (Mean= 2.2)	After learn from Focus group (Mean=4.3)	**Z-value (% change)**	After learn from Group activity (Mean=5.2)	**Z-value (% change)**
Low	5 (10.4%)	8 (16.6%)	**0.8 (+6.2%)**	15 (31.2%)	**0.8 (+14%)**	5 (11%)	5 (11%)	**0 (0%)**	12 (26%)	**3.55* (+15%)**
Medium	5 (10.4%)	7 (14.5%)	**0.38 (+4.1%)**	10 (20.8%)	**0.64 (+6.3%)**	6 (13%)	7 (15%)	**0.09 (+2%)**	11 (24%)	**1.1 (+9%)**
High	8 (16.6%)	11 (22.9%)	**0.59 (+6.3%)**	11 (22.9%)	**0 (0%)**	6 (13%)	7 (15%)	**0.09 (+2%)**	12 (26%)	**1.6 (+11%)**

Number of student *p<0.05, ***p<0.01*
(% of all sample)

Regarding to Table 6.8, after students learned from gamification focus group activity, in urban, the number of medium and low performing students who have score excess mean score of control method, are increased; low group increasing 3.2%, medium group 9.2%. Meanwhile, high group does not increase. In rural, the number of high, medium, low performing students are increased; Low group increasing 3%, Medium group increasing 3.1%, and high group increasing 3.2%. Then, they participate in Active learning activities. After students learned from active learning activities, in urban, the number low, and high group increasing 2.8%, and 3% respectively. Meanwhile, medium group does not increase. In rural, the number of high, medium, low performing students are increased; Low group increasing 3.2%, medium group increasing 6.2%, and high group increasing 3%.

Table 6.8 Number of students who have score excess mean score of control group (Educational gamification)

Academic achievement	Number of students									
	Urban area (Total 33 students)					Rural area (Total 32 students)				
	Pre-test (Mean= 1.9)	After learn from Focus group (Mean=3.6)	**Z-value (% change)**	After learn from Group activity (Mean=5.2)	**Z-value (% change)**	Pre-test (Mean= 1.8)	After learn from Focus group (Mean=3.4)	**Z-value (% change)**	After learn from Group activity (Mean=5.0)	**Z-value (% change)**
Low	7 (21%)	8 (24.2%)	**0.08 (+3.2%)**	9 (27%)	**0.79 (+2.8%)**	8 (25%)	9 (28%)	**0.08 (+3%)**	10 (31.2%)	**0.07 (+3.2%)**
Medium	6 (18%)	9 (27%)	**0.77 (+9.2%)**	9 (27%)	**0 (0%)**	6 (18.7%)	7 (21.8%)	**0.09 (+3.1%)**	9 (28%)	**0.3 (+6.2%)**
High	10 (30%)	10 (30%)	**0 (0%)**	11 (33%)	**0.07 (+3%)**	7 (21.8%)	8 (25%)	**0.08 (+3.2%)**	9 (28%)	**0.08 (+3%)**

Number of student *p<0.05, ***p<0.01*
(% of all sample)

6.1.6 Effectiveness of model for low-performing group in rural area

According to low-performing group in rural area, MOOC hybrid learning and educational gamification models can apply to both rural and urban area. However. the improvement of rural mean score is greater than urban mean score. The model contains 3 main activities; out-of-class, teacher, and in-class activities. Firstly, out-of-class activities, students learn main contents from MOOC contents and game learning. After they have learned from e-learning content, rural student can improve their score better than urban students. Then teacher activities, teachers analyze students' score to prepare the struggling contents for the focus group activities. After students participated in MOOCs focus group activities, the number of low performing students who have score excess mean score of e-learning and motivation method, increase 16% for urban students but rural students do not increase. Meanwhile, urban control group increase only 1.9%. In line with e-learning method, rural group does not increase. Moreover, after students participated in gamification focus group activities, the number of low performing students who have score excess mean score of e-learning and motivation method, increase 10% in urban and 21.5% in rural area. However, control group increase only 3.2% in urban and 3% in rural area. Moreover, MOOCs focus group provides more effective when apply with e-learning and motivation method. In the same way, gamification focus group shows better performance when apply with e-learning and motivation method. In class activities, after students participated in active learning activities, the number of low performing students who have score excess mean score of e-learning and motivation method, are increased 19% in urban and only 7.7% in rural. However, control group increase only 16% in urban and only 3.4% in rural. In addition, after students participated in gamification active learning activities, the number of low performing students who have score excess mean score of e-learning method, increase 14% in urban and 15% in rural area. Meanwhile, control group increase only 2.8%. in urban and 3.2% in rural area. Additionally, gamification focus group shows better performance when apply with e-learning and motivation method. Meanwhile, gamification active learning provides more effective when apply with e-learning method. Furthermore, focus group and active learning are the high performing tools which are suitable to improve rural low performing students' abilities. Teacher could adopt these features and proposed model to deal with lacking teacher and teaching material problem. It is easy to adapt the features and factors of the model for the suitability of learner.

6.1.7 E-learning model features which design to solve rural low-performing education

In rural, there are many RLIS schools. Most students are low potential students with low GPA and they do not have an opportunity to reach high standard education because they live in poverty and learn with unskilled teachers. Small rural schools lack teachers, teaching materials, and infrastructure. Most teachers have to teach many subjects, including those in which they have no experience. MOOC hybrid learning and educational gamification model is considered as the effective tools that can solve rural and low-performing students. This model is combined with flipped learning, MOOCs, gamification (teacher-centered model), and active learning (student-centered model) tools. Using this tool, teachers become companions and supporter, helping students to learn collaboratively with their classmates.

Most rural students got low GPA grade. They are low potential students and get a hard time to understand the contents, and some are slow to grasp the knowledge. Our result showed that any GPA grade students improve their learning using our model. This is meaningful especially, in rural education. This model is designed with interactive interface and step by step instructions. Students can understand the content easily and get immediate feedback from the teacher and their classmates in the discussion forum. Moreover, video playback options integrated within video quiz tool, are used for repeating the contents and check their understanding. Video feature can improve 60% of students' scores compare to control group

(57%). It enables students to easily understand the teaching contents and get immediate feedback from the program. If students choose wrong answers, thus indicating that they did not understand the contents correctly, the program will repeat the same content with another example and check their understanding again. Due to flipped learning, student can learn from MOOCs video lectures and gamification out of class time. They have freedom to choose their place, pace, and time. Some students are afraid to ask teacher in class. Peer tutoring and JiTT help them with private time for discussing with their classmate or teacher. These features can improve 70% of their score for MOOCs and 98% for gamification compare to MOOCs control group (28%) and gamification (52%).

Most students do not deeply understand the contents. They cannot recall the knowledge after one week. Repeating content tools such as video play-back options, content warm up, and wrap up, help them to recall and brush up their cognition. More practice time will provide more memory ability. However, after one week of using MOOCs and educational gamification model, Students forgot only 27%, of the contents they had learned from MOOCs and 15% from gamification. This rate is quite impressive when compared to that obtained from MOOCs control group (34%) and gamification (59%) The model enables students to concentrate on content and try to reach new achievements for the next levels by motivating them with interactive game mechanisms and exercises. In this way, they are able to measure their progress in each learning stage and compare it with that of their classmates. These tools force them to get more absorbed in the proceedings and get more practice time, which forces them to increase their memory ability and learning retention. The results we obtained show that there is a correlation between students' learning ability and the degree of satisfaction they are able to get while learning. They were satisfied with the learning procedure that taught them standard designed contents with interactive game activities. It appears that if they are satisfied with the game interface and learning contents, they will be able to concentrate on learning process, and that this will affect their ability to learn and retain knowledge

Lack of teachers, teaching materials, experience, and evaluation tools are the biggest problems in rural education. High standard video and game presentation, teaching support features, and high- quality materials are provided in this model. Teachers needed time to understand all the processes and tools. However, they were satisfied with students' improvement. MOOC video lectures and gamification help low-skilled teachers teach various kinds of subjects to students and identify risk groups. Teachers tracked students' performance before class and taught tailored content individually.

Active learning enabled the teachers to focus on their students instead of class handling. They participated directly in student group activity and used peer tutoring with low-performing students. Group discussions and social skills are social elements that will help students gain a deeper understanding through exchanges of thoughts and opinions. They can help students absorb more knowledge and retain it for a longer time. Though some students tend to be afraid to ask teachers questions in class, participating in group discussions can help them overcome this tendency. These features can improve 63% of students' scores for MOOCs and 58% for gamification compare to control group of MOOCs (56%) and gamification (23%)

In the remote area, infrastructure and equipment are another important problem when applying this model. Internet access and computers are still required to apply our model. In some rural areas where schools do not have enough equipment, the non-interactive mode with video presentations is possible, but some tools are not usable such as the interactive feedback or JiTT method. Teachers can track and measure students' ability by the paper-based system. In future, the technological device will be affordable by the economy of scale. Internet connection is transferred from the mobile signal and public Wi-Fi. This model will play the important role in distance education. Moreover, rural students also lack computer literacy. These are a major barrier for rural students. Many online learners lack self-motivation and fall behind. The teacher can use MOOCs video as teaching material to teach students step by step. The students should practice with the computer at least once a week in computer class.

In conclusion, MOOC hybrid learning and educational gamification model are an important educational tool for improving students' ability. However, it is quite difficult to apply this tool because it requires expensive equipment such as computers, mobile phones, and tablets. Presently this is a huge barrier for students and schools in remote areas. In the future, hopefully, technological devices will become more affordable and these tools will play an increasingly important role in education. These models will be solutions to solving education problems in rural areas where there are low potential students. Teachers can use it to teach subjects they are not particularly skilled in and students can use it to learn by themselves and ask the teacher when they need any advice. These models will solve the rural education problem not only Thailand but it also adapts to solve rural education in other developing countries which share the similar learning environment and economic situation.

6.2. Significance of research outputs

6.2.1. Contribution to knowledge science

This research relates to knowledge science, which is human knowledge, knowledge creation and knowledge management. The research direction proposed to service dominant logic (SDL) which concerns on the role of customers (students) and service value (learning outcome) determined by students. In SDL, Students acts as the co-creator, rather than the receiver of knowledge. Therefore, the interaction between teachers and students (e.g., collaborative learning and Just in time teacher) will improve learning process to meet with the students' satisfaction. Due to our proposed model, the service value for students, both learning ability and satisfaction are concerned. We aim to optimize learning experience in the viewpoint of students. Moreover, our research also uses the knowledge creation process to create new knowledge by learning from our research. Teachers could adopt our proposed model and apply in real situation. Moreover, it will be a starting point to explore new idea to create suitable model, which is suitable for difference group of students.

6.3. Limitations and future research

This research has some limitations, which provides the new aspect of future research. Firstly, the proposed model requires the Internet connection and electronic device. In future research, we will apply paper-based model in rural low-income school (RLIS). Secondly, participants are limited to one school in Thailand. In future research, we will collect the data from both areas (rural and metropolis school), both type of schools (public and rural school), and both countries sort (developed and developing countries). Due to model design issue, the current study is limited only flipped learning model. However, there are various kind of blended learning such as Flex, Self-blend, and Enriched Virtual model. In future research, we will incorporate all kind of blended learning and use the visual reality technology to improve students' ability and satisfaction

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APPENDIX
QUESTIONAIRE
"FACTORS AFFECTING ON MOOCs HYBRID LEARING AND EDUCATIONAL GAMIFICATION MODEL"

Questionaire
"Factors affecting on MOOCs hybrid learning and educational gamificational model"

Instruction: The purpose of this questionaire is to study the student's behavior and find the effective factors that affect on learning outcome and knowledge retention. This study has been conducted by *secondary school student*s from Sub Mongkhorn Wittaya School , Chaiyaphu, Thailand.

PART 1: PERSONAL BACKGROUND

Direction: Please provide your background by marking ✓ on the box for each question.

1.1) Gender: ☐ Male ☐ Female

1.2) Age: ☐ 13 years (M1) ☐ 14 years (M2) ☐ 15 years (M3) ☐ 16 years (M4)

1.3) Have you ever learned from e-learning method?

☐ Never ☐ Sometime (less than 1 time a week) ☐ Usually (more than 1 time a week)

1.4) How much time did you spend on gamification per day? (From the Duolingo prgram)

☐ Casual (15 mins/day) ☐ Regular (30 mins/day) ☐ Serious (45 mins/day) ☐ Insane (60 mins/day)

1.5) What is your personality type? (From the Keirsey website)

☐ Guardian ☐ Artisan ☐ Idealist ☐ Rationalists

PART 2: QUESTIONS ON MOOCS HYBRID LEARNING FACTORS

Direction: Please provide the information about your opinion by circle on the appropriate choices for each statement.

What do you think about these statements?

Statements	Disagree	Partly agree	Agree
2.1) Teachers teach well and have good teaching techniques.	1	2	3
2.2) Course structure and content design are suitable and well organized.	1	2	3
2.3) Design of interface is attractive and easy to use.	1	2	3

2.4) This model provides good technical support and suitable devices.	1	2	3
2.5) Focus group is useful and help you to get deeper understanding of contents.	1	2	3

PART 3: QUESTIONS ON EDUCATIONAL GAMIFICATION FACTORS

Direction: Please provide the information about your opinion by circle on *the appropriate choices for each statement.*

What do you think about these statements?

Statements	Disagree	Partly agree	Agree
3.1) I satisfy with educational gamification model.	1	2	3
3.2) I prefer to learn by educational gamification as my primary contents	1	2	3
3.3) Educational gamification improves my social skill. It helps me to interact and communicate with others.	1	2	3
3.4) I fully involved and focused on game learning activities	1	2	3
3.5) Emotion affects on my learning concentration and ability	1	2	3
3.6) Difficulty level and storyline motivate me to learn more on gamification	1	2	3
3.7) Time restriction increases my learning engagements	1	2	3

E-LEARNING FACTOR CRITERIA

Factors	Criteria	Evaluated by
Quizzes	0 = Do not understand the contents 1-3 = Recall only the basic concept 4-6 = Understand the content 7-9 = Apply the concept to solve new problems 10 = Analyze the connection between the concepts	Teacher
Social elements	0 = Do not understand and participate 1-3 = Do not understand and partly participate 4-6 = Partly understand and partly participate 7-9 = Partly understand and fully participate 10 = Fully understand and participate	Teacher
E-learning and game learning factors, and self-element	1 = Disagree 2 = Partly agree 3 = Agree	Students (Questionnaire)
GPA	1 = below 2.00 2 = 2.00-3.00 3 = 3.00-4.00	Students
Age	1 = 13 years old 2 = 14 years old 3 = 15 years old 4 = 16 years old	Students
Learning time	1 = Casual (15 mins/day) 2 = Regular (30 mins/day) 3 = Serious (45 mins/day) 4 = Insane (60 mins/day)	Students
Personality type	1 = Guardian 2 = Artisan 3 = Idealist 4 = Rationalists	Teacher (Keirsey personality type)

List of publication

Name: TITIE PANYAJAMORN

Title: Effectiveness and suitability of MOOCs hybrid learning with educational gamification model and factors that affect e-learning outcome and retention.

List of publication and presentation

1. Accepted paper

1.1. Effectiveness of e-learning design and affecting variables in Thai public schools

Authors: Titie Panyajamorn, Youji Kohda, Pornpimol Chongohaisal, Suthathip Suanmali, and Thepchai Supnithi

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2. Paper in submission

2.1. Effectiveness and suitability of MOOCs hybrid learning model and factors that affect e-learning outcome: Case study of public school in rural Thailand

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3.2 Titie, P., Kohda, Y., Pornpimol, C.,Thepchai, S. (2016). The effectiveness and suitability of MOOCs flipped learning: A preliminary study of public schools in Thai rural area. In

Proceedings of the 24th International Conference on Computers in Education. India: Asia-Pacific Society for Computers in Education, 28 November - 2 December 2016, Bombay, India. pp. 621-626.