Digital Game-based learning (DGBL) model and development methodology for teaching history

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Abstract: - History subject plays a vital role in instilling the spirits of patriotism among the students; to nourish and instill love and loyalty to one's country and to be a true citizen.The lack of creativity in history teaching caused students to become bored and lose interest in the subject.Digital games, an interactive technology can foster learning process effectively and interestingly especially among young learners. Digital Game Based Learning (DGBL) approach utilizes the game as a medium for conveying learning contents. There are many models for educational games development which combined the Instructional Design (ID) and game development process. However, there is still a conflict on how to merge ID and game development effectively. Therefore, we looked into the pedagogy and game design aspects. We then propose a DGBL model for History educational games design and a developmentmethodology which combined the ID and game development process, named DGBL-ID model. The DGBL-ID model consists of five phases: analysis, design, development, quality assurance as well as implementation and evaluation.

Key-Words: - serious games, DGBL, Instructional Design (ID), History educational game, video games

1 Introduction

History subject plays a vital role in instilling the spirits of patriotism among the students; to nourish and instill love and loyalty to one's country and to be a true citizen. Teaching and learning of history is appropriate for students' intellectual, spiritual, emotional and physical development. However, studentsperceived history subject is difficult and very boring subject because one has to memorize all facts in the text book besides understand those facts, concepts, time and historical events. The lack of creativity in history teaching caused students to become bored and lose interest in the subject.

There are few studies shown that majority people have experience in playing digital games. Nowadays, digital games have been used in education that called educational games. They use educational games as teaching and learning tool in some subjects, such as mathematics, science, history and language learning.

Digital games (video games or computer games) are positively accepted among children and teenagers [1]. In United States, Video game industry approaches yearly revenues of 15 billion, with the game playing population falls between the ages of 10-34 years old, the majority are between 14-19 years old [2].A preliminary study conducted in 16 local secondary schools involving

341 students found that majority of them (92.1%) have experienced playing computer or video games [1].

Games are played primarily for entertainment [3]. Games especially computer games are an important part of leisure lives for young people.Computer games also become one of the favorite online activities for teenagers [4]. The most popular computer games include role playing games, real time strategy games, shooting and fighting games, adventure games, action games, puzzle games and chess games [5].Games have been integrated into education to form an innovative educational paradigm [6]. Online game has been applied to education in Korea as it has been used extensively [7].

Digital games, an interactive technology within the multimedia learning environment could foster learning process effectively and interestingly especially among young learners. Despite the enormous potential of DGBL, it is still difficult to integrate games into curriculum of formal education. This is because of the difficulty in identifying their relevance to the curriculum, potential benefits and practical integration method [5]. Researchers and game designers have noted this promising technology and proposed some frameworks and models to foster multimedia learning environment[6]. The researches data also shown that the use of games in education is perceived as a useful tool for learning and destined to engage students in educational experiences for achieving specific learning goals and outcomes [8, 9].

DGBL is a paradigm which utilizes the game as a medium for conveying the learning contents, it is all about leveraging the power of computer games to captivate and engage endusers for a specific purpose, such as to develop new knowledge and skills [10]. DGBL is also defined as an applicationwhich uses the characteristics of video and computer games to create engaging and immersive learning experiences for delivering specified learning goals, outcomes and experiences [11]. DGBL is widely adopted in manufacturing, energy/utilities, computer technology, higher education, retail, financial, telecommunications, pharmaceutical, hospitality, construction, computer software, public departments and healthcare sectors [10]. The intention of DGBL is to address new ways of ICT based instructional design and at the same time toprovide learners the possibility to acquire skills and competencies [12].

In this paper, we do a preliminary analysis and document analysis to find out the problems in teaching and learning history. We also reviewedprevious studies in the methodology development of educational games. Then, we propose a DGBL Model for History educational game designand the development methodology for History educational games which is based on ID andgame development models.

2 Teaching and learning of history

This section discusses the problems in teaching and learning of history, the GBL approach to teaching and learning of history and the proposed components in GBL Model for history courseware design. We also present results of preliminary analysis carried out at local secondary schools.

2.1 Problem of learning History subject

According to Azwan et al. [13], Curriculum Development Division reported that history subject is known as a ‘dead’ and boring subject. In addition, our society presume that history subject do not have commercial value. Furthermore, the problems faced by history teachers is that student have no interest in studying history subject.

Students’ impression of history subject is that it is difficult and very boring because one has to memorize all facts in the text book besides understand those facts, concepts, time and historical events [14, 15]. These students’ attitude has indirectly caused the decrease in passing percentage for Malaysian Certificate of Education (SPM) examination and Higher School Certificate of Malaysia (STPM) [15]. Failing percentage of history subject for SPM examination in 2005 SPM was 25.6% [16].

This failing percentage increased to 34.3% in 2006 [16, 17,18]. Failing percentage for history subject in 2005 STPM was 45.11% [19]. History was one of the subjects showing a decrease of more than 3% in passing percentage in SPM, thus necessitate a detailed analysis and study for this poor performance [20].

Moreover, a study by Rozita and Zaliza [15] found problems with history learning such as students’ attitude; namelylazy to read, read but did not memorize facts, not interested in history subject, student interested but have to memorize too many facts, cannot manage to master the themes and the teaching and learning which is not effective. The lack of creativity in history teaching caused students to become bored and lose interest in the subject [13].

History teaching in school is less challenging for students’ mind and intellectual development and learning by rote memorization also does not encourage students’ analytical and critical thinking [14].

2.2 Findings from Preliminary Analysis

A preliminary analysis was carried out to identify problems and to determine the requirements to overcome these problems. We did a document analysis of SPM performance report from year 2002 to 2005 [16]. The report indicated that students in moderate

performance group are able to give good historical facts but did not give suitable examples, and/or gave long irrelevant elaboration. Students in low performance group commented the questions without giving answers and repeated the same facts, answered one/two questions, did not understand questions and weak in language style. As for structured questions, students are confused, thus mixing all historical facts. They lacked understanding and do not use historical facts properly. Performance report (2002-2003) indicated that overall students' performance is less satisfactory. The report (2005) also indicated that students still did not answer questions properly but gave abstract answers.

Further investigation was carried out using questionnaire and interview. Respondents for this study are 582 form four students and fifteen teachers fromfive local secondary schools in Selangor. Results show that 79% of students have problems when learning history. Difficulty in memorizing facts is the main problem faced by 69% of the students. Teaching media such as boring text books also cause students to lose interest and thus face problems when learning history. Table 1 shows details of problems faced by students. Problems faced by students from teachers' perception (Table 2) also include difficulty in memorizing facts,besides having no interest in history.

Table 1 Problems in history learning from students' perception

Problems in history learning	Percentage (%)
Have no interest in history because of teaching media such as boring text books.	44.5
Have no interest in history because of teacher's boring teaching method.	15.8
Lack of teaching aid/material used by the teachers.	16.5
Lack of history references.	19.6
Did not get clear descriptions about the historical events.	38.8
Difficult to memorize historical facts.	70.6
Did not understand history context.	37.3
Other.	7.9

This finding is supported with data from the interview of form four history teachers [21, 22, 23]. The problems are mainly that students are not interested in learning history and have difficulty in memorizing too old and too many historical facts. Noraini [22] also mentioned that students have no interest in history learning because there is too much and too boring text contents. Additional problems are lack of teaching aid/material and not proficient in Malay Language.

Interviews with history teachers [21, 22, 23, 24, 25] also showed that there is currently no history courseware used in schools. They agreed that game based learning can help by providing interactive elements for visualizing the continuity of historical events. They also supported the development of history courseware using GBL approach to increase students' interest and performance inhistory [23] and to reduce students' boredom with history learning [25].

Findings from this survey also indicated that, 92% students have experienced playing digital games. 27.7% of them played games for less than 1 hour per week while 16.4% played for 1 hour per week. Table 3 shows students' frequency of playing games.

Table 2 Problems in history learning from teachers' perception

Students' weaknesses in history learning	Percentage (%)
Did not get clear descriptions about the historical events.	66.7
Difficult to memorize historical facts.	100
Did not understand history context.	60
Have no interest in learning history.	100
Lack of history reference.	0
Other.	26.7

Table 3 Frequency of playing digital/electronic games

Frequency	Percentage (%)
<1 hour/ week	27.7
1 hour/ week	16.4
2 hour/ week	15.8
3 hour/ week	13.6
4 hour/ week	5.6
>4 hour/ week	13.6

Different platforms for digital/electronic games are television based system (such as the Sony PlayStation® series, Nintendo GameCube™, Microsoft's Xbox®, Xbox 360™), Computer/PC-based DVD-ROM or CD-ROM, Games-specific handheld consoles (such as Nintendo's Game Boy® and DS™ series, Sony's PSP™) using button and joystick control and other handheld unit [mobile computer, mobilephones, Personal Digital Assistants (PDA)]. Table 4 shows the percentage of students using different platforms for playing games, 66.7% use other handheld unit. Table 5 shows the percentage of students playing different types

of digital/electronic games. Most popular genres are racing games (66.7%) and adventure games (62.1%).

Table 4 Percentage of students using different platforms for playing digital/electronic games

Forms of digital/electronic games	Percentage (%)
Television based system (Sony PlayStation® series, Nintendo GameCube™, Microsoft's Xbox®, Xbox 360™)	61.6
PC-based DVD ROM or CD ROM	58.8
Games-specific handheld consoles (Nintendo's Game Boy® and DS™ series, Sony's PSP™) with using button and joystick control)	41.8
Other handheld unit [mobile computer, mobile phones, P.D.As (Personal Digital Assistants)]	66.7

Table 5 Percentage of the students playing different types of digital/electronic games

Types of digital/electronic games	Percentage (%)
Tactical shooters	42.4
Role playing	18.6
Racing	67.2
Car combat	26.6
sports game	50.8
adventure games	62.1
Fighting games	55.9
Combat Sims	19.8
Puzzle games	42.4
Rhythm games	21.5
Other	4.0

Table 6 Percentage of students and their reasons for playing digital/electronic games

Reasons why I like to play digital/electronic games	Percentage (%)
Fun.	72.9
Fill up free time.	62.7
Enthusiastic with adventure activity.	29.9
To show ability.	30.5
Enthusiastic with fantasy world.	45.2
Other.	6.8

Furthermore, 83.6% of the students stated that they like to play digital/ electronicgames, one reason being gaming is fun, while 62.7% play games just to fill up their free time. Table 6 shows the percentage of students and their reasons for playing games. Table 7 presents the advantages of playing digital/electronic games.

Table 7 Percentage of students rating the advantages of playing digital/electronic games

Advantages of playingdigital/electronic games	Percentage (%)
Fun.	53.7
Improve electronic gaming skills.	39.0
Calming the thought.	49.2
A method to fill up the free time.	50.8
Increase creativity.	47.5
Other.	5.1

In conclusion, many students surveyed have played digital games previously, mostly using handheld units such as mobile phone and PDA. Most of them played racing and adventure games. 83.6% students like to play games and 69.5% students stated that playing digital games bring advantages to them. Findings from this preliminary analysis showed that the main requirements of game based history courseware are: illustrate history facts clearly, increase students' interest to learn history and learn history through creative experience. Table 8 shows the requirements of GBL history courseware from students' perception.

In summary, key findings fromthe preliminary analysis are: (1) types of problems faced by the students in learning history; (2) need for interesting, creative teaching approach such as interactive history courseware to encourage history learning; (3) GBL approach has potential to be used in the development of interactive courseware to increase students' interest in learning history via an entertained experience; (4) 3D and multimedia technology should be used in development of interactive history courseware to illustrate historical facts clearly thus increase history learning.

Table 8 Requirements of a GBL courseware from students' perception

Requirements	Percentage (%)
Animate historical personality in a virtual environment to enable users to visualize the truth through role playing.	61.6
Animated history event in a virtual environment to enable users to visualize the truth through role playing.	54.8
Challenging adventure element.	53.1
Audio element for attraction to history learning.	52.5
Video element for attraction to history learning.	58.8
2D animation for attraction to history learning.	22.6
3D animation for attraction to history learning.	58.2
Graphic element for attraction to history learning.	49.7
Adaptive learning based on individuals' ability.	48.0
Increase students' interest in history learning.	66.7
Learn history via an entertained experience.	65.5
Illustrate historical facts clearly.	70.6
Other.	1.7

3 Current research in development methodology of educational games

According to Smith and Ragan [26], Instructional Design is a systematic and reflective process of interpreting principles of learning and instruction into plans for instructional materials, activities, information resources, and evaluation. Instructional designers need to analyze, plan, implement and evaluate in such a way that their work will do the most good with the least harm, and to learn from mistakes to improve.

For the game development methodology, Thompson et al. [27] stated that the digital games development process consist of new game proposals, multiple idea, concept selection, game development, game testing and game launch.However, Phil Co [28] stated that the digital games development process consist of pre-production, high concept, design document, prototype/demo, production, alpha testing, beta testing, final candidate and GoldMaster.

Currently, there are a few studieson methodology development for educational games. *Simulation-Games Instructional Systems Design Model (SG-ISD)* is a model proposed by Kirkley et al. [29]which support the integration between development process of Instructional Systems and game development. The phases of SG-ISD consist of analysis, concept, design and quality assurance. They have integrated SG-ISD Model into a prototype authoring system which supports the upfront analysis and design process while enabling any game engine to be used as the development and delivery platform. They have studied ADDIE model, spiral design approach, user-centered instructional design and Waterfall development model for game. There are no other details mentioned after the design and quality assurance phase.

According to Han and Zhang [5], Quasi Game Based Learning (Quasi-GBL) is an instructional method which integrates game elements with role play in collaborative learning for the undergraduate course "Software Engineering". In Quasi-GBL, seven basic elements including goal, rule, competition, challenge, fantasy, safety and entertainment are embedded into roleplaying and manifest themselves in the forms of real problems, individual tasks and group collaboration, scores, puzzles, awards and replays. Seven steps are involved in Quasi-GBL which comprised grouping, nomination, nomination of project manager, nomination of other roles, requirement analysis, design, implementation and deployment. However, application of Quasi-GBL processesis confusing, andthe activities or steps involved in all phases were not well explained.

Ho et al. [30] studied games based e-learning design and developmentof *Virtual Filial Piety Legend* which consists of analysis phase(learning goal and learner analysis), development phase (deciding the learner's role and situation**,** demonstrations of problem models**)** and creative phase (problem analysis and selection as well as evaluations**)**. However, they did not mention the game development process in methodology. On the other hand, Games for Activating Thematic Engagement (GATE) is a design theory intended to provide specific guidance to instructional designers on how to design and implement video games for engaging learners in a given topic or field [31]. GATE consistsof activities of developing the context, problem space or world of experience; preparing learners to benefit from game and implement game as designed**;** and providing feedback to the learner.

Flanagan and Nissenbaum [32] alsostudied a methodological framework named Value at Play (VAP) which was developed to foster values integration into the design process through the creation of a toolkit. The VAP framework has been further developed through work with RAPUNSEL, a dance game to teach girls

about programming. The VAP approach comprises three "constitutive" and iterative activities named discovery, translation and verification. This methodology did not mention instructional part for game design methodology.

Hays [33] proposed a systematic approach for instructional game design, involving three main parts; understanding the instructional environment (develop problem statement, develop instructional objectives and select game strategy), develop the game (develop game model, develop students' role in game and develop rules, events and winning criteria) as well as implement and evaluate the game (develop supporting game resources, evaluate game compared to alternate instruction & modify game based on results of evaluation). The weakness in this approach is that the methodology follows just a linear path, there is no iterative way should problem occurred in any of the steps.

Rothschild [34] studied the principles of good game design and learning.They merge instructional and game design results in the JUMP Into Reading for Meaning (JUMP) game. Content specialists created and organized instructional content to support the program requirement while game and instructional design specialists integrated the content into a game design that used the key game characteristics of fantasy, rules and goals, sensory stimulus, challenge, genre and form mystery, control and mystery.

There are a few shortcomings in the development methodology for DGBL from the studies reviewed: (a) do not explain instructional part clearly in game development methodology; (b) methodology is just a linear process, does not providefor iterative development process; (c) some phases or activities in the methodology model are not clear.These are the gaps need to fill up with the detail model for educational game development. The educational game development methodology should include ID part and game development part so that can increase the learning effectiveness through an educational game. To develop an well educational game, all activities must clear and it is an iterative process.

4 DGBL Model for History educational games design

Several previous studies showed that there are a growing number of researchers exploring the potential of digital games for engaging students in learning experience. They studied how to develop a model which can support ID for effective design and integrating game process in a learning environment efficiently. Therefore, we believe that DGBL approach has the potential to help overcome problems in history learning, especially for the younger IT generation students.

Games were subdivided by time and by place. There are four types of games, which are synchronous/ central game, synchronous/ distributed game, asynchronous/ central game and asynchronous/ distributed game [35]. This history educational game is synchronous/ central game. This game session usually take place synchronously, group of students come together in a classroom. The sessions will take an hour, twice a week. Students will communicate by face to face meetings. There are a lot of opportunities for informal communication like non-verbal communication and small-talk, for example asking for help. The session is also not interrupted and external disturbances can be avoided. Students cannot block the progress of the game and speed of play is high and intensive [35].

We proposed components in the form of a Model for history educational games design using DGBL approach as shown in Fig. 1.The main components identified are pedagogy and digital games. For the pedagogy component, several elements are elaborated as follows:

(A) Learning goal setting
A clear learning goal setting in history courseware design with DGBL approach is important to help accomplish the learning goals for history learning.

(B) Learning theory setting
Selection of suitable learning theories for history learning is important to foster the learning process effectively.

(C) Educational Psychology
Educational psychology is a discipline concerned with the overall teaching and learning process, for example, the influence of development and differences among individuals on the process of learning [36]. Therefore, educational psychology is one of the crucial components in history courseware design for delivering an effective history lesson to learners.

(D) Country curriculum needs
Each country has different curriculum.Integrated Curriculum for Secondary School (KBSM) is a curriculum used in Malaysian schools. Therefore, KBSM components need to be considered for DGBL approach to history courseware design to ensure that the courseware meets the curriculum needs.

(E) Patriotism and moral value
Patriotism and moral values embedded in history learning through a history courseware with DGBL

approach is important to foster the spirit of loyalty to the country.

(F) Memorization and forgetting theory
According to Davidovitch et al. [37], the learning process comprised of forgetting components, which is applicable when the learning phase is ended or when the learning process includes breaks. A study on the process of learner memorization and how forgetting occurred especially in history learning, is important for designing a history courseware which can help the student to memorize history more effectively.

For the Digital Game, several components that need to be considered during designinclude:

(A) Game story's background
BackgroundStoryof every game is important as it shows how historicalevents happened. Features of each events which consist of date, location and time need to be designed properly and not digressed from original historical facts stated in history syllabus.

(B) Rules
Clear instructions and rules for every game are very important. It is a guideline and regulations for learnersto follow when they are involved in the game play.

(C) Immersive
The game design should make learners feel immersive and absorbed when involved in each game play.

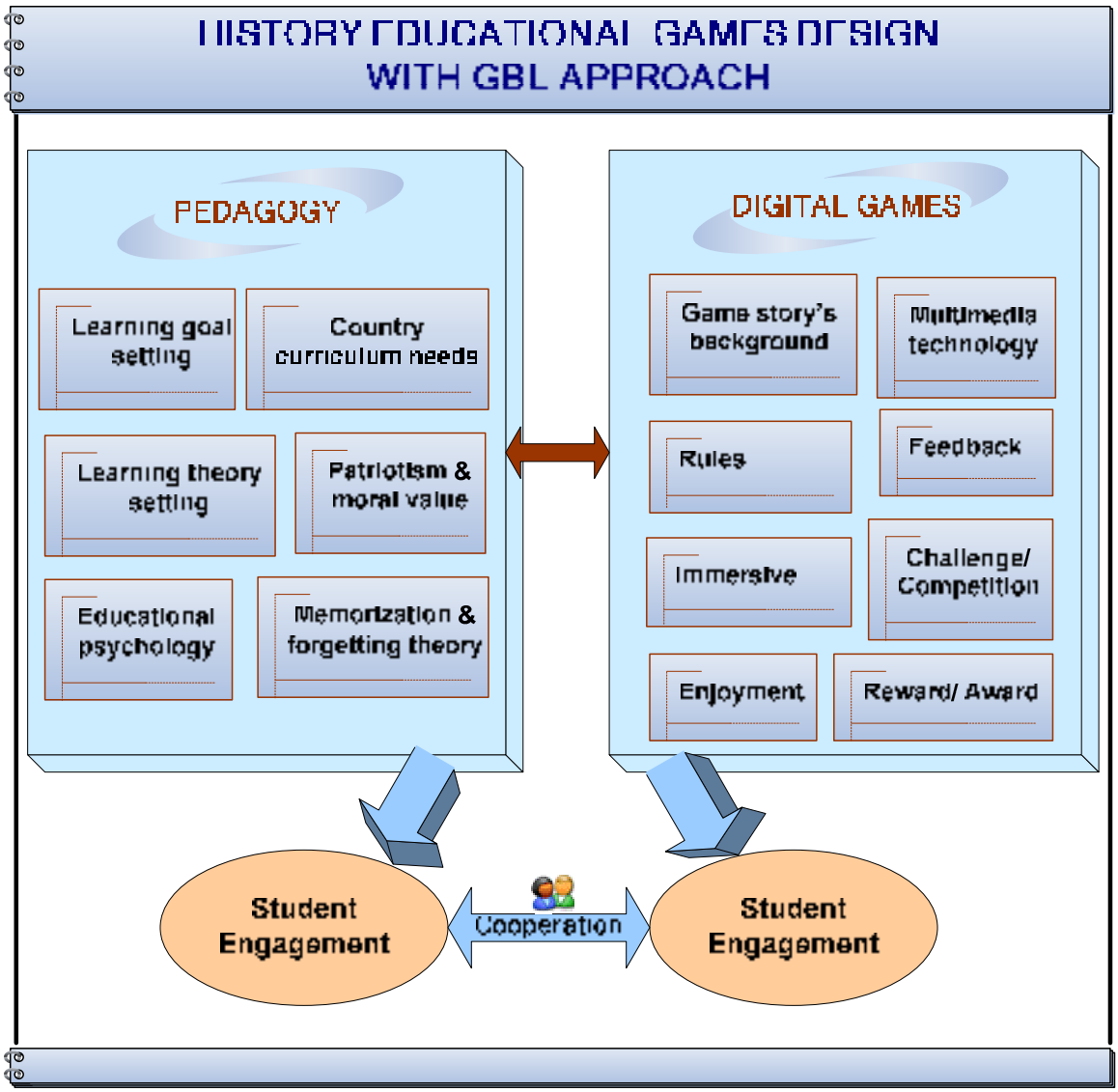

Fig. 1 Proposed components in DGBL Model for History educational games design

(D) Enjoyment
Enjoyment is a crucial component that makes the learners enjoy with the game play. Without enjoyment of game play, learners will simply give up the game play.

(E) Feedback
Learner's feedback is the instant learning response in the game. The user interface design in the game design should make it easy for learners to give feed back to the game.

(F) Multimedia technology
Multimedia effects with 2D or 3D animations, immersive graphical environment and imitative soundare important to attract learners to involve themselves in every game play.

(G) Challenge & competition
Every student has different abilities for every game play. Challenge of one game play should match learners' skill level without being boring and not tolet them give up easily. Competition setting for each history game design is important for game level and so is the difficulties setting.

(H) Reward/Award
Reward/award is one of the ways to motivate learners to continue the game play and overcome the difficulties of each game level.Students' engagement and cooperation among students in every game play is the way of giving mutualsupport in history learning together towardsaccomplishing the learning goal.

5 Development methodology for History educational games design

History educational games development process focused on development methodology to produce game based multimedia educational application. An educational game design and development model is developed based on ID and game development methodology. Fig. 2 illustrated the proposed methodology in the form of digital game based learning-ID model (DGBL-ID). Each phase consist of activities which need to be accomplished before moving on to the next phase. The DGBL-ID model consists of five phases, which are analysis phase, design phase, development phase, quality assurance phase as well as implementation and evaluation phase. Each phase consists of a few steps to be completed. The phases mentioned include all the main activities for instructional part and game part so that the educational game will enable students to learn while they are playing games.

Previous research studiedshowed the models or steps for educational game development, but did not explain details for each phase or step.

For DGBL-ID Model, we will test the quality and content of the educational game before we launch to learners. After the quality assurance phase, we will launch the game and do the usability and effectiveness evaluation to make sure that learners learn effectively when they are playing the immersive game. After the quality assurance phase, we do not go back to design phase, but we just do a modification to improve the game since it take a long time to re-design the game, determine specification, implement and testing again.

Analysis phase includes the process of determination learning goal, learning analysis as well as problem and requirement analysis. Problems faced by the students in history learning and the students' readiness for digital game based learning was analyzed via interview and questionnaire. Students' characteristics such as students' learning style and their existing knowledge were also analyzed. Game idea for the digital game based courseware was also determined in this phase. Then, the types of game platform (such as television platform, computer platform or mobile phone platform) and game features are analyzed and selected. Game platform and game features' strength and weakness will be analyzed so that it can help students learn history in a suitable game environment.

In design phase, teaching and game design were determined. Delivery method and teaching strategy which is used in educational game were determined so that the outcomes of the design can help to achieve learning outcomes. Constructivism, information processing model, Tolman learning theory are the teaching and learning theories used in the design of History educational game. Inquiry, narrative and problem solving are the teaching strategies used in history educational game development. In game design, storyboard for the History digital game based courseware was built, the types of multimedia elements (text, graphic, audio and video) were determined for every game script and screen. Game play design also play a vital role at this design phase, it shows how a player play in an educational game. If a player need to shoot an enemy, design of the game must be determined either to use mouse click or joystick. Besides that, art design is a design process of game's character, game's environment, game's background and game's object such as car, gun, ball and ship. Character's features and motion need to be designed before development phase.

In addition, the features of game's level also need to be designed and determined. Each game's level needs to be designed well from the beginning until the end of the

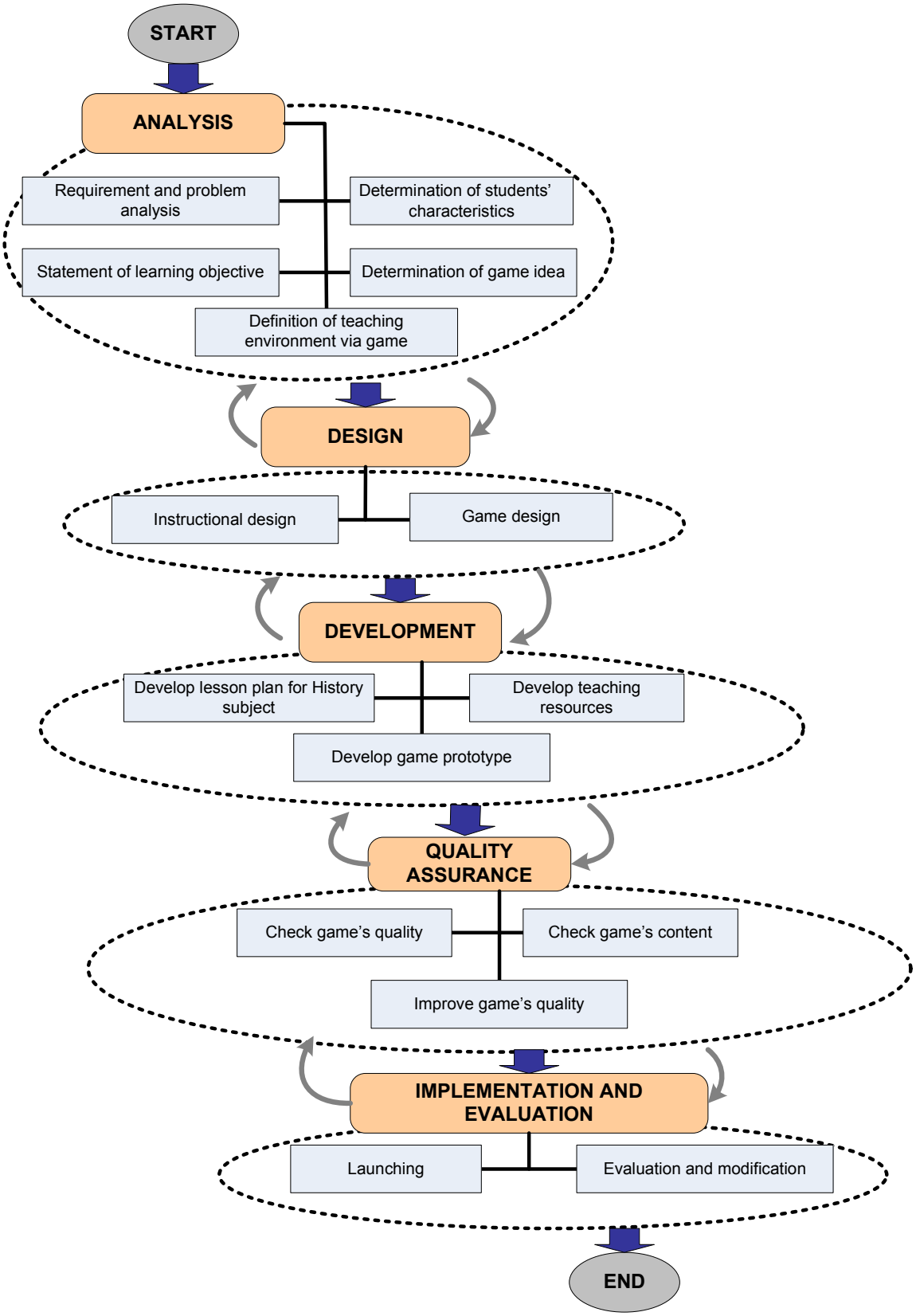

Fig. 2 Digital Game Based Learning-Instructional Design Model (DGBL-ID) for History educational games.

game, such as trap and the types of challenge. Game's technical specifications such as types of tools which need to be used are determined. As an example, hardware and software specifications need to be determined for computer platform to be used for the digitalgame-based courseware. At the same time, suitable programming language for the development is determined. The types of lesson plan and teaching resources which needs to be inserted in game menu must be provided before development of educational game prototype. Everything about the lesson plan such as learning outcomes, teaching syllabus and teaching plan need to be inserted in the educational game. Teaching resources such as historical photos of people, and buildings need to be collected before the development of educational game.

To develop the prototype (development phase), the types of game technology need to be determined. The history character can be modeled via modeling software such as 3D Studio Max or Maya.In this research, Virtools is selected for developing this 3D educational game. Game's level isthen developed, followed by the difficulty level. Player's data and score will be saved in database of the prototype. Player's role and situation also need to be determined for the prototype development.

During the quality assurance phase, the educational game prototype which is well developed will be tested. The prototype's quality will be checked before implementation. The prototype will be tested via play testing, alpha testing and beta testing. Alpha testing is to test whether the game can be played from the beginninguntil the end. Beta testing will test for errors such asgame's interactivity. For example, the game character can walk through the wall and texture mapping error for game character and game environment. This checking is a must to ensure the educational game prototype will not have error when the players play the game. In addition, game's features will be improved by solving the problems caused by the game's error. The game'scontent will also be checked to ensure compliance tolearning outcomes and learning contents based on the syllabus.

For theimplementation and evaluation phase, the prototype will be developed and tested completely. It will be launched in Compact Disc (CD) form. This educational game will be installed in school computer lab for evaluation. The effectiveness and usability ofPMIS prototype will be evaluated by target users-form four students who took History subject.

6 Conclusions

Educational games have become a huge research which enabled players to learn some knowledge while they play in an immersive game environment. Since students and teachers perceived history as a boring subject because it is difficult to memorize facts, we believe that history educational games can be used as an alternative to foster history learning in an entertained experience. Therefore, we propose a DGBL model for History educational game design and a developmentmethodology, DGBL-ID for History educational gameswhich blend the instructional design process and gamedevelopment process.

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