# An Investigation of the Influence of Learning Effectiveness and Motivations in a Taiwan History Digital Game – Govern Formosa

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**Abstract:** A digital puzzle game, named Govern Formosa, was developed in this research for the history course in the 5th grade primary school in Taiwan which is about the Taiwan history in late Qing dynasty. The game was used in conjunction to formal education history class. One randomly selected class in a primary school in Taiwan participated in the instructional experiment. The influence of the game to students' learning achievement was examined in this research. Pretest and posttest were conducted. The result show students' learning achievements have positive improvements and all have reached significant differences. Also, they can all increase students' learning motivations and immerse in the game.

**Keywords:** Digital game-based learning, learning effectiveness, formal education.

## 1. Introduction

History and geography course content, unlike science course content that can be learned through logistics and reasoning, relies heavily on memories. Social science course content contain names, events, time, location, and objects that are complexly interrelated and the memory was purely done through texts. When students were facing periodic evaluations, they have to memorize all the content with little comprehension in short-period of time, and gradually dislike the subjects. Song, He, & Hu (2012) thought that history educational games that combine digital stories into them are helpful to students on history learning. Learning history and geography through digital games can make the learning process more interesting via visualization, students can see the historical scenes, and relate to the learning content in a more experiential ways.

There are many different educational types and styles of game-based learning; all intend to reach high interactions and motivations (Qian & Clark 2016; Tsai, Huang, Hou, Hsu, & Chiou 2016). Students can actively explore, observe, participate, and manipulate things in the digital games, and learn through texts, graphics, and multimedia to retrieve relevant knowledge content. However, which kind of learning content and presentation modes would be more effective to students' memory, short-term and long-term, to learning content?

A digital game of Taiwan history in late Qing dynasty was developed in this research for the 5th grade history course in the primary school in Taiwan. Students who participate in this research can experience the simulation, entertainment, and challenge the game brings about. They learn history content in the digital game. Research questions include how the students' effectiveness after the game-based learning; and what the students' game satisfactory levels are.

## 2. Literature Review

### 2.1 Game integrated courses

Digital game has become a part of the regular lives to most students. In the educational realm, the application of digital games is getting more prevalent. Digital games are regarded as one of the best substitutions to the traditional courses in the classrooms, and are supplementary activities with high effectiveness and high quality (Dobrescu, Greiner, Motta, 2015). Many teachers think digital games are one of the teaching tools that can be successfully used in the classrooms (Proctor & Marks 2013). Tüzün, Yılmaz-Soylu, Karakus, Inaland & Kızılkaya (2009) pointed out that students' grades are improved when computer games are used in their geography course in the primary schools. Teachers' roles have changed from lecturer to advisor and manager in the game-based learning courses.

Lester et al. (2014) used narrative-centered learning and problem-solving as the base to develop a digital game called "Crystal Island: UnchartedD Discovery." It was used in the natural science education courses in the primary school. Their research showed that students' science learning and problem-solving ability are enhanced, and the gaming environment had highly improved students' participation and their learning motivation. All, Castellar, and Looy (2016), as well as Ucus (2015) both used qualitative methods to investigate digital game mediated school courses in formal education and offered some suggestions. School teachers generally think that game-based learning is a good instructional method, and can enhance students' learning motivation. The teachers also think that games are appropriate to sociology courses. However, to effectively enhance students' learning effectiveness, game play hours have to be adjusted to the proper ratio to lecture classes, and the game content has to be appropriately corresponded to course content.

## 2.2 Historical games

More and more digital games have integrated cultural and historical contents in them, such as the series of <Record of the Three Kingdoms>, <Europa Universalis>, and <Assassin's Creed>. Such games were very popular and have been widely marketed in various forms as commercial products. Sar (2012) pointed out that as teachers use these commercial games that were not originally designed with educational goals, their history and geography content were still relevant to history and geography learning. Students can experience the historical scenes and backgrounds in the virtual world of the 3D games.

As the learning of history and geography include interwoven people, time, locations, and events, the retention of the knowledge depends heavily on memory. Akkerman, Admiraal, and Huizenga (2009) invited students in the age between 12 and 16 to participate their mobile game learning research. The students worked in groups to explore in the city of Amsterdam using mobile devices. The learning effectiveness had reached significant differences. However, learning motivation was not enhanced since long time use of technology would influence students' attention span to learning content. Fang, Tan, Subramaniam and Loi (2013) used Singapore history as the main learning content, and designed a 3D virtual world allowing students to interact with historical people in the virtual world. They used animations and mini-games to assess the students' learning effectiveness. It is found that the students' learning motivation and effectiveness were all improved. The multimedia presentation and 3D environment were especially appropriate for historical learning. In these studies, learning of history and geography that mainly requires memory had become much more interesting, thus the learning improvement were a natural consequences (Watson, Mong, & Harris 2011). To have effective game-based learning, appropriate game stages and difficulties, as well as content presentation modes are important.

## 3. Game Development

The game developed in this research used the history of Taiwan in late Qing dynasty as the story background. The learning content is based on the primary schools history curriculum defined by Ministry of Education in Taiwan. Three stages were developed for the game. Stage one: Treaty Ports, in the period after 1860. Stage two: SHEN Bao-Zhen, in the period between 1874 and 1875. Stage three: LIU Ming-Chuan, in the period between 1885 and 1891. Students play the role of Taiwan governor, and collect resources required in the tasks as the goal. The game events are ordered in the real historical sequence, and the students complete the game tasks in order. Do    not

assemble illustrations at the back of your article, but incorporate them in the text, as close as possible to the first reference.

The game in this research was developed by the game engine Unity. The game was presented in the mixture of 2D and 3D forms. The main interface of Govern Formosa is done with 2D map of Taiwan. The administrative regions are presented in different colors and are in correspondence to the three historical eras. In the meantime, students learn about the district changes through time.

Each of the three game stages present three cities and three ports. When the students enter the game, they choose one of the four actions, namely trade, and raise funds, reclamation, and exploration. They would be led into the 3D game scenes and gather resources such as money, labor, and crops (tea, sugar, camphor, and rice). Students can go to the cities to hire labors, plant crops, and explore the scenes; or go to the ports to choose exporting country and doing trades. Different crops have their corresponding countries in which they worth higher values. On a global map, crop symbols are tagged on the corresponding countries, such as America, Europe, China, Japan, and Southeast Asia.

In the game, the students have to understand and learn the best strategies to gain most profits to carry on the game. By repeating these game actions such as collecting resources and completing the tasks, students learn about the historical content and events, economic conditions, and trading goods and ports. When the students decide to explore the 3D scenes, four locations can they choose from, namely Tamsui, Kaohsiung, Keelung, and the mountain area. These scenes are built based on history, documentary books and location reference of Google map. The students have to interact with the non-player character (NPC) and objects in the scenes to complete the game tasks. By doing this, the students would have better memories to the historical events.

## 4. Research Design

The goal of this research is to investigate how the digital game-Govern Formosa would influence primary school students' learning effectiveness to history content. The content in the tests include historical content about Treaty port, SHEN Bao-Zhen, and LIU Ming-Chuan which are normally taught in 5th grade history classes about Taiwan in late Qing dynasty. Students' reactions to learning motivations and game satisfactions are collected by questionnaire. Twenty-seven 5th grade students, 13 boys and 14 girls, in a primary school in southern part of Taiwan were invited as the research participants. The experiment was conducted before the students having lessons of the corresponding history content. The instructional experiment was conducted in a computer classroom for two sessions of 40-minutes class. Students had the pretest for 15 minutes, game time for 45 minutes, posttest for 15 minutes, and 5 minutes class reflection.

The history learning assessment in pretest and posttest were all about the history learning content about Taiwan in late Qing dynasty which were adopted from history textbook, learning sheets, and the students' mid-term evaluation. All questions were reviewed and validated by history teachers in the primary school. All tests have 20 questions with a total score of 100. Question 1 to Question 8 are related to game stage 1, which are about Taiwan Treaty Ports, relocation of the economic center, and the influence of the western missionaries. Question 9 to Question 14 is related to game stage 2, which are about the time of SHEN Bao-Zhen. Questions include Botan tribe incident, and city constructions done by SHEN Bao-Zhen, such as the prohibited immigration to Taiwan, accept native people to be citizens, and build military defense. Question 15 to Question 20 is related to game stage 3, which are about the time of LIU Ming-Chuan. Questions include Sino-French War, and the city constructions done by LIU Ming-Chuan, such as establishing post offices, setting up railways, installing telegraph lines, and imposing tax breaks. Questions in all tests are different but in the same style and difficulty level.

Questionnaire about learning motivations and game satisfactions is designed in 6-point Likert scale including motivation, system, content and memory, four aspects. There are 24 questions in the questionnaire. The motivation part contains 5 questions. It is to understand whether digital game integrated history learning can positively enhance students' learning motivation, and whether the resources are attractive for the students to continue playing. The system part contains 5 questions. It is to understand how difficult the game is to students. The content part contains 5 questions. It is to understand whether students would follow the instructions to go through the game,

and whether they can effectively learn history content from the game. The memory part contains 9 questions. It is to understand which kind of presentation mode would increase students' impressions more to the learning content, and whether the students would relate the content presented in the game to the content taught in the history class. Although it is a self-reported questionnaire, it is to the students' impressions about whether each presentation modes would help them memorize the historical facts better. Pretest (Cronbach's α=0.843) and posttest (Cronbach's α=0.963) both have high credibility.

# 5. Results

## 5.1 Results of learning effectiveness

A Paired Sample t-test of learning effectiveness regarding to Taiwan's historical content in late Qing dynasty were shown in Table 1. After the game, the scores were raised from pretest (m=26.48) to posttest (m=60.00) and learning effectiveness aspect had reached significant differences (t=8.196***, p<.000) between pre- and post-tests. The results indicated that the participants could learn the historical knowledge after playing Govern Formosa.

Table 1

Pretest and posttest results of learning effectiveness

| Topic | | N | Mean | SD | t | p |
|---|---|---|---|---|---|---|
| Learning effectiveness | Posttest | 27 | 60.00 | 16.350 | 8.196*** | .000 |
| | Pretest | 27 | 26.48 | 17.640 | | |

***p<.001*

## 5.2 Results of questionnaire

To compare the participants' feeling between commercial digital games and Govern Formosa, Paired Samples t-test was used to analyze the pre-experiment and post-experiment questionnaire scores from four aspects, namely motivation, system, content, and memory.

Table 2

Pretest and posttest of game questionnaire -motivation

| Topic | | N | Mean | SD | t | p |
|---|---|---|---|---|---|---|
| game questionnaire -motivation | Posttest | 27 | 27.52 | 3.130 | 5.064*** | .000 |
| | Pretest | 27 | 23.07 | 4.739 | | |

***p<.001*

   In the aspect of motivation, it mainly explored whether the students' of playing and learning motivation could be improved after this game and if their exceptions stay the same. The analysis result in Table 2 has shown significant difference (t=5.064***, p<.05). Govern Formosa could make students feel interesting which means it has high sustainability. As the results of learning effectiveness, it is proved that the historical content in late Qing dynasty could be learned through the game.
   In the aspect of system, it mainly investigated whether the students' feeling including game design, interface, operation, and game mechanism were the same as their exceptions before. The analysis result in Table 3 has shown significant difference (t=3.314*, p<.05). For game system, the game experiences of Govern Formosa were higher than the students' exceptions before they play.

Table 3

Pretest and posttest of game questionnaire -system

| Topic | | N | Mean | SD | t | *p* |
|---|---|---|---|---|---|---|
| game questionnaire -system | Posttest | 27 | 26.81 | 4.161 | 3.314[*] | .003 |
| | Pretest | 27 | 24.41 | 3.703 | | |

*\*p<0.5*

In the aspect of content, it mainly investigated whether the students notice and learn the learning contents which were inserted into game stories and mechanism. The analysis result in Table 4 has shown significant difference (t=3.635**, p<.05). For the aspect of content, the game presentations including game stories and mechanism were satisfying.

Table 4

Pretest and posttest of game questionnaire -content

| Topic | | N | Mean | SD | t | *p* |
|---|---|---|---|---|---|---|
| game questionnaire -content | Posttest | 27 | 27.37 | 3.564 | 3.635[**] | .001 |
| | Pretest | 27 | 24.63 | 3.477 | | |

*\*\*p<0.05*

In the aspect of memory, it aimed to investigate whether the participants could increase their impressions through game presentations and remember the learning content one month after the game experiment. The analysis result shown in Table 5 has reached significant difference (t=4.786***, p<.000). It shows that students think the game created in this research can help them to increase their impressions to the history knowledge.

Table 5

Pretest and posttest of game questionnaire -memory

| Topic | | N | Mean | SD | t | *p* |
|---|---|---|---|---|---|---|
| game questionnaire - memory | Posttest | 27 | 49.15 | 5.953 | 4.786*** | .000 |
| | Pretest | 27 | 43.33 | 6.127 | | |

*\*\*\*p<.001*

## 6. Results

This study aimed to integrate game-based learning and history learning in the primary school formal education using a Taiwan History Digital Game – Govern Formosa. The research questions include: 1. how the students' effectiveness after the game-based learning; and 2. what the students' game satisfactory levels are.

About question 1, each of the three game stages takes ten to fifteen to play. In the experiment, all students could find the right strategies and finish the game in time. According to the results of learning effectiveness, their learning effectiveness has significantly improved. Therefore, it is feasible and effective to use game-based learning in history course.

About question 2, from the results of questionnaire, the participants feel satisfied about Govern Formosa. The game is intriguing and attracts them to continue self-learning after school course. The students were also willing to play again. The results of the motivation aspect also correspond to their scores in the postponed test. In the system aspect, the students suggest that the game needs more hints to give more information so to proceed the game, and the game can implement more presentation modes. In the content aspect, the game can be design to require the students to do more complicated thinking and reflections, and to be more immersed in the game. In the memory aspect, they think Govern Formosa can help them to memorize history content and connect to the questions in the history learning assessment.

From the research results and discussions, there are some recommendations to the game design, experiment design, and integration to future primary school courses. Students also recommended in the interviews to increase hints in the game. A more careful and detailed descriptions and clues can be added as an option for the students to use while needed. A play-again button can be added to allow students to go back to the game. It would also be easier for the researchers to check the playability of the game.

In summary, this research successfully integrates game-based learning in history formal course, and positively increases students' learning effectiveness and motivation, even after a long time. In this research, it is evident from the results of postponed test that students' history knowledge memory was retained. In the future, the three game stages can be integrated into formal education courses respectively to check the sustainability of the instructional design. More qualitative analysis can be conducted to see the relationship between students' long-term memory and short-term memory. More in-depth issues can be investigated in a more comprehensive manner.

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