DEVELOPMENT OF A DIGITAL SNAKE AND LADDER GAME AS A STRATEGIC INTERVENTION MATERIAL FOR BASIC EDUCATION

JASTEN KENETH D. TRECEÑE*,
MICHAEL B. BATAN, ALJON L. ABINES

Eastern Visayas State University – Tanauan Campus
Tanauan, Leyte, Philippines
*Corresponding Author: jastenkenneth.trecene@evsu.edu.ph

Abstract

Digital game-based learning (DGBL) applications enable learners to learn and play. The usage of DGBL as a learning tool might also motivate users to expand their understanding of learning. The goal of this study was to design and develop a digital game-based learning application called E-Snake and Ladder Game that can be used as a strategic intervention material for teaching various subjects. It is a digitized snake and ladder game where subjects and quizzes were incorporated to achieve the goal of the study. The game was evaluated by 20 teachers and 80 students using the MEEGA+ model, the game evaluation has proven to be satisfactory to the players and it is easy to learn and play while promoting fun and relaxing gameplay and providing educational value.

Keywords: ADDIE model, Digital game-based learning, Educational games, MEEGA+ model, Snake and ladder.

1. Introduction

The Department of Education (DepEd) established the use of Strategic Intervention Materials (SIM) in basic education as a sort of remediation to enhance the academic performance of low-performing learners [1]. Various training workshop was conducted by the Department that paved the way for teachers to develop and use SIM in classrooms in which the individual need of the students was addressed by the use of instructions and interventions. SIM focuses on the skills or competencies that are not mastered by the students during the regular classes [2]. It is an understandable educational tool that can be used by a student alone or by a group of students in cooperative learning [3]. The usefulness and effectiveness of SIM has already been proven by various studies [1, 2, 4-6]. An intervention material should be fun and exciting which may contain puzzles, vivid illustrations, concept maps, or educational games to motivate and stir up the attention and interest of the students [7].

Educational games can be used as a choice of learning media [8]. Students learn to play and study through educational games. Additionally, using educational games as teaching tools helps spark students' interest in the lessons they are learning as they play. Learning and playing activities are combined in educational games. Like all humans, children enjoy learning when it isn't imposed upon them [9]. When people are intrinsically motivated to learn, they don't just learn more, they also have more positive experiences [10]. According to Paras [11], while the game environment has a lot of potential to be involved in the process of acquiring this knowledge or skill, learners must be engaged. The use of educational games as learning medium can also stimulate users to discover and improve their knowledge of learning, as can be inferred from these assertions. Educational games have the capacity to motivate students and also deliver positive experiences.

Learning through playing is one of the common pedagogical strategies used in education. Nowadays, the advent of information and communications technology paved the way to improve the quality of education. There are many opportunities to create inventive learning solutions because of increasing technologies including digital games, IoT, augmented worlds, cloud computing, among others. Digital technologies are used to develop a playing-based learning approach that relies on the fundamental pedagogical development of children. In a competitive activity known as digital game-based learning (DGBL), students set academic objectives designed to encourage knowledge acquisition. The games may either be made to encourage learning or the growth of cognitive skills, or else they may be forms of simulations that let students hone their skills in a digital setting. Several authors have come up with definitions of DGBL. For Mayer and Johnson [12], for instance, in order for a DGBL environment to be effective, it must have the following elements: (1) rules and restrictions, (2) dynamic responses to the learners' activities, (3) suitable challenges that foster a sense of self-efficacy, and (4) incremental, learning outcome-focused increases in difficulty. DGBL is commonly an instructional strategy that can be incorporated through computer-based applications [13]. It is intended to strike a balance between educational material and online gaming, as well as between the learner's or player's capacity to comprehend, remember, and apply the material to the outside world.

This study attempted to develop a digital game-based learning application called, E-Snake and Ladder Game that can be used as SIM for teachers in basic

education. It is a computerized snake and ladder game similar to the traditional one. It comprises an admin module with the required log-in process, and a database of least learned skills which are based on the results of the teacher's evaluation of the students/game players' learning abilities. The admin user will choose the specific subject and the topic, and the admin user will input the questions based on the chosen topic. These questions will be displayed randomly and in an audio-visual presentation to provide interactions among game players. The game players will choose the available subject for them. An avatar will be used to signify each game player's identity, and all of them are placed in the starting tile where all scores are zero. The players will roll the dice and a series of questions will appear based on the tile where the player was placed. If the answer to the question of the game player is correct, he will move to the tile concerning the result of rolling the die, otherwise, the game player will remain. A score is recorded if the question was answered correctly. The process is repeated with the other players until a specific player reached the last tile.

Snake and ladder have been developed into digital games by many, from simple that based on traditional snake and ladder [14-16], to the use to improve one's knowledge such as on COVID-19 health protocols and solving fractions in Algebra [17, 18]. The traditional snake and ladder board game has been also used effectively in instruction such as teaching vocabulary [19, 20], used to enhance the speaking skills of students [21], used as a promotion of clean and healthy lifestyle [22], and oral hygiene [23]. However, few studies and developments were made on snake and ladder games as digital game-based learning and can be used as an aid in the teaching and learning process. Previous studies [17-23] focused mainly on one specific topic with the use of snake and ladder games for instruction. Thus, the development of a digital snake and ladder game that can be used as strategic intervention material for all subjects and topics is essential.

This study aimed to develop a computerized snake and ladder game using the ADDIE model that will be used by teachers both from elementary and secondary levels as an aid to improve the learning of the students. The game was also evaluated by teachers and students based on the MEEGA+ model for digital games.

2. Development of the E-Snake and Ladder Game using the ADDIE Model

The approach utilized in the study was the Instructional Systems Designs (ISD), it is a structured process in the education and training programs that will help improve someone's performance [24]. It involves five stages, analysis, design, development, implementation, and evaluation (ADDIE). The ADDIE model was developed in 1975 and has been already in use since the early 1950s [24]. Following the model, the product of each working phase was subjected to formative evaluation and revision. The model is presented in Fig. 1.
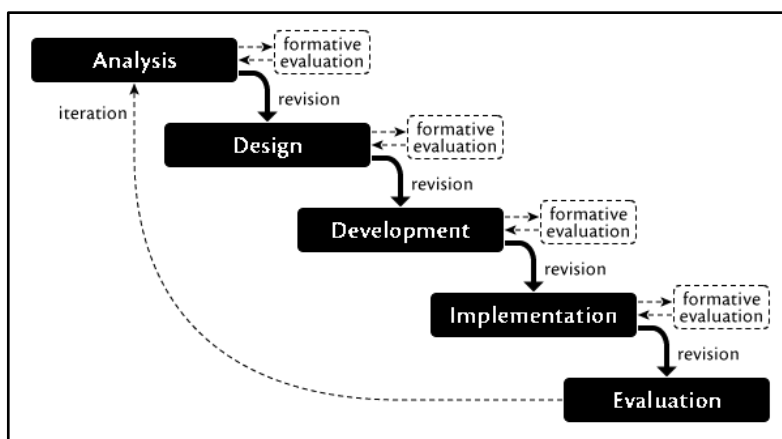
Fig. 1. ADDIE Model.

2.1. Analysis

In the analysis phase, the researchers focused on the target audience of the project, sometimes it is called the goal-setting stage. Also, this is where the presentation adapts to the knowledge and ability of each audience. In this stage, the researchers analysed the system based on its characteristics, importance, and limitations, and formulate teachers' needs for the application. An initial interview was conducted with both elementary and high school teachers who work in the Department of Education (DepEd) in the Province of Leyte. The results indicated that these teachers are already using intervention materials in their classrooms as an aid for the teaching-learning process to improve the performance of the students. These teachers are using traditional materials such as cardboard, coloured papers, manila papers, etc. Given the advancement of technology nowadays, the use of information technology (IT) in the classroom can form a crucial part of their teaching strategies [25]. Teachers may use various technologies from online sources, software programs, or applications to help students engage with and improve their learning of concepts across the curriculum. Furthermore, the utilization of information technology in the classroom may help boost students' engagement, and evidence suggests that the use of IT enables richer, more engaging learning environments [26]. According to Schindler et al. [27], the use of IT in the classroom, especially on digital games, influences students' behavioural, emotional and cognitive engagement.

In this study, the teachers said that they are interested in using digitized intervention materials as it will encourage the students more to participate in the classroom. Commonly, intervention materials utilized by these teachers are through games, such as the use of traditional board games, e.g., bingo, monopoly, snake and ladder, and improvised board games. Based on the interview conducted, it was also found that the topics being covered in the intervention materials are based on the least learned skills or competencies of the students. The numerous learning competencies for each learning area that the teachers assessed as having not yet attained full competency as a consequence of the evaluations undertaken are referred to as the "least learned skills" [28]. This will serve as a basis for planning, projection, and adjustment for any programs, projects, and activities in every

learning area. Consequently, all agreed that they need an innovation using a digital snake and ladder game that is flexible to all subjects taught by the teachers that can be used as an intervention material in their teaching.

2.2. Design

The next step in the ADDIE model is the design phase, it is where the researchers think of creating digital game-based learning called E-Snake and Ladder games to fill the gaps. In this stage, the learning objectives are determined, the content of the game was outlined, the script of the game was also developed, and the user interface and the environment were carefully planned [24, 29]. In this stage, wireframes were also created. It is a two-dimensional sketch that serves as a visual guide to the developer and is also used to illustrate how the application will work. Figure 2 shows the sample wireframes of the E-Snake and Ladder games.
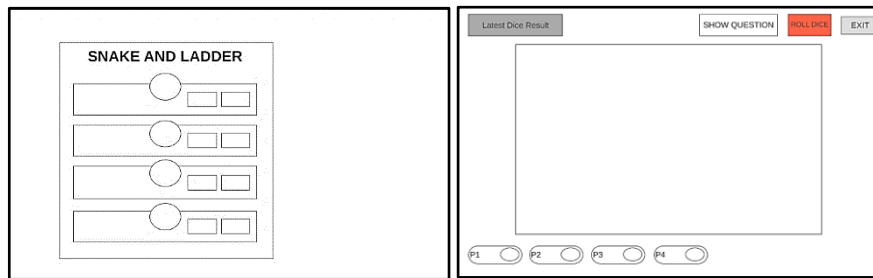

Fig. 2. Sample wireframes of the E-Snake and Ladder games, the left side is the start screen and the right side is the game screen.

2.3. Development

After the design phase is the development step, it is where the researchers developed the game based on the design and the storyboard from the previous step [24, 29]. In this study, the app development was computer-based, with the name E-Snake and Ladder. It was developed using Hypertext Pre-processor (PHP) programming language, CSS, and JavaScript and was embedded in HTML. E-Snake and Ladder game is a 2D board game that can be played on computers. When the game is loaded it begins with a list of the registered players. Players can be registered by the teacher or the admin function. It is composed of buttons for changing the name and avatar of the player, and the button to remove the player. It also includes the admin button and the start game button. The start screen is presented in Fig. 3(a).

The admin button leads to the admin page where several functions are available. It is composed of functions of adding a new category, categories are subjects that might be used in the game to supplement the instruction. Other functions are choosing the category for the game-play, managing questions and answers, and the exit button. Before starting the game, the teacher should choose the category of the subject to be played by the students. The questions that will appear during the game-play are based on the category selected by the teacher. The admin page is presented in Fig. 3(b).

(a) Start screen.	**(b) Admin page.**

Fig. 3. Start screen and admin page of the snake and ladder game.

The start game button will direct the player to the main board game page, on the board game, each user can choose the avatar of their character. When the player clicks on the roll dice button, the dice will roll, then each character moves on the board based on the result of rolling the dice. However, before the player can move to the desired tile on the board, a question will appear for the player to answer, if the player answers the questions correctly, the player will move to the tile. The number on the dice determines the number of steps the character moves. If the character lands at the feet of the ladder, the character will climb on the ladder and will stay on the tile where the ladder is placed. If the player landed on the mouth of the snake, the character will go down where the tail of the snake is placed. The dice results and the questions are stored. The board game is presented in Fig. 4.

Fig. 4. Snake and ladder board game.

2.4. Implementation

The implementation phase contains testing the actual digital game for the intended users [24, 30, 31]. In this study, a procedure for the training of the game for the teachers for both elementary school and secondary school was done. The training includes an orientation on the primary goals of the digital game and the actual playing of the game. Ten (10) elementary and 10 secondary teachers agreed to participate in the said study. These teachers come from different public schools from different grade levels and are handling advisory classes. The actual playing of the game with the students was facilitated by the teachers. A survey design was carried out to evaluate the game. For the playing time, the game may only run between 45 – 1 hour on average. In each class, the teacher picked 4 students to play the game, these students are those with the lower scores on the identified least learned competency. After the game, the students and the teacher were given survey questionnaires to rate the game based on their experience. In total, 80 students were considered participants in the study.

Before the data collection, a letter was sent to the School Principals of each school to seek approval. The study permission was also obtained from the parents of the students. The researcher also asked permission from the ICT coordinator of the schools to use the computer laboratory for the actual playing of the game. Upon approval, the participants were asked to sign an informed consent as they agreed to participate in the study.

2.5. Evaluation

Both at the start and the end of the process, the evaluation phase is crucial. Many of the discoveries made throughout the analysis process are reflected in the evaluation objectives. In this stage, a survey was administered to evaluate the digital game based on some characteristics. To evaluate the game, a survey questionnaire was distributed to teachers in elementary and secondary schools. Ten (10) elementary and 10 secondary school teachers were purposively selected to evaluate the digital game. Moreover, 80 students also evaluated the said game. The evaluation started by orienting the teachers on the main purpose of the E-Snake and Ladder game, how to use the game as teachers, including the other game features, and after, the students and teachers were given the time to play the game. Afterward, a survey questionnaire was distributed to evaluate the game, based on MEEGA+ [32], a tool for assessing the usability and player experience of educational games. The MEEGA+ model is divided into two parts, usability and the player experience. Usability includes evaluation on its aesthetics, the learnability of the game, operability, and accessibility. While player experience involves assessment on the game's user error protection, focused attention, fun, challenge, social interaction, confidence, relevance, satisfaction, and its perceived learning.

For the game ratings, this study used the 5-point Likert scale, where questions were responded to in a set of scores. The mean scores of each dimension were verbally interpreted as Very Satisfied to Very Dissatisfied. The gathered data were tabulated, and the mean score was used to determine the evaluation score of the digital game as shown in Table 1.

Based on the results of the evaluation from the 100 respondents, the digital game performed well in all the dimensions of the survey instrument. It gained an overall

mean score of 4.32 which is interpreted as satisfied. For the usability factor of the digital game, learnability garnered the highest mean score of 4.8 interpreted as very satisfied. According to Straker [33], when developing a game, players should learn the game to enjoy and continue playing, otherwise, they will abandon it. In this study, the students were able to accomplish the tasks the first time they encounter the interface and how the game works. According to Gunesekera et al. [34], the very satisfactory learnability of a game contributes to usability.

Moreover, in the player experience, relevance to the goals of the game gained the highest mean score of 4.9, also interpreted as very satisfied. A clear and concise goal of a game is important as it adds the purpose and measures the quality of the play [35]. According to Schaul [36], the goals should be well structured, clear, and concise as will provide a sustained meaning to the game. Furthermore, it will also help motivate players to achieve their goals. Weitze [37] said that the goal should not be easy to achieve without building the skills necessary to achieve the goal. For instance, in this study, the students need to answer the question first before moving to tiles.

Table 1. The evaluation result of the Snake and Ladder Game based on the MEEGA+ model.

Factor	Dimensions	Mean Score	Interpretation
Usability	Aesthetics	4.2	Satisfied
	Learnability	4.8	Very Satisfied
	Operability	4.1	Satisfied
	Accessibility	3.5	Satisfied
Player Experience	User error protection	4.3	Satisfied
	Focused Attention	4.3	Satisfied
	Fun	4.5	Very Satisfied
	Challenge	4.7	Very Satisfied
	Social Interaction	4.6	Very Satisfied
	Confidence	4.0	Satisfied
	Relevance	4.9	Very Satisfied
	Satisfaction	4.0	Satisfied
	Perceived Learning	4.5	Very Satisfied
Overall Mean Score		**4.34**	**Satisfied**

3. Conclusions

In this study, a digital game-based learning application called E-Snake and Ladder Game was developed using the ADDIE model and was evaluated using the MEEGA+ model. Based on the results. the respondents are satisfied with all of the dimensions presented. More importantly, the results have proven that the game is easy for the players to learn and play, it lets the players enjoy and relax while playing, it gives the player a challenge based on their competence, and it promotes the feeling of a shared environment, the educational content of the game is consistent, and it provides learnings as perceived by the players.

For future works, a varied gameplay mode with the integration of a suitable algorithm may be developed, provide a database of scores and an analysis of scores, and conduct action research to test if a significant change of learning is achieved using the E-Snake and Ladder game as an intervention material for teaching.

Abbreviations	
DepEd	Department of Education
DGBL	Digital Game-Based Learning
IT	Information Technology
SIM	Strategic Intervention Material

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