A FRAMEWORK FOR EVALUATING TABLET-BASED EDUCATIONAL GAMES FOR PRIMARY SCHOOL TEACHERS IN THAILAND

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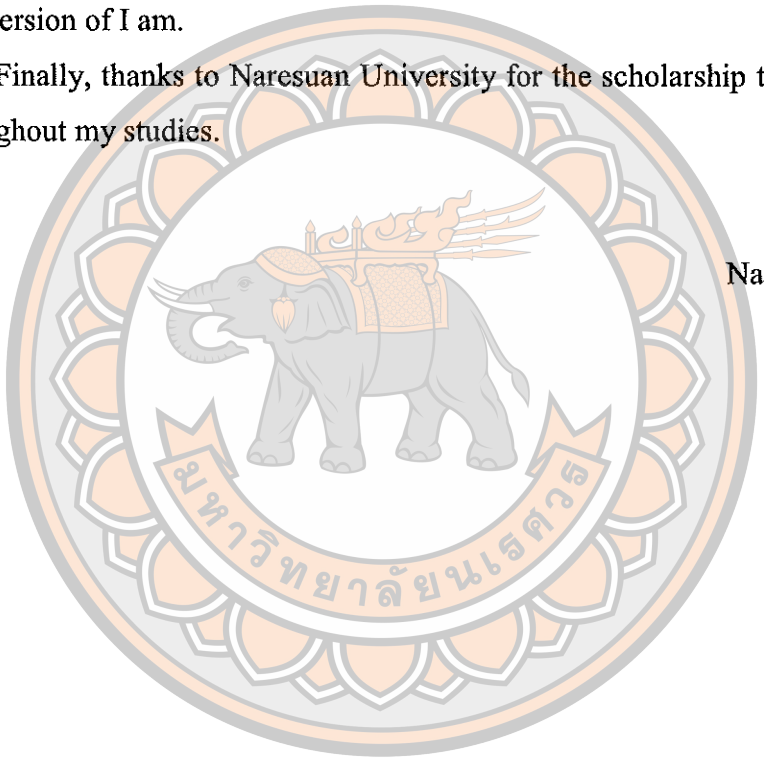

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ABSTRACT

In the last decade, governments across the globe have initiated policies which aim to transform traditional primary school classrooms with tablet-based teaching activities. In implementing these policies, primary level teachers are facing difficulties in utilizing tablets as teaching aid materials in their classes. Evaluating the suitable mobile applications is one of the current difficulties in successful teaching with tablets. The proposed framework is the Four-Dimensional Framework for Tablet-based Educational Games (FDF-TEG) with the objective to support the teacher in enhancing tablet-based teaching activities in class. To ensure FDF-TEG can be applied to evaluate educational games, a concrete implementation of the framework was created as a web application called Apps4Youth and experiments at four primary schools were undertaken. The results show that the system and framework can reduce some of the difficulties faced by teachers and therefore increases teacher confidence which plays a critical role in applying tablet-based games in the classroom. In particular, the system is best suited to assist teachers in discovering new applications, evaluating the suitability of applications for particular classes and suggesting activities that have had positive outcomes for other teachers.

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CHAPTER I

INTRODUCTION

Long before the rise of technology, games have been applied to stimulate students in learning. This area of research, known as game-based learning (GBL), is concerned with using games as a technique to attract student's attention and make the study more playful in the classroom (Prensky, 2005). There has been a huge increase in the number of teachers implementing games into classrooms in the past 10 years. Some educational games are completely focused on teaching by using the learning material as opposed to increase fun and entertainment (Pedersen, 2003), where some educational games are developed from exercises in a textbook (e.g. spell words or solve calculations), to reinforce the exercises with some additional entertainment value.

The mobile devices are becoming popular among school children and their most common activity is playing games. A study in Southeast Asian countries showed that 72% of children are accessing mobile devices to play games (The Asian Parent Insights, 2014) and it is not only teenagers, but the ages of 3 to 8 years old are using mobile devices for more than 1 hour per day. In Singapore, playing games on mobile devices is a common activity in primary school children (Goh, Bay, & Chen, 2015). A separated study from Thailand highlighted that playing games on tablets is a dominant activity in all different age groups and the percentage is increasing every year (Harfield et al., 2014). Another study from New Zealand described that children loved to play games in any kind of mobile devices than other activities (BSA, 2015).

The tablet is a popular mobile device that can be used to deliver educational materials including GBL. The significant features of tablets, i.e. portable, lightweight, and finger friendly touchscreen display, are suitable for children of all ages. Researches suggested that the use of tablets in the classroom can help improving students' learning performances (Koile et al., 2007; Koile, & Singer, 2006). The work of Verenikina (2008) showed the use of tablet-based educational games can help to develop children's learning skill. The level of curiosity and concentration are increased during the play activity. Author found that children requested their siblings or parents to play games

with them if they failed challenges or could not understand the game scenario. They could help children to have a deeper understanding in game scenario. The study presented the critical role of peers in supporting cognitive development process (Verenikina, & Herrington, 2008).

Another advantage of using GBL is that it can give an own space for players to test their abilities or knowledgesindependently (Flannery et al., 2013). The research suggested that not only high performing students can level up into deep learning, but also lower performing students could learn or refresh basic concepts of a subject within the game. Games can help teacher to overcome the difficulties of supports among students with different skill levels at class. The most successful games are highly interactive where students can learn new skills with passionate involvement, social interaction, explicit and implicit motivation and enjoyment (Habgood, & Ainsworth, 2011).

In some cases, GBL is combined with other learning approaches such as collaborative learning (Bruffee, 1993) or constructionism (Papert, 1980) in order to have a more effective learning environment. Learners get new knowledge from the different personal perspectives, interpretations and information processing skills. These are the inputs for the individual understanding and judgement on a given task (Cooper, 1993). GBL activity persuades learners to take more challenges in the game context by simply competing with others or by themselves to get higher points. Therefore, GBL lets the students to explore new approaches to access the content, which could force students to challenge themselves.

Despite the positive effects and enthusiasm for the use of tablets and GBL, there are significant challenges to overcome before they are likely to be accepted more widely as part of the classroom. The problems with games can be ranged from the game content does not match with the learning objectives and an imbalance between teaching and entertainment. It is possible that game designers or developers lack the prerequisite skills to align the syllabus of the subject and the teaching objectives. Barendregt, & Bekker, 2004 described how to balance learning and fun in education games for classroom use. Authors pointed out that game designers should think thoroughly which abstract presentations are relevant to present as the simple explanations in game context.

The bad visual presentation or unclear explanations can lead to misunderstanding by players and resulting in a missed learning opportunity.

Even if good educational games are available, teachers are often too busy and do not have enough time to search or prepare educational games for classroom use. They often do not have enough ability to choose the appropriate games for a level of study. Results from the Granz Cooney Center (2016) showed that 80% of teachers found that to find the right games for using in their class is difficult. In the study, only 45% of teachers said that commercial games could be used in the classrooms and they were using it (Center, 2014). Teachers believed that they might waste their valuable teaching time if games did not match on academic syllabus.

In summary, mobile devices and games are popular for teaching aid materials in primary school children, but there are two significant challenges in GBL on tablets at the classroom:

1. Discovery of games related to syllabus.
2. Evaluation of games to match the learning objectives and teaching activities.

Therefore, one of the key areas of interest in this thesis is to develop guidelines for teachers to find and evaluate which games are relevant for classroom activities in different subjects and different levels of study.

Objectives of the Study

The objective of the study is to propose a framework and technological support for primary school teachers in Thailand to discover, evaluate and select appropriate tablet-based educational games for classroom usage.

Scope of the Study

The scope of this research is to focus on educational applications on tablets for Thai primary school children. The learning activity involves mobile learning, game-based learning, individual and collaborative learning. From this point onwards, this area will be referred as "tablet-based educational game" or TEG. For practical reasons of scale, the scope of the research is TEG for Mathematics, Technology and English. This study is structured into two main parts as follows:

1. The proposed framework is for primary school teachers in Thailand.
2. The experiments of the study are carried out at primary schools in Thailand.

Research Question and Hypothesis

The objective of the thesis is to answer the question: How can tablet-based learning with games be used and evaluated in primary school classrooms?

To answer this question, this thesis proposes a framework for evaluation that is validated by the following hypotheses:

"Teacher confidence in applying tablet-based education games in the classroom is increased through the use of proposed framework".

Benefits of Research

Teachers would have more confidence in applying tablet-based education games in the classroom through the use of proposed framework. While the direct benefit of the thesis is to primary school teachers, the wider contribution is towards technology acceptance in the educational community. By providing support in the form of frameworks and tools for teachers, this research can have a positive effective on reducing the barriers to apply tablets and mobile technology in classrooms that is common in schools, particularly those in rural or less-developed areas such as northern Thailand.

CHAPTER II

LITERATURE REVIEW

This chapter introduces the literature related to the implementation of mobile devices at schools, positive and negative impacts of teaching with tablet-based applications, and teachers' weaknesses in brining tablets to the class. Besides, the frameworks to evaluate educational games from the different perspectives are discussed in this chapter.

The Implementation of Mobile Devices at Schools

Schools are implementing to use mobile devices in the United States of America and nearly 25% of schools had implemented mobile devices (IESD, 2013). The report stated teachers have their own preferences in deploying mobile devices at class. They liked iPads to deploy as first choice and followed by Google Chromebook, iPod Touch and others. Mobile devices are becoming more and more the common part of teaching aid materials at class. Teachers believed that it can help students to become independent learners and do more self-study in lesson when they require it most.

The media consumption and screen time are unavoidably growing up while the use of mobile device is increasing (Erikson Institute, 2016). The study showed 85% of young children were using the technological devices such as tablets, smartphones, computers, and televisions for their entertainments. A similar report from the United States of America in 2016 presented 6-15 years old students liked to buy online video clips and watch on tablets was popular in that age group (Ofcom, 2016). The watching television program or films via tablets was popular amongst 3-4 and 5-15 years old. The age group between 5-15 years are fond of consuming the mentioned activities on their smartphones. The purposes of uses are varied on the different age groups and their preferences.

A study from United Kingdom in 2016 stated 42% of teachers were using desktops, laptops, and tablets weekly at schools (DigitalEducationSurvey, 2016). 53% of tablets were used by Grade K-2, 36% for Grade 3-5, 30% and 25% for Grade 6-8 and

Grade 9-12 respectively. The young students spend more time on accessing tablet more than old students. The study reported that games are used as a teaching tool and they are popular among teachers. 63% of Grade K-2, 66% of Grade 3-5, 51% of Grade 6-8 and 35% of Grade 9-12 teachers were using games for a specific content. Further, the study presented the portable tablets are more convenience for students than other mobile devices. They like to access the portable mobile devices for their entertainments and educational purposes. The traditional classrooms are flipped into the informal teaching environments by implementing mobile devices.

A separate study showed the rate of media consumption among school children in South East Asia is increasing every year (The Asian Parent Insights, 2014). 71% of aged 3-8 years old Singaporean children took place as the highest media consumption in South East Asia. 67% of South East Asian children were consuming their parent-owned mobile devices. 58% of Philippines children were using their parent-owned mobile devices at different locations. Only 17% of children are using mobile devices at school while 83% of children had never used it in schools in the south east Asian countries (The Asian Parent Insights, 2014). The deep analysis showed 76% in Philippines, 83% in Singapore and Thailand, 91% in Indonesia never use mobile devices at school.

In the past decades, the different types of mobile devices are being trailed or deployed at schools across many countries to follow government policy. The Ministry of Education from Singapore aimed students to improve in critical thinking, self-direct learning, collaborative and familiar with the help of technology (Ministry of Education Singapore, 2008). The implementation of mobile devices at school is regarded as the national learning strategy and system in Taiwan (Dias et al., 2008). Malaysia is contributing Chromebooks for primary and secondary school children according to their "Education blueprint 2013-2025" (Malaysia, 2012). "FAITH" project designed to provide interactive learning and teaching with mobile computing devices at schools in Turkey (Initiative, 2013). Their common purpose is to enhance the quality of education and provide effective and efficient learning environment for students.

Tablet-based Education Activities in Primary Levels

Comparing a variety of mobile devices, tablets are easy to bring to classroom and teachers can easily adapt using them more than other computational devices (Geist, 2014). The school children and teachers have positive impressions on the implementation of tablets for learning activities (Cukurbasi, Isbulan, & Kiyici, 2016). They can practice more on their lessons where the dynamic feedbacks can help them to comprehend and gain knowledge by themselves. Many of researches have done the improvement of student learning in different skills with the use of tablet-based teaching activities. Table 1 presents the some evidences showing the improvements of learning skills in different subjects with the use of tablet-based applications.

Table 1 Improvements of student learning skills in different subjects

Subjects	Improvements	Authors
Mathematics	Numeracy skill Literacy skill	(Haßler et al., 2016)
Science	Literacy skill Understanding on the lesson concepts	(Siemieniecki, & Majewska, 2015)
Mathematics	Learning performances Student engagement level Calculation process	(Ven et al., 2017)
Mathematics	Cognitive skill Mathematics concept	(Outhwaite, Gulliford, & Pitchford, 2017)
Science and History	Literacy skill Creativity skill	(Couse, & Chen, 2010)
Art and storytelling	Development in cognitive memory Creative thinking and imagination Know more vocabularies	(Carrell Moore, 2017)
Geography	Collaborative skill Communication skill Motivation in learning	(Walczak, & Taylor, 2018)
Science	Better understanding in energy concept Practical experiments	(Falloon, 2017)
English and Mathematics	Know more in vocabularies Reading, writing and listening skills Good engagement in learning with application and classmates	(Neumann, 2018)

The Challenges of Tablet-based Teaching

Although researches showed the value of teaching with tablet-based application, schools are struggling to give the rich learning experiences for students. Table 2 summarizes the common challenges in bringing tablets to the class from the different perspectives.

Table 2 Challenges in Tablet-based Teaching

Challenges	Authors
1. Technical problems, human resources, and limited application support. 2. Activity plan.	(Alajmi, 2011)
Ineffective classroom management as efficient teaching method, and class activities.	(Alajmi, 2011)
Time management and technical issues at class. Student negative behavior.	(Durak, & Saritepecİ, 2017)
1. A well-plan for the technology integration at class. 2. Support IT staffs, and trainings for technology use. 3. Lack of knowledge in minimizing the technological drawbacks at class. 4. Support the individual needs at class.	(Kukulska-Hulme, 2010)
1. The appropriate use of pedagogy at tablet-based activity. 2. Teachers' willingness on the interactive tablet-based classrooms.	(Kim, & Kim, 2017)
Require the effective technical support teams. Knowledge in the integration of tablets in teaching.	(Ifenthaler, & Schweinbenz, 2013)
A certain amount screen-time for tablets. An effective integration of technology at class.	(Prasertsilp, & Olfman, 2014)
The effective trainings for tablet-based teaching.	(Savas, 2014; Vosloo, 2012)

Teachers' Difficulties in Bringing Tablet into Class

Although tablets are easily used in the classroom and teachers can easily adapt using them more than other computational devices (Geist, 2014), teachers are getting stresses to integrate tablets with lessons in the class. There are many reasons why teachers are facing the difficulties to construct an informal teaching environment to improve students' performances in learning. Table 3 shows teachers' weaknesses in creating the informal teaching activities with tablets.

Table 3 Teachers' Weaknesses in Forming Tablet-based Activities

Teachers' Weaknesses	Authors
1. Teachers lack of confidence and ability in the integration of tablets at class. 2. The inappropriate use of methodological strategies in tablet-based teaching environment.	(Montoya, Rojas, & Dussan, 2016)
Insufficient skill of accessing technology and educational applications.	(Fabian, & MacLean, 2014)
Lack of teaching guidelines in the concepts of tablet-based teaching.	(Hussain, & Shiratuddin, 2017)
1. Lack of sharing knowledge in tablet-based teaching with colleagues. 2. The inappropriate use of education pedagogies in teaching activities. 3. Difficult to maintain students' enthusiasm in tablet-based learning activities. 4. Teachers are not willing to take responsibilities. There is no redefining and remodifying integrated activity, and on-going tryouts.	(Lih-Juan, 2017)
The effective guidelines are required for teachers in forming students' oriented instructional teaching activity.	(Nasongkhla, & Sujiva, 2015)

Table 3 (Cont.)

Teachers' Weaknesses	Authors
1. Lack of confidence, skills, and knowledge in incorporating tablet technology at class. 2. Teachers are not interested in the development of technological knowledge and practical experience on use of tablets and software.	(Meletiou-Mavrotheris et al., 2014)
1. The unclear decision in what students need to learn. Inappropriate choose of applications from a variety of applications. 2. Lack of knowledge in how technology can execute in the restricted settings of traditional classroom.	(Tahir, & Arif, 2016)
1. Technical problems, lack of integrating an instructional activity and pedagogy on tablets. 2. The lack of knowledge in selecting and reviewing education apps and creating teaching contents devices.	(Antonioli, Blake, & Sparks, 2014)
Teachers do not apply the relevant pedagogy for tablet activity at class.	(Anshari et al., 2017)
Teachers do not interest in new teaching method, which could have positive effects on the student learning performances.	(Kim, & Kim, 2017)
There is no alignment between lessons and appropriate use of applications in game-based learning.	(Brown, Englehardt, & Mathers, 2016)
Some teachers are lack of having the positive acceptance on tablet-based teaching at class.	(Ifenthaler, & Schweinbenz, 2013)

Summary from Literature

The thorough preparation sought to discover how to collaborate tablet-based teaching activities to get a good result. The literature presented that the applied pedagogies or the use of guidelines are critical to form an effective teaching

environment properly. Teacher's confidence, the new technical skills and knowledge are the requirements in bringing tablets to the class. The findings from literature show

1. The productive learning outcomes are relying on teachers' confidence and ability.
2. The searching and evaluating education applications, applying the relevant pedagogies for tablet activities and lesson plans are stressful works for teachers.
3. The inadequate professional development trainings for teachers to adopt tablets into their classes.
4. The technical issues in mobile devices or applications make teachers have less confidences in achieving the teaching goal.
5. The lack of competent trainings, guidelines, and strategic technology plan give stresses to teachers in forming tablet-based activity.

Teaching with mobile devices is never a stand-alone activity and the literature illustrates the current positions of bringing tablets at different locations. Although students are enjoying and have the positive impressions, teachers are struggling on new workloads and difficulties in bringing technology to the class. An optimal solution to help teachers in forming tablet-based teaching environment remains required.

Review on the Game Evaluation Theories

The systematic evaluation on educational games is critical and is to ensure that games meet certain requirements of a focus group. Many researches have shown that with the use of framework for evaluating games, it can help to form an effective teaching environment. Three well-known frameworks for evaluating education games are chosen to evaluate the games systematically:

1. Input-Process-Outcome Model (IPO)
2. Adapted Interaction Cycle (AIC)
3. Four Dimensional Framework (FDF)

1. Input-Process-Outcome Model

Input-Process-Outcome (IPO) model is developed by Garris and his colleagues in 2012. The idea is to motivate learners while they are playing simulation games (Garris, Ahlers, & Driskell, 2002). The objective is to give the suggestions in a careful combination of game characteristics and instructional content in game

development. These are the inputs for players to construct their own knowledge and make decision to perform tasks. The player's judgements on the outcomes are the inputs for the next action. The accomplishment of a given goal is depending on the learner interest and judgements on the outcomes.

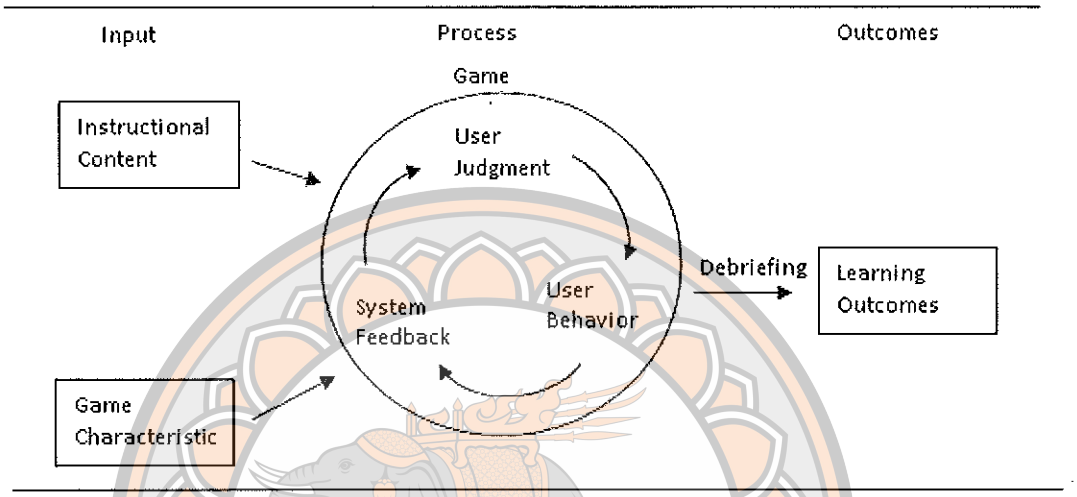

Figure 1 Input-Process-Outcome Model

Figure 1 describes the Input-Process-Outcome model, which contains three sections: input, process, and outcomes. Each section has their own corresponding criteria where the instructional content and game characteristics are related with the input section. Players' judgement, behaviors, and system feedbacks are related on each other in the process game cycle. The system feedback is the outcomes of a user's action, which is relying on the user judgement. It is an iterative process until the user accomplished the given task. The learning outcomes are relying on the user's understanding, their performance on an activity and the input of game. This model demonstrates the whole user's interaction in performing a task.

The strength of IPO model is the sharing knowledge to understand the procedures of mental work in the information processing. It is easy to understand and could be used in game design and game evaluation to know the missing information. This model helps to figure out the wrong usage of game characteristics in the instructional content, which might effect on the players' learning outcomes.

IPO model did not specifically explain what the instructional content and game characteristics in a serious game are. It is emphasized in presenting the information processing from the user's interaction perspective. The author did not highlight which game characteristics and what kind of instructional content are relevant to apply in a serious game context.

2. Adapted Interaction Cycle (AIC)

The adapted interaction cycle (AIC) is an improvement on the interaction cycle of user action framework by Andre et al. (2001). The user action framework is a reliable usability engineering tool to report usability problems. AIC is a tool for reporting the usability problems in the adventure game (Andre et al., 2001). The framework explains the step-by-step user's interaction and difficulties in performing a task.

The adapted interaction cycle was developed by Barendregt and Bekker in 2004. The framework gives the guidelines to find the usability problems in adventure game which is designed for 5-7 years old. The objective is to find out the misused of metaphors and ambiguous explanations in an adventure game context. It would be useful for the game designer and developer. The authors shared the knowledge to aware in structuring game design by answering the questionnaire of AIC (Barendregt, & Bekker, 2004).

1. What is the goal or finish point of a game?
2. There should have clear clues or hints for players to achieve the goal.
3. The free controls on an avatar or object should be allowed to players. It would lead as challenges in the scenario of game.
4. The uses of appropriate feedbacks acknowledge players by presenting the result of right or wrong answer.
5. The outcome of an activity should provide clear information to players in order to avoid deviation from goal.
6. Time limitation on each task should be enough for players to think of further actions.

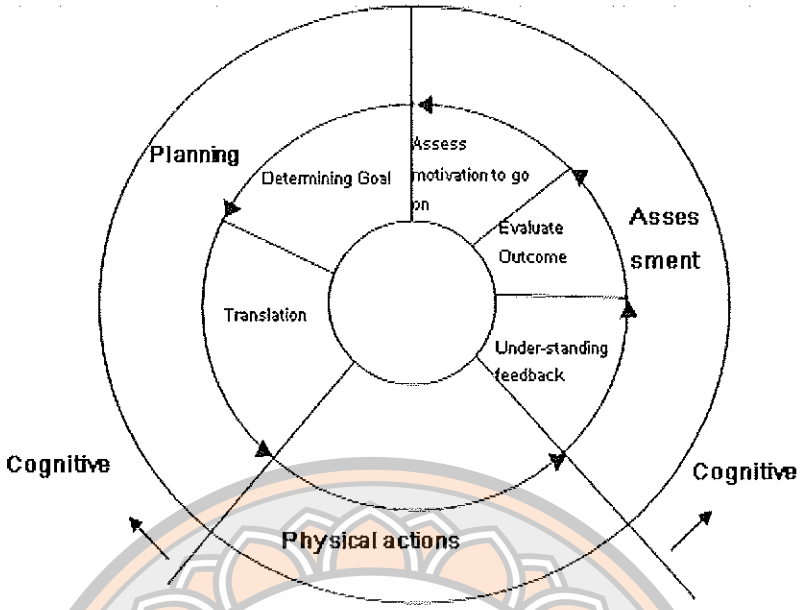

Figure 2 Adapted Interaction Cycle

Figure 2 illustrates the overall actions taken by players when they started to interact with an application. The adapted interaction cycle is comprised of two loops; the outer loop is described how the player plans to take an action, and the inner loop presents the mental process while they are performing a task. It is a repetitive process that would take place until a player accomplishes a given goal. The outer loop is comprised with planning, physical action, and assessment sections. Each section presents the corresponding activities, where players start to plan and perform a task.

Before performing an action, players determine the goal first and transition is occurred to take physical actions. The follow-up plan for the next action is depended on the level of understanding, feedback, judgement on the outcomes, and tag along with motivation.

The strength of AIC is well explained from a player's first action to achieve goal. The framework predicts the common intractable problems and potential barriers in user-centered game design. The usability issues might be varied on the players' thinking, experiences and decision. The weakness of this framework is strongly emphasized on the interaction problems and the detail descriptions in each segment is not discussed. Therefore, the procedures in an adapted cycle are not easy to use for naïve users.

3. Four Dimensional Framework (FDF)

Four Dimensional Framework (FDF) was introduced by Freitas and Oliver in 2006 as shown in Figure 3. The purpose is to evaluate the educational-and-simulation-based games. The author cited that tutors are facing some difficulties in practice when introducing the game-based and simulation-based learnings. There are few frameworks that can help instructors to choose the suitable games for teaching in a certain subject (De Freitas, & Oliver, 2006). The objective is to help tutors, and developers by illustrating the effects of game features in students' learnings, and the future enhancements in game design. The four dimensions contain in the framework are

1. Learner specifics: a certain focus group, knowledge level, and preferences are the fundamentals in this dimension. The diversity of preferences in learning styles and competencies are other considerations in it. To know the focus group's profile is important as a figural factor.

2. Pedagogy: the relevant use of teaching theory or pedagogy contains in the second dimension. The appropriate use of pedagogy is a primary concern to support learners for a deeper understanding.

3. Context: an environment that could be able to form the informal learning activities. The teaching aid tools, educators with knowledge in a specific domain, and a technical support team are the basic requirements for the various contexts.

4. Representation: a contextual presentation of a game is discussed in this dimension. The immersion and fidelity are the important criteria in the interactive simulation game design. The interaction is another requirement which reinforces player to take the challenges in game play.

Each dimension presents the fundamental criteria to know before forming an informal learning activity. In one particular case study (De Freitas, & Oliver, 2006), FDF framework is used to evaluate two educational games: MediaStage and Savannah. MediaStage simulation allows students to create their own avatars, gestures on it, or allow to build their own interactive virtual world with recording voice. The framework pointed out the future improvements and to imply more suitable theories to reinforce learning activities in game. Besides, it suggested the best way to use applications in different learning context. The Savannah adventure game is used to teach about animal behavior, and the objective is to improve players' self-motivations in the interactive

context. The evaluated result by FDF showed the activities in game should have a better dependency on the learning objectives. Besides, it described the future improvements in simulation-based adventure games.

Four Dimensional Framework	
Learner specifics	**Pedagogy**
Profile Role Competencies	Associative Cognitive Social/Situative
Representation	**Context**
Fidelity Interactivity Immersion	Environment Access to learning Supporting resources

Figure 3 Four Dimensional Framework

The strength of FDF framework is carefully viewed from technology, educational theories, game design, and context. It is easy to understand for users to apply the framework in evaluating games. It can be applied as an iterative process in game development process or creating game-based learning to meet the focus group's needs. The weakness of FDF framework is basically emphasized in the virtual world-based simulation games. Thus, the consideration facts in the presentation dimension is emphasized in the simulation game's characteristics.

Each framework and model have their own strengths and weaknesses. Teachers can use the various kinds of frameworks on what they would like to minimize difficulties in educational application (i.e. technical problems, usability issues or requirements in activities). Technology-based teaching at class has a great potential to enhance in learning experiences it still need supports for the full potential improvements at class.

In general, the evaluation could be usability aspect, educational content, or playability. The aim is to find out the issues to be treated at class. The evaluation frameworks and theories that help teachers to choose a suitable evaluation method that can fit their needs. The next chapter is going to discuss on the survey study of accessing mobile devices among school children and the current stage of implementing them at class in Thailand.

CHAPTER III

SURVEY OF MOBILE DEVICE USAGE

This chapter focuses on the use of mobile technology amongst young people in Thailand. A long-term survey was conducted over 4 years to gather information on the use of mobile technology in the local area of northern Thailand.

The use of mobile devices is growing swiftly in developing countries especially among school children and adults. Thailand and Singapore were transforming technology-based teaching and leading in Asia (The Asian Parent Insights, 2014). Further, Thailand is one of the Asian countries in the transformation of traditional teaching to technology-based teaching with the use of tablets in primary levels (The Asian Parent Insights, 2014). The fact about how children use technology in their daily lives, and the integration of mobile technology in education could provide a better teaching strategy for teachers.

Research Method

Over 4, 213 school students from the lower northern area of Thailand were participated in 4-years of survey study. It carried out once per year at Naresuan University Science Fair in August. The different age groups of students are categorized as Prathom 1-3, Prathom 4-6, Matthayom 1-3 and Matthayom 4-6.

The survey questions are divided into four parts; the different types of technological devices (PCs, tablets and smartphones), location, frequency, and purpose of uses. The multiple-choice survey questionnaires were set up at PC workstations in Thai language with staffs. Their responsibilities were to help students in answering the questions. The survey's questionnaire is shown in Table 4. Excel statistics was used to analyze the data in terms of penetration in technology consumptions.

Table 4 Survey Questions

Survey Questions
1. Gender
M / F
2. Age
3. Year of study
P.1-P.3/ P.4-P.6/ M.1-M.3/ M.4-M.6
4.1 Do you use computer (PC)?
Yes/ No
4.2 How often do you use computer?
Everyday/ 3-4 times per week/ 1-2 times per week.
4.3 Where do you use computer?
School only/ Home only/ School and home only.
4.4 What do you use computer for?
Education/ Playing games/ Contacting friend/ Browsing internet/ Watching video.
5.1 Do you use tablets?
Yes/ No
5.2 How often do you use tablet?
Everyday/ 3-4 times per week/ 1-2 times per week.
5.3 Where do you use tablet?
School only/ Home only/ School and home only.
5.4 What do you use tablet for?
Education/ Playing games/ Contacting friend/ Browsing internet/ Watching video.
6.1 Do you use smartphone?
Yes / No
6.2 How often do you use smartphone?
Everyday / 3-4 times per week / 1-2 times per week.
6.3 Where do you use smartphone?
School only / Home only / School and home only
6.4 What do you use smartphone for?
Education/ Playing games/ Contacting friend/ Browsing internet/ Watching video.

The compulsory questions are described from question number 1 to 4 in Table 4. The rest of questions are depended on the personal choice of mobile devices use. If a participant answered "Yes" to a question "Do you use computer (PCs)?", then a set of multiple-choice questions for purposes will give on the screen.

Limitation of the Study

The parental control and technology-based activities at school were not considered in this study.

Results

The quantitative survey result is divided into three parts which are the overall trend of mobile devices usage at different locations, break down analysis on the level of study, and gender preferences on the use of technological devices for the different purposes (Harfield et al., 2014; Nang, Harfield, & Viriyapong, 2015; Nang & Harfield, 2019).

Technological Devices Usage

Figure 4 describes the increased use of mobile devices by school children from 2014 to 2017. The consecutive four years of study stated smartphones are the most popular used and followed by PCs. The smartphone use has slightly increased in each year. However, tablet is not popular mobile device and takes place at the least used among Thai students.

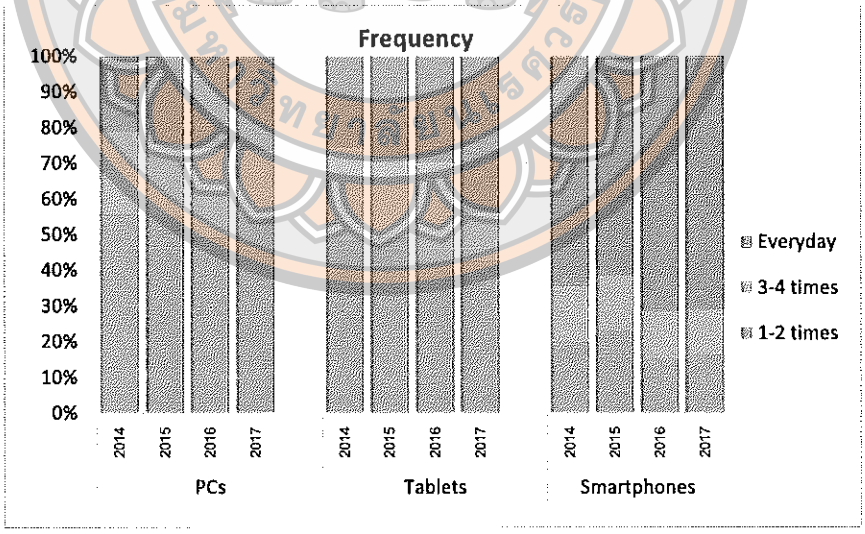

Figure 4 Usage of computational device of school children

Frequency of Use

Figure 5 illustrates the frequency of computational devices usage by primary and secondary school students. It illustrates that Thai school children like to use all technology devices in their daily lives. The daily frequency use of smartphones is in the highest place. PCs whereas tablets are not frequently used daily instead they are accessed 1-2 times per week in most students. The finding is different from the US survey study in 2015. i.e. students like to access tablet use in everyday (Poll, 2015).

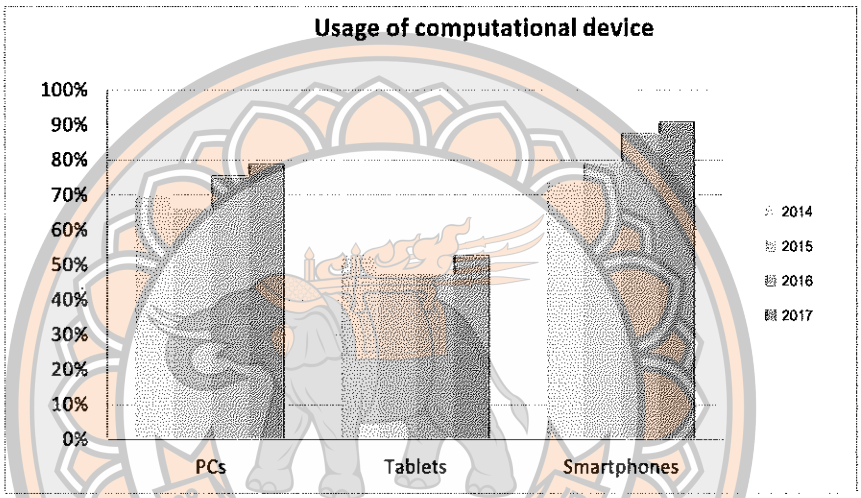

Figure 5 Frequency of computational device usage

Location of Use

Table 5 demonstrates how school children like to use technological devices at different locations. The percentage of computational device use is varied at different locations. At home, more than 89% of students like to use tablet whereas more than 96% of students prefer to access smartphone. It is in the same line as a report from US in 2015 which stated that smartphone is regularly consumed at any locations by students (Poll, 2015). The percentage of PC usage is fairly spread in both home and school locations.

Technology usage at different locations from year 2014 to 2017 have the same pattern. The result describes PCs is still mostly used at school. The portable hand-held smartphone is at the highest percentage in both locations.

Table 5 Location of use

Year	PCs		Tablets		Smartphones	
	School	Home	School	Home	School	Home
2014	63%	66%	16%	94%	42%	97%
2015	54%	80%	17%	96%	41%	97%
2016	62%	74%	27%	89%	54%	96%
2017	64%	74%	23%	91%	43%	97%

Purpose of Usage

The various purpose of technological devices usage is shown in Table 6. Playing game activity is a popular one on all devices. The result describes that the purpose of usage is varied on the individual preferences and their choice on mobile computational devices. Children choose smartphones for contacting with friends, while playing games on portable computational devices as tablets and smartphones. Generally, children are consuming technological devices for the entertainment and the access rate is increasing every year.

Table 6 Purpose of use

PCs				
	2014	**2015**	**2016**	**2017**
Education	67%	41%	46%	45%
Play games	34%	45%	48%	65%
Contact with friends	24%	21%	32%	31%
Watch movies	23%	27%	45%	65%
Tablets				
Education	39%	26%	34%	38%
Play games	52%	58%	54%	69%
Contact with friends	23%	21%	31%	39%
Watch movies	27%	27%	52%	64%

Table 6 (Cont.)

Smartphones				
Education	32%	29%	42%	46%
Play games	41%	50%	60%	69%
Contact with friends	53%	43%	53%	54%
Watch movies	28%	28%	50%	72%

Breakdown Analysis by Levels of Study

In this section, data was analyzed by different levels of study. The aim is to understand whether levels of students would affect the usage, frequency of usage, purpose of usage and location of usage of computational devices.

1. Usage

Figures 6, 7, 8 and 9 explained the deep analysis on mobile devices by level of study. The similar patterns are found within four years of study. School children like to access PCs and smartphones more than tablets. Both computational devices seem to be the essential technology and occupied in their daily lives.

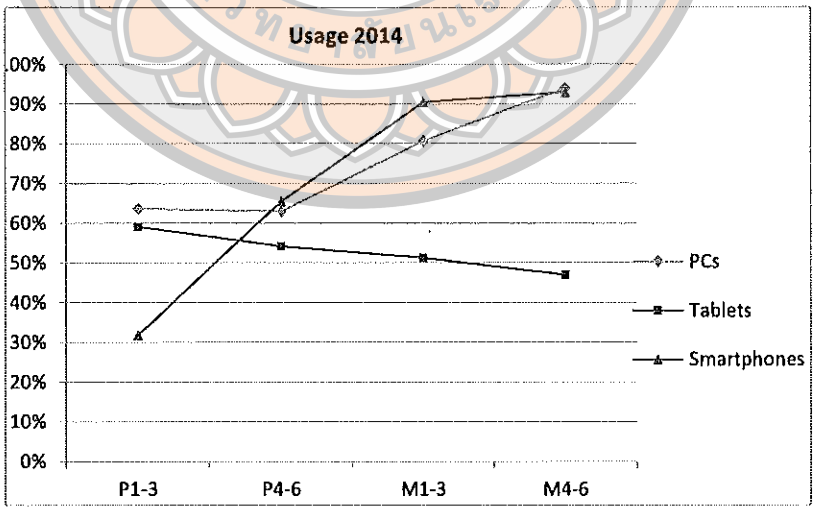

Figure 6 Usage by level of study in 2014

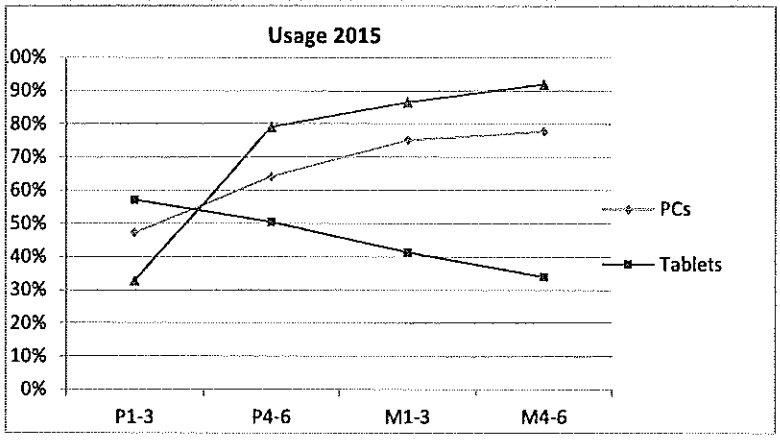

Figure 7 Usage by level of study in 2015

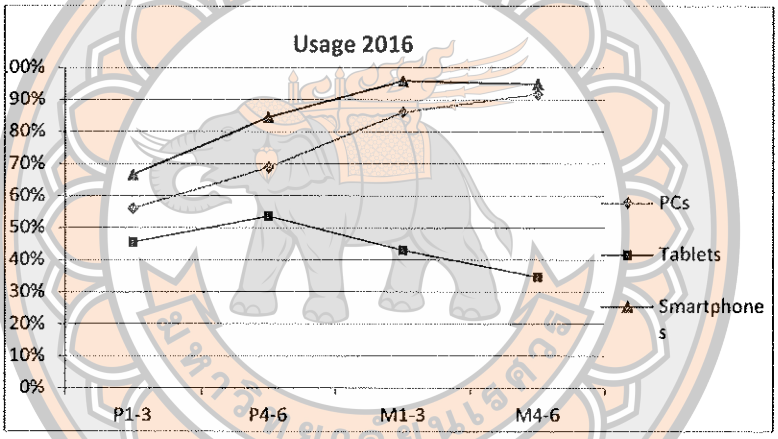

Figure 8 Usage by level of study in 2016

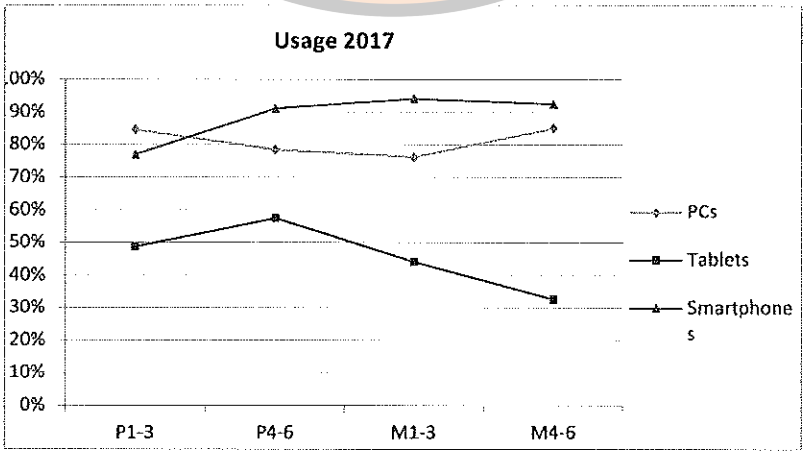

Figure 9 Usage by level of study in 2017

The finding is similar to the study from US. The US study found out that smartphone is a major used by aged 14-18 in US which is 87% (Toh et al., 2017). In UK, 79% of 12-15 years old teenagers used smartphones for different purposes (Ofcom, 2016). The smartphone usage is high among upper primary and secondary levels. When school children get older, they access PCs and smartphones more than tablets. PCs usage is marginally not stable while smartphone usage is continuously increasing every year. Tablet usage is obviously decreased when students get older.

2. Frequency of Usage

Figure 10-12 present the varied frequency of technological devices use on different levels of study. The everyday frequency of using lightweight computational device as smartphone is in the highest place. The evidence is consistent with a survey result from US (Gutnick et al., 2011). Both results recognize smartphone is growing and becoming their daily needs. The percentage of using PCs for 1-2 times/week frequency is higher than tablets and smartphones in all levels of study. The daily use of tablets and PCs are not significant while smartphones in the highest place. It is similar to the findings from USA in 2015 stated that adult users consume at least 3 hours per day for smartphone (eMarketer, 2015). Overall, results demonstrate that the higher level of study, the more frequent children use the technological devices.

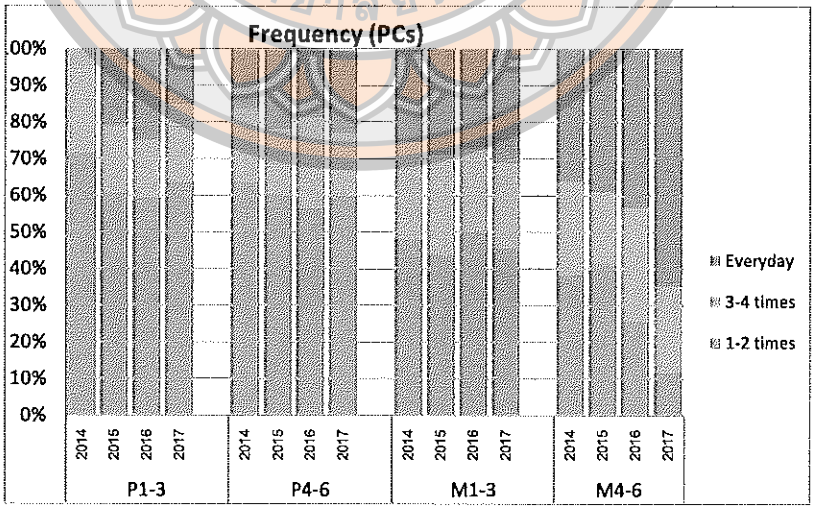

Figure 10 Frequency by different levels (PCs)

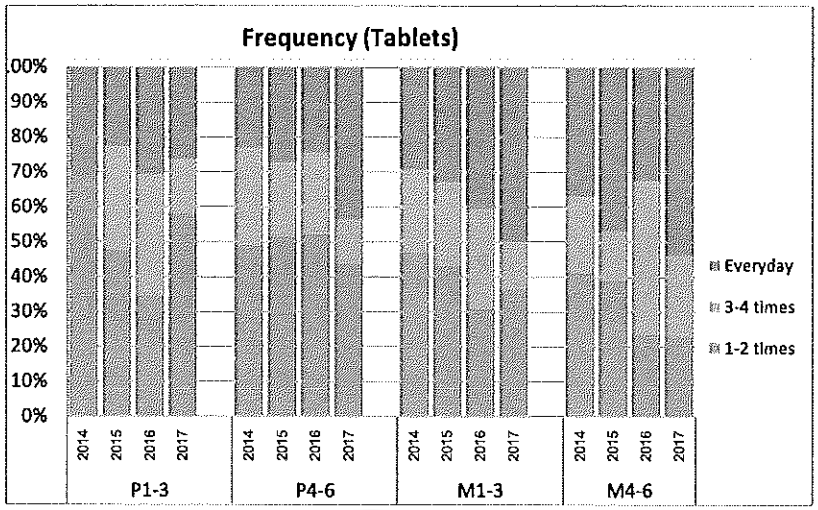

Figure 11 Frequency by different levels (Tablets)

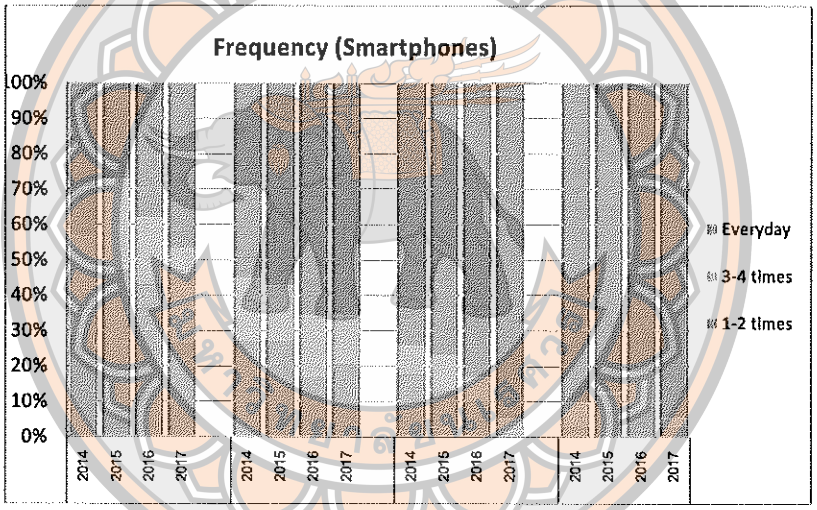

Figure 12 Frequency by different levels (Smartphones)

3. Purpose of Usage

The purposes of use on the various technological devices across different levels of study are shown in the Figure 13-15. In all levels of study, students use PCs particularly for educational purposes. Figure 13 shows the students usage of PCs for different purposes. "Playing game" is increasing every year in all levels of study except P1-P3.

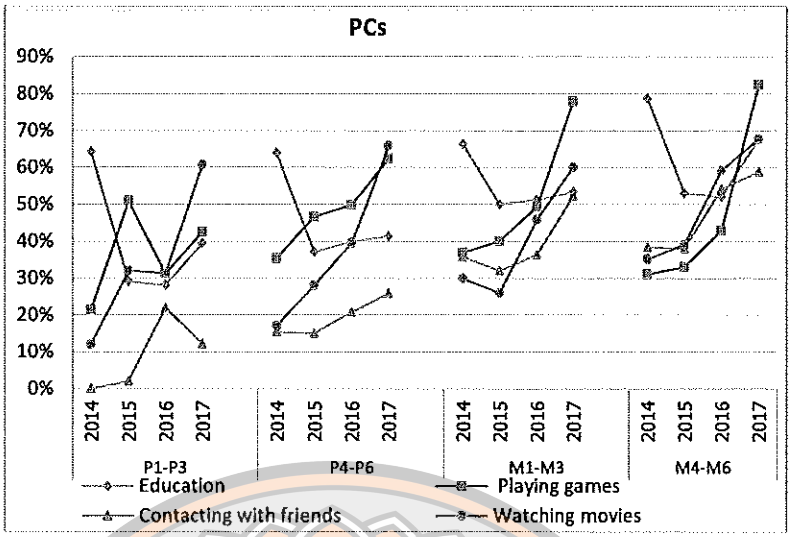

Figure 13 Purposes of use (PCs)

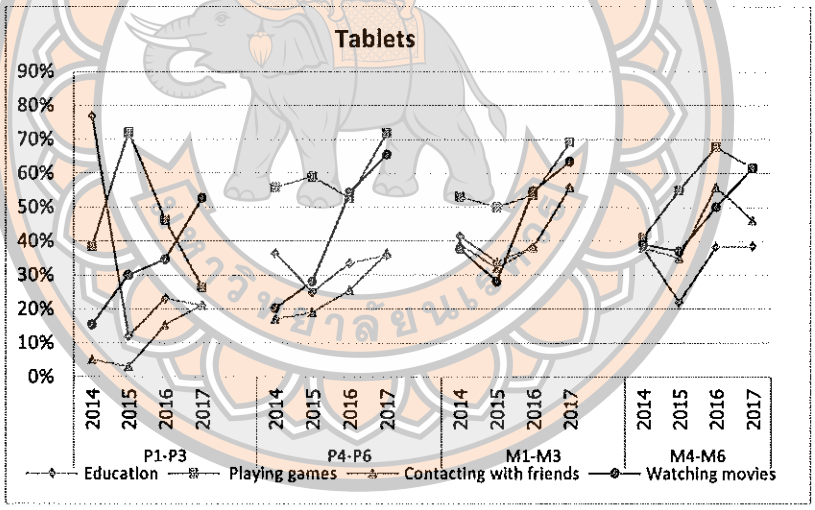

Figure 14 Purposes of use (Tablets)

Figure 14 illustrates students in all levels of study are accessing tablets for entertainment as watching movie and play game activities. Generally, students are more likely to use tablets for the entertainments than educational purposes.

Figure 15 shows the purposes of using smartphones. The result illustrates that school children access smartphones for all purposes. Surprisingly, the percentage of accessing smartphones for education purpose is increasing among P4-P6 and M1-M3

levels since 2015. Interestingly, M1-M3 and M4-M6 students use smartphone for contacting friends much more than P1-P6 students.

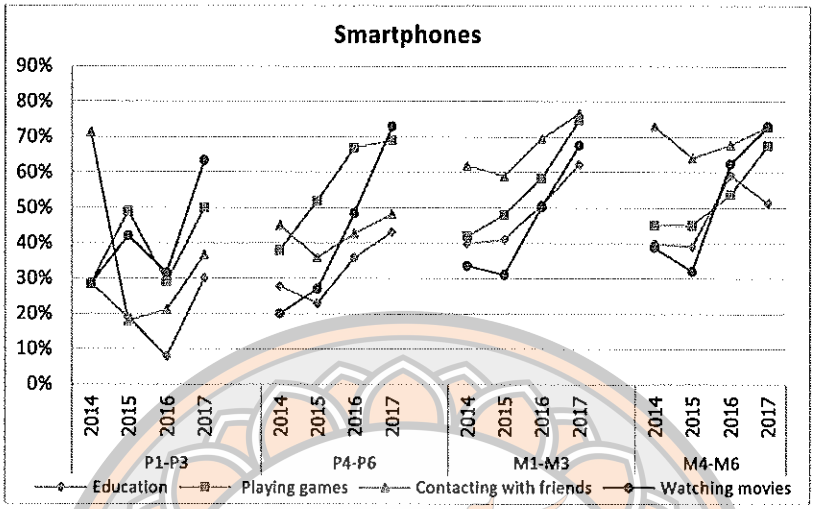

Figure 15 Purposes of use (Smartphones)

4. Locations

Table 7 compares the use of mobile devices at different locations by levels of study. Results demonstrate a larger usage of all devices at home than school and the more percentage in usage is in higher level of study. Both tablets and smartphones give a larger gap in percentage of usage between at home and at school in all levels of study (i.e. high use at home). Interestingly, the use of PCs in all levels of school children is not much different in percentage between at home and at school.

Table 7 Mobile device usage by level of study

Level	Year	PCs		Tablets		Smartphones	
		School	Home	School	Home	School	Home
P1-3	2014	79%	36%	31%	69%	29%	100%
	2015	42%	61%	20%	83%	17%	91%
	2016	69%	53%	16%	89%	16%	97%
	2017	72%	68%	26%	79%	30%	93%

Table 7 (Cont.)

Level	Year	PCs		Tablets		Smartphones	
		School	Home	School	Home	School	Home
P4-6	2014	59%	65%	10%	96%	26%	98%
	2015	53%	81%	15%	97%	34%	97%
	2016	60%	74%	25%	83%	43%	97%
	2017	82%	73%	23%	91%	35%	97%
M1-3	2014	72%	64%	28%	91%	58%	97%
	2015	61%	81%	20%	96%	54%	98%
	2016	67%	75%	31%	91%	70%	95%
	2017	58%	79%	31%	96%	68%	98%
M4-6	2014	60%	79%	24%	93%	77%	97%
	2015	51%	83%	32%	100%	77%	98%
	2016	60%	83%	42%	94%	74%	98%
	2017	48%	88%	31%	92%	86%	100%

Data Analysis by Gender

Data was analyzed by gender in order to know their preferred activities on mobile technological devices and usage. The result shows that gender gives no impact to the trend of technological usage as they show the similar pattern in trend.

1. Usage

Figure 16 illustrates the technological devices use by different gender for consecutive four years of study.

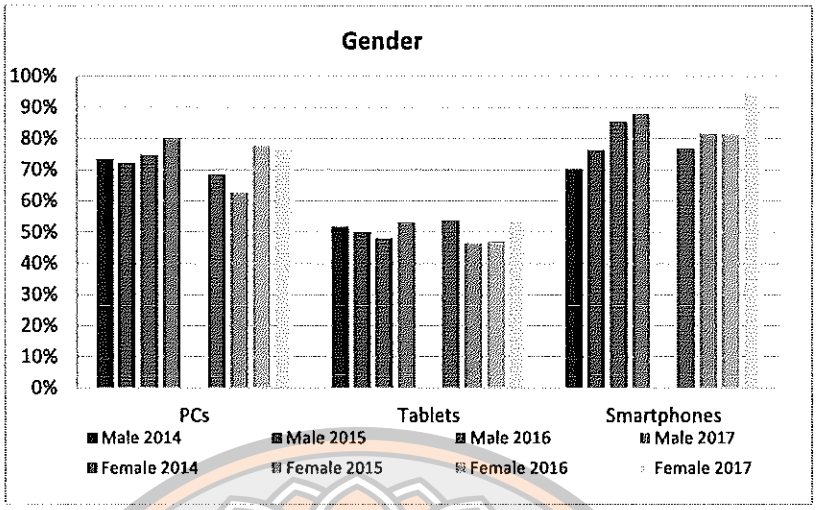

Figure 16 Usage by different genders

2. Purpose of Usage

Figure 17-19 represent the increment and decrement of purposes consumed by different gender from 2014-2017. There is no specific different pattern on the use of purposes consumed by different gender in each year. There is no specific pattern on the use of purposes among male and female students.

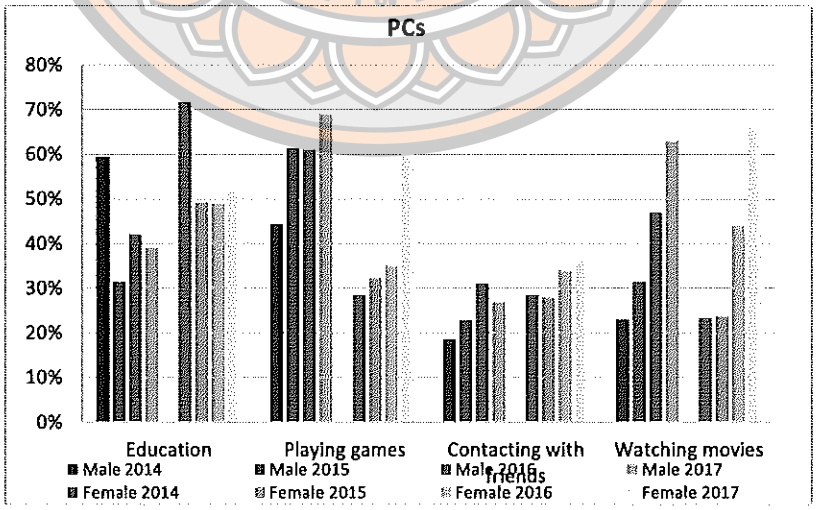

Figure 17 Usage (PCs)

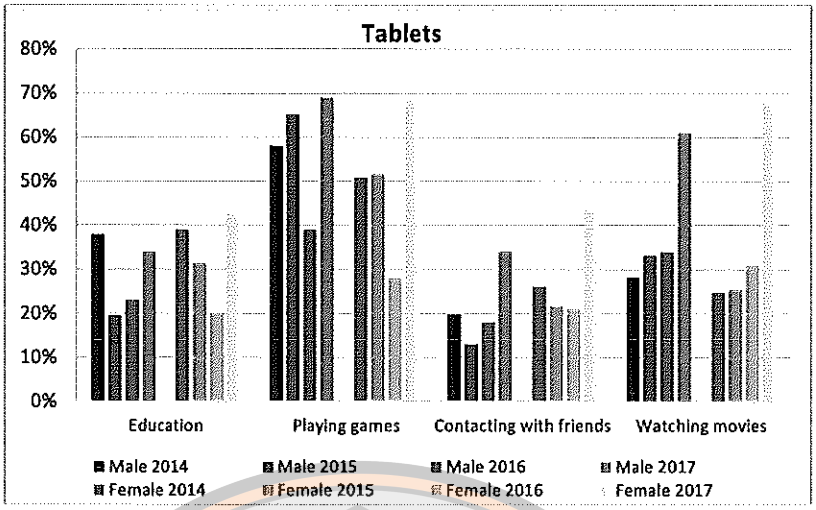

Figure 18 Usage (Tablets)

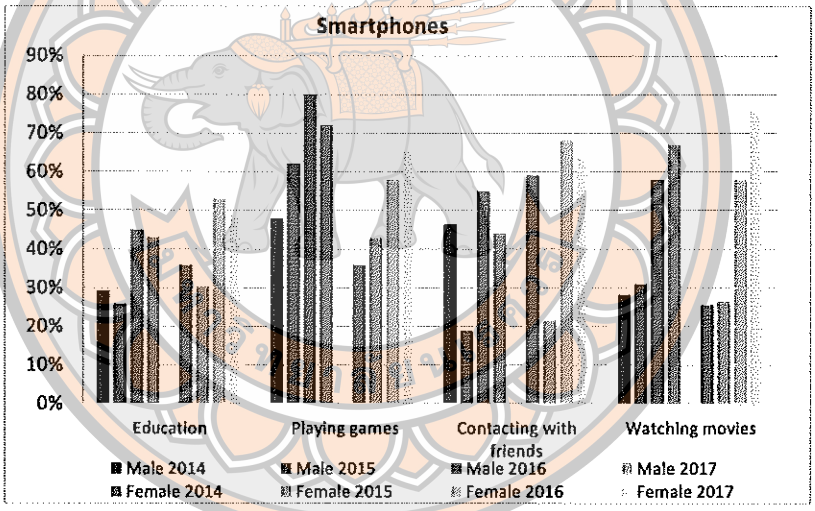

Figure 19 Usage (Smartphones)

Findings and Discussion

"Playing game" is the most popular activity in male and female students. Tablet takes place as the lowest position while smartphone is in the highest position of use. In agreement with study from Singapore, the digital device usage has a similar finding in Thailand (Long, Liang, & Yu, 2013). In this case, we can assume Asian school children like to use PCs and smartphones more than tablets. This might be because of parental control or school policy.

The result shows the percentage of smartphone usage is increasing while tablets and PCs usages are decreasing. School children like to use smartphones in their daily lives. It is similar from a separate study at New Zealand, where the use of smartphone is higher than other devices (Mascheroni et al., 2013).

Thai students consume more smartphones for educational purposes than tablets. The usage of tablets is decreased when the students get older. The purposes of use and location are dependent on different age groups, individual knowledge and preference.

The interesting point of this survey is that students are less using tablets for educational purposes at schools. Although, the Ministry of Education in Thailand is deploying tablets as teaching assistant tools in primary and secondary schools. Schools are implementing to use tablets in the initial stage, but result shows primary school level is not significantly accessed tablets for learning processes. In order to understand more this situation, the next chapter will focus on how to use tablets and educational applications at class, and the current difficulties at primary schools in Thailand.

CHAPTER IV

PILOT EXPERIMENTS AT PRIMARY SCHOOLS

The previous chapter indicated that the use of tablet for educational purpose is low in Thai schools. Before proposing a framework to support teachers in use of tablet-based games via tablets, three separate experiments were undertaken to gain further understanding about the use of TEGs in primary school levels: the characteristics of tablet-based educational games, student performance in tablet-based activities, and the initial pitfalls of using tablets in classrooms.

Experiment 1: Children Preferences in Game Characteristics

The objective of the first experiment is to identify the game characteristics preferred by Thai school children in Mathematics and English TEGs.

Method

The participants were 21 Primary-3 and 25 Primary-4 students from Wat Dhammakaset primary school in Phitsanulok, in the Lower Northern Part of Thailand. One hour per week class was taken for each level, over four weeks from February 11, 2015 to March 4, 2015. The observation and interview methods were applied in this study.

There were 9 educational games for Mathematics and an English subject game are selected for the experiment, which were loaded onto 22 iPads. In the first two weeks, Mathematics subject games were focused on fraction, decimal, multiplication, division, addition, and subtraction. In the last two weeks of study, English subject games were emphasized on vocabularies. The descriptions of games are presented in Appendix A.

The students' like and dislike on games and their perspectives on playing games on iPads was carried out by interviewing individually. The questionnaire is described in Appendix B. The observation questionnaire was done by observers, and it comprised of nine questions (i.e. divided into technical and behavioral perspectives) as shown in Appendix C.

Each game was evaluated by six game characteristics, in a similar method to the study by Verenikina, that could help in student learning development (Verenikina, & Herrington, 2008). The chosen characteristics for this study consist of:

1. Metaphor: the game has a concrete context or metaphor meaningful in the real world (e.g. feed the hippo game), or the game is more abstract (e.g. addition of numbers).

   ○ Abstract, ● Concrete

2. Feedback: Level of sound, alert and animation during the interaction with game.

   ○ Little or no feedback, ◐ Some feedback, ● Good feedback.

3. Scaffolding: The level of tutorials, instructions, and in-game support.

   ○ Little or no support, ● Significant scaffolding support.

4. Graphics: Level of detail or complexity or detail or realism of graphics.

   ○ Simplistic or minimal graphics, ● Complex or detailed graphics.

5. Time: The game describes a time element.

   ○ No time element (e.g. players can complete at their own pace), ◐ Time is not limited but not recorded (e.g. players see their time and have time-based scoring, but they can control pace), ● Time limited (e.g. players have a time limitation).

6. Touch: The input numbers of touches in the game.

   ○ One touch (e.g. button press) only, ● Multi-touch or gestures (e.g. drag, or long press or more than one touch).

Limitations of Study

This study emphasized only a small number of games in English and Mathematics. This study was investigated from children and observers points of views on use of educational games. Teachers' opinions of games are not considered in this study.

Results

The findings were divided into three perspectives: student preferences in games and its characteristics, game design and students' behaviors, popularity and usefulness of game (Nang, Harfield, & Viriyapong, 2015).

1. Student Preferences in Games and its Characteristics

Table 8 shows the results from all weeks. The most popular games in each week are shaded (determined by asking the students which was their favorite game).

In week 1, 83% of like are received by top 2 games which are "Sushi Monsters" and "Math to the Rescue". All of those games were characterized as concrete features in game design. The least popular concrete game was "Zap Zap Fraction" amongst students. In week 2, most games have abstract features, where "Math Factor II" has least concrete metaphor and liked by students. In week 3, the highly ranked 2 games "Platte (Colors)" and "Search (Colors)" have concrete metaphor by the students. In week 4, 71% of 5 out of 11 games were popular because they were characterized as concrete. They are "Whack", "Fruit Mouse", "Feed the Beast", "Feed the Hippo", and "Bear the food".

Table 8 Game Characteristics

Week	Games	Likes	Dislikes	Metaphor	Feedback	Scaffolding	Graphics	Time	Touch
Week 1	Sushi Monsters	22	4	●	●	○	●	○	●
	Math to the Rescue	12	6	●	◐	○	●	◐	○
	Quick Math+	7	20	○	●	●	○	○	●
	Zap Zap Fraction	5	6	●	○	●	●	●	○
Week2	Math Factor II	18	8	○	●	●	●	●	○
	Clock Master	8	16	○	◐	○	○	○	●
	Math Tris	8	17	○	○	●	●	●	○
	Measure	5	3	○	◐	○	○	○	●
	Math Tris Dec	4	0	○	○	●	●	●	○

Table 8 (Cont.)

Week	Games	Likes	Dislikes	Metaphor	Feedback	Scaffolding	Graphics	Time	Touch
Week 3	Palette (Colors)	12	6	●	○	○	○	◐	●
	Search (Colors)	8	5	●	◐	○	●	◐	○
	Bubbles (Colors)	5	7	○	○	○	○	○	○
	Memo (Colors)	3	17	○	●	○	●	◐	●
	Two by Two (Colors)	3	1	○	○	○	●	◐	●
	Spellbounce (Colors)	2	3	○	◐	○	○	◐	●
	Whack (Animals)	15	3	○	●	○	○	○	○
	Two by Two (Animals)	5	7	○	○	○	●	●	●
	Silhouettes (Animals)	3	6	●	◐	○	●	◐	○
	Spellbounce (Animals)	2	5	○	◐	○	○	◐	●
	Voice Choice (Animals)	1	8	○	◐	○	○	○	○
Week 4	Fruit Mouse (Fruits)	19	10	●	◐	○	●	◐	●
	Feed the Beast (Fruits)	8	11	●	●	●	●	○	●
	Fruit Market (Fruits)	3	0	○	◐	○	●	◐	○
	The Blender (Fruits)	3	3	○	◐	○	●	◐	○
	Smash (Fruits)	2	9	○	◐	○	○	○	○
	Feed the Hippo (Food)	14	11	●	●	●	●	○	●
	Bear the food (Food)	13	6	●	◐	○	●	◐	●
	Vending Machine (Food)	8	4	○	◐	○	●	◐	○
	Platter Scatter (Food)	3	11	○	●	○	●	◐	●
	Splat (Food)	3	7	○	◐	○	○	○	○
	Banquet (Food)	0	3	●	◐	○	●	◐	○

Unusually, both highly liked and disliked games were the most popular games in English subject games (week 4). It is because they had different games design since they were produced by different individuals or companies.

The result showed metaphor realism (i.e. the application is rooted in concrete or abstract context) was influenced the popularity as determined by primary school students. It was standing as one of the strongest characteristics in educational games.

The level of feedback (i.e. ○ little or no feedback, ◐ some feedback, ● good feedback) was classified as one of the main factors in many of the most popular games. The amount of support, description, in form of tutorials or scaffolding (support) did not have an effect on student preference.

The games which got many likes from students are assumed as the most popular games (shaded rows) have complex graphics, which were a driver for popularity of games. Interaction design (gesture-based or single touch) did not relate to students disliked and liked the games. Time limitation was not affected and unrelated to popularity of games.

2. Game Design and Student's Behaviors

Table 9 describes the observation results done by the observers for each game, rated from 1 (strongly disagree) to 5 (strongly agree). The corresponding survey statements are described in the below. Totally, there are nine statements which are divided into two parts. The technical statements (TS) are represented from 1 to 4, and behavioral statements (BS) are from 5 to 9.

TS1: The students can get started in the game without guidance.

TS2: The user interface is easy to understand for the students.

TS3: The user interface is aesthetically pleasing to the students (they enjoy the graphics).

TS4: The game gives appropriate feedback (e.g. sound and animation).

BS5: The students concentrate hard while playing the game.

BS6: The students communicate with their friends while playing the game.

BS7: The students show positive emotions of enjoyment while playing.

BS8: The students show negative emotions of frustration while playing.

BS9: The students get bored with the game after a short time.

Table 9 Observation Questions

Games \ Questions	TS1	TS2	TS3	TS4	BS5	BS6	BS7	BS8	BS9
Food	4.6	4.6	5.0	4.5	4.8	4.6	4.9	1.1	1.5
Animals	4.3	4.9	4.9	4.6	4.8	3.6	4.6	1.5	2.5
Fruits	4.3	4.6	5.0	4.5	4.8	4.5	4.9	1.1	2.1
Colors	3.6	4.4	4.4	4.5	5.0	3.6	4.4	1.8	2.4
Quick Math+	3.8	4.5	3.8	4.5	4.8	4.0	4.5	1.8	2.3
Math Factor II	3.3	3.8	3.4	3.6	4.5	2.6	3.6	2.0	2.4
Sushi Monsters	2.8	3.5	4.8	4.3	4.5	4.0	4.3	1.8	1.3
Clock Master	2.8	3.5	3.6	2.9	4.6	2.6	2.9	2.1	2.6
Zap zap	2.8	2.5	3.5	3.5	4.3	2.5	3.0	2.5	2.5
Clock Tapper: Measure	2.5	2.8	3.5	2.4	4.0	2.5	3.1	1.8	2.3
Math to the Rescue	2.0	3.3	4.5	3.3	4.3	4.3	4.3	2.0	2.3
Math Tris	1.4	2.4	3.3	3.0	3.9	2.3	2.6	2.3	2.1
Math Tris Dec	1.4	2.4	3.3	3.0	3.9	2.3	2.6	2.3	2.1

The observers ranked each question from 1 to 5 and the observation concluded that students needed helps from peers to start the Mathematics games where the average score is 2.5 in question "games without guidance from assistants (TS1)". There are many possible reasons such as the user interface designs are not clear to understand for students (TS2) where the average score is 3.2, or poor feedback for young learners (TS4) where the average score is 3.4. Another reason is that students were not familiar to access tablets.

Most young students started to play English games without guidance from the assistants. The first 4 rows (i.e. technical statements) of table present the high scores in most questions. The possible reasons are the "familiarity effect" because students were experienced with educational games. This will contradict with the previous program or the game presentation in English games are better than Mathematics games.

In order to discuss from game design perspectives, the most liked games have the aesthetical application presentation (TS3). However, they were not easy to get started from the supported evidences. In order to compare with English and Mathematics games, the appropriate feedback (TS4) was the most apparent in English subject games.

Table 9 demonstrates that students had the high levels of concentration on games whether they disliked or liked it (BS5). The significant communication was taken around class and children usually pre-occupied tablets before play activity (BS6). School children would like to discuss and communicate with their classmates while they were performing tasks to accomplish the goal. The game-related discussion such as their achievements, accomplishments, and supporting each other were the common topics. The competition and small quarrels were observed in some groups.

A very little negative emotion (BS8) and mostly positive emotion (BS7) were shown by students during play time. They loved to play games and did not express boredom after a short time play (BS9). Students particularly appeared negative emotion or got bored with poor interface design or bad feedback in the first week. Hence, the play activity was changed in the last week of the experiment. During semi-structured interviews, students described they had fast thinking, gained knowledge, played with friends, loved to play via touch screen, and felt relaxed. They had more fun in learning than at normal teaching class. Most of the students said "they like to do exercise and play with tablets because it is fun".

3. Popularity and Usefulness of the Games

There were some unusual results found in this experiment that are worth noting. "Quick Math+" is a high-ranking application in the App Store for children and all of the observers agreed that it was high quality because it has a simple user interface design and ease of starting to use were the reasons for getting high scores. The application has good feedback and scaffolding was provided in game.

However, it was one of the most disliked games among children and did not receive many likes. In the first week of experiment, observers/assistants ranked and assumed "Math to the rescue" had difficult user interface design to understand and poor feedback. Nonetheless, it got a high number of likes and was the second most popular game. It stated "Math to the rescue" game has concrete (realism) metaphor while "Quick Math+" does not have even both games have good graphics design pleasing to students.

Finding and Discussion

The evidences in this study showed students prefer educational games with concrete contexts. Therefore, making topic or lesson on more concrete learning context (i.e. virtual "real-world" context or by placing it in a digital) becoming common for educational applications.

The perspectives from the observers' sides are not consistent altogether with the student preferences. Perhaps, it is not surprising result because what the observers thought was most successful than the preferences of students. The majority of children were more likely to play non-educational games than an educational game for learning Mathematics. The experiment has highlighted an effective and efficient educational game might be relied on some factors:

1. Metaphor and graphics were the most relevant characteristics for popularity amongst students.

2. Levels of scaffolding and feedback would be appropriate to consider for the effective game-based learning in the class.

It is hard to choose games that could satisfy to students' enjoyment and teaching requirements. Nonetheless, this study highlights "metaphor, graphic, scaffolding and feedback" are the fundamental to have in educational games, which can persuade students in learning lessons.

Experiment 2: Learners' Performance on Tablet-based Activities

Another study was carried out to measure student performance on tablet by using education applications. The following experiment was undertaken with primary-3 and primary-4 students using Mathematics and English educational applications on tablets. The objective of this study is to know the positive learning outcomes with use of tablet-based educational games.

Method

A total of 46 students (21 from primary-3 and 25 from primary-4) from Wat Dhammakaset primary school participated in this experiment. There were 18 educational games matching the primary Mathematics and English curriculum that were used by the participants. The statistical method was used to analyze the data. The description of each game is described in the Appendix D. Topics covered in this

experiment were Mathematics - addition, multiplication, greater than, less than, and patterns for Primary-3 and Primary-4 levels. English subject - animals, colors, school things, and animals for Primary-3 and school things, body parts, family members for Primary-4.

For each level, one hour per week experiment was taken, over a four week from March 20th, 2015 to June 10th, 2015. The various types of pre and post assessments were used as required by topics and lessons, which are described in Appendix E. It is designed to cover the lessons which are studied by students during play activity. Before undertaking one hour of tablet activity, a warm-up session was given to teach the students the required knowledge, followed by a pre-test.

Limitations of Study

This study only focuses on learning performance in English and Mathematics subjects on tablet-based learning activity at class.

Results

1. Outcomes of Learning Performance on Mathematics

Table 10 shows the Primary-3 student performance on Mathematics subject. There is a positive gain score in the first week but decreased in the following week.

Table 10 Mathematics Scores in Pre and Post-tests (primary-3)

Math	P3	Pre-test			Post-test			Gain score	
	n	Mean	Min	Max	Mean	Min	Max	Mean	Mean %
W1	15	16.6	7	19	16.67	10	19	0.07	0.4%
W2	15	18	9	20	17.17	8	20	-0.83	-5.5%

Table 11 illustrates the improvement of Primary-4 student performance in Mathematics. Their performances on the mathematics skill is increasing from 3.6% to 10.3% in the two weeks of study.

Table 11 Mathematics Scores in Pre and Post-tests (primary-4)

Math	P4	Pre-test			Post-test			Gain score	
	n	Mean	Min	Max	Mean	Min	Max	Mean	Mean %
W1	19	14.2	9	19	14.9	9	19	0.7	3.7%
W2	19	13.5	6	20	15.45	5.5	20	1.95	10.3%

2. Outcomes of Learning Performance on English

Table 12 shows the analyzed result of student achievement in Primary-3. There is a significant gain score percentage in the week 1 which is 22.7%, but drop into 1.8% in week 2.

Table 12 English Scores in Pre and Post-tests (primary-3)

English	P3	Pre-test			Post-test			Gain score	
	n	Mean	Min	Max	Mean	Min	Max	Mean	Mean %
W1	15	12	4	20	15.4	3	20	3.4	22.7%
W2	15	12.53	6	20	12.8	7	17	0.27	1.8%

Table 13 illustrates the improvement of Primary-4 student scores. The positive percentage of student performance is 14.4% in the first week and 2.8% in the following week of study.

Table 13 English Scores in Pre and Post-tests (primary-4)

English	P4	Pre-test			Post-test			Gain score	
	n	Mean	Min	Max	Mean	Min	Max	Mean	Mean %
W1	18	10.6	3	18	13.2	2	20	2.6	14.4%
W2	18	9.1	4	17	9.6	4	17	0.5	2.8%

Finding and Discussion

The Primary-4 learning performance on Mathematic subject was progressively increased in each week while Primary-3 level was decreased. The finding shows the gain scores of English subject is higher than mathematics subject. There are four possible reasons as follows:

1. Young students were more interested in learning English subject than Mathematics.

2. Applications for learning English were better at capturing the young students' interest than the applications for Mathematics.

3. English as a subject is more suitable for Primary-3 student in learning via tablet than Mathematics, or

4. Young learners enjoy studying English on tablets informally than the traditional classroom teaching.

The observation result showed that often children interest was not sustained for long periods of usage with the tablet. The possible reasons for warning interest in the tablet activity could be:

1. After becoming familiar with devices, learners get bored to perform an activity after a specific amount of time.

2. The alternative changes of activities (paper-based pre-test, play activity, and paper-based post-test) decreased students' interest in tablet-based teaching.

3. Student attention has high at the beginning for all applications, but their interest decreased depending on the application and topic.

In this experiment, the positive learning outcomes in different subjects by different levels can be seen. However, the longer experiment is required to verify the learning improvements in each week.

Experiment 3: Initial Pitfalls of Tablet-based Teaching at Class

The Ministry of Education in Thailand is implementing a nationwide pilot study of tablet-based teaching in 50 primary schools. This project provides iPads for primary students to learn STEM subjects and projection facilities for the primary level teachers. The more information could be found in the www.obec.iclassroom.go.th.

The aim of this study is to know the current problems that are encountered by the primary school teachers.

Method

The experiments were carried out at Anuban Phitsanulok School with 46 Primary-4 students, 4 STEM subject teachers and at Wat Yang En primary school with 26 Primary-4 students on English and Technology subjects. Currently, schools are integrating tablet activities for the Primary-4 level on STEM subjects. All the primary school teachers have less than 1-year experience in teaching with tablets. They attended the trainings and workshops provided by Ministry of Education before implementing tablet-based teaching at school.

The qualitative data collection method was used for the classroom observation covers from three parts: field notes (taken during the class), narrative summary and follow-up conversations and the unstructured interviews with subject teachers.

Table 14 Timetable for STEM Subjects

Grade	School	Subject	Duration	Applications & resources	Description of application use
P-4	Anuban Phitsanulok School	English	2:40 p.m. - 3:30 p.m.	GoogleEarth, YouTube, video clips, pupil's book, and activity book	Gain general knowledge, improve listening skill
		Maths	8:40 a.m. - 9:30 a.m.	Pages and Google	Solve given Math problems
		Science	8:40 a.m. - 9:30 a.m.	QuickTimePlayer	Make a movie clip for learning science (plants and trees) in the compound
		Technology	1:40 p.m. - 2:30 p.m.	Intelligram	Learn how to do a movie clip
P-4	Wat Yang En primary school	English	9:30 a.m. - 10:30 a.m.	Pages	Use as a notepad
		Technology	10:30 a.m. - 11:30 a.m.	Animatics	Learn to create mini animation project

Table 14 describes the timetable and applications used in the tablet-based teaching activities. Teachers had to install the applications that they would like to use at class and prepare activity.

Limitation of Study

There were some restrictions in the data collection such as the limited number of teaching subjects, teachers and levels of study.

Results

The English teacher from Anuban Phitsanulok primary school said that she had to teach Primary 3, 4 and 5 levels, at least 3 sessions per day. The target was to finish the lessons before the term was over. The teachers from Wat Yang En also said that they had to finish lessons in time. They did not have the extra time in searching applications, preparing and organizing an activity to form an effective tablet-based activity. Generally, teachers are more emphasized on finishing the courses in time than to create a student-centered learning with tablets.

They said that they do not have knowledge in searching educational applications and they are using free applications from www.obec.iclassroom.go.th. In order to present how do teachers organize the tablet-based teaching classes, two examples are provided.

Example 1: The young English teacher from Wat Yang En school used tablet as a presentation tool with projector. The teachers did not assign any tasks or activities to students. They were sitting, listening and repeating lessons delivered by English teacher. The mathematics and technology teachers from Anuban Phitsanulok always prepared demo and gave a briefing of the application before giving to class. The English teacher from Anuban Phistansulok assigned tasks to students and let them have freely access to Google to accomplish the tasks.

Example 2: Technology teacher from Wat Yang En primary school was given the "Anatomy 4D" interactive application and let students play by themselves. They were accessing the application by themselves although they did not understand the terms of anatomy in English. The content of this application is not aiming for Primary-4 level students. It is a good application for the upper secondary or medical students. The subject teacher said that "students liked to access the application that they could have fun".

In such case, young learners are always loved to access an interactive application with good graphics as finding from the previous study. The responsibility of teacher is to give a suitable application to the class. Teacher should access the applications and assure that application is matched with the teaching objective and student needs before giving to class. Although Ministry of Education was given many useful applications, teachers did not well prepare to use at class.

The present situation illustrates that teachers need motivation and confidence in forming technology-based teaching effectively. In order to reduce teachers' workloads on tablet-based activity, there should have enough IT staffs and provide workshops for teachers to have the basic knowledge in technological mobile devices and its applications. The detailed findings are described in the Appendix F and G.

Finding and Discussion

The present situation describes the applied pedagogy could vary between teachers significantly. The results illustrated that teaching experiences and age are not affected on technology-based teaching activity. Some teachers were simply transforming from paper to paperless activity (i.e. converting the worksheet class exercises to digital-based) – the students experienced the same traditional teaching situation and the benefit of technology is lost. It might not be supportive to use mobile devices in this way to level-up their present knowledge. The primary level teachers were using a limited selection of applications suggested by Ministry of Education, which are similar as a small set of general application. There are eight key findings (Nang, & Harfield, 2018a) from the pilot study is summarized as follows:

1. Variety of use: Using a limited selection of applications and some teachers use only generic applications (e.g. Word application).

2. Discovery: Do not know how to find appropriate applications that complement their classroom material.

3. Preparation time: Teachers are taking more time in order to form a tablet-enabled activity.

4. Integration: Teachers are lack of experience in integrating tablets and its applications with the curriculum.

5. Suitability: Teachers do not have clear decisions on which pedagogical approaches are well supported to use tablets in the classroom.

6. Dependence on technical ability: A teacher's technical ability often determines the successful outcome of a classroom activity.

7. Keeping students motivated: The balance in delivering lessons and class activities should be balanced to motivate and encourage active learning.

8. Fear factor: A bad technology-based teaching experience is likely to decrease teacher confidence and lead to resistance to technology in the classroom.

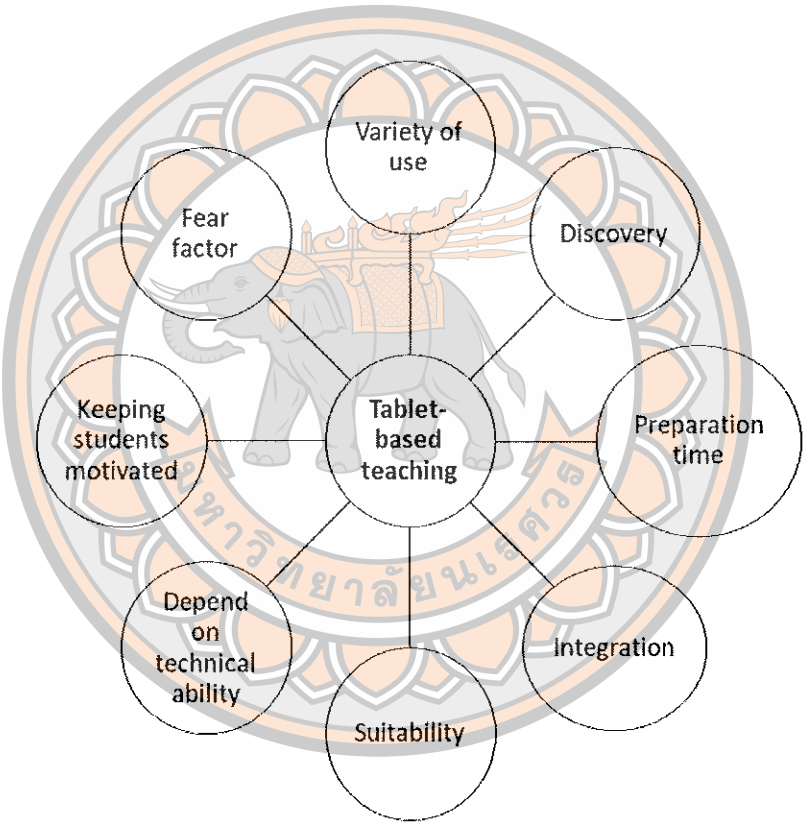

Figure 20 The effects to decrease teachers' confidences in teaching

Figure 20 shows the effects which lead to decrease teacher's confidence in creating tablet-based teaching activity. The right choice of applications might have some barriers for teachers such as they are lacked experience in blending technology and teaching method together. They required to prepare different kinds of activities to increase student interest in tablet-based learning. However, they did not have enough time for preparations and experiences in creating technology-based course material.

Although teachers had the positive attitudes in using tablets as the teaching aid tools at class, they needed supports from experts to get the right track of tablet-based teaching. In summary, teachers need a community of practice approach (Lih-Juan, 2017) to share knowledge in setting up mobile devices at class, education applications and preparations before delivering technology-based lessons. Therefore, the next chapter is going to propose a framework which will focus in evaluating and selecting the suitable applications from a mass of educational applications.

CHAPTER V

PROPOSAL FOR FDF-TEG

This chapter proposes a framework that is designed to overcome the challenges in the current state of tablet-based educational games in Thailand, based on the literature discussed in Chapter II and the initial experiments in Chapters III & IV.

The Need for a New Framework

Chapter II discussed three frameworks or models that are designed for evaluation in educational technology: Input-Process-Outcome model (IPO), Adapted Interaction Cycle (AIC), and Four-Dimensional Framework (FDF). The models and frameworks have their own strengths and weaknesses. IPO model is focused on validating that game characteristics and instructional content are related to each other, AIC framework evaluates the usability issues in adventure games, while FDF is helping teachers to evaluate simulation-based educational games in order to form an efficient and effective teaching situation.

Table 15 summarizes the significant features of frameworks and models in order to have a better understanding on their strengths and weaknesses.

Table 15 Comparison of Difference between Models and Frameworks

IPO	AIC	FDF
Evaluate motivation in the instructional games.	Evaluate usability issues in adventure games.	Evaluate education/simulation games in a context of use.
-	5-7 years old	Lifelong learners
Combine instructional content and game characteristics	Initial usability problems	Evaluate simulation-educational games
Design an effective instructional game	Understand the interaction problems	Suggest suitable games and how to apply in context

IPO and AIC are both highly focussed on the design of educational games for children although they approach it in two different ways: IPO looks for games that effectively instruct and motivate learners; AIC analyses usability issues to select games that are likely to be most effective. In FDF, **design (or "representation") is only 1 dimension** out of 4 dimensions. The other 3 dimensions are considering the **context of use** (of the educational game or simulation).

The eight challenges highlighted in Chapter IV have shown that there are many contextual factors that could affect the use of tablets in Thai primary schools. Therefore, FDF offers a broader framework than IPO and AIC, that is appropriate for this thesis.

FDF is for evaluating the use of simulation-based educational games by life-long learners. For tablet-based games in primary school, the framework needs to consider the teaching objectives, the learning environment, the group of students, the background knowledge, the design of the technology and the method of applying the technology. The framework also needs to be used by school-teachers (not life-long learners) in evaluating an educational game. Hence, FDF is not completely aligned with the needs of this thesis.

Modifying FDF for Tablet-based Educational Games

Table 16 shows FDF is aimed at lifelong learners using simulation-based games. Therefore, a modification to the framework for teachers to apply tablet-based educational games in the classroom is proposed in this thesis. This new framework is called the Four Dimensional Framework for Tablet-based Educational Games (FDF-TEG) (Nang, & Harfield, 2018b).

The reasons for modifying FDF are to remove simulation-specific sections, to narrow the focus on tablet-based education games for primary school and to make it applicable for teachers and parents instead of life-long learning instructors. Table 16 demonstrates the differences between the original FDF and the proposed FDF-TEG frameworks.

Table 16 Differences between FDF and FDF-TEG Framework

FDF	FDF-TEG
Simulation-based games in virtual world.	Educational games.
Computer-based learning.	Tablet-based learning.
College and life-long learners.	Primary school teachers.
Help the instructors to evaluate the potential use of games-and-simulation based learning.	Help teachers to have more confidence in using educational applications.
To analyze game and simulation in virtual world.	To support careful considerations in tablet-based applications.

FDF-TEG will cover four perspectives similar to FDF, where three of the dimensions (learner specifics, pedagogy, and context) follow the original framework. The motivations for keeping the first three dimensions the same as FDF are as follow:

1. "Learner specifics" is relevant to any kind of technology-based learning activity.

2. "Pedagogy" is applicable to any learning whether it is life-long learning or classroom-based learning.

3. The "Context" of the learning is very broad in life-long learning, whereas for classroom-based learning it is most likely a subset so the criteria are still relevant from this dimension.

The fourth dimension (representation) of the original FDF is not well aligned with tablet-based applications because of the changes in hardware (from PC to tablet) and software (from simulation to educational game). In most cases, tablet-based educational games have simpler features and presentation than simulation-based games. Hence FDF-TEG addresses these differences in the fourth dimension called "Game representation".

According to the previous experiments in Chapter IV, the results illustrated that "feedback" and "scaffolding" are important features in applications for young learners because they give direction to accomplish a task, prevent deviation from goal, and reduce confusion in an educational game. The results from these experiments assisted

in determining that "presentation", "styles of application", and "interactivity and feedbacks" are the key criteria for evaluating the "Game representation" dimension.

Figure 21 summarizes the evaluation criteria of the proposed FDF-TEG framework:

Learner specifics dimension is to understand the profile of a focus group, including their competencies and role in the tablet-based teaching activity.

FDF-TEG Framework	
Learner specifics	**Pedagogy**
Profile Role Competencies	Associative Cognitive Social/Situative
Game representation	**Context**
Presentation Styles of the application Interactivity and feedbacks	Environment Access to learning Supporting resources

Figure 21 The proposed FDF-TEG framework

1. **Pedagogy** dimension helps to determine which education theories (i.e. associative, cognitive, social) should apply in the integration of lessons, application and activity.

2. **Context** dimension helps to estimate the supporting resources and access for learning in the different environment.

3. **Game representation** dimension is to understand the presentation of game style, interactivity and feedback usage in game.

The Checklist for FDF-TEG Framework

The FDF-TEG checklist is a tool for teachers to write a complete evaluation that includes all the criteria from Figure 21. It consists of 20+ questions for each game (3-6 per dimension) that a teacher to should answer when writing their evaluation. Table 17 shows the checklist broken down by dimension and criteria.

Table 17 Checklists of FDF-TEG for Tablet-based Education Games

Learner specification	
Profile	1. Who is the learner?
Profile	2. What is their background and learning history?
Profile	3. What are the learning styles/preferences?
Profile	4. Who is the learner group?
Competencies	5. How can the learner or learner group are best supported?
Role	6. In what ways are the groups working together (e.g. singly, partially in groups) and what collaborative approaches could support this?
Pedagogic considerations	
Cognitive	1. Which pedagogic models and approaches are being used?
Cognitive	2. Which pedagogic models and approaches might be the most effective?
Associative	3. What are the curricula objectives?
Associative	4. What are the learning outcomes?
Associative	5. What are the learning activities?
Social/Situative	6. How can the learning activities and outcomes be achieved through existing games or simulations?
Social/Situative	7. How can the learning activities and outcomes be achieved through specially developed software (e.g. embedding into lesson plans)?
Social/Situative	8. How can briefing/debriefing be used to reinforce learning outcomes?
Context	
Environment	1. What is the context for learning (e.g. school, home, and combination of several)?
Supporting resources	2. Does the context affect learning (e.g. level of resources, accessibility, and technical support)?
Access to learning	3. How can links be made between context and practice?
Game Representation	
Extra question	1. What tablet-based education game is being used?
Extra question	2. Which part of the game is being used?
Styles of the application	3. What is the style of the game (e.g. goal-oriented, open-ended, and scenario-based)?
Presentation	4. What metaphors (abstract or concrete) of realism are used?
Interactivity and feedbacks	5. Are there any scaffolding (e.g. tutorial, instruction) provided by game?
Interactivity and feedbacks	6. What rewards (achievements, scores, time taken, and level-up) are given to describe player's performances?

Applying the FDF-TEG Checklist

Before the checklist was digitalized, it was utilized as part of the earlier experiments at Wat Dhammakaset school which forms the example in this section. In this example, the author plays the role of an educator whose task was to evaluate the tablet-based educational games by using the FDF-TEG checklist. Table 18 presents one example of an evaluation that was written by answering the questions from the checklist during the "Experiments: 1 and 2" in Chapter IV.

Table 18 The Evaluated Result of 100 Words

Learner specification	**Pedagogic considerations**
The game was used with 8-9 years old children. (1) (4) The focus group needs the improvement in listening, knowledge in match the words with pictures. (2) Students prefer to play individually. (3) The assistant helped players to overcome high level or not being well in performing activities. (5) They played independently and freely allowed student-student. (6)	The purpose of 100 Words is to improve young student's recognition skill in new vocabularies. (1) The objective is teaching vocabularies in several contexts and the purpose is to enhance listening and pattern recognition. (2) (3) Learning outcomes and debriefing are directed from the total scores of games. (4) (8) Ten minutes teaching session is occupied before play activity; an assistant taught word and give oral visualization in pictures before play games on tablets. (5) (6) (7)
Game representation	**Context**
A part of 100 Words, "Family (sound and image categories)" is played by young students. (1) (2) The simple game presentation makes children to adapt and play it by themselves. (3) The game presentation is similar to the traditional "card game". (4) There is no description or tutorial part is not described in it. (5) Scores and animation indicated the right or wrong answer of each question. (6)	100 Words is played by 20 primary school children in the activity room. (1) It is a one-time online play game before offline, offers the various kind of activities (sound, image and multiple choices). (2) It supports for learning vocabularies to improve listen and recognition skills in English. (3)

The purpose of such evaluations is to provide other teachers with guidance on the use of TEG for their own classes. From the evaluation in Table 18, we can observe that "100 Words" is a game structured with different categories of English language for learning and the content is interactive by questions asked in each category. We can learn that it was necessary to have a good internet at the beginning to load the content, so in the future teachers might pre-load the content if they have poor internet. From the learner specification dimension, the game worked well for students 8-9 years old where they were able to play independently but with student-to-student engagement encouraged. The game was suitable in a class of 20 students. However, it is not clear from the context dimension whether the teaching assistant was necessary for the class, so a teacher might expect to work hard to oversee the students – particularly to check on students who might be struggling with the content. Furthermore, if a teacher is looking for a game that can track individual performance then "100 Words" is suitable as it keeps scores as seen from the evaluation.

The above description illustrates the broad nature of evaluations generated by teachers using the FDF-TEG checklist. The evaluations are not quantitative, nor do they suggest any way to rank TEGs. Instead evaluations are qualitative, suggesting what situations each TEG may or may not work. The evaluations are intended to be helpful for a teacher to form a decision on how to apply the TEG in a particular situation.

To realize the framework's potential for supporting teachers, FDF-TEG and the checklist is implemented as a web-based system. Hence, the next chapter is going to discuss on the system development process of the proposed framework to support teachers in evaluating tablet-based education games.

CHAPTER VI

SYSTEM DEVELOPMENT

This chapter discusses the requirements, design and development of the Apps4Youth web-based system which is a concrete implementation of the FDF-TEG framework to support teachers.

From FDF-TEG Framework to Apps4Youth Web-based System

As proposed in Chapter V, FDF-TEG is a framework for evaluating tablet-based education games. Apps4Youth is the actual system for teachers to evaluate educational games in the context of classroom activities. The objective of developing Apps4Youth is to investigate the effectiveness of FDF-TEG. Apps4Youth is one possible implementation of FDF-TEG (there could be other systems using FDF-TEG for evaluations in future) that aims to realize the potential of FDF-TEG in supporting teachers to evaluate suitable activities for tablet-based teaching.

In order to implement FDF-TEG, the four evaluation dimensions (Context, Learner specifics, Pedagogy, and Application representation) need to be converted into discrete questions or evaluation criteria that can be digitalized in the system. The FDF-TEG Checklist (introduced in Chapter V) is used as the basis for the Evaluation Form that will be asked in the evaluation of a game in Apps4Youth. The Evaluation Form consists of text and multiple-choice questions. Table 19 illustrates the mapping of FDF-TEG dimensions and Apps4Youth evaluation form. The implementation of the electronic version of the evaluation form is described later in this chapter.

Table 19 The Relation between FDF-TED and Apps4Youth Evaluation Form

Dimension	Sub-dimension	Apps4Youth Evaluation Form
Context	Environment	The context for play activity *In the classroom, Multimedia classroom, Activity room, Outside of the classroom*
	Access to learning	Number of students will participate in game-based learning * *<10, 10 - 19, 20 - 29, 30 - 39*
	Supporting resources	The context needs special technical requirements. *Extra equipment: headphones, wi-fi, projector or TV, technical support staffs, teaching assistants*
Learner specifics	Profile	Level of study *Primary 1, Primary 2, Primary 3, Primary 4*
	Competencies	Students' background knowledge in the topic *Familiar, Some knowledge of topic, Already learnt the topic, Didn't learn it yet*
	Profile	Preferences in learning style *Individual, Co-operative, Collaborative, Competitive*
	Role	Play together or alone Single: one tablet per student, Multi: play together
Pedagogy	Cognitive	Pedagogic models and approaches used in game *Problem solving, Situated learning: situated knowledge in a specific topic, Constructivism: discovery by learning, Principle learning: If A then B, Progressive learning: learn from progress, Cognitive learning: learner's understanding, Behaviorism: repetition and positive reform*
	Associative	The objectives of syllabus
	Associative	The expected learning outcomes
	Social/ Situative	Learning activities in games *Practice, Improve learning achievements, Increase communication skill*

Table 19 (Cont.)

Dimension	Sub-dimension	Apps4Youth Evaluation Form
Game representation		What tablet-based education game is being used? *
		Which part of the game? *
	Styles of the application	The style of game presentation *Goal-oriented, Open-ended, Scenario-based, Exercise sheet*
	Presentation	Does the game give sufficient assistant for getting started? *Great in-game tutorial, no teacher assistance required, Tutorial or instructions, but teacher assistance needed, Not enough instruction, teacher must give explanation*
	Interactivity and feedbacks	Achievements used in game *Achievements, Leaderboard/Scores/points/time, levels*
	Presentation	Is the game time-dependent? * *Time taken, Time stamp, Time limitation, Neither*
	Presentation	How does the game reward users? * *Unlock new levels/ areas, New character, Bonus section, Stamp: stars*
	Interactivity and feedbacks	How does the game measure skill/progress? * *Leaderboard, Level completed, Achievement completed, Time taken, Stars collected*

* represents additional item

The items in the evaluation form were adapted from the FDF-TEG Checklist described in the previous chapter. The Checklist outlines possible questions to evaluate each game and its usage in the classroom. Additional items were added in "*Context*" and "*Game representation*" dimensions that are specific to teaching in the classroom (marked with an asterisk *). For example, in the context dimension, the class size is added to the form as this is a factor that can determine the success of a tablet activity. Three questions are added in "*Game representation*" to categorize the design of tablet-based educational game. These are factors found to be significant in the success of tablet-based activities from the "Experiment: 1" in Chapter IV.

Requirement Analysis for the System Development

The requirements for the system were captured from interactions with teachers during past experiments at Wat Dhammakaset primary school. The scope of the requirements is particularly aimed at primary school teachers in Thailand.

Apps4Youth is designed to support 2 types of user:

1. Registered users who contribute game evaluations
2. Public users who would like to discover games and read the evaluations of games

The registered users can:

1. Insert the new evaluations on the educational games
2. Edit their previous evaluation on an application such as subjects, topics and comments on the class activity
3. Add new educational games

The public users can:

1. Browse for games by subject, by different categories and by year of study
2. Search for games by keyword
3. Read evaluations (reviews/comments) on each game. The use case diagram is shown in Figure 22.

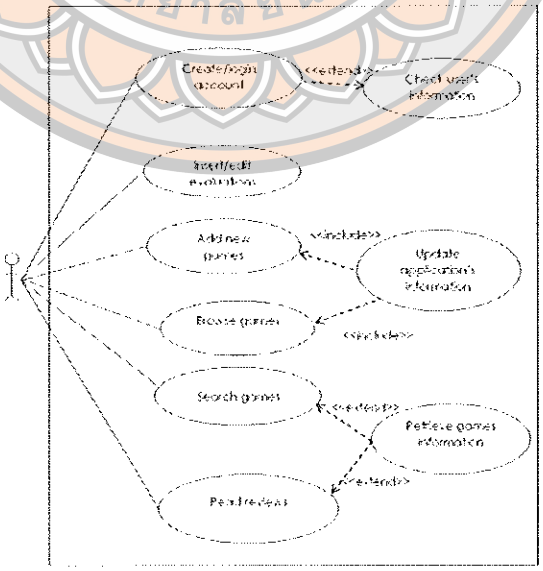

Figure 22 Use case diagram

System Architecture

Figure 23 illustrates the system architecture design of Apps4Youth web-based system. The system will document teachers' evaluations to give them confidence by reducing the technical burden of trying new activities at class. Teachers contribute evaluations by logging into the system and filling an evaluation form. The information of each application and its evaluation are stored in the database. The application information needed for the evaluation form is directly pull-down from the respective application play stores.

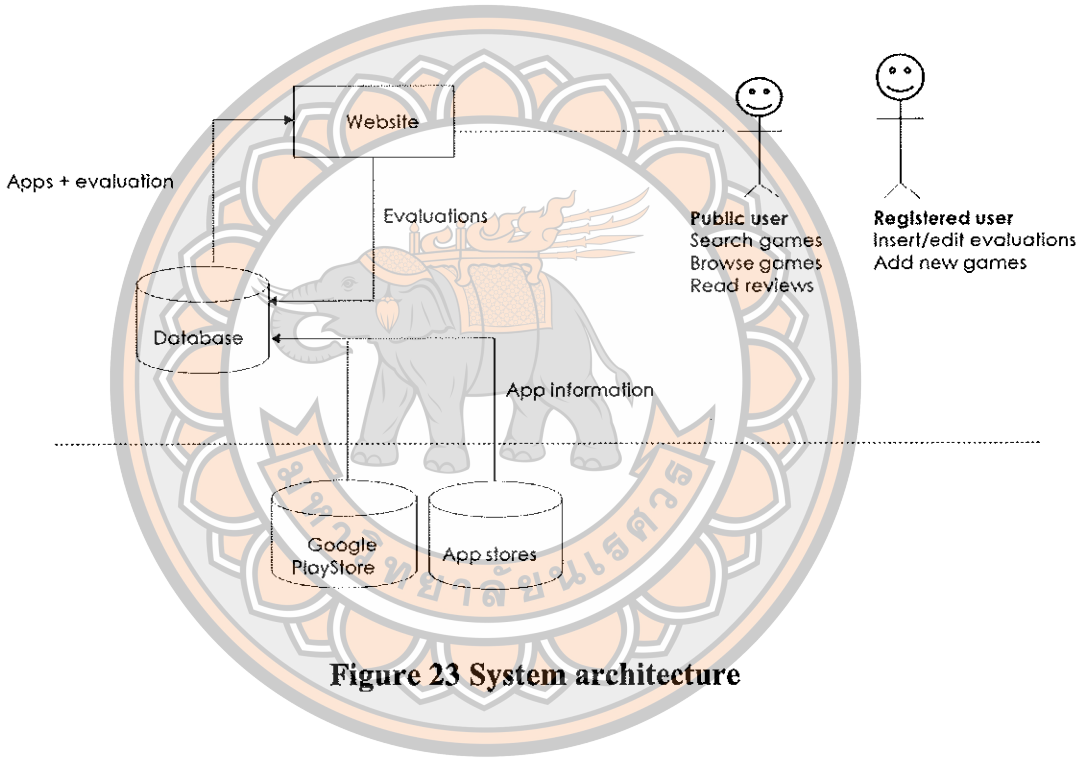

Figure 23 System architecture

System Implementation

The technologies used for implementing Apps4Youth include:

1. MySQL - a relational database management system.
2. PHP – a server-side language for web applications.
3. Laravel – a PHP web application framework, which helps easy to control in authentication, sessions, caching, and routing of web projects. It follows MVC (model-view-controller) architecture pattern (Pecoraro, 2015).
4. Elastic Compute Cloud – a cloud-based server platform on Amazon Web Services which can host a web application. The content of website is provided in Thai and English.

Features of the Apps4Youth System

1. Add a new evaluation for an educational game

Figure 24 shows the first part of FDF-TEG evaluation form of Apps4Youth web-based system (complete evaluation form is in Table 19). The registered user needs to answer the open-ended and multiple-choice questions. The evaluation form composed of four parts as FDF-TEG framework. The first part of questions is from the "*Game representation*" dimension, followed by "*Learner specifics*", "*Context*" and "*Pedagogy*" dimensions.

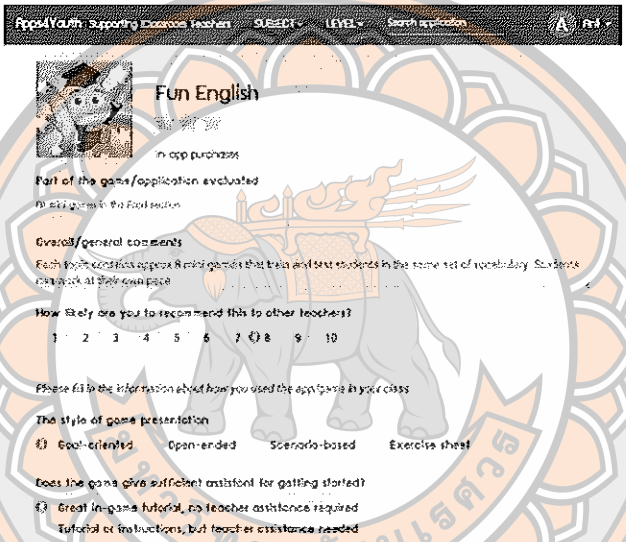

Figure 24 The evaluation form

2. Import educational games from App Stores

Often teachers will be evaluating new games that are not yet in the system. Therefore, this feature provides searching of Apple's App Store and Google's Play Store to import the game information as shown in Figure 25. After clicking on a 'Select' button, the user will be directed to the FDF-TEG evaluation form to create a new evaluation for the selected application as shown in Figure 24.

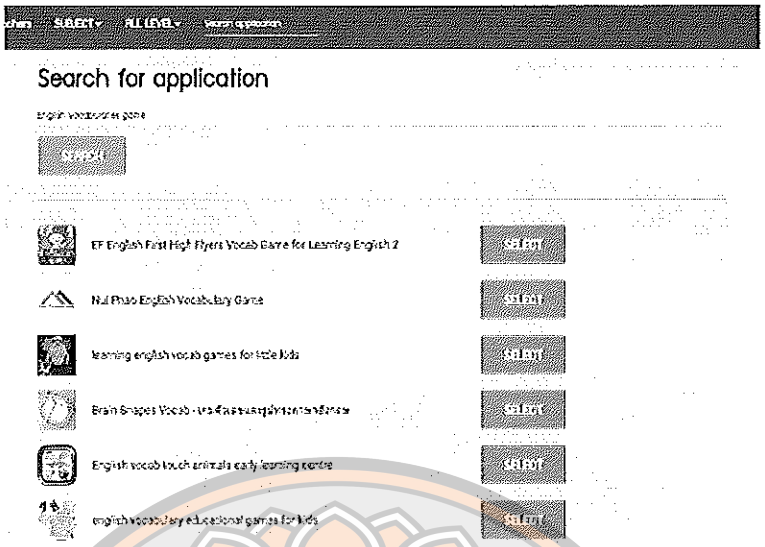

Figure 25 Related application results from keyword search

3. Browse/search educational games and the evaluations

For public users and registered users, they can browse the evaluations and games by subject or level and they can search games by keyword. If a user clicks on a specific category, the relevant applications will display on the system as shown in Figure 26. It shows the applications from "Problem Solving" category.

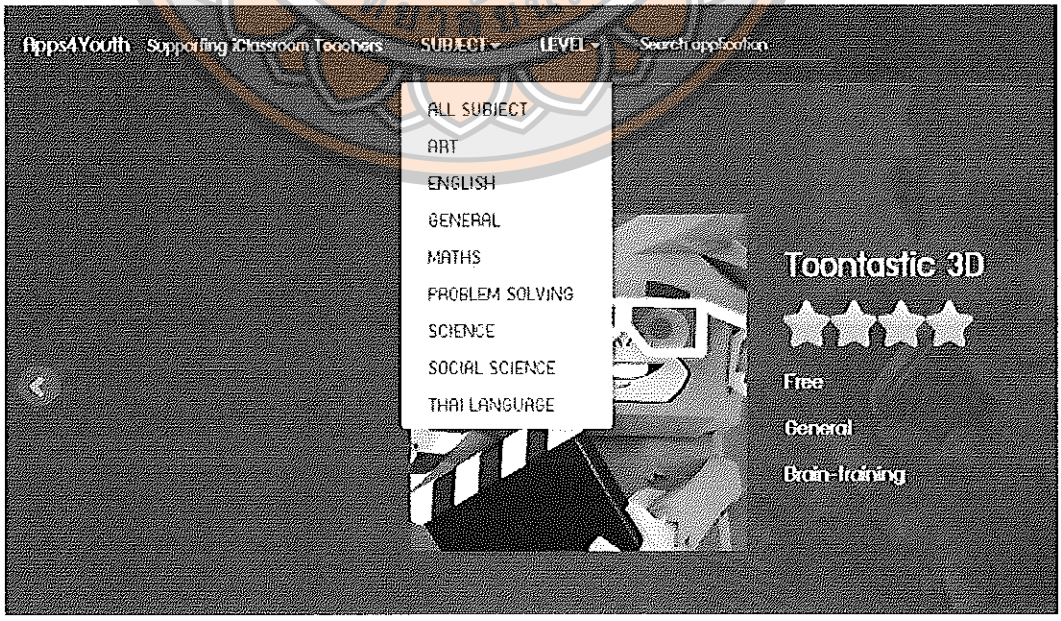

Figure 26 Different categories

The application name, rank, and price are described in each application as shown in Figure 27. It helps user to know the prerequisite information of an application before exploring the further information.

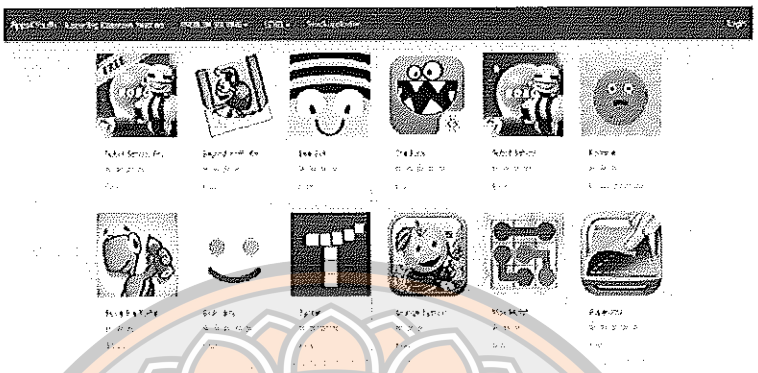

Figure 27 Applications (specific category)

When the user selects an application, they will see the application description and the evaluations submitted by other teachers as shown in Figure 28.

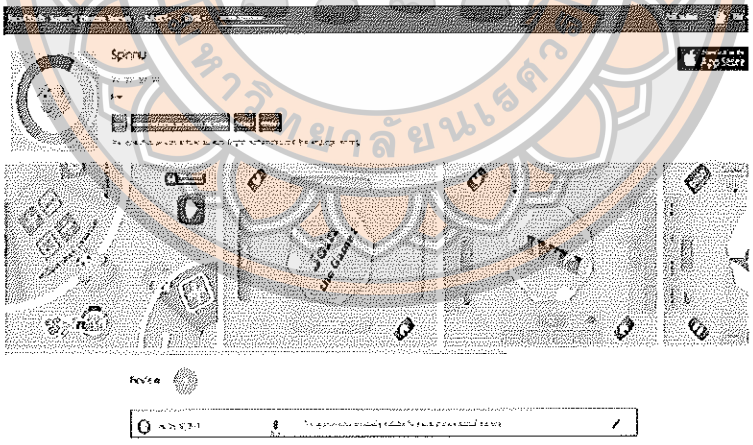

Figure 28 A description of an evaluated application

4. Administration

The registered users have the authority to add a new subject if they could not find it from provided information. The relevant subject or topic name in Thai is compulsory because the target user of system is primary school teachers in Thailand. Figure 29 presents the adding new subject process to Apps4Youth web-based system.

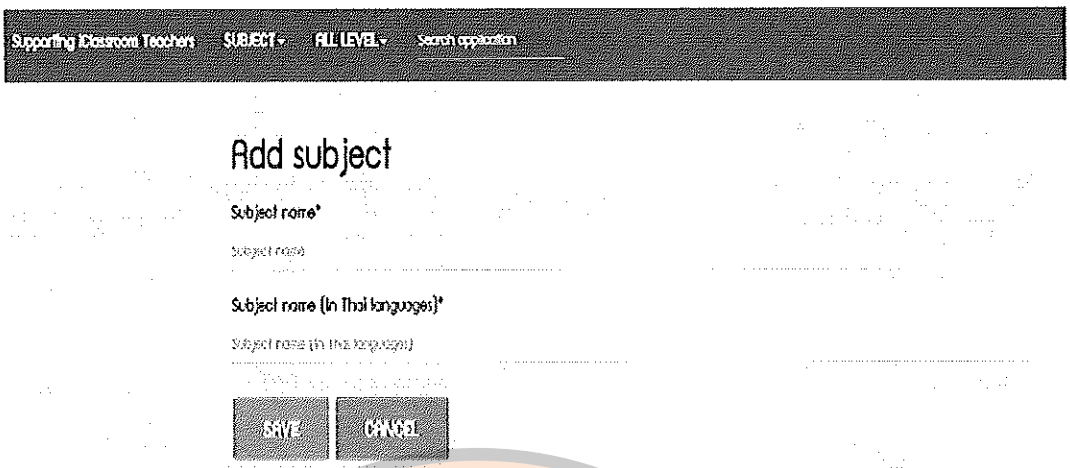

Figure 29 Adding a new subject

In this chapter, the design and development of the Apps4Youth system as a concrete implementation of FDF-TEG is discussed. The next chapter is going to discuss the introduction of Apps4Youth web-based system at three schools to evaluate this implementation of FDF-TEG for supporting primary school teachers.

CHAPTER VII

EVALUATION OF APPS4YOUTH SYSTEM

This chapter describes the evaluation methods and results of introducing the Apps4Youth web-based system to primary school teachers. It discusses teachers' perspectives on the use of web-based system and their suggestions for the future system improvements. Their experiences would be useful for other teachers in designing and forming a tablet-based teaching at class.

Evaluation Method

The evaluation is a survey of school-teachers reaction to the Apps4Youth system, involving quantitate and qualitative methods.

Before the survey, teachers were given one and a half hours training on how to use Apps4Youth web-based system. During the training they were given specific tasks such as search for a game and write an evaluation on a game. The survey on the use of Apps4Youth web-based system was carried out after training.

The survey is divided into three areas: system quality, content, and overall impression. The qualitative and quantitative methods were used to collect data. The likert-type scales and semi-structured questions are focused on the teachers' satisfaction on web-based system. The informal interview session took with 5 teachers who have taken the main responsibility in tablet-based teaching.

There was a total of 27 primary school teachers who took part in this study, consisting of 21 teachers from the English programme in St. Nicholas International School and 5 teachers from Wat Yang En and a Mathematics teacher from Anuban Phitsanulok were participated in November 2017. Table 20 shows the summary of participants from different schools. The survey questionnaire is shown in full in Appendix H.

Table 20 The Overall Participants

Gender	Public School	Private School	Total
Male	0	8	8
Female	6	13	19
Total	6	21	27

Limitation of the Study

This study was not considered student perceptions on Apps4Youth because the system is particularly designed for the primary school teachers.

Results

The evaluation results consist of three parts: evaluation result on system quality, teachers' comments on Apps4Youth system and teachers' perspectives on the use of tablet-based teaching at classroom (Nang, & Harfield, 2018b).

Part 1: Evaluation Result on System Quality

The evaluations are valuable to other primary level teachers engaged in the practical use of applications on tablet. The web-based system can help through the discovery of new applications or activities, giving the suggestions of integrating tablet-based activities in the classroom, and introduce the use of an appropriate pedagogical methods. The system would make it easier to search for primary school level applications, which could make easier to understand difficult lessons for students.

The Apps4Youth web-based system acts as a tool for teachers to evaluate the use of games in practice. The evaluations are giving a way to support application used at class. The documented evaluations in the system is giving confidence to teachers on their use of tablets at class (e.g. by reducing the technical loads in a technology-based activity).

Table 21 The System Evaluation Result

Questions	Avg	SD
System Quality		
1. It is easy to search applications for primary level.	4.08	0.50
2. I felt frustrated while using the system.	2.88	0.99
3. User interface design is clear and easy to understand.	3.79	0.59
4. The system responds slowly.	2.58	0.88
Content		
5. The system provides sufficient information about each application.	3.96	0.69
6. I can get ideas for classroom activities by using the system.	3.92	0.72
7. It was difficult to insert a review.	2.92	0.83
8. Reviews provide useful information.	3.83	0.76
9. The teacher comments are more useful than the scores.	3.71	0.75
10. Reviews can help me plan a lesson.	3.67	1.01
Overall Impression		
11. I would like to submit reviews again.	3.50	0.83
12. Overall, I like to use the system.	3.71	1.00
13. I would recommend this system to other teachers.	3.75	0.90

Table 21 summarizes the responses on the system quality and its content.

System Quality: The participants agreed that Apps4Youth web-based system design is easy to search games on their needs and the system design is user friendly.

Content: The primary school teachers agreed that the system provided sufficient information on each application. The presented information helps them to get ideas for the class teaching activity. They prefer to read teachers' comments on an application than scores in it, and the application reviews are helpful for them to plan a class.

Overall impression: Teachers like to use the system and they likely to recommend this to use other teachers. However, some untruthful biased responses are found in the survey. This is because participants were endorsed by contradictory statements and standard deviation is quite high.

In general, the primary level teachers agreed that the system can provide a place for sharing knowledge on education applications which can be used in the classroom. The system helps them to evaluate education applications and makes easier to search for primary level applications from a mass of education applications.

Part 2: Teachers' Comments on Apps4Youth System

Generally, the old teachers have more than 10 years and above experienced in teaching where the young teachers teaching experiences in between 1-5 years. All the teachers said that the web-based system is easy to access and gives knowledge in technology-based teaching at class. However, their suggestions for the future improvements in web-based system are not the same because of their teaching experiences and different perspectives. The detail descriptions of teachers' comments on Apps4Youth system are described in Appendix I. Teachers' comments on the Apps4Youth system from the positive views are -

"Apps4Youth web-based system gives new knowledge in technology-based teaching".

"The described applications could increase learners' curiosity level that leads to inquisitive in their lessons".

"Apps4Youth system is giving ideas to us on teaching and provides many kinds of applications which can attract students' interest in learning".

"The system is easy to access and gives education technology knowledge".

"The web-based system can help them to create a better teaching activity for student understanding".

"There are many of applications which can be used as the teaching aid applications".

"The reviews on each application help us to use as a teaching aid application at class but the limited information on class activity cannot support the ideas to create a class activity".

The primary school teachers admitted that they need to learn more on how technology can indirectly deliver lessons. Their negative concerns on the Apps4Youth system are-

"The evaluation form should be short and more concise".

"The procedures to write a review for each application is complex and not clear".

"The system should provide the applications in many kinds of different subjects".

"The major inconvenience is providing only on the iOS and Android applications. The provided applications should be available from the different application stores (e.g. Amazon and Window application stores)".

"Limited numbers of applications and information are the weakness of system".

The situations state Apps4Youth web-based system got the good impressions from teachers. Teachers were keen to learn about the possibilities of using tablets in the classroom, where the Apps4Youth system offers a place for sharing knowledge. The system gives some useful tablet applications, which could help students easy to understand lessons. However, there are some issues that could improve the system.

Part 3: Teachers' Perspectives on the Use of Tablet at Classroom

The informal interview session took place with teachers who have taken the main responsibility in tablet-based teaching. Teachers said that the use of tablets at class have the positive and negative impacts. They are -

1. Some applications are only allowed to access specific features or trial version. Such that, teachers need to spend a lot of time to search an application.

2. The extra workloads on teachers such as the careful consideration in teaching techniques, classroom activities and worksheets to consider before use at class.

3. In order to choose the relevant applications is not easy as per teachers' experiences. They need to carefully evaluate the quality of application before using in the class.

4. If technological issues are occupied at class, teaching lesson was stacked and could not go further for the lessons.

5. Students are more interested in learning and become independent learners after using tablets as learning aid tools at class.

6. The primary schoolchildren have fun while performing activity and help their classmates after they accomplished the tasks.

7. Another problem is to control students' behaviours at tablet-based teaching class because some students like to play non-education games or YouTube.

8. The schools could not support the requirements in technological requirements such as Wi-Fi, and IT staffs in forming an effective teaching activity.

The situation illustrates that teachers were still requested more supports in human resources and guidelines in tablet-based teaching until they have enough confidence to overcome difficulties at class.

Analysis

The findings illustrated the knowledge sharing is a common need in adapting tablet-based teaching at class. Apart from the technological issues at class, Apps4Youth web-based system helped teachers' difficulties in forming tablet-based teaching activity. Chapter IV discussed teachers are facing the eight pedagogical issues at tablet-based teaching class. After introducing the Apps4Youth web-based system and teachers confirmed that the system can assist in overcoming problems relating to "variety of use, discovery and suitability", which are discussed in Chapter IV. Some teachers said that the system provides applications to keep "student motivated" and persuade them in learning lessons.

Therefore, teachers have the positive attitudes on Apps4Youth which can help them to deliver tablet-based lesson at classroom. Their perspectives on the web-based system is depending on their teaching experiences, technological knowledge and ages, which are described in "Part2: Teachers' comments on Apps4Youth system". To summarize the findings from this chapter, we have found the following areas that Apps4Youth can benefit teachers:

1. In the survey, teachers were most confident that Apps4Youth will help in discovering new applications to use in their classes.

2. In the evaluation result of Apss4Youth system, the web-based system is given the knowledge in tablet-based activity and application, which are helpful for teachers to persuade students in learning.

However, the results also highlight areas that the system can be improved:

1. The clear procedures to write a review on an application is required.

2. More useful educational applications from the different play stores is needed.

Finally, there are areas that teachers need support that it might be impossible for Apps4Youth to provide assistant:

1. Apps4Youth system cannot help teachers in reducing the preparation time and finding suitable application.

2. Apps4Youth system cannot provide any technical knowledge in iPads and its issues.

They would like to recommend their colleagues to access system, but they were not sure it would be helpful for them in preparing the lesson material. Apart from solving some difficulties in evaluating educational applications, teachers who are using tablets at class were demanding the perquisites in tablet-based activity (i.e. more human supports such as the IT staffs and experts to guide them in teaching with tablets until they have enough confidences). The Apps4Youth system is only a partial solution to overcoming the issues *"variety of use, discovery, student motivated,* and *suitability"*.

We expected that the system would help teachers to reduce the time in finding suitable application *"preparation time"* for tablet-based activity but the results did not make any particular comments on it. It is difficult to find out that the system would be able to help teachers in the *"integration"* of tablet applications into the existing class activity. A longer study is required to prove and identify the *"integration"* of tablet-based applications, the improvements in teachers' *"technical ability"* and reduce their *"fear factor"* through the use of Apps4Youth system.

CHAPTER VIII

CONCLUSIONS

As outlined in Chapter I, this thesis aims to answer the question: How can tablet-based learning with games be used and evaluated in primary school classrooms? Before answering it, the literature reviews illustrate the experiences of brining tablet-based educational applications at primary schools as discussed in Chapter II. The frameworks and theories for evaluating the different types of education applications are described in it. It helped to have better understanding the different purposes of framework for evaluating educational games.

In order to understand the present situation in Thailand, Chapter III has given a deeper understanding in the use of mobile devices for the various purposes among school children. The survey was conducted over 4 years indicated the use of tablet is significantly low in Thai schools even the Ministry of Education was implementing tablet-based teaching at class. The result indicated both male and female students like to "playing game" activity on tablets at home. It is a common behavior in school children and their screen-time is increasing every year for their entertainment activities (The Asian Parent Insights, 2014; Erikson Institute, 2016).

The use of tablets at primary schools is unexpectedly lower than smartphones and PCs. Therefore, the next step is to know the current situation of tablet-based teaching at Thai schools. In Chapter IV, three experiments were carried in Thai schools to know the student preference of educational game characteristics in play activity, their positive learning performance, and the initial pitfalls of using tablets at primary level classrooms.

The "feedback" is one of the main factors to attract student's interest in learning and the popular games have "complex graphics". Applications with "realism metaphor" were more popular than "abstract metaphor" in primary school students. "Tutorial or scaffolding" part had not effects on the student preference in game. It showed that primary school children had the positive performances on the tablet-based learning

activities. The last experiment illustrated primary level teachers do not have self-confidence in forming tablet-based activity because of eight pedagogical issues.

The eight issues that encountered among teachers at class are similar with the other researches' findings. The inadequate knowledge in cooperating application and mobile devices at class (Tahir, & Arif, 2016), more professional coaching workshops for tablet-based teaching activities (Meletiou-Mavrotheris et al., 2014; Nasongkhla, & Sujiva, 2015; Savas, 2014), unskillful to access technological devices (Fabian, & MacLean, 2014), apply the irrelevant pedagogy for tablet-based activity (Lih-Juan, 2017), teachers' attitudes on transforming tablet-based teaching at class (Ifenthaler, & Schweinbenz, 2013), using a limited set of applications, lack of knowledge to find appropriate applications (Antonioli et al., 2014), suitability of use (Brown et al., 2016), and preparation time are leading to lack the confidence in bringing tablet to the class. Towards the end of chapter, the results of the experiment begin to highlight the factors that would be relevant to a framework for evaluating tablet-based educational games.

In Chapter V, I have proposed a framework as a solution to overcome challenges in the current state of tablet-based educational games in Thailand, based on the findings from the literature and experiments in Chapters II-IV. The framework is to verify the remainder of thesis is concerned with the following hypothesis:

"Teacher confidence in applying tablet-based education games in the classroom is increased through the use of proposed framework".

In order to realize the framework's potential, FDF-TEG framework is proposed and implemented as a "Apps4Youth" web-based system as an implementation of the proposed framework described in Chapter VI. It is a tool for teachers to indirectly use the FDF-TEG framework to evaluate educational applications by answering questionnaires. Chapter VII covers an experiment to evaluate the appropriateness and effectiveness of the system for teachers in 3 schools which are Wat Yang En Primary School, Anuban Phitsanulok Primary School, and St. Nicholas International School to support for the hypothesis.

The result shows web-based system can help teachers to overcome some issues such as using "variety of use, "discovery", and "suitability" as described in Chapter VII. Moreover, teachers can have information in forming tablet-based teaching activities and recommended applications from others. The results demonstrated teachers released their

stresses in applying tablet-based education applications at class and gained new knowledge in education technology.

FDF-TEG framework is not about finding the best applications, but about finding a good match between the application, the content and the teacher's ability. The framework illustrates the information of an application which might deviate from achieving the teaching goal. This study expected the proposed framework would help teachers having confidence in tablet-based activities as per hypothesis. They accepted "Apps4Youth" web-based system helped them to have confidence in the informal teaching. They gained new knowledge in creating technology-based teaching at class after getting the guidelines.

The overall evidences illustrated the proposed framework can reduce some fear factors in lacking confidence to form a tablet-based activity. Nonetheless, teachers were still requesting to minimize the possible risks in creating an effective teaching activity. They still wanted to get demonstration from educationalists or experts in tablet-based teaching activities. The more human supports as the experienced IT staffs, teaching assistants and effective trainings were other requirements from primary school teachers. The future study is needed to see teacher's confidence by seeing the way to organize the teaching activities successfully with use of FDF-TEG framework.

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APPENDIX

APPENDIX A Descriptions of Games

Before the experiment is carried out, the Mathematics games such as Sushi Monster, Math to the Rescue, Quick Math+, Zap Zap Fraction, Math Factor II, Clock Master, Math Tris, Math Tris Dec, and Measure are analysed. The briefly description of each games are explained as in below.

1. Sushi Monsters: Players feed sushi to monsters to add, or multiple the given numbers.

2. Math to the Rescue: Allow kids to practise the addition, subtraction of algebra and fraction by rescuing victims from disasters.

3. Quick Math+: Simple game as worksheet for students to practice math skills and performance speed.

4. Zap Zap Fraction: Fractions by solving addition and subtraction in maths to destroy asteroids in the space.

5. Math Factor II: Players have to choose the right answers (multiplication of a given number) within a given time.

6. Clock Master (Math Tappers): Analog or digital clock is given to set time (hour and minutes).

7. Math Tris: Players have to sum numbers on the columns equal to the multiple of 10.

8. Math Tris Dec: Same as Math Tris but with decimals.

9. Measure (Math Tappers): An object is given with a virtual ruler to measure the length.

Fun English was chosen for linguistic learning in the third and fourth week of the experiment. It helps children to learn vocabularies by listening and spelling in the areas of Colour, Animals, Fruits, and Food. Each category has up to 7 mini games (not every area contains every mini game).

1. Palette (Colours): To splash colours to a given object, players need to mix colours in their own ways.

2. Memo (Colours), Memo (Animals) and Platter Scatter (Food): Match pictures and vocabularies.

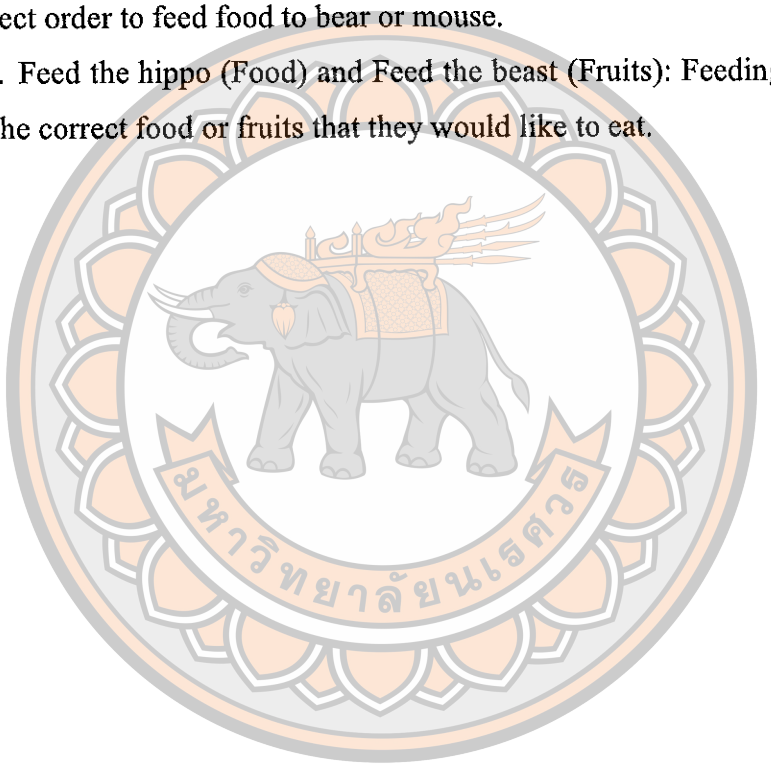
3. Bubbles (Colours), Whack (Animals), Splat (Food) and Smash (Fruits): Listen and choose the corresponding vocabularies.

4. Two by Two (Animals): Switch and match animals cards to get the correct answers.

5. Search (Colours), Silhouette (Animals), Banquet (Food), Vending machine (Food), Fruit market (Fruits), and The blender (Fruits): Children need to find the correct pictures of colours, animals, fruits or food as expressed by narrator.

6. Bear food (Food) and Fruit mouse (Fruits): Spell vocabularies letter by letter in the correct order to feed food to bear or mouse.

7. Feed the hippo (Food) and Feed the beast (Fruits): Feeding hippo/beast by choosing the correct food or fruits that they would like to eat.



APPENDIX B Questionnaire for Students

1. Student's Code / Gender / Year (รหัส -นามสกุล/เพศ/ชั้นปีที่ศึกษา)

A..... B.....

C..... D.....

E..... F.....

2. Which game did you like the most? (นักเรียนชอบเกมใดมากที่สุด)

A..... B.....

C..... D.....

E..... F.....

3. Which game did you like the least? (นักเรียนชอบเกมใดน้อยที่สุด)

A..... B.....

C..... D.....

E..... F.....

4. What do you like about playing on the iPad? (นักเรียนชอบอะไรจากการเรียน (เล่น) บน iPad)

A..... B.....

C..... D.....

E..... F.....

5. What do you NOT like about playing on the iPad? (นักเรียนไม่ชอบอะไรจากการเรียน (เล่น)บน iPad)

A..... B.....

C..... D.....

E..... F.....

APPENDIX C Observation details for observers/assistants

Rate the statements (1 = strongly disagree, 5 = strongly agree)	**Game's Name (P-3)**	**Game's Name (P-4)**
The students can get started in the game without guidance. นักเรียนเริ่มเล่นเองได้โดยไม่ต้องมีคนช่วย		
The UI is easy to understand for the students. นักเรียนคิดว่าแอพพลิเคชั่นเกมนี้ง่ายต่อการใช้งาน		
The UI aesthetically pleasing to the students (they enjoy the graphics). นักเรียนชอบหน้าตารูปลักษณ์โดยภาพรวมของแอพพลิเคชั่น		
The game gives appropriate feedback (e.g. sound and animation). ภายในเกมมีระบบตอบรับที่ดี เช่น เสียง ภาพเคลื่อนไหว		
The students concentrate hard while playing the game. นักเรียนตั้งใจเล่นเกมอย่างจริงจัง		
The students communicate with their friends while playing the game. เกมที่เล่นนำพานักเรียนไปสู่ปฏิสัมพันธ์กับเพื่อนๆ		
The students show positive emotions of enjoyment while playing. นักเรียนมีความรู้สึกดีในการเล่นเกม		
The students show negative emotions of frustration while playing. นักเรียนมีความรู้สึกไม่ดีในการเล่นเกม		
The students get bored with the game after a short time. นักเรียนเบื่อเกมในเวลาอันสั้น		

APPENDIX D Descriptions of Educational Games

1. Arithmetric Wiz – Math Drills: Children do arithmetic drills on blackboard by adding, subtraction, diving and multiplying numbers.

2. Addition & Multiplication Number Bubbles: Addition and multiplication games are designed base on Chinese multiplication table.

3. Math Chase: Players perform mathematics calculation to treat infected zombies to contain the danger and stop them from attacking player's house.

4. Math Monsters - Bingo: Players must find monsters hidden under the tiles as answering mathematics questions.

5. Tiny Chicken learns math: An arithmetic problem is solved by placing a raft on correct answer for tiny chicken to bounce to get across the river.

6. Quick math: Simple game for students who want to improve math skills and response speed.

7. Free 1st grade math worksheets: Young learners can play and learn basic mathematics operations on iPad independently.

8. Math for Brain: Within a given time, players need to solve given mathematics problem.

9. Greaterthan free: Learners choose the correct sign (greater than or less than) to answer a given question.

10. Math Smash Animal Rescue: Players click on blocks describing correct answer in order to rescue animal.

11. Mental Math Cards Challenge: It is design to improve learner arithmetic abilities through solving problems on given sheets.

12. Sequences - train your brain!: The game is designing for players to think and fill the missing numbers in sequences.

13. What's the missing number? Ultimate puzzle math quiz game - brain teaser & intelligence:

14. A Number Math App: It is for practicing basic elementary number facts and mathematics signs to enable focused learning.

15. Fun English: It is a structured English language course for learning four skills with engaging realism contexts.

16. Word Fun World: Young learners can learn and practice vocabularies for Cambridge English: Young Learners exams.

17. Vocabulary Builder: It categorizes vocabularies with the attractive graphics. Players can simply by dragging the correct answer to corresponding pictures. They can tap to hear words spoken if they are not able to recognize or read words.

18. 100 Words (Family members: Words and Images): The multiple choices are given and players have to choose the correct answer.

APPENDIX E Learning Outcomes

Pretest (Mathematics, Primary-4)

ชื่อ-นามสกุล.....กลุ่มที่.....

แบบทดสอบก่อนเรียน (Pre-test)
การบวก และ การคูณ สำหรับชั้น ป.4

1. จงเติมคำตอบที่ถูกต้องลงในช่องว่าง

a) 28 + 30 = ...

b) 19 * 41 = ...

c) 30 * 49 = ...

d) 25 * 53 = ...

e) 64 + 45 = ...

f) 83 + 22 = ...

g) 55 + 65 = ...

h) 89 + 97 = ...

i) 15 + 32 + 20 = ...

j) 35 + 52 + 21 = ...

2. จงเติมคำตอบที่ถูกต้องลงในช่องว่าง

a) 8 x 9 = ...

b) 12 x 11 = ...

c) 9 x 11 = ...

d) 30 x 3 = ...

e) 15 x 4 = ...

f) 7 x 20 = ...

g) 50 x 4 = ...

h) 17 x 3 = ...

i) 25 x 8 = ...

j) 18 x 11 = ...

Posttest (Mathematics, Primary-4)

ชื่อ-นามสกุล.....กลุ่มที่.....

แบบทดสอบหลังเรียน (Post-test)
การบวก และ การคูณ สำหรับชั้น ป.4

1. จงเติมคำตอบที่ถูกต้องลงในช่องว่าง

a) 30 * 28 = ...

b) 19 * 41 = ...

c) 30 * 49 = ...

d) 25 * 53 = ...

e) 54 * 45 = ...

f) 22 * 83 = ...

g) 55 * 65 = ...

h) 89 * 97 = ...

i) 32 * 15 * 20 = ...

j) 35 * 21 * 52 = ...

2. จงเติมคำตอบที่ถูกต้องลงในช่องว่าง

a) 8 x 9 = ...

b) 9 x 11 = ...

c) 11 x 12 = ...

d) 30 x 3 = ...

e) 15 x 4 = ...

f) 50 x 4 = ...

g) 7 x 20 = ...

h) 17 x 3 = ...

i) 25 x 8 = ...

j) 11 x 18 = ...

Pretest (Mathematics, Primary-3)

ชื่อ-นามสกุล.....กลุ่มที่.....

แบบทดสอบก่อนเรียน (Pre-test)
การบวก และ การคูณ สำหรับชั้น ป.3

1. จงเติมคำตอบที่ถูกต้องลงในช่องว่าง

a) 9 + 8 = ...
b) 10 + 11 = ...
c) 13 + 15 = ...
d) 25 + 13 = ...
e) 34 + 10 = ...
f) 55 + 15 = ...
g) 12 + 12 + 12 = ...
h) 20 + 13 + 30 = ...
i) 25 + 10 + 10 = ...

2. จงเติมคำตอบที่ถูกต้องลงในช่องว่าง

a) 3 x 5 = ...
b) 10 x 4 = ...
c) 2 x 7 = ...
d) 8 x 6 = ...
e) 9 x 3 = ...
f) 7 x 10 = ...
g) 5 x 9 = ...
h) 7 x 4 = ...
i) 12 x 2 = ...
j) 8 x 11 = ...

Posttest (Mathematics, Primary-3)

ชื่อ-นามสกุล.....กลุ่มที่.....

แบบทดสอบหลังเรียน (Post-test)

การบวก และ การคูณ สำหรับชั้น ป.3

1. จงเติมคำตอบที่ถูกต้องลงในช่องว่าง

a) 9 + 8 = ...

b) 13 + 15 = ...

c) 11 + 10 = ...

d) 25 + 13 = ...

e) 30 + 28 = ...

f) 10 + 34 = ...

g) 55 + 15 = ...

h) 12 + 12 + 12 = ...

i) 25 + 10 + 10 = ...

j) 20 + 13 + 30 = ...

2. จงเติมคำตอบที่ถูกต้องลงในช่องว่าง

a) 5 x 3 = ...

b) 10 x 4 = ...

c) 7 x 2 = ...

d) 9 x 3 = ...

e) 8 x 6 = ...

f) 7 x 10 = ...

g) 4x 9 = ...

h) 4 x 7 = ...

i) 12 x 2 = ...

j) 11 x 8 = ...

Pretest (English, Primary-4)

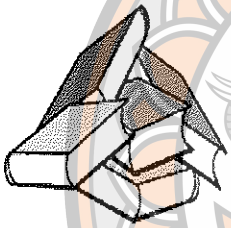
ชื่อ-นามสกุล.....กลุ่มที่.....

แบบทดสอบก่อนเรียน (Pre-test)

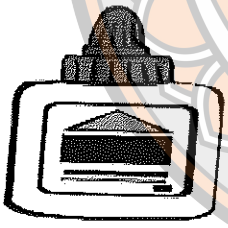
คำศัพท์ภาษาอังกฤษ หัวข้อ โรงเรียนและส่วนต่างๆของร่างกาย สำหรับชั้น ป.4

จงจับคู่ภาพกับคำศัพท์ให้ถูกต้อง

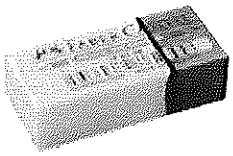
Eraser



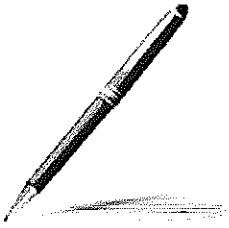
Pen



Crayon



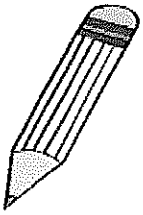
Book



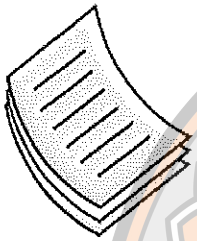
Glue

ชื่อ-นามสกุล.....กลุ่มที่.....

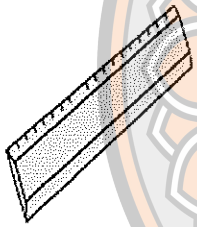
จงจับคู่ภาพกับคำศัพท์ให้ถูกต้อง



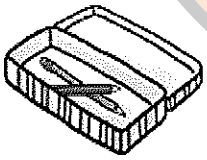
Pencil Case



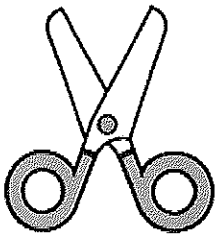
Ruler



Scissors



Paper

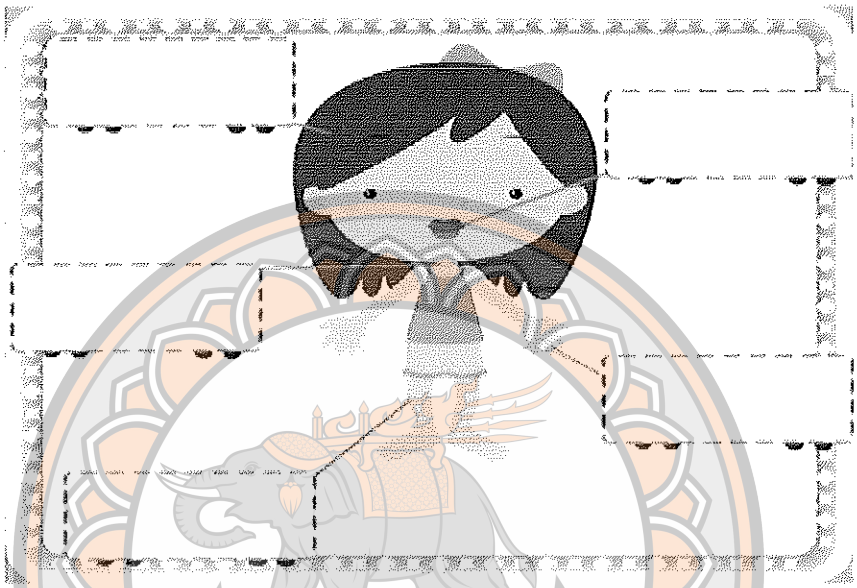


Pencil

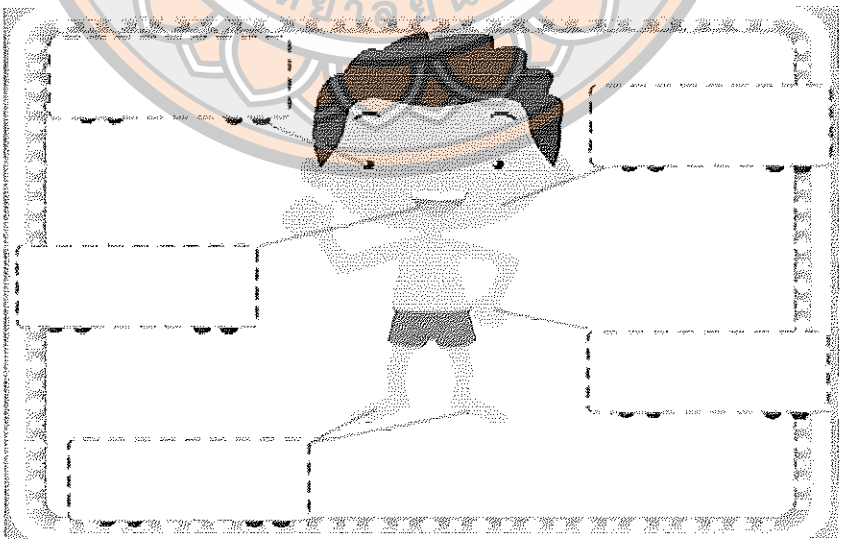
ชื่อ-นามสกุล.....กลุ่มที่.....

จงเติมคำศัพท์ให้ตรงกับส่วนต่างๆของร่างกายให้ถูกต้อง

Mouth	Hair	Neck	Finger	Knee



Face	Eyes	Feet	Mouth	Hand



Posttest (English, Primary-4)

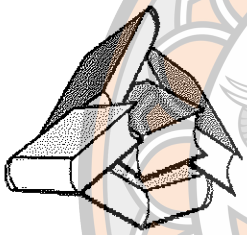
ชื่อ-นามสกุล.....กลุ่มที่.....

แบบทดสอบหลังเรียน (Post-test)

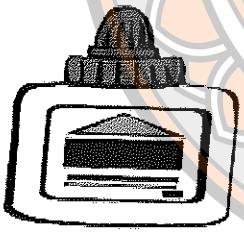
คำศัพท์ภาษาอังกฤษ หัวข้อ โรงเรียนและส่วนต่างๆของร่างกาย สำหรับชั้น ป.4

จงจับคู่ภาพกับคำศัพท์ให้ถูกต้อง

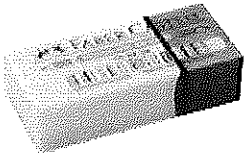
Eraser



Pen



Crayon

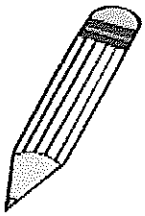


Book

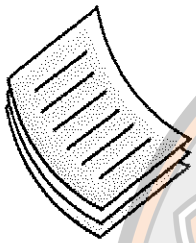
Glue

ชื่อ-นามสกุล.....กลุ่มที่.....

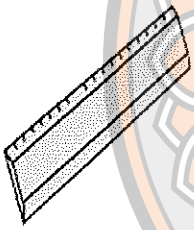
จงจับคู่ภาพกับคำศัพท์ให้ถูกต้อง



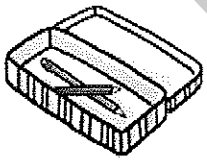
Pencil Case



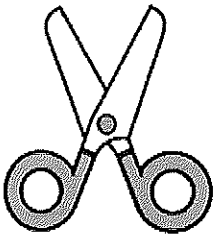
Ruler



Scissors



Paper

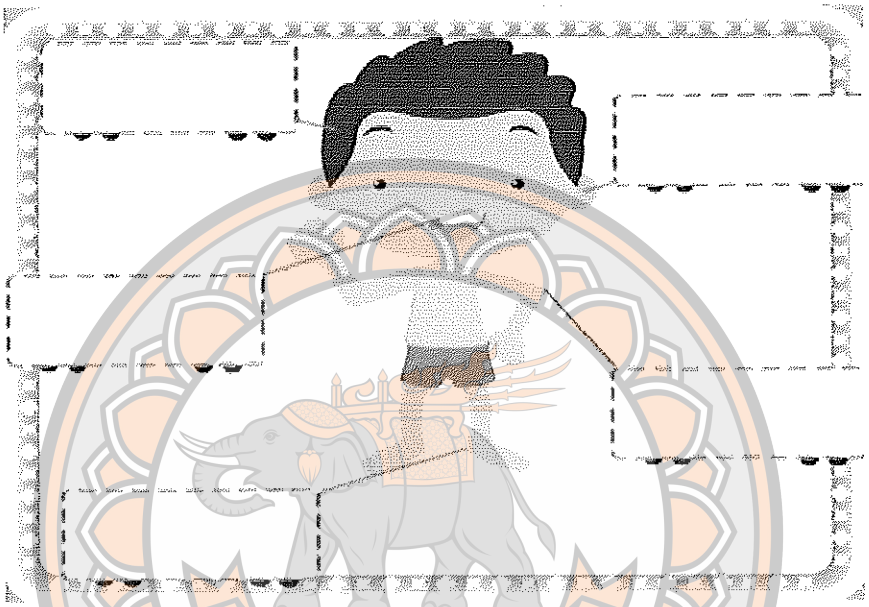


Pencil

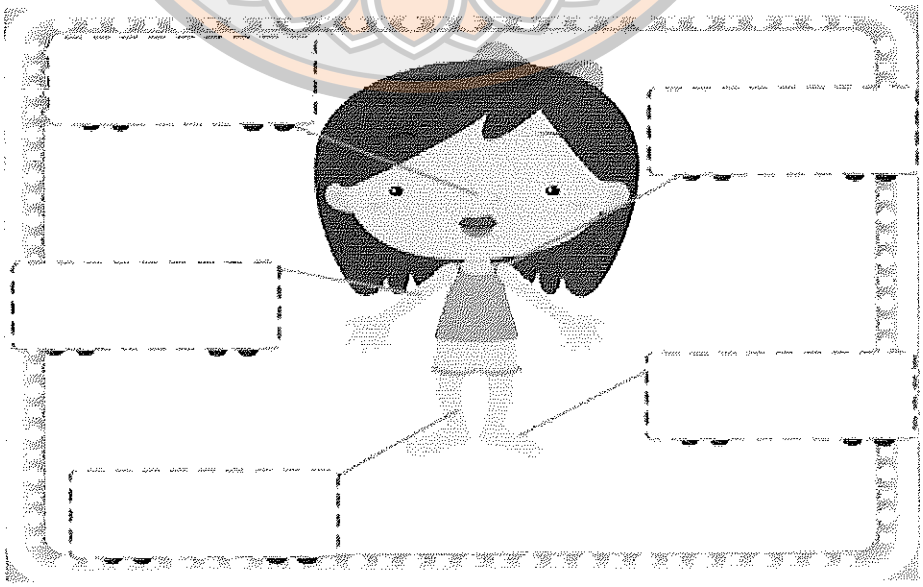
ชื่อ-นามสกุล.....กลุ่มที่.....

จงเติมคำศัพท์ให้ตรงกับส่วนต่างๆของร่างกายให้ถูกต้อง

Elbow	Ear	Teeth	Head	Ankle



Nose	Shoulder	Leg	Arm	Foot



Pretest (English, Primary-3)

ชื่อ-นามสกุล.....กลุ่มที่.....

แบบทดสอบก่อนเรียน (Pre-test)
คำศัพท์ภาษาอังกฤษ หัวข้อ สีและสัตว์ สำหรับชั้น ป.3

จงเขียนคำแปลลงในคำศัพท์ต่อไปนี้

A. Brown สี.....

B. Yellow สี.....

C. Blue สี.....

D. Pink สี.....

E. Purple สี.....

F. Orange สี.....

G. White สี.....

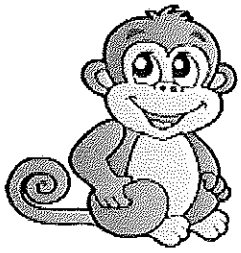
H. Black สี.....

I. Grey สี.....

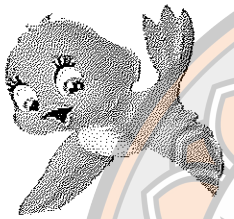
J. Green สี.....

ชื่อ-นามสกุล.....กลุ่มที่.....

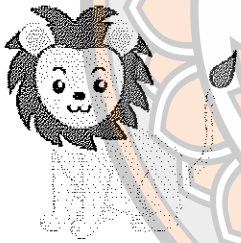
จงจับคู่ภาพกับคำศัพท์ให้ถูกต้อง



Tiger



Monkey



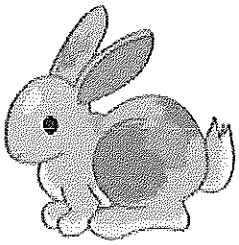
Pig

Lion

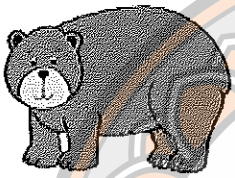
Bird

ชื่อ-นามสกุล.....กลุ่มที่.....

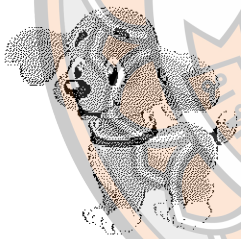
จงจับคู่ภาพกับคำศัพท์ให้ถูกต้อง



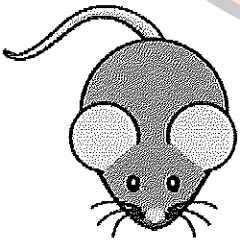
Bear



Cat



Rabbit



Mouse

Dog

Posttest (English, Primary-3)

ชื่อ-นามสกุล..... กลุ่มที่.....

แบบทดสอบหลังเรียน (Post-test)
คำศัพท์ภาษาอังกฤษ หัวข้อ สีและสัตว์ สำหรับชั้น ป.3

จงเขียนคำแปลลงในคำศัพท์ต่อไปนี้

A. Brown สี.....

B. Yellow สี.....

C. Blue สี.....

D. Pink สี.....

E. Purple สี.....

F. Orange สี.....

G. White สี.....

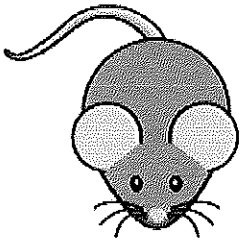
H. Black สี.....

I. Grey สี.....

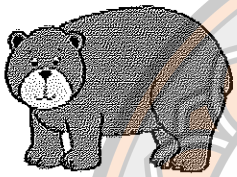
J. Green สี.....

ชื่อ-นามสกุล..... กลุ่มที่.....

จงจับคู่ภาพกับคำศัพท์ให้ถูกต้อง

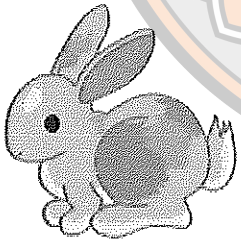


Bear

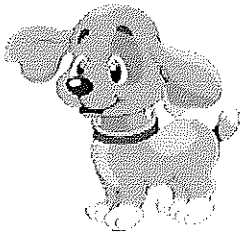


Cat

Rabbit



Mouse

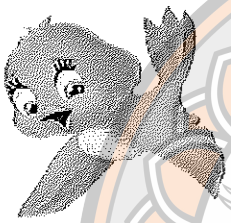


Dog

ชื่อ-นามสกุล.....กลุ่มที่.....

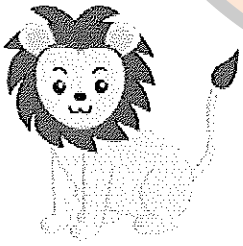
จงจับคู่ภาพกับคำศัพท์ให้ถูกต้อง

Tiger

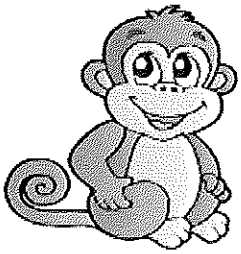


Lion

Pig



Monkey



Bird

APPENDIX F Analyze Tablet-based Classroom Teaching (Anuban Phitsanulok Primary School)

Field Note 1: English

No. of teachers – 2 (subject teacher and teaching assistant)

Place – iClassroom

2:40 Class starts.

2:45 Teacher explains questions and gives oral answers about Phitsanulok.

2:47 Teacher opens video clip (without song) for deeper understanding.

2:49 Teacher asks questions (the name of places in Phitsanulok) from video.

2:51 End video clip.

2:51 Teacher opens a song.

2:53 Teacher closed it because of sound problems. Teacher tells students to turn on activity book.

2:54 Teacher tells student to use Google Earth and search country, Japan.

2:56 Teacher asks students to find shopping places in Japan.

3:03 Teacher asks students to find Sakura street in Japan.

3:05 Teacher asks, "What are the interesting places in Japan?"

3:09 Teacher tells student to change location, Thailand and asks the same question "What is the interesting places in Thailand?"

3:12 Teacher tells students to answer questions in activity book.

3:24 Teacher tells the class to finish worksheet before going back.

3:29 Class dismissed

Field Note 2: English

The following "field note 2: English" describes the continuous lesson of the previous week "what are the interesting places?" and new lesson on "what shape is it?"

2:48 Class starts by recalling the previous lesson.

2:57 Teachers tell students to open Youtube application.

2:58 Teachers tell them to search "What shape is it?" at Youtube.

3:00 Teacher and the assistant circulate class to help technical problems.

3:01 Teacher opens a song with projector.

3:04 Song end and questions are asked to students.

3:05 Teacher asks students "what shape is it?" by pointing at objects in class.

3:09 Teacher tells students to open "What's 3D shape?" topic in the text book (Pupil's book).

3:14 Teacher explains the contents with use of concrete objects in the real world.

Teacher uses Thai and English language.

Teacher delivers lessons of the name of shapes by using English and Thai languages.

3:16 Teacher tells students to do exercise on topic "Match Word and Picture" in their activity book.

3:20 Teacher asks the names of shapes from activity book in order to give hints to get the right answers in each question.

3:30 Teacher gives homework on naming the shapes in the activity book.

3:31 Class dismissed.

Narrative Summary

Teacher started the class by asking places from pupil's book to know their general knowledge. Young students did not know the places as described from book. Teacher instructed students to use Google Earth to explore the interesting places around the world. After students explored the places as their interests, they started to answer the questions from activity books by Cambridge Press. Students had to finish their works before class dismissed.

Teacher revised the previous lesson and checked students' works before ongoing new lessons. The question and answer teaching technique occupied by asking the different shapes, which could be seen in the class. Subject teacher explained the differences between 3D shape and normal shapes by using objects, textbook, and music video. Students did exercises in the workbook before class was over.

Follow-up Conversation

The subject teacher said students do not know the places in Pupil's book. Thus, I would like to show the interesting places in different countries via Google Earth.

I can only discipline students sitting near me. I do not have much knowledge in using tablet and applications. I have attended trainings for using technology in class but still difficult to adapt. The difficult is sound problems in some useful applications

for the P4 class. I use "Conversation in daily life 1" but there has an audio problem. Even it is a good application for the P4 class, my class is encountered issue in audio. I used it for conversations but children could not hear well. We are using "Echo English" for the pronunciation but there also have difficulties as the application does not provide scores or achievement. Could you recommend any applications, which can improve students' pronunciation skill and listening skill? 1 hour teaching with technological device is not enough to finish lessons as I planned. It is more difficult to monitor whether students have done all the exercises before the class is over.

I still need more knowledge on how to use applications well even I attended workshops for tablet teaching at class. The providing training classes are not enough for teachers as I am weak in knowledge about applications and technology.

Field Note 1: Mathematics

The mathematics teaching took place at iClassroom with subject teacher and teaching assistant, who particularly helps learners' difficulties in technological problems.

No. of teachers – 2 (subject teacher and teaching assistant)

Place – iClassroom

8:40 - Class begins.

8:43 - Check Wi-Fi connection and teacher assists to class to get online.

8:48 - Teacher gives oral instructions to class to access application.

8:55 - Ready to start lessons.

8:56 - Teacher gives a problem and explain it to class.

9:00 - Teacher uses questions and feedback technique on problems to interact with class.

9:05 - Teacher tells students to use "Pages" app.

9:06 - Teacher and an assistant assist students to access application.

9:07 - Students start to solve the given problem.

9:08 - Teacher and the assistant circulate room and help individual needs while solving a given problem.

9:18 - Most students have solved the given Mathematics problem.

9:19 - Teacher tells students to submit answers via AirDrop.

9:20 - Teacher explains and deliver the correct answer on projector.

9:21 - Teacher check with students why he/she cannot submit answer.

9:25 - Teacher concludes class.

Field note 1 shows the situation of tablet-based teaching at class. Mathematics teacher allowed the students to create and solve their own mathematics problems in the second session of teaching at iClassroom. It is described as in field note 2.

Field note 2: Mathematics

8:44 - Class starts.

8:45 - Teacher tells students to open Pages application.

8:48 - Teacher tells students to create their own Mathematics problems.

8:49 - Teacher gives an example of Mathematical problem.

8:51 - Students ask questions because they are not clear the assignment.

8:57 - Class starts to do the assignment.

Teacher circulates the class to help students' problems in assignment or technical.

9:05 - Teacher gives oral guidelines in searching Mathematics problem because some students still haven't started it.

9: 10 - Teacher circulates the class.

9:17 - Students finished their works and sent it to teacher via AirDrop.

9:19 - Teacher randomly chooses student roll number to present their assignments.

9:22 - Students asked teacher how to insert picture via Page application. They are still doing their works by decorating pictures in it.

9:25 - Teacher tells the class to submit the assignment in pdf format before leaving.

9:30 - Teacher warns students not to use extra equipment (headphones) in the class.

Narrative Summary

The teacher initiated the class by asking students to check Wi-Fi connectivity and instructed to access Pages application. The students sat in groups of four, read the given problem in Pages application for their peer understands. Teacher was circulating and helping individual needs while they were performing given task. After student submitted their answer sheets via AirDrop, teacher gave the correct answer to class. The class ended and all left the room.

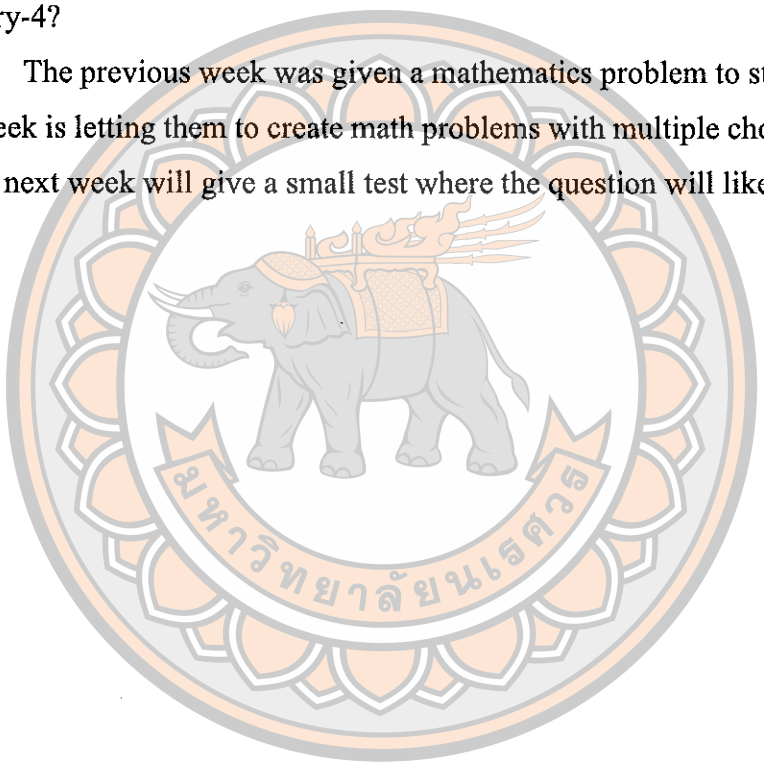
Students opened "Pages" application and did their own mathematics problem scenarios when the class started. The subject teacher gave instructions to create a meaningful mathematics problem. Students were allowed to access Google Images to decorate scenarios. Students were asked questions to teacher and discussing on the

mathematics problems at class. They sent PDF file via AirDrop after they had done on their works.

Follow-up Conversation

It was an extra teaching and learning activity for students by using tablets. The content was about Mathematics calculation in addition and subtraction. Students were already learnt before and it is an extra activity. I was trying to improve their mental calculation skills. It is difficult to find relevant application for lessons. I do not have much time on searching games. Would you like to recommend any Mathematics games for Primary-4?

The previous week was given a mathematics problem to student and solved it. This week is letting them to create math problems with multiple choice answers. The following next week will give a small test where the question will like this week.



Field Note 1: Science

Not like the other subjects, science teacher assigned a mini project to students to collaborate together. Teaching places occupied at iClassroom and school compound. Field note 1 presents the teaching situations inside and outside of the class.

No. of teachers – 1 (subject teacher)

Place – iClassroom & school compound

8:40 Classroom starts.

8:41 Teacher reviews the previous recording of a random group's movie.

8:43 Teacher explains what they have done last week.

8:50 Teacher introduces what students are going to learn for today.

8:53 Teacher tells what the homework is for today within 30 mins. Teacher asks students to form a group.

9:00 Students set off from class to make their own assignment (i.e. to record video) in the compound.

9:01 Teacher also joins with them to control, manage, and scaffold knowledge on topic. Teacher randomly chooses a group and asks questions related topics.

Students are making video.

Students do one by one or pair presentation.

Some groups have discussions on what they are going to present. They do rehearsal before record a movie.

9:25 Students back to class.

9:26 One of the groups shows their project via Apple TV.

9:30 Teacher gives a briefing on what they have done for today.

9:31 Teacher tells she is going to teach how to make video clips with iMovie next week.

9:31 Dismissed class.

Narrative Summary

Teacher recalled what student had learnt on last week. Teacher briefly discussed the topic before introducing a new lesson. The teacher gave an introduction of lesson, followed up activities and homework. Students in group of 2-4 took iPads and went out to make a movie clips on plant science learning. Teacher followed and gave

guidelines to students in doing project. She was helping to solve minor technical problems if they encountered. After 30 minutes, students back to class.

Follow-up Conversation

I give an activity to make a short movie clip for plant science learning. It is a continuous lesson of previous week but different activity. Students had tactical knowledge in this topic. There are not many difficulties in tablet-based teaching. In technical point of view, there has a sound-system problem in recording movie. Next week, I am going to teach how to make movie clip. After that, each group will represent what they have learnt this week.

Field Note 1: Technology

Technology teacher gave a mini project to class and explained the various ways to present it. Individual learning activity is occupied and described as in field note 1.

No. of teachers – 1 (subject teacher)

Place – iClassroom

2:15 Classroom starts.

2:16 Teacher tells what they are going to learn and which application will be used.

2:17 Teacher introduces "Tellagami" application to make a Gami movie.

2:18 Teacher gives a suggestion to access Google Earth to take a photo of their own avatar at their favourite places.

2:20 Teacher gives oral instructions how to search places in Google Earth.

2:22 Students start to make movies. Teacher is still giving oral instructions.

2:24 Teacher circulates the class. Teacher explains and supports in using application individually. Students are searching places via GoogleEarth and making a Gami movie.

2:30 Teacher tells the application in some tablets are not working properly.

2:31 Teacher checks functions in application is performing accurately in student's iPad.

2:32 Teacher asks class to share their projects after they have done.

2:34 Teacher helps to make and share movie if student's needs.

2:35 Teacher tells students sit down and perform a given task quietly.

2:36 Techer explains how to record and make a Gami movie to class.

2:37 Teacher shows a demo made by herself.

2:38 Teacher tells students to quit application.

2:39 Teacher gives a briefing of how to combine scenery from Google Earth and an avatar from Tellagami to make a movie clip.

2:30 Class dismissed.

Narrative Summary

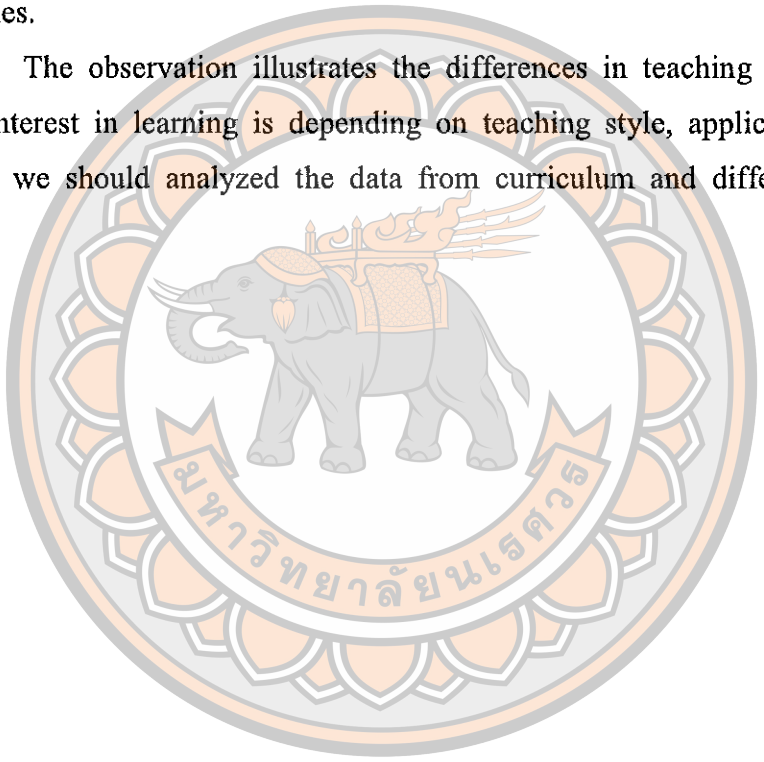
The class started late. Teacher showed a mini project to class before Tellagami application was introduced to class. She explained the functions of tools in application to make a mini project. Meanwhile, she suggested the students to access

GoogleEarth and take a photograph to use it in the scenario. The oral instructions and guidelines were followed in making movie clip. The subject teacher provided helps upon students' needs in creating avatar, combining photograph and avatar together to form a scene. Before the class was over, teacher showed a full demo to students.

Follow-up Conversation

I taught them how to use Tellagami application in making a movie. The purpose is letting them to familiar with applications. Wi-Fi issue is a common difficulty at iClassroom teaching. Students can have fun and know how the technology can use in their studies.

The observation illustrates the differences in teaching styles via iPads. Student interest in learning is depending on teaching style, application, and tasks. However, we should analyzed the data from curriculum and differnt activities on lessons.



APPENDIX G Analyze tablet-based classroom teaching (Wat Yang En Primary School)

Field Note: Technology

No. of teachers – 1 (subject teacher)

Place – iClassroom

9:40 - Class starts.

9:42 - Teacher talked to students what applications that they have learned via tablets.

9:45 - Teacher instructed students to do mini project animation based on their imaginations via Animatic application.

9:47 - Some students requested ideas from teachers. Some are discussing with their friends on what should they draw for animation.

9:08 - A student says they should do animation on "Loy Krathong" festival because tomorrow they have to make a Krathong.

9:09 - The whole class agree and do mini project under "Loy Krathong" title.

9:10 - Teacher is sitting at the front of class and accessing the tablet for a personal purpose. Student helps each other if they encounter problems.

9:30 - Teacher circulates the class and checks students' work on the project.

10:15 - Teacher asks random students to show their works via projector. Teacher gives feedback on their works.

10:25 - All students present their finished works judged by teacher and classmates.

10:35 - Class dismissed.

Narrative Summary

The class started at 9.40 a.m. Technology subject teacher reviewed on different applications that given before. She instructed students to open "Animatic" application and do animation on their own imaginations. Students are freely allowed to do and discuss with your friends while doing on their mini projects. Teacher circulated around class and gave comments on each work. Before the class was over, she instructed

to show individual accomplishments via AirPlay to class. Each student got comments from their classmates and teacher before class was dismissed.

The Follow-up Conversation

Normally, students learned how to use PowerPoint, presentation movie, and take notes by using applications. iMovie, Keynote, Pages, Anatomy 4D, and iBook are applications used for technology teaching session. Students liked to use good graphic application as Anatomy 4D. We attended trainings at Chiang Mai for using those applications at class. But, most teachers at our school do not have knowledge in application and technology. So, we only use applications recommended from Ministry of Education.

The field note for English subject class is illustrated as in below. Teacher accessed the tablet and projector as replacement of blackboard. There was class activity was occupied in learning English subject. The summary of teaching style is presented in the following field note.

Field Note: English

No. of teachers – 1 (subject teacher)

Place – iClassroom

1:30 - Class starts. Students get tablets as per their seating numbers before the lesson begin.

1:32 - Teacher recalls the previous lessons that students learned at traditional classroom.

1:35 - Teacher continues the lesson (two common ways of telling time) in English with Pages application.

Teacher gives oral explanation by typing time in digit and word formats via Pages application. Students are sitting on their seats and learning lessons.

2: 30 - Class dismissed.

Narrative Summary

Tablets are given to students according to their seat numbers before the lesson starts. English teacher recalled the previous lessons without tablets and introduced what students will learn for the new class. Teacher continues the lesson by using Pages application as word processor. The written words are shown via projector and questioning technique is used while teaching. Tablets are placed on their desks but there is no activity to perform on it. Students do not bring stationaries to take notes on iClassroom teaching session. The oral teaching session is over at 2.30 p.m.

Oum, the 5th year student from PSLE instructed the topic. She is an English subject teacher from Primary-3 level. It was her first time for teaching with use of tablets. In a formal teaching, she can control the class without any teaching assistants. If she had to use mobile devices, it was difficult to control the class and needed to cover all students' attentions. The substitute teacher knew the topic and application before the class start. She is going to use tablets as teaching assistant tools in her primary-3 class.

The Follow-up Conversation

I do not have many problems except Wi-Fi. I continued lessons that I have not finished yet at normal classroom. I normally use "Pages" application and some relevant applications suggested by Ministry of Education. Our school got iPads last six months ago, and we are implementing to use particular for primary-4. We need time to familiar with technology and find an effective way to teach lessons.

APPENDIX H Questionnaire for Apps4Youth

แบบสอบถามสำหรับครูผู้สอนเกี่ยวกับระบบ Apps4Youth

Questionnaire for Teachers about Apps4Youth

ข้อมูลเกี่ยวกับผู้ทำแบบสอบถาม

Demographic

1. **เพศของท่าน**

   What is your gender?

   ☐ ชาย Male ☐ หญิง Female

2. **อายุของท่านอยู่ในช่วงใด**

   Mark the appropriate range for your age.

   ☐ 20-30 ปี ☐ 31-40 ปี ☐ 41-50 ปี ☐ 51-60 ปี

3. **ระดับการศึกษาของท่านอยู่ในช่วงใด**

   What level of certificate you are holding?

   ☐ มัธยมศึกษา Junior College ☐ ปริญญาตรี Degree

   ☐ ปริญญาโท Master ☐ ปริญญาเอก PhD

4. **ท่านสอนในระดับใด**

   What grade (levels) do you currently teach?

   ☐ ชั้นประถมศึกษาปี ที่1 Primary 1 ☐ ชั้นประถมศึกษาปีที่ 2 Primary 2

   ☐ ชั้นประถมศึกษา ปีที่ 3 Primary 3 ☐ ชั้นประถมศึกษาปีที่ 4 Primary 4

   ☐ ชั้นประถมศึกษาปีที่ 5 Primary 5 ☐ ชั้นประถมศึกษาปีที่ 6 Primary 6

5. **ท่านสอนมาทั้งหมดกี่ปี**

   How many years have you taught through your career?

   ☐ 11-15 ปี 11-15 years ☐ มากกว่า 15 ปี More than 15 years

6. **ขณะนี้ท่านสอนรายวิชาอะไรบ้าง โปรดทำเครื่องหมาย ในช่องที่เกี่ยวข้อง**

   What subjects do you currently teach? Please mark all that apply.

   ☐ ภาษาไทย Thai ☐ ภาษาอังกฤษ English

   ☐ คณิตศาสตร์ Mathematics ☐ วิทยาศาสตร์ Science

   ☐ ศิลปะ/ดนตรี Art/Music ☐ วิชาอื่นๆ Others

ข้อมูลเกี่ยวกับผู้ทำแบบสอบถาม

รายการ	เห็นด้วยอย่างมาก Strongly agree	เห็นด้วย Agree	เฉย ๆ Neutral	ไม่เห็นด้วย Disagree	ไม่เห็นด้วยอย่างมาก Strongly disagree
1. แอปพลิเคชันสำหรับนักเรียนชั้นประถมศึกษาสามารถค้นหาได้ง่ายในระบบ It is easy to search applications for primary level.					
2. ข้าพเจ้ารู้สึกว่าระบบนี้ใช้งานยาก I felt frustrated while using the system.					
3. การออกแบบส่วนติดต่อผู้ใช้มีความชัดเจนและง่ายต่อการเข้าใจ User interface design is clear and easy to understand.					
4. ระบบมีการตอบสนองที่ช้า The system responds slowly.					
5. ข้อมูลของแต่ละแอปพลิเคชันมีความสมบูรณ์เพียงพอต่อการใช้งาน The system provides sufficient information about each application.					
6. ข้าพเจ้าได้รับไอเดียสำหรับกิจกรรมในชั้นเรียนโดยใช้ระบบ I can get ideas for classroom activities by using the system.					

ข้อมูลเกี่ยวกับผู้ทำแบบสอบถาม (ต่อ)

รายการ	เห็นด้วยอย่างมาก Strongly agree	เห็นด้วย Agree	เฉย ๆ Neutral	ไม่เห็นด้วย Disagree	ไม่เห็นด้วยอย่างมาก Strongly disagree
7. ยากที่จะเขียนรีวิว It was difficult to insert a review.					
8. รีวิวให้ข้อมูลที่เป็นประโยชน์ Reviews provide useful information.					
9. รีวิวของครูมีประโยชน์มากกว่าคะแนนของแอปพลิเคชัน The teacher comments are more useful than the scores.					
10. รีวิวสามารถช่วยให้วางแผนการเรียนการสอนได้ Reviews can help me plan a lesson.					
11. ข้าพเจ้าสามารถเขียนรีวิวด้วยตนเองได้ I would like to submit reviews again.					
12. ในภาพรวม ข้าพเจ้าชอบในงานระบบนี้ Overall, I like to use the system.					
13. ฉันอยากแนะนำระบบนี้แก่ครูคนอื่นๆ I would recommend this system to other teachers.					

คำถามปลาย

Open-ended Questions

1. คุณพบปัญหาอะไรบ้างเมื่อใช้งานระบบ

   What problems did you face while using system?

2. ปัจจัยใดของระบบที่ทำให้เกิดประสบการณ์เชิงบวก

   Which features of the system gave you positive experience?

3. ปัจจัยใดของระบบที่ทำให้เกิดประเชิงลบแก่ท่าน

   Which features of the system gave you negative experience?

4. ท่านต้องการปรับปรุงระบบอย่างไรบ้าง

   How would you like to improve the system?

APPENDIX I Teachers' Comments on the Use of Apps4Youth System

Above 15 years experienced teachers said the user interface design is attractive and persuades them to explore more. "Apps4Youth" web-based system gives new knowledge in technology-based teaching. Primary school teachers admitted they need to learn more on how technology can indirectly deliver lessons. The system can go far in giving ideas to teachers to decide on teaching with technology aid materials and application. They suggested system should provide many kinds of applications which might get learners' interest in learning. The "Apps4Youth"system is giving ideas to teachers on teaching and provides many kinds of applications which can attract students' interest in learning. The applications could increase learners' curiosity level that leads to inquisitive in their lessons. Besides, they could help children rapidly develop in comprehension and learning skills. For a long-term use, they still need more time to spend to familiar with system. The primary school teachers complained the loading speed is slow while accessing system. They suggested evaluation form should be short and more concise.

11-15 years experienced teachers stated system is user friendly and easy to accessible. It can help them to create a better teaching activity for student understanding. Teachers suggested system should provide applications in various subjects that could be available from different application stores and can use it on all kind of computational mobile devices (e.g. Amazon and Window application stores) than Apple and Android play stores. The reviews on each application will be more useful to use at class. The present limited information on each application cannot support the ideas for classroom use.

3-5 years experienced teachers mentioned the limited numbers of applications and information are the weakness of system. The system should state ideas for class use in each application to use in an effective way. Another major inconvenience is the availability of iOS and Android applications' information on system. However, teachers observed there are quite many of applications that look interesting for using as teaching aid applications. They need to access and have experiences on applications before give class for practical exercises.

Teacher who have less than 1 year experience said the procedure to write a review for each application is complex and not clear. Nonetheless, the system is easy to access and gives education technology knowledge.

APPENDIX J Semi-structured and informal interview sessions for teachers on the tablet-based teaching activities

How will you describe your experience using tablet-based activity at iClassroom?

Teacher 1: Tablets are using to teach STEM subjects at primary levels of study in Thailand. Students love to learn and explore new knowledge in different subjects over tablets. iMovie is used to summarize and present lessons, that have learned as individual or group activity for Science subject.

Teacher 2: -

Teacher 3: English in daily life, iMovie, Notepad, Keynote, and educational related applications are currently used for teaching English subject. Students learn the native accent by accessing applications. As per lecturing experiences, choosing the relevant applications is not easy. We need to carefully evaluate the quality of application before use at class.

Teacher 4: I have 1year teaching experience in Technology subject at iClassroom. Students are more interested in learning after using tablets as learning aid tools at class. The iClassroom teaching is especially emphasized on STEM (Science, Technology, English, and Mathematics) subjects.

Teacher 5: I always review previous lessons and prepare the continuous lessons advanced in a week. I usually arrange Mathematics exercise thoroughly to match with lessons that they learned at normal classroom. Children always have fun time and enjoy performing their works on mobile devices, iPads.

What types of helps are needed for tablet-based learning activities?

Teacher 1: I need to spend a lot of time to search applications because some applications are only allowed to access specific features or trial version. School does not allow us to buy applications and have restrictions in downloading applications. I would like to get suggestions from the experienced teachers have knowledge on educational applications.

Teacher 2: I have more than 15 years teaching experiences but my colleagues and I do not have much knowledge in technological device, software, and application. We need to learn new technology skills to familiar with tablets in order to create tablet-based teaching.

Teacher 3: I need guidelines from experienced teacher or expert who have practical experiences in teaching with technology. Teaching assistants can help in classroom control, and technology supports at class. Teaching techniques, classroom activities and worksheets are carefully considered if we use applications at classroom. Thus, we should have training class on forming effective teaching methods for iClassroom.

Teacher 4: Sometimes, the inadequate numbers of tablets make difficulty to design classroom activity. We requested to the ministry of educational to support more tablets at school. Besides, we need teaching assistants to help children in technical and lessons at iClassroom teaching activity. The specific reason is a teacher cannot control and support the whole class requirements. If possible, we would like to get more training on how we can search and use iOS educational applications.

Teacher 5: I have to consult with colleagues or IT staff to minimize technological requirements or problem before giving an activity to class. Some applications have potentials to use at class such as Spin NU, Quick Math+, and Sushi Monster. Those applications encourage students to level-up their learning performance by competing each other. Apart from it, talking with educational expert to know more about on useful education applications is better than naive.

Does the technology make classroom practices or difficult or easier?

Teacher 1: Technology helps classroom to give hands-on experience and make students easier to learn lessons. In order to compare with normal class, students are more concentrated and absorbed knowledge faster on their lessons.

Teacher 2: The new computational mobile device as tablet makes easier for teacher to teach lesson.

Teacher 3: Technology persuades student attention in learning. It makes the class easier to teach and practice different kinds of lessons on tablets.

Teacher 4: At first, teaching with tablets at classroom is difficult for teachers and students because we do not have knowledge on the use of tablets. The researchers

from NU demonstrated the ways to use tablets as teaching aid materials. They illustrated the needs of appropriate worksheets in combining teaching methods and technology together.

Teacher 5: If technology issues are occupied, teaching lessons was stacked and could not go further for teaching. Mostly, students and I had to solve technical problems by ourselves than from IT staffs. If we can regularly use tablets for teaching at class, the issues might less occur. At class, to submit electronic worksheets via AirDrop, and use AirPlay are common problems. I think that problem will happen less when students get more familiar with devices and applications.

Another problem is to understand students' nature and behaviour at technology-based learning class. There have five students who are attention seekers. They are active and talk to their classmates to show their accomplished tasks. We need to understand their natures. As well, I need to care the low-level performance students who need more guidelines in learning than other children.

How does iClassroom improve student learning?

Teacher 1: Students are more enthusiastic and curiosity level is increased in learning. Students pay more attention on their assigned tasks for better outcomes.

Teacher 2: The use of mobile devices and application support unlimited learning for students.

Teacher 3: Technology helps students to improve thinking skills by letting them to explore new knowledge by themselves. It makes students to learn lessons easily.

Teacher 4: The mobile applications are acting as teaching materials, which can gain their knowledge and learning skills. One of the examples is children learned new vocabularies and gain logical thinking skill by playing Tynker. The objective is teaching basic programming skill application, but the commands as "walk, jump, and repeat" are new English words for students and they learned it while playing game. Another application "Animatic" let students to create storylines on their imaginations. We can see their improvement of imaginative storylines by using it over three weeks. School children have fun and learn informally at iClassroom. Now, we are planning to develop informal teaching activities for P5 and P6.

Teacher 5: The activity promotes student learning outcome and creativity, which are essential in Mathematics. After students have learned new lessons in class, children would like to inquire more information on unclear lessons. They like iClassroom teaching session because they preferred to search new knowledge on topic by themselves. They have fun while performing activity and help others after they accomplished their tasks. So, iPads are useful for teaching and learning at classroom.