Gamification Design for Teaching Numeracy to Slow Learners

Nur Rahmah Zulkifli, Nor Azan Mat Zin, Rosadah Abd Majid

Abstract: ***Slow learners in school are students who have difficulty in learning due of their limited cognitive abilities. Most of these students have difficulty in literacy and numeracy. There is an existing debate on how to motivate them to learn and become literate. This paper discusses the use of gamification approach in the development of an application for delivering numeracy content to slow learners in primary schools to motivate them to learn numeracy and improve their numeracy understanding in a fun and enjoyable manner. The NUMERATica application is designed using digital game-based learning instructional design (DGBL-ID) method. The development starts with requirements gathering from users and stakeholders, followed by interface and content design, development, and evaluation of the prototype. The application consists of three modules; learning, play and exercise module. Gamification is applied in each module to increase user motivation and engagement. This application can help motivate learning and promote understanding of numeracy for slow learners and gamification approach may help students with special needs and thus can help decrease the number of students in remedial classes.***

Keywords: Gamification, Games, Numeracy, Primary school , Remedial students, Slow learner

I. INTRODUCTION

Slow learners are students who have intelligence quotient (IQ) between 70 and 84 but do not have any behavioural problems [1]. However, some other researchers stated that the intelligence measure for slow learners ranged between 71 and 89, or 76 and 89, and 70 and 90 [2]. As an example, Novitasari et al. (2018) suggested that the range should be from 71 to 89. Therefore, people with IQ between 70 to 90 can be classified as slow learners Students who fall within this range are normal students; however, because their thinking process is somewhat slow [3], they need special learning approach to exploit their abilities [4]. In Malaysia, normal students with mild and slow learning abilities but do not show any medical problems are typically placed in remedial classes [4]. These primary school students are identified and classified after the Literacy, and Numeracy Screening (LINUS) has been conducted. Such students tend to have problem to understand numeracy and have low motivation.

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For slow learners, the visual application is more recognizable than audio [5]. Furthermore, Felani et al. (2015) proposed visual interactive learning using information communication technology (ICT) as an important element in a conducive learning framework for slow learners [5]. Hence, studies should be conducted to explore the advantages of ICT to help slow learners learn. A comprehensive research underpinned by theory on pedagogy is required to increase the effectiveness and decrease possible disadvantages of any ICT-based applications develop for learning intervention [6]. To fill any existing gap in the literature, the research should provide some modules that explore the method to be used by slow learners based on their ability [7].

II. MULTIMEDIA TECHNOLOGY FOR SPECIAL NEEDS

In the world of ICT, various applications and systems have been developed to cope with user needs. One of the fields that widely applies ICT is education. The use of ICT in education has grown from the era of electronic learning until the use of games. A study by [8] discovered the advantages of ICT in improving motivation and understanding of mathematics. The National Council of Teachers of Mathematics Report emphasized that technology has an impact on the process of teaching and learning of mathematics [9]. The interactivity in ICT has changed the way of learning. Interactivity is one element of multimedia technology, a subset of ICT. Multimedia application has transformed the process of learning, working, and interaction[10].

The application that uses multimedia technology can provide knowledge and information in various entertaining ways using the element of multimedia interactivity, depending on the learning objectives for different levels [10]. A study by [11] found that multimedia technology increased the learning of mathematics for students with low visual difficulty. Multimedia has been applied in many applications from courseware to games development. Games applications use the elements of text, audio, video, animation, graphics, and interactivity from multimedia elements.

III. GAMES APPROACH

In the era of ICT, the new generation of population is more intent on the use of games application [12]. Player, environment, rule, challenge, interaction, goal, emotional experience, quantifiable outcome, and negotiable consequences are the main features that define the games [13]

Previous research by [14] as cited by [15] stated that about 55% of young boys regularly played games while only 29% of girls played games. The research further found that most of the children played games at least once.

The findings suggest that games could be used in education because they can engage users. Games can engage users [16] since:

- Games are a form of fun that gives players enjoyment and pleasure. Games are a form of play that gives players intense and passionate involvement.
- Games have rules that gives structure.
- Games have goals that gives players motivation.
- Games are interactive that gives players some activities to do.
- Games have outcomes and feedback that provide players with learning. Games are adaptive that gives players 'flow'.
- Games have win states that gives players ego gratification. Games have conflict/competition/challenge/opposition. That gives players adrenaline.
- Games have problem-solving that sparks player creativity. Games have interaction that gives players social groups.
- Games have representation and story that gives players emotion.

A game application is capable of making the process of learning efficient and enjoyable for children because of the elements of multimedia and interactivity [17]. At the same time, games can also offer motivation, creativity, emotion, and ego gratification [16]. Studies showed that game play could initiate the skills of thinking, planning, communication, number application, negotiation, decision making, and data management in learning [18], further promoting many studies on games in learning. Serious games, game-based learning, and gamification are the approach of games that have been studied in education. Serious game is a concept of applying the context of game in a certain field for training and education [19]. On the other hand, game-based learning is an interactive games application that outlines the learning outcomes [20]. While gamification is the use of game elements in non-games applications.

IV. GAMIFICATION APPROACH

The word 'gamification' was initiated in 2008 and was popularized in 2010 by the digital media industry [21]. Gamification involves applying the game elements in a non-game based application or object [13] [21][22]. Gamification is defined as a process that uses the elements of games with a gameless object to produce a gameful object, as shown in Figure 1. The idea of gamification is to use the elements of games in different contexts and not to design the games application itself [23].

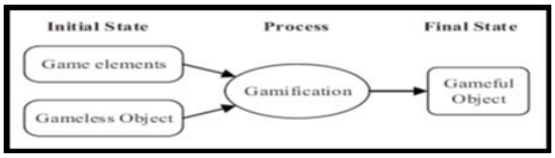

Fig. 1 Definition of gamification (Yohannis et.al, 2014)

Gamification is widely used in many fields; however, it is mostly applied in the education field [24]. It has the potential as a teaching tool or teaching aid for teachers [25][26][27]. A study by Martí-parreño et al. (2016) showed that teachers are willing to apply gamification in their future courses [28]. Engagement, excitement, and motivation have increased from the use of gamification in the education environment [24][27]. The elements of games in gamification can engage unmotivated students with the application in the learning process [22]. These elements include rewards, competition, and altruism to fulfil thehuman desire in a virtual environment based on human needs in the real environment [23]. Gamification enhances user's intrinsic and extrinsic motivation [29], which can trigger user to engage with the gamified application as the user continues to achieve the goal and obtain the rewards. Intrinsic motivation is the action towards the gamified application despite the elements offered by the application while extrinsic motivation is the action towards gamified application based on the elements offered by the application [29]. The reported benefits motivated this research of NUMERATica with gamification approach for slow learners, to increase their understanding and motivation in numeracy.

V. RESEARCH OBJECTIVES AND SCOPE

Numeratica is developed as a teaching aid with gamification approach for remedial students so that they can learn basic numbers and to motivate them to learn the subject by themselves. Studies have shown that positive feedback on student autonomy increases student motivation [30]. The objective of this study is to design and develop an application, NUMERATica with gamification approach for Remedial Students. The target users of this application are remedial students in primary schools. The content of this application is developed in the Malay language, and is based on the syllabus for remedial students issued by the Ministry of Education. The topic focused on numeracy and basic numbers. This paper presents the design of the application.

VI. RESEARCH METHODOLOGY

The methodology used to develop the application is the digital game-based learning instructional design (DGBL-ID) model. This model has five phases; analysis, design, development, quality assurance, implementation, and evaluation phases [17]. Every phase consists of sub-phases to be accomplished. Table 1 shows the mapping of objective and expected results to be achieved from the phases and activities following the (DGBL-ID) methodology.

Table. 1 Phase, Activities, Results and Objective result

No	Phase	Activities	Results	Objective
1.	Analysis	• Requirement and problem analysis • Determination of student characteristics • Statement of learning objective • Determination of game idea • Definition of teaching environment via the game	-User requirements	To identify the requirement of NUMERATica for remedial student
2.	Design	• Instructional design • Game design	-Model of numeracy for slow learner -Storyboard -Navigation flow -Interface and games design	To design NUMERATica for remedial student
3.	Development	• Develop a lesson plan for Numeracy subject • Develop teaching resources • Develop game prototype	-NUMERATica prototype	To develop NUMERATica for remedial student
4.	Quality Assurance	• Check game quality • Check game content • Improve game quality	Testing result and prototype improvement	To test and evaluate NUMERATica for remedial student
5.	Implementation and Evaluation	• Launching • Evaluation and modification	Usability Testingresult for NUMERATica application	

VII. DESIGN AND DEVELOPMENT

The process of designing the NUMERATica application starts after the process of analysis in the digital game-based learning instructional design (DGBL-ID) methodology. The process of design is divided into instructional design and games design. In instructional design, the process involves identifying the suitable theory to determine the user guidelines in learning and the content for remedial students. On the other hand, the game's design involves the process of determining the elements of the game for children, the elements of motivation for remedial students, and the navigation flow of the application, as shown in Figure 2. There are three modules in the navigation flow as shown in Figure 2 - the learning module, the play module, and the exercise module. The modules are developed based on the activities applied in the syllabus for remedial classes as issued by the Ministry of Education.

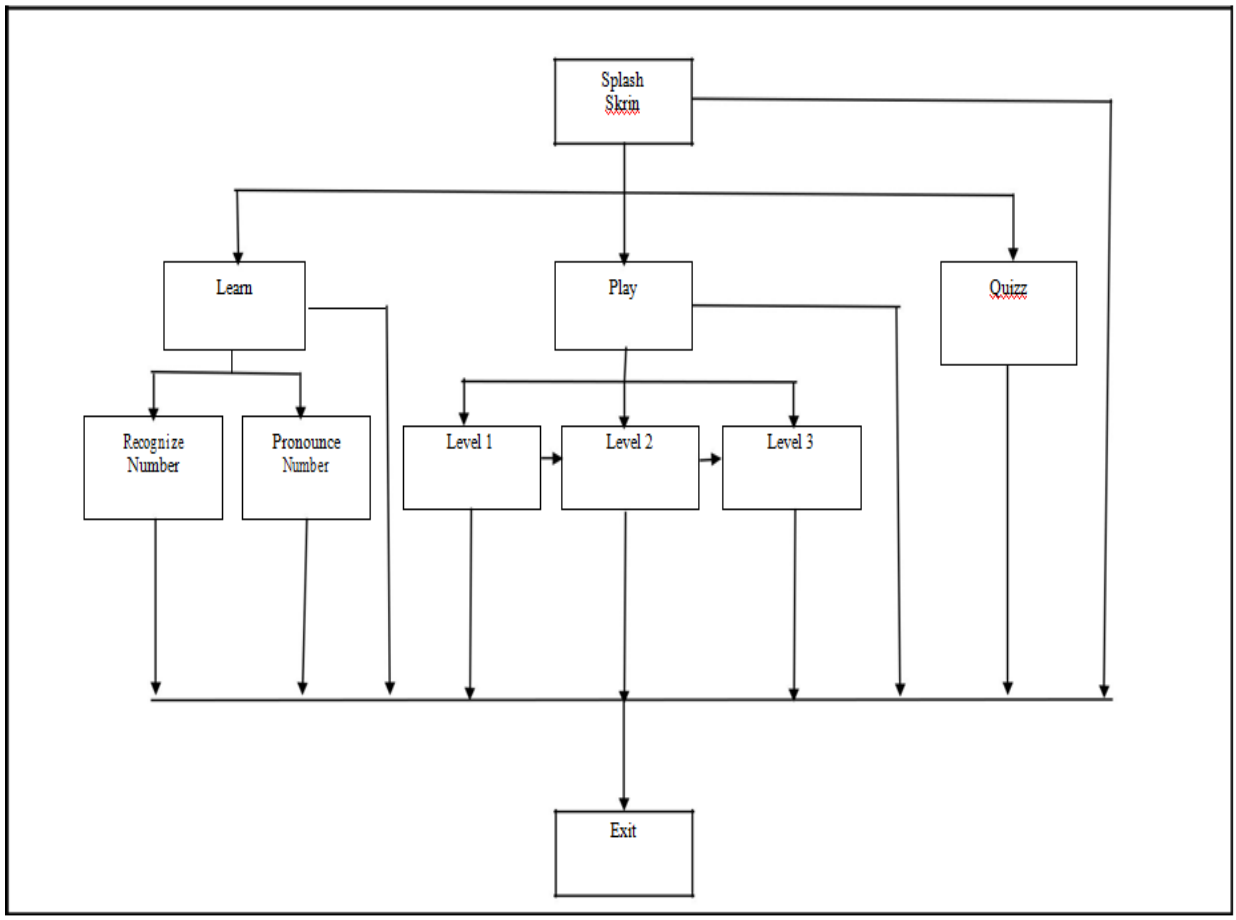

Fig. 2 Navigation Flow

The learning Module

This module consists of two modules; 'Recognize Number (Kenal Nombor)' and 'Pronounce Number (Sebut Nombor)' as in Figure 3. 'Recognize Number' module shows the user how to write down a number. The 'Pronounce Number' module introduces to the user how to pronounce the number. Each number has an image and is accompanied by an audio that can be clicked repeatedly, as shown in Figure 4. A study showed that repetition helped slow learners in learning [31]. The module introduces to the students basic numbers using multimedia elements and interactivity.

The play module

This module contains activities with games or gamification elements. The student will use the module to revise what they had learned in the learning module. As shown Figure 5, Levels, progress tracking and rewards are the elements of games as applied in this module design.

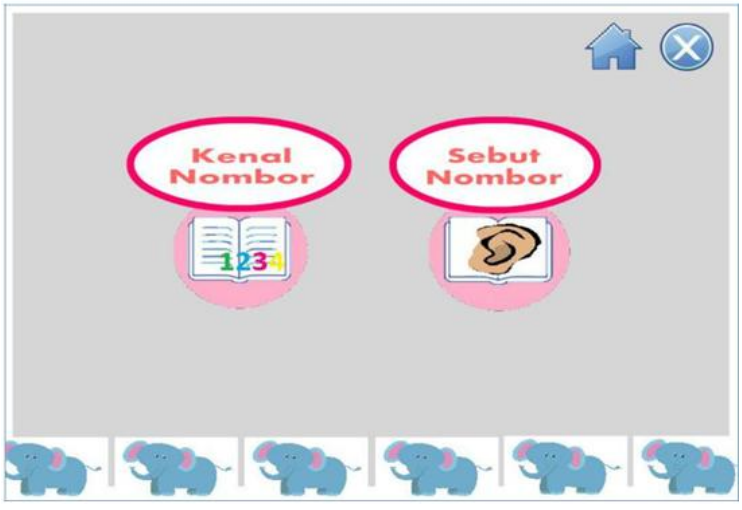

Fig. 3 Learning Module Interface

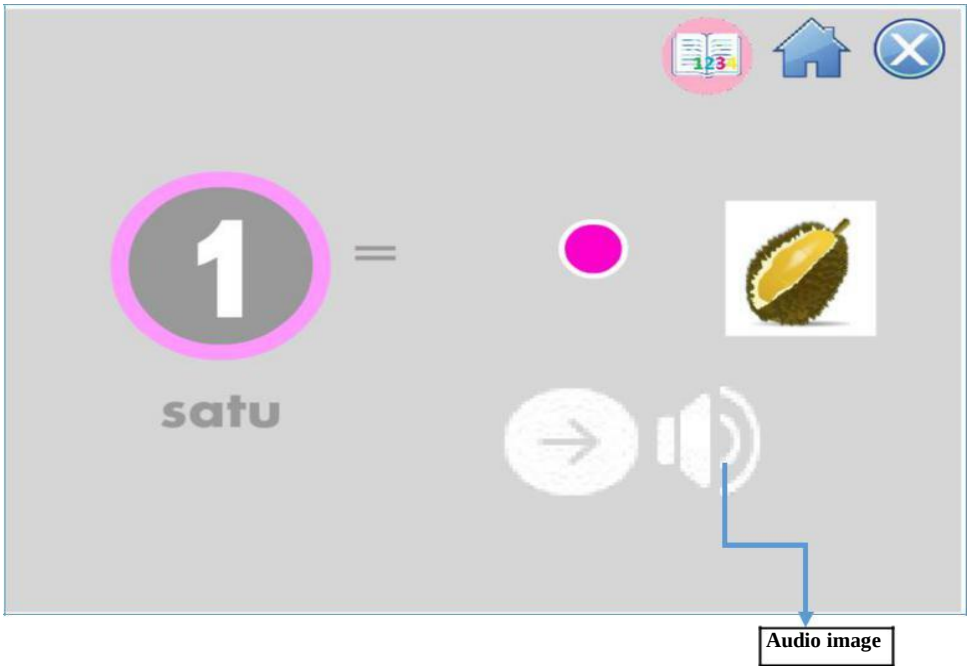

Fig. 4 Audio image can be clicked repeatedly to listen to the pronunciation

The quizz module

This module tests what the students had learned. There are ten multiple-choice questions on basic numbers. The student has to choose the right answer to move on to the next question. Progress tracking will be used to show the student's accomplishment, to motivate him or her, as shown in Figure 6.

Fig. 5 Levels in Play Module Interface

Fig. 6 Quizz Module Interface

VIII. CONCLUSION AND DISCUSSION

In this paper, we presented gamification approach applied to NUMERATica application design, to provide new way of learning for students in remedial class. The instructional and game design was carried out in the design phase of digital game-based learning instructional design (DGBL-ID) model. Suitable elements were determined during analysis phase, based on student characteristics, requirements and problem analysis, learning objective and games idea. For future works, the interface will be evaluated by experts in multimedia usability field. The result will be used to improve the application before the final process of usability evaluation is carried out.

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