Low-fidelity Prototype Design for Serious Game for Slow-reading Students

Saffa Raihan Zainal Abidin[1], Siti Fadzilah Mat Noor[2], Noraidah Sahari Ashaari[3]
Faculty of Information Science & Technology, Universiti Kebangsaan Malaysia, Bangi, Malaysia

***Abstract*—Serious game is an alternative teaching aid that is getting a place of use by teachers and parents. Its widespread use has basically changed the way of life and learning of children and has a positive impact on achievement and increased the motivation of children in learning. However, not all serious game designs are suitable for slow-reading students. They are slightly different from other students in terms of cognitive potential and are struggling to meet academic demands in the class. Therefore, the main objective of this study is to produce low-fidelity prototypes involving target users as early as the design process. This study focuses on the production of storyboard contents suitable for slow-reading students to save time and cost of game model development. This study uses a child-centered design (CCD) method that involves paper prototypes, chauffeured prototype, think aloud protocols and observations. The results of this study are low-fidelity prototypes in the form of computerized storyboards that have been verified and will be used for heuristic assessments. These low-fidelity prototypes are expected to give an early look and help researchers in developing high-fidelity prototypes.**

Keywords*—Serious game; brain-based learning; low-fidelity prototype; paper prototype; chauffeured prototype; think aloud protocol; slow-reading students

I. Introduction

Serious game has grown rapidly over the last decade into becoming a popular and successful new technology in the 21st century. According to [1] and [2], serious game is built with a specific purpose besides just entertainment. The word 'serious' can be referred to as the role of the game in delivering inputs either in the form of education or training to players. Study [3] has shown the growing interest of the public in serious game review. The increasing number of research papers on serious games published in various fields from the late 1990s to 2013 showed a positive impact. Serious games have been used in various areas such as health, education, training, culture, defense and society [1].

Designs of a serious game vary according to target users. So, in designing a gameplay, it is very important to understand the needs of users [1]. Designing a serious game for children is a challenge as they are different from adults. Children see things from a different view [4]. According to [5], children should be involved in the design process because their expectations and meaningfulness of the product may not be the same as the designer's assumption since the worlds of children and adults are different. Hence, this study uses the child-centered design (CCD) method proposed by [6]. This method is a repetitive process and is the same as user-centered design (UCD), with the difference being that the end users of this study are children [6].

However, most serious games on the market are designed for children with normal learning abilities. Only a limited number of software is designed to meet the needs of students with learning problems [7]. According to [8], the design principles for developing child technology are different from adults because the desire, the readiness and the needs of these people differ. The focus of this study is on children who are left behind in reading literacy. Reading skills are the basic skills that everyone must master because without reading skills, children will not be able to face challenges in their lives. According to [9], students with poor reading literacy, better known as slow-reading students (SRS), are those who fail in examinations and must follow the remedial classes provided by the school.

Humans are generally never aware of the complicated process of language in the brain. Teachers need to step up their role and innovate to make teaching and learning (T&L) more fun and meaningful, especially for SRS [9]. Brain-based learning (BBL) approach in a serious game is an innovation that is proposed in this model. BBL is not a new approach; in fact, it has been used daily by teachers during T&L. According to [10], BBL focuses on the overall brain function which can have a positive impact on student achievement. Individual self-potential can be enhanced when the function of the brain is optimally utilized with the help of teachers and teaching aids in a way they are most comfortable. According to [11], using game techniques is an approach that is well-liked by the students as games become a routine in which they play not only in the classroom, but also in their free time.

II. Background Study

This section discusses backgrounds study related to the approach applied in this game model, which is brain-based learning (BBL), the technology used to help slow-reading students (SRS) which is serious game and low-fidelity prototypes covering paper prototypes, chauffeured prototype, think aloud protocols and observations.

A. Brain-Based Learning (BBL)

The approach or strategy used in game designs should be taken into account in designing the game model. Theoretical approaches and brain-based learning (BBL) strategies are applied in serious games. In the context of this study the BBL is defined as a technique that values the optimal function of the brain compared to the usual teaching method [12]. Optimal

This research was supported by the Universiti Kebangsaan Malaysia, Grant no. KRA-2018-025.

learning state integrating relaxed alertness, orchestrated immersion and active processing instructional techniques is the main feature of this approach [13]. BBL are seen as a technique that encourages the best way of learning and encouraging teachers to use this information when planning a teaching strategy to stimulate student motivation more effectively and to improve learning [13] [14].

Brain is the most important organ in supporting daily life. This BBL is based on the theory that learning is occur as long as human brain is not prevented from undergoing routine processes as opposed to traditional teaching. [12] [15]. According to [16], BBL can be seen as a technique used to improve teaching and learning (T&L) through the ability to learn to use the most comfortable ways they can. For the purposes of this study, students are required to i) be actively involved in all the seven brain compatible instructional phases listed below, [17], ii) have fun learning (serious games) and iii) Learn in their context and in related to existing knowledge. Seven brain compatible instructional phases are:

1) Activation: To stimulate the learning of a new concept, the existing knowledge of the student is activated. This is because prior knowledge always influences the teaching process by helping students to get rid of irrelevant things. Thus, the content developed should include the prior knowledge of SRS by involving their syllabus. This phase is where we activate student's memory processor system (prior knowledge) in order to stimulate their learning transfer process.

2) Clarify the outcomes that need to be achieved and the learning process involved: Teaching objectives as well as a comprehensive overview of new knowledge that students will learn will be shown. In this game model, players are introduced with learning objectives before players start a game session. This is to give an overview of the ideas taught to help students develop the desired understanding where students affirm for themselves their personal performance target, activate the right brain processor prior to the left brain, and alleviate anxieties over the accessibility and relevance of the material.

3) Making connection: Making connection and develop meaning is the stage where the topic or unit of work about to be completed is connected to what has been done before with what is yet to come. It builds on what the learners already know and understand. This process stimulates the student brain to make connections between newly learned and existing ideas. These three phases of teaching activities are thought to be able to create "Relaxed alertness" among students.

4) Carry out learning activities: This activity requires a thorough involvement by each student. Doing the learning activity is the stage for digesting, thinking about, reflecting on and making sense of experience utilizing visualization, auditory, kinesthetic in multiple contexts as well as to access all of the multiple intelligences. Here, students were encouraged to be in the state of "Orchestrated immersion", which immerses them in multisensory experiences.

5) Demonstrating student's understanding: Understanding demonstration activities provide opportunities for students to use their new knowledge or skills in new situations. This process gives students time to feel comfortable with the newly acquired concept and indirectly reinforces their conceptual understanding. This is the stage for brain-active processing. Through this game, it allows students to consolidate and internalize information effectively when they are actively engaged with the knowledge itself. Students can test their understanding and driving the transfer of information into the long-term memory of the students.

6) Review for students' retention: Evaluation and closing activities provide students with an opportunity to assess their understanding and stimulates working memory to summarize the lesson, which helps to strengthen the transfer process.

7) Preview the next topic: This activity is the experience that helps the brain pre-processor and the reptilian brain to focus on the new lesson and help improve the effectiveness of the learning process. This is important to prepare the brain for the new learning activities.

B. Serious Game and Slow-Reading Students

A serious game by definition [3] is an application with three main components: experience, entertainment and multimedia where serious game has a role to convey messages and inputs, knowledge, skills or general content to players. According to [18], serious game is designed interactively and has an educational goal of entertaining and creating an active learning environment available on any digital platform such as computers and smartphones. Its use is increasingly in various fields including in education. According to [19], a serious game is becoming increasingly popular not only as a game but as a convincing educational tool.

This study focuses on slow-reading students (SRS) where they are normal students but struggling to meet academic demands. They are slightly different from other students in terms of cognitive potential [9], understanding, thinking and they are not categorized as special needs students. According to [20], this computer-based learning technique can help slow learners learn to understand more easily in learning because of the use of multimedia elements and the ability to convey the same information but in different forms like sound, text, and images.

Serious game used because of the game potential that can have a positive impact on SRS. This SRS wants something fun while learning and at the same time lets them play [21]. This affects the emotions of the players, when they have fun in learning, memory space can be improved [22] [23] [24]. Past studies show that this serious game is capable of making learning more effective [25] [26] [27] and improving performance in learning [26] [28] [29] [30] [31]. While from the aspect of student psychology, serious games can increase motivation and students give more respond [25], [27], [29] [30] [31] [32] [33] [34] [35].

C. Low-Fidelity Prototype

In [36], author states that a prototype resembling an application developed on a real device is known as fidelity. The prototype used to rate applications can be simple as sketches on paper as well as complex fully interactive models on developed application devices. In [37], author refers prototype as low-fidelity and high-fidelity.

In [37], author states that normally a low-fidelity prototypes are made with paper, glue, cardboard and pen. Low-fidelity prototypes are very useful in the early stages of the design process for gathering needs and analysis. This prototype is useful in providing alternative design that can be produced quickly and valued [36] [38]. This prototype can also avoid misconceptions of communication between stakeholders in the early stages. Low-fidelity prototype is easy to recover and can sometimes be changed during the evaluation phase [36].

The purpose of this study is to get feedback in terms of the content and basic features of the software suitable for SRS. For paper-based sketches, storyboards have been created. This storyboard is then computerized using software like Photoshop and Microsoft Power Point. However, to understand the user's expectations and impressions, the chauffeured prototype, think aloud protocol and observation were used to get the feedback and improved storyboard.

III. Research Methodology

Users are involved as early in the game design process. Triangulation methods containing three research methods are used. Paper prototypes for producing storyboards are used and chauffeured prototype and think Aloud protocols (TAP) are carried out with observation. All tests are conducted at a school that runs the LINUS and remedial program. The results of the analysis are analyzed to produce storyboards that have been verified by users. This storyboard is used as a guide by researchers to conduct heuristic assessments before developing a high fidelity prototype.

The purpose of this study is to produce low-fidelity prototypes for serious games that have been verified. The researcher gets an approval by the school management first because it involves teachers and students as respondents. The study was conducted for two days. The first day involves only teachers who run paper prototypes while the second day involves teachers and students who run the chauffeured prototype, TAP and observation. The methodology of this study was developed as shown in Fig. 1.

The study participants consisted of teachers and slow-reading students (SRS) from a school running the LINUS and remedial program. Table I shows the number of teachers and students involved in low-fidelity prototypes. On the first day the prototyping test was carried out involved five teachers as respondents. The second day involved five respondents consisting of 3 teachers and 2 SRS.

This study involves three phase:

A. Phase 1: Design the Storyboard

Paper Prototype; According to [39], one of the fastest prototyping methods is to use paper. This prototype is cheap and fast designed to illustrate models, ideas or features. This prototype is used in the early phase of the design because users can view the product description without having to use the code. Changes can also be made quickly and the results will continue to be seen. Three processes are involved in paper prototype.

The first process, the researchers sketches the storyboard using pen and paper. The initial sketch idea is obtained from literature studies and preliminary studies conducted earlier. The initial sketch proposed by the researcher is shown to the teacher. Five teachers were involved in this test and they briefed on the purpose of this test is to produce storyboards. Teachers then sketch their ideas on storyboards.

The second processes, all the sketches from teachers are collected and the assessments are done by researcher. The researcher justified the storyboard by teachers and decides which one to use after the discussion.

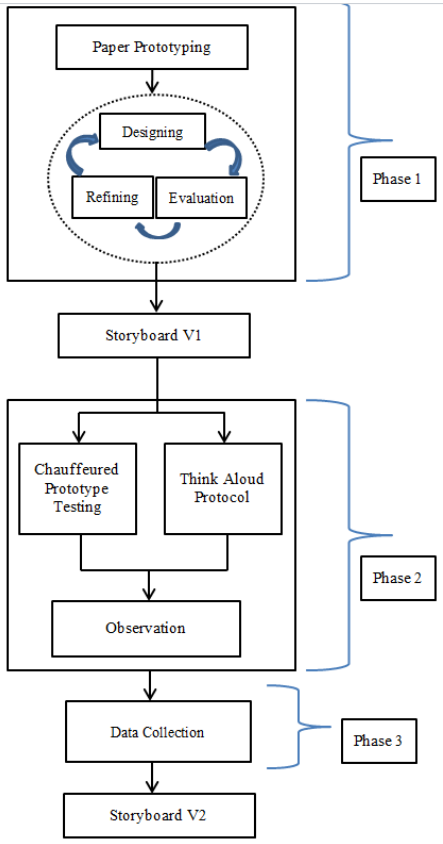

Fig. 1. Low-Fidelity Prototype Methodology.

TABLE I. Numbers of Teachers and Students

SK Bebuloh, W.P Labuan		
Techniques	**No. of Teachers**	**No. of Students**
Paper Prototype	5	-
Chauffeured Prototype	3 (Respondent 1, 2, 3)	2 (Respondent 4 and 5)
Think Aloud Protocol	3	-
Observation	3	2

The third process, the purification of the design in which the researcher improves the storyboard as required by the teacher. This process repeats until the teacher is satisfied with storyboard. In this study, two repetitions of paper prototypes were repeated by each teacher to get storyboard version 1.

B. Phase 2: Test and Improve Storyboards

Results from phase 1, which are storyboards, have been computerized using computer software Power Point and Photoshop with several functions that can be used. In this phase, chauffeured prototype, TAP and Observations are used to test and improve the storyboards.

1) Chauffeured prototype: According to [40], the chauffeured prototype is similar to the Wizard of Oz technique. The advantages of the chauffeured prototype are not all parts need to be together but interactivity can still be tested. Researchers directly can create the parts in storyboard based on user requirements. [39] the main difference between both techniques is for the chauffeured test, the user knows that the tested system is not a real and incomplete system. Users are aware of the existence of chauffeured where researchers or people who are aware of the prototype play a role as a driver or chauffeured. If a user tries a function that does not exist, chauffeured can add the function by drawing a new part directly in the prototype.

2) Think Aloud Protocol (TAP): Simultaneously with the chauffeured prototype, the Think Aloud protocol (TAP) technique is used. Basically, TAP is a technique that requires users to express their thoughts when doing tasks or solving problems. According to [41], in TAP users are encouraged to tell their experiences, their thoughts, actions, and feelings when interacting with the interface. According to [42], TAP is a voluntary activity where respondents are required to speak what they feel loudly. However, SRS is not involved with TAP, only the teachers do. According to [43], in conducting tests with children, the assessor should use variations in the TAP as it is difficult for the child to follow the instructions for the TAP standard test. Teachers are required to express what they feel while testing the storyboard. In this study, researchers use the concurrent think aloud technique where players are required to state what they think when viewing storyboards. The objective is to identify usability issues and propose solutions to the issues raised.

3) Observation: In [44], author states qualitative methods for data collection such as interviews, observations and document analysis known as "Ethnographic Methods". Observation is performed when the user is running the chauffeured prototype and the TAP using the computer. This observation is done to see users reaction when interact with the storyboard and to record the player's sense of storyboard. Observations are performed with the help of visual recording. Observation data is recorded in the field note during the test session.

C. Collection of Data

The results of the triangulation test were collected and analysed. The results then are used to improve storyboards to produce storyboard version 2. This new version will be used for heuristic assessment tests.

IV. Results and Discussion

The final result of the test is a validated computer storyboard. This storyboard is then used in conducting heuristic evaluation to see the suitability of the game interface. Table II below shows a summary of the results obtained from tests carried out.

In this study, researchers engaged users from the early phase of prototype design development to obtain immediate feedbacks before moving on to the next phase. Researchers and respondents are more focused on the development of game content. For paper prototypes, researchers and respondents started from scratch using pens and papers. The process is repeated twice for paper prototypes to produce a storyboard version 1. After researchers converted the sketches into computerized storyboards, the chauffeured prototype involved three teachers and two SRS executives to observe user interactions using storyboards.

Respondents 1 and 3 asked what happens if the player draws the right or wrong answer. Driver informed that an audio sound is implemented for correct and incorrect answers. Respondent 2 asked whether the pictures were given in order or at random to which the driver revealed that the pictures are given in order. Respondents 1 and 2 also asked what happens if the player clicks the image. The driver notified that the picture has an audio description. For example, if the player pressed the image of a ball, the audio "Ball" will be on. For both SRS respondents 4 and 5, they are only interested in pressing the buttons and menu that has functions, for instance, the ‘Next’ and ‘Back’ buttons. Respondent 4 went directly to the ‘drag and drop’ menu while Respondent 5 looked from the beginning of the storyboard before moving to the game menu. By showing a storyboard, both SRS respondents clicked the picture and repeated the driver’s voice to say alphabet 'a', 'b', and so ‘e’.

When respondents (teachers) conducted the chauffeured prototype, they also applied the think aloud protocol (TAP) where respondents expressed what they felt when they used the prototype. The researcher also conducted an observation with the aid of a visual recording of the respondents while carrying out the TA. In this technique, observations are performed and responses from respondents are recorded in the field note as well as with audio and visual help. Respondents 1 and 3 agreed that colourful contents can attract the attention of SRS to play longer. This is important because SRS have limited hearing and vision, a short focus and can quickly feel bored to a static thing [45]. Both respondents also stated that Times New Roman font did not correspond to SRS and suggested researchers review the appropriate font for SRS. Respondent 2 (Teacher) stated that this software is suitable for SRS. All

respondents agreed that the software and modules are easy to use, understandable, enjoyable, interesting and can be played anywhere and anytime, even at home with adult supervision. Respondent 2 (Teacher) also stated that the content of the game is the same as that used in the classroom, but the innovation of this computer game is able to attract students because it is something new. Respondents 1, 2 and 3 hope that this software can help SRS, improve their literacy skills and increase their passion in learning.

Through observation, Respondents 1, 2, and 4 have had no problem in using their computers and equipment but Respondents 3 and 5 had a little difficulty. Respondent 3 is a senior teacher who is not very skilled at using computer but had no further problem when assisted by the researcher. While Respondent 5 is an SRS who has never used computers but faced no further problems as she is used to playing games using smartphones. All teacher respondents (1, 2, and 3) concentrated on the content of the game so that it will suit SRS. For SRS respondents (4 and 5), they did not know which button to click because of their weakness in reading the instructions. So, SRS just clicked the buttons and pictures that were appealing to them. After the teacher explained to SRS, they understood what they need to do. For SRS respondents, they did not find using a computer and mouse difficult although, at first, they were a bit clumsy. All the respondents were also interested in seeing colourful storyboards with sound effects.

The researcher also explained that BBL strategy is applied in this serious game to the teacher respondents (1, 2 and 3) because the strategy has been used in their daily T&L in reality. They are seven brain-compatible teaching phases [17] that have been adopted in designing the BBL strategies in this game. This game is used by the remedial students who have basic reading skills. When a new concept is taught, students can link it to prior knowledge and thus, existing knowledge is activated. In [46], author stated that the BBL approach emphasizes the relevance of new and existing information to students to make them more prepared in T&L. Through games, information is obtained in various forms such as visual, audio and kinesthetic to give students the opportunity to link the information obtained to create profound meaning. This BBL approach is able to increase the understanding and achievement of students in learning [13], [17], [46]. For each game, the students are briefly explained about the activity objective to give an overview or idea about the activity. After the T&L session, a teacher repeats the topic taught previously and describes the new topic to be learned. This allows the brain to prepare for future lessons which can help improve the effectiveness of the learning process. After getting feedback and making improvements to produce storyboard version 2, researchers will use this new version to make heuristic evaluation of the game interface. In [47], author state that heuristic inspection methods are a method of engineering usability to identify the usability problems of a user interface design so that software can be improved in a recurring development process. These assessment results are used to make changes to the software before developing high-fidelity prototypes.

There may be some possible limitations in this study. This study is focused on SRS but one of the method uses not involved them as it is difficult for the SRS to follow the instructions without teachers help. SRS can only be involved with qualitative data collection because of their lack of understanding in written instructions if quantitative studies are carried out.

TABLE II. FINDINGS

Sekolah Kebangsaan Bebuloh W.P Labuan	
Category	Details
Issues	1. The font used does not correspond to the slow reading student. 2. The font size is quite small. 3. The background for font should be contra to facilitate students to see the letters and words. 4. Students need guidance assistance because of their weakness in understanding the written instructions. 5. A teacher and a student need assistance in using a computer and mouse.
Advantages	1. Contents used are appropriate and parallel to the student's syllabus of LINUS and remedial. 2. Game content is easy to understand and the game is easy to play. 3. Colorful interface can attract the students. 4. Ideally played anytime and anywhere with adult supervision. 5. Game is easy and playable by students. 6. Suitable for classroom use to attract students to play and learn. . 7. Help students with a short period of concentration with colorful animations.
Observation	1. Respondents are attracted to colorful graphic. 2. Respondents are attracted by sound effect. 3. Three out of five respondents had no problem using the computer and mouse. 4. For a functional menu, the respondent repeated several times to hear sound effects (Example: Next Button and Back Button). 5. Students repeat the voice by the chauffeured to say alphabet 'a', 'b', so 'e'.
Suggestions	1. Create an avatar. 2. Have Menu "Let's Learn" and "Activity". 3. Menu "Let's learn" contains letter and word identification. 4. Activity and exercise menu are combined. 5. The menu for exercises is sorted by topic (letters, words, syllables). 6. Have Menu singing abc songs. 7. Separate instructions with the main interface. 8. Differentiate the syllable instructions with different colors. 9. For "Drag" and "Drop" exercises, the respondents suggested that the given picture was arranged instead of randomly. 10. Distinguish the sound for correct and wrong answers.
Hope	1. Teachers hope to play a fully functional game. 2. Can improve students reading literacy skills. 3. Can encourage students to learn.

V. CONCLUSION

The study was aimed at developing a low-fidelity prototype of computerized storyboards. This storyboard is used for further development of the heuristic evaluation of the interface and subsequently the development of high-fidelity prototypes. In this study, users are involved from the initial phase of storyboard making from scratch. They contributed ideas about the content that are relevant to the target audience. Researchers also explained briefly about BBL strategies that are indirectly but commonly used by teachers in T&L daily as well as to get teachers' response about BBL. Not only is the game element important when designing a serious game but the strategy or approach used is also important. The game applies seven phases of the brain-compatible teaching [17] as well as strategy [48]. In conclusion, this low-fidelity prototype is expected to be an early reference for the development of a high-fidelity prototype for slow-reading students.

ACKNOWLEDGMENT

The authors would like to thank Sekolah Kebangsaan Bebuloh, W.P Labuan. The Ministry of Higher Education for the finance sponsored under program MyBrain15 (MyPhD). The Faculty of Information Science and Technology, Universiti Kebangsaan Malaysia for providing facilities and financial support under the university Grant with Project Number KRA-2018-025.

REFERENCES

[1] A. Shapi, N. A. Abd Rahman, M. S. Baharuddin, and M. R. Yaakub, "Interactive Games Using Hand-Eye Coordination Method for Autistic Children Therapy," Int. J. Adv. Sci. Eng. Inf. Technol., vol. 8, no. 4, pp. 1381–1386, 2018.

[2] H. F. Md. Muslim, T. S. M. Tengku Wook, and N. A. Mat Zin, "Kajian awal permainan serius untuk warga emas mengidap diabetes," Proceeding Glob. Summit Educ. GSE 2014, vol. 2014, no. March, pp. 553–559, 2014.

[3] F. Laamarti, M. Eid, and A. El El Saddik, "An Overview of Serious Games," Int. J. Comput. Games Technol., vol. 2014, 2014.

[4] C. M. Ruland, J. Starren, and T. M. Vatne, "Participatory design with children in the development of a support system for patient-centered care in pediatric oncology," J. Biomed. Inform., vol. 41, pp. 624–635, 2008.

[5] J. C. Read and S. Gilutz, "Research Methods for Child Computer Interaction." pp. 927–930, 2016.

[6] S. Idler, "Child-Centered Design is User-Centered Design, But Then Different," UXKids, 2013. [Online]. Available: http://uxkids.com/blog/child-centered-design-is-user-centered-design-but-then-different/.

[7] N. Abdollah, W. F. Wan Ahmad, and E. A. Patah Akhir, "Multimedia Design and Development in ' Komputer Saya ' Courseware for Slow Learners," in Second International Conference on Computer Research and Development, pp. 354–358, 2010.

[8] A. R. Mohd Salihan, M. A. Nazlena, and M. Masnizah, "Comelgetz Prototype In Learning Prayers Among Children," Asia-Pacific J. Inf. Technol. Multimed., vol. 6, no. 1, pp. 115–125, 2017.

[9] S. R. Zainal Abidin, S. F. Mat Noor, and N. Sahari, "Guidelines of Brain-based Learning through Serious Game for Slow Reader Students," in 2017 6th International Conference on Electrical Engineering and Informatics (ICEEI), 2017.

[10] S. Saleh and A. D. Halim, "Kecenderungan Otak dan Hubungannya dengan Pencapaian dan Motivasi Pelajar," J. Pendidik. Malaysia, vol. 41, no. 1, pp. 65–70, 2016.

[11] K. Squire and H. Jenkins, "Harnessing the power of games in education," Insight, vol. 3, pp. 5–33, 2003.

[12] R. N. Caine and G. Caine, Making Connections: Teaching and the Human Brain., no. 218. 1991.

[13] S. Saleh, "The Effectiveness of the Brain Based Teaching Approach in Enhanching Scientific Understanding of Newtonian Physics among Form Four Students," Int. J. Environ. Sci. Educ., vol. 7, no. 1, pp. 107–122, 2012.

[14] A. Bawaneh, A. Nurulazam, and Salmiza Saleh, "The Effect of a Brain-Based Teaching Method on Conceptual Change in Students ' Understanding of Electricity ChangeAgent," Eurasian J. Phys. Chem. Educ, vol. 4, no. 2, pp. 79–96, 2012.

[15] E. Jensen, "Brain-Based Learning: The New Paradigm of Teaching," 2nd Ed., Corwin Press, 2008.

[16] J. D. Connell, "The Global Aspects of Brain-Based Learning," in Educational Horizons, vol. 88, 2009, pp. 28–39.

[17] S. Saleh, "Keberkesanan Pendekatan Pengajaran Berasaskan Otak Dalam Menangani Masalah Berkaitan Motivasi Belajar Fizik Pelajar," in Prosiding Seminar Jawatankuasa Penyelarasan Pendidikan Guru, 2008.

[18] M.-A. Maheu-Cadotte, S. Cossette, V. Dubé, G. Fontaine, T. Mailhot, P. Lavoie, A. Cournoyer, F. Balli, and G. Mathieu-dupuis, "Effectiveness of serious games and impact of design elements on engagement and educational outcomes in healthcare professionals and students : a systematic review and meta- analysis protocol," 2018.

[19] G. Kokkalia, A. Drigas, A. Economou, P. Roussos, and S. Choli, "The Use of Serious Games in Preschool Education," Int. J. Eng. Technol., vol. 12, no. 11, pp. 15–27, 2017.

[20] N. Abdollah, W. F. Wan Ahmad, and E. A. Patah Akhir, "Development and Usability Study of Multimedia Courseware for Slow Learners : 'Komputer Saya,'" in 2012 International Conference on Computer & Information Science (ICCIS), 2012, pp. 1110–1114.

[21] T. Y. Su, P. Gates, and I. Harrison, "Digital Games and Learning Mathematics : Student , Teacher and Parent Perspectives," Int. J. Serious Games, vol. 3, no. 4, pp. 55–68, 2016.

[22] P. Felicia, Digital Games in Schools. European Schoolnet, 2009.

[23] M. Liu, J. A. Rosenblum, L. Horton, and J. Kang, "Designing Science Learning with Game-Based Approaches," Comput. Sch., vol. 31, no. 1–2, pp. 84–102, 2014.

[24] N. Peirce, "Digital Game-based Learning for Early Childhood A State of the Art Report," 2013.

[25] S. De Freitas and S. Jarvis, "Serious games - Engaging training solutions: A research and development project for supporting training needs," Br. J. Educ. Technol., vol. 38, no. 3, pp. 523–525, 2007.

[26] M. W. Martin and Y. Shen, "The Effects of Game Design on Learning Outcomes," Comput. Sch., vol. 31, no. 1–2, pp. 23–42, 2014.

[27] A. C. Siang and R. K. Rao, "Theories of learning: a computer game perspective," Multimed. Softw. Eng. 2003. Proceedings. Fifth Int. Symp., pp. 239–245, 2003.

[28] M.-E. Ntourlia, D. Gouscos, and M. Meimaris, "TuxMath: Is it Possible for a Game to Enhance Multiplication Skills ?," in 4th European Conference on Games-Based Learning: ECGBL 2009, 2009.

[29] M. Kebritchi, A. Hirumi, and H. Bai, "The effects of modern mathematics computer games on mathematics achievement and class motivation," Comput. Educ., vol. 55, no. 2, pp. 427–443, 2010.

[30] N. Muhamad, J. Harun, S. Md Salleh, and M. A. Z. Megat Zakaria, "Penggunaan Game-Based Learning Bagi Meningkatkan Kemahiran Penyelesaian Masalah Kreatif Dalam Matematik," in 2nd International Education Postgraduate Seminar (IEPS 2015), 2015, pp. 1–9.

[31] N. A. Mohamed Masrop, H. A. Mak Din, A. N. Zainal Ariffin, and I. F. Mohammed Salleh, Nur Muizz Ahmad, "Kesan Permainan Digital Dalam Pendidikan," Proceeding Int. Conf. Inf. Technol. Soc., no. June, pp. 1–7, 2015.

[32] L. P. Rieber, "Seriously considering play: Designing interactive learning environments based on the blending of microworlds, simulations, and games," Educ. Technol. Res. Dev., vol. 44, no. 2, pp. 43–58, 1996.

[33] M. Prensky, "The Digital Game-Based Learning Revolution," in The Digital Game-Based Learning Revolution, vol. 1, no. 1, 2001, pp. 1–19.

[34] M. Papastergiou, "Digital Game-Based Learning in high school Computer Science education: Impact on educational effectiveness and

student motivation," Comput. Educ., vol. 52, no. 1, pp. 1–12, 2009.

[35] H. Tüzün, M. Yilmaz-Soylu, T. Karakuş, Y. Inal, and G. Kizilkaya, "The effects of computer games on primary school students' achievement and motivation in geography learning," Comput. Educ., vol. 52, no. 1, pp. 68–77, 2009.

[36] E. Bertou, "Low - fi Prototyping Tablet Apps for Children," Tilburg University, 2013.

[37] J. Sauer, H. Franke, and B. Ruettinger, "Designing interactive consumer products : Utility of paper prototypes and effectiveness of enhanced control labelling," Appl. Ergon., vol. 39, pp. 71–85, 2008.

[38] J. Rudd, K. R. Stern, and S. Isensee, "Low vs. high-fidelity prototyping debate.," Interactions, vol. January, no. 1, pp. 76–85, 1996.

[39] S. Hietala, "User Study of a Prototype for Mobile Work Time registration," Luleå University of Technology, 2016.

[40] J. F. Nunamaker, A. R. Dennis, J. S. Valacich, D. Vogel, and J. F. George, "Electronic meeting systems to Support Group Work.," Commun. ACM, vol. 34, no. 7, pp. 40–61, 1991.

[41] O. Alhadreti and P. Mayhew, "Rethinking Thinking Aloud : A Comparison of Three Think-Aloud Protocols," in Conference on Human Factors in Computing Systems, 2018, pp. 1–12.

[42] J. Cowan, "The potential of cognitive think-aloud protocols for educational action-research," Act. Learn. High. Educ., 2017.

[43] J. Nielsen, "Usability Engineering," in Academic Press, 1993.

[44] B. B. Kawulich, "Participant Observation as a Data Collection Method," Forum Qual. Sozialforsch. / Forum Qual. Soc. Res., vol. 6, no. 2, 2005.

[45] H. Azizzeanna, M. Murni, and M. T. Abu Osman, "Tablet Technology Integration framework for Slow Learner Learning," in Information and Communication Technology for The Muslim World (ICT4M), 2014, pp. 3–7.

[46] F. Fazil and S. Saleh, "Keberkesanan Pendekatan Pengajaran Berasaskan Otak Dalam Meningkatkan Kefahaman Pelajar Tingkatan Empat Terhadap Pembelajaran Konsep Dan Mekanisme Fotosintesis," Asia Pacific J. Educ. Educ., vol. 31, pp. 69–83, 2016.

[47] N. Ashaari, H. Mohd Judi, A. A. Abdul Ghani, S. Mohd Hasan, and A. S. Md Yunus, "Skor Pengukuran Kebergunaan Perisian Kursus Matematik Berdasarkan Faktor Penilai," Sains Malaysiana, vol. 39, no. 4, pp. 677–684, 2010.

[48] S. Hileman, "Motivating Students Using Brain-Based Teaching Strategies," The Agricultural Education Magazine, vol. 80, no. 2, pp. 1–28, 2006.