A Time Scale-based Concept Map Approach to Developing Educational Computer Games for Historical Courses

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Abstract: This research aims to propose a time scale-based concept map approach to developing educational computer games for historical courses. Based on the proposed approach, an historical game is designed by the time scale-based concept map of history. To demonstrate the effectiveness of the proposed approach, a subject unit "Taiwan's recovery history by Zheng Cheng-Gong" of an elementary school historical course is chosen to be the learning topic. It contains the "cross relationship" of these events that affected the following historical events. We aimed to explore the effects of the time scale-based concept map educational game on students' historical achievement and their learning motivation. It is hoped that the students can find the interactive relationships among the historical events that occurred in different period through the learning process.

Keywords: concept mapping, game-based learning, history education, cognitive load, flow experience

1. Introduction

Game-based Learning with the integration of entertainment and education has been largely developed in recent years. Besides, many studies in various fields have shown that games could assist learners in learning, as they could make learning more interesting [1]. However, few studies have been conducted to develop educational computer games for history instructions. Many scholars even regarded history as a difficult-to-learn subject [2][3], which contained the staggered relationship among people, events, time, places, and objects. Without proper learning supports, most students would consider memorizing such abundant data rather than comprehending them. Some researchers attempted to cope with this problem from the aspect of the interactive relationships between history and geography and considered the essentiality of adding geographic information into history education [4][5]. As a result, the effectiveness of history-based games could be improved by providing map-based support to guide students to learn.

Concept map was proposed by Joseph D. Novak, a professor in Cornell University, in 1960. It was a learning strategy to present knowledge with graphs, aiming to assist students in finding the relationship among concepts with graphical structure to enhance the learning effectiveness. It has become a widely applied Mindtools in recent years [6][7][8]. This study tended to propose a game-based history learning system, integrated with time scale-based concept maps. Based on the history event, the time scale-based concept map was generated with time relationship to guide students learning from games. The historic material, The Recapture of Taiwan by Zheng Cheng-Gong, was included in the digital games with RPG maker that learners could experience the history by role-play and learn

historic knowledge. It expected to trigger off students' learning motives and flow experiences. The levels in the games followed the structure of concept maps, and questions were asked after each level so that they could learn by following the time--scales-structured concept map. Learners were expected to learn history in the games and to review the learning process through answering questions. To help students comprehend the time sequence of history, an expert concept map scaffoldings was also included that the learners could acquire the concept map related to the levels in the games. Therefore, the students could review the prior knowledge from the concept map to understand the relationships and structures among the people, events, time, places, and objects in the history as well as to enhance the learning efficiency and achievements. Before the experiment, a trial system was proceeded, and experts were asked for inspect the contents.

2. Literature review

Computer games contain the factors of rules, objectives, feedback, interaction, and rewards, which could enhance learners' learning motives [9]. Playing games has been an important role in the growth of human beings, as it naturally constructs knowledge and skills that a lot of researchers devote to the development of Game-based Learning [10][11]. Lo, Chang, Tu, et al. (2009) developed a network-based history education system and compared it with general webpages to study the learning effectiveness and attitudes of college students toward Chinese history of three kingdoms [5]. It was found that students who utilized the system appeared superior learning attitudes and effectiveness to the ones browsing general webpages, as browsing webpages was similar to traditional way of learning but reading the texts through the Internet. The students therefore could not be enhanced active learning motives.

In this study, an expert concept map was provided in a digital game for guiding the students to learn the relationships between historical events. Concept map is a common Mindtools, which could assist students in applying computer programs with high-level thinking in the learning process [12]. Researchers have devoted to including learning materials into games so as to enhance learners' learning motives and learning effectiveness [13].

3. Digital historical game with a time scale-based concept map approach

The evolution of history events usually contains time-related relationships; therefore, adding those time-based relationships in the concept map is helpful to students in clarifying the cross-relationships among various events. In order to help students learn the relationships between historic events in en effective and efficient way, a time scale-based concept map approach is proposed in this study for developing digital games.

A history teacher in a junior high school in New Taipei City, with twelve-year teaching experiences, participated in this study. Based on the selected learning content, a time scale-based expert concept map is developed by the researchers and the history teacher in order to ensure the correctness of the content and the correlation of time in the concept maps. RPG maker, a role-play game maker developed by Enterbrain, was utilized for developing the games. Cmap tools, developed by University of Florida, were utilized for the concept map [14].

Based on level design, the concept map was divided into four levels based on the time sequence, as shown in Figure 1. Level 1 refers to the first attack to Dutch troops of Zheng's troops for recapturing Taiwan, Level 2 refers to Dutch troops being sent from

Batavia to Taiwan. Level 3 refers to Dutch troops looking for reinforcements from the north after the failure of the first reinforcements and Dutch generals' betrayal and fleeing. Level 4 refers to the second attack of Zheng's troops to take down Zeelandia as well as Dutch troops' final surrender and signing treaty of peace. The concept maps appear mutually causality and time correlations. After acquiring all concept maps, the four concept maps could be assembled as one for integrated review.

To have learners comprehend the relationships between history events, a role-play game was designed for learners to learn with entertainment and joy. Some frames are shown in Fig. 2. Learners would role-play Zheng Cheng-Gong to experience various major events in the historic event, The Recapture of Taiwan by Zheng Cheng-Gong.

From Zheng Cheng-Gong deciding to recapture Taiwan to expelling Dutch troops out of Taiwan, the game was divided into four levels. Players could acquire historic information from the story and receive rewards by expelling Dutch troops. After a story, the students would be asked relevant questions for passing the level, as shown in Figure 3. The concept map of the story would be rewarded to the player for passing the level so that learners could further integrate and review the historic information. After all levels were passed, the concept maps could be assembled as a complete concept map, as shown in Figure 4.

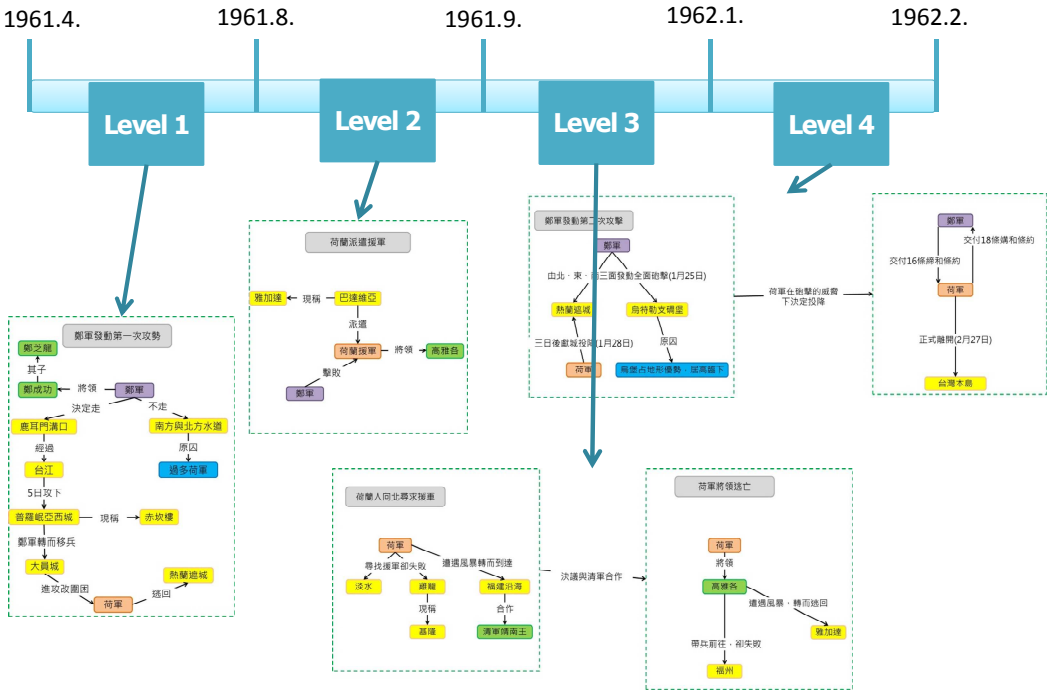

Figure 1. Time sequence diagram of level design of the game

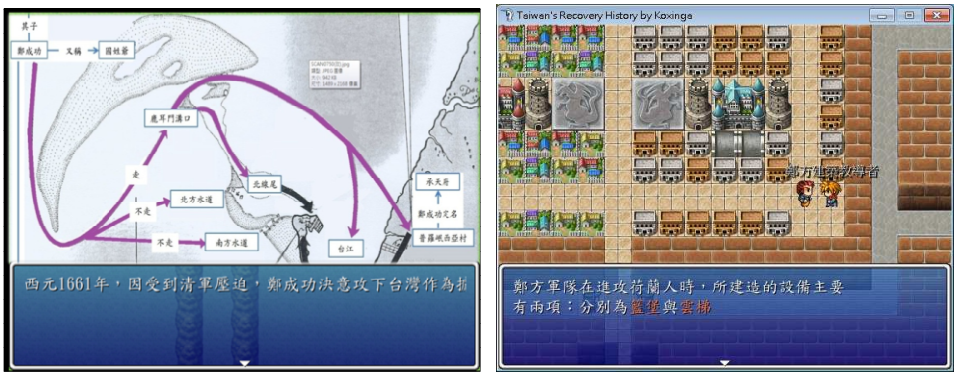

Figure 2. Game process frame

Figure 3. Question about ancient weapons

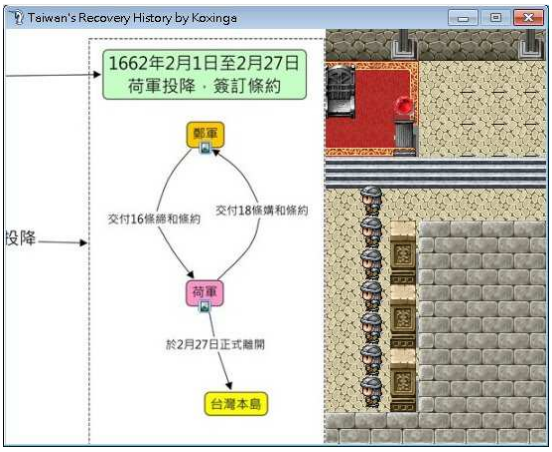

Figure 4. The completed concept map

Players could learn history through the stories and be asked historic questions through the battle. If the student answers the question correctly, the role would be rewarded fighting capability; otherwise, he/she would return to the question point for reviewing the historic learning material. The fighting capability would affect the difficulty of the battle and enhance the playfulness for the corresponding concept map knowledge.

4. Experiment Design

To evaluate the effectiveness of the innovative approach, an experiment was conducted to compare the learning achievements and attitudes of the students who participated in a historical game-based learning activity with different learning strategies. The difference of the learning strategies was that the experimental group used the time-scales based concept maps to help the students learn the historical events and built their concept map during the game playing process, and the students in the control group just played the game and learn the historical events without built concept map.

Participants

The participants are 36 elementary school students from two classes of fifth graders in Tainan County in Taiwan. They are 11 years old on average. They were divided into two groups; that is, 18 students from one class in the experimental group, and 18 students from another class in control group. The experimental group and the control group were guided to play a historical digital game.

Measuring tools

The measuring tools in this study included a pre-test, a post-test, and the questionnaires for measuring the learning attitude and the self-efficacy of the students. The test sheets were developed by an elementary school teacher who had taught the course for more than 15 years. The pre-test was used to evaluate the prior knowledge of the students. It contained 20 multiple-choice items and 20 fill-in-the-blank items, with a perfect score of 100. The post-test consisted 15 multiple-choice (60%), 9 fill-in-the-blank items (10%) and 2 concept-of-link items (30%) for assessing the students' knowledge in historical courses. The perfect score of the post-test was 100.

The “attitudes toward history learning” questionnaire was developed by Chu, Hwang, Tsai, and Tseng (2010)[15]. It consisted of eight items (e.g., “I am more interested in taking the history course after participating in this learning activity”) with a six-point rating scheme, where ‘6’ means strong agreement or positive feedback and ‘1’ represents high disagreement or negative feedback. The Cronbach's alpha value of the questionnaire was 0.92.

Experiment Procedures

At the beginning of the learning activity, the two groups of students received basic instruction about the introduction of Zheng Cheng-Gong recovered Taiwan in 30 minutes, and then the pre-questionnaire was conducted to analyze the students’ learning attitude toward history class.

In the first stage the learning activity, the students in the experimental group received instruction about the use and conception of concept map and then they learned with the personalized educational computer game, which provides time scale-based concept maps for helping the students understand the relationships between the historical events. Figure 5 shows the learning scenario of the historical game-based learning course. After the learning activity, the students took the post-test and the questionnaire for measuring their learning achievements and their learning attitude.

Figure 5. Learning scenario of the historical game-based learning activity

5. Results

Analysis of Learning Achievement

The aim of this study was to examine the effectiveness of the personalized educational computer game with time-scale based concept maps for improving the learning achievement of the students. The mean values and standard deviations of the pre-test scores were 74.27 and 14.27 for the control group, and 79.72 and 9.28 for the experimental group. The independent t-test result (t=-1.359, p-value>.05) shows that there was no significant difference between the two groups; consequently, it is evident that the two groups of students had equivalent prior knowledge before the learning activity.

After the learning activity, the analysis of independent t-test was used as an indicator for representing the learning achievements of the students. Table 1 shows the result of post-test ratings of the two groups. The mean value and standard deviations of the post-test scores were 52.17 and 11.22 for the control group, and 61.22 and 13.02 for the experimental group. It is found that the students in the experimental group had significantly better learning achievements than the control group (t=-2.235, p<.05), implying that the time scale-based concept maps game-based learning was helpful to the students in improving their learning achievement of the historical course.

Table 1. *t*-test result of the post-test scores

	Group	N	Mean	S.D.	*t*
Post-test	Control group	18	52.17	11.22	-2.235*
	Experimental group	18	61.22	13.02	

*$p<.05$

Analysis of learning attitude toward history learning

The means and standard deviations of the pre-questionnaire ratings were 5.34 and 0.58 for experimental group, and 5.40 and 0.46 for the control group; the means and standard deviations of the post-questionnaire ratings were 5.20 and 1.01 for experimental group, and 5.49 and 0.63 for the control group. It is found that there was no significant difference between the two groups of students.

6. Discussion and Conclusion

History is an integrated subject with people, events, time, places, and objects. In addition to the abundant data, it is also hard to comprehend that students are likely to lack learning motives in learning history. For this reason, the historic event, The Recapture of Taiwan by Zheng Cheng-Gong, was designed to enhance learners' learning motives through game-based learning. Moreover, in this study, the expert time scale-based concept maps were integrated into the games to help students successfully understand the correlations of the event and to enhance the learning effectiveness.

The developed system was applied to the history class in an elementary school in Tainan County in Taiwan. Total 36 fifth graders students were equally divided into experimental group and control group. The historic event, "The Recapture of Taiwan by Zheng Cheng-Gong" was selected as the experimental subject. The experiment results show that the students in the experimental group had significant better learning achievement than those in the control group, showing that the time scale-based concept map approach was helpful to the students in improving their learning achievement.

In terms of "Attitudes toward history learning", most students gave positive feedback of the educational computer game, although no significant difference was found between the two groups. It is speculated that the students of the two groups both used game-based learning strategy to learn the history course. Moreover, all of the students have learned the course by game-based learning; therefore, the students did not reveal significant differences in terms of their learning attitude after the learning activity.

The experiment results confirmed that with the aid of the Mindtool, it is helpful to the students to learn the history course following the expert concept maps to learn in improving their knowledge structure as well as their learning achievements in comparison with the game-based learning approach that provides the students all history events in the course. This finding complies with what has been reported by other researchers, that is, students will improve significantly when they use Mindtool to be their intellectual partner [16].

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