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Papers

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Short Paper

A Rasch Model Analysis on Junior High School Students' Scientific Reasoning Ability

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Active Learning Using Digital Smart Board to Enhance Primary School Students' Learning

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Abstract—Digital smart board is one of interactive technology tools which has been used widely in schools to facilitate teaching and learning. Empirical evidence shows that digital smart board allows students to construct their knowledge while mastering more advanced thinking skills. Thus integration of digital smart board facilitates active learning, which is fundamental to mastery of skills. Active learning using smart board program is a program which integrates smart board in Data Handling so that primary school students can learn Data Handling concept actively and meaningfully. Therefore, this study was conducted to identify the effectiveness of active learning using smart board program to enhance primary school students' learning. Five experts in teaching Mathematics Education and thirty year five students were involved in this study. The students were selected based on purposive sampling. This study used both quantitative and qualitative research approach. A set of interview protocol and a set of questionnaire were used during the data collection phase. Findings from the questionnaire were analysed based on descriptive and inferential statistics by using Winsteps Version 3.72.3. In addition, thematic analysis was used to analyse the qualitative data. Findings from the study indicate that active learning using smart board program has the attributes which can effectively enhance primary school students' learning. It is hoped that the results from this study can contribute towards development of active learning strategies, methods or activities using smart board in order to enhance primary students' learning in school.

Keywords—Active learning; digital smart board; primary school students; learning

1 Introduction

Learning is seen as using a skill of thinking to arrive at an informed view [5]. It is the process of discovery in which the student is the main agent, not the teacher [1]. Students do not learn much just by sitting in class, listening to teachers, memorizing

prepackaged assignments, and spitting out answers. Students must talk about what they are learning, write about it, relate it to experiences, and apply it to their daily lives. When students are actively involved in the learning task, they learn more than when they are passive recipients of instruction [9].Students must make what they have learned as part of themselves [6]. Dale's Cone of Learning shows the average retention rate for various methods of learning [10]. It reveals that the least effective method is passive learning such as watching classroom presentations or reading books. In addition, lecture method is also an example of passive learning and it is a relatively poor instructional approach for maintaining students' attention [5]. Lecturing in front of large groups of students who passively absorb ideas that actually demand intense deductive and inductive mental activity coupled with personal experience leave virtually nothing significant or permanent in the student mind [27]. On the other hand, active learning techniques result in up to 90% retention, and therefore can be considered as effective learning. Dale's Cone of Learning underlines the premise that if teachers show students how to do something, they will probably remember. However if teachers involve them in a meaningful way, they will likely understand the lesson better. In other words, the most durable form of learning is when teachers involve students directly in a meaningful way and preferably through the availability of hands on experience. In addition, students learn best when they use perceptual learning styles which are sensory based since it enables students to interact with resources provided by the teachers.

Active learning is a classroom approach which acknowledges that learners are active in the learning process by understanding and constructing knowledge in response to learning opportunities provided by their teachers [20]. Active learning is based on constructivism theory which states that learning occurs mostly through social interaction with others, such as peers or teachers. Vygotsky defines zone of proximal development (ZPD) as the area where active learning activities should be emphasised, lying between what the learner can achieve with the teacher's professional guidance and what the learner can achieve independently [28]. Understanding information is the key aspect of learning, it is crucial for learners to recognize what they understand and what they do not. By doing so, learners can monitor their mastery of subjects. Meanwhile, teachers actively facilitate students to develop deep level of understanding by providing guidance, scaffolding activities, supporting learners in facing challenges and providing rich feedback using assessment for learning. In addition, learners have more incentive to learn when they have control over not only how they learn but also what they had learnt [16].

Today, many teachers want to adopt active learning as a way to engage students in the learning process. Introduction of technology and computers in academic life has emerged as a necessity [2], [15], [19], [24]. As technology becomes part of social development, new learning technologies should be adopted to update traditional learning approaches [21]. In the last decade, governments around the world have been vigorously promoting the integration of ICT learning as it can lead to significant educational and pedagogical outcomes in schools, and beneficial to learners and teachers [17], [29]. Smart board is popular in the United States educational system. In addition, more than 75% of classrooms in United Kingdom have adopted the multimedia tech-

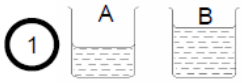
nology [23]. The use of smart board in classrooms provides a lot of benefits to students. It is well-known that students with attention and behavioral difficulties gain benefit from its use. Besides, smart board also facilitated students to visualise mathematics, verify conjectures, involve in active learning strategies, insist positive attitudes, and build confidence in their ability to do mathematics [18].

Several studies review that smart board has great potential to be used as an interactive learning tool with endless motivational application to enhance learning among students. However, smart board alone is not adequate in supporting learning. Thus, it is therefore reasonable to consider the incorporation of smart board with proper learning theoretical framework, particularly active learning. Therefore, findings from this study can be used to support teachers to develop active learning strategies, methods or activities using smart board program in order to promote effective learning.

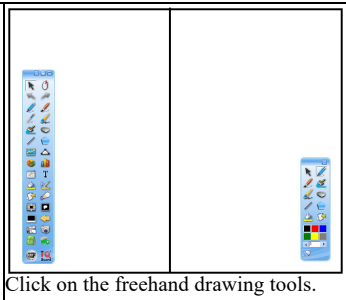
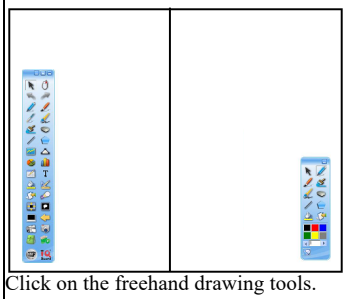
1.1 Design and Development of Active Learning Using Smart Board Program

In order to design interactive learning instruction using smart board program, smart board as a teaching and learning interactive tool needs to be integrated with active learning. A model of active learning [20] is used to design active learning instruction during the teaching and learning process which consists of set induction, step one, step two, step three and closure. Teachers can implement various active learning activities such as dialogue with self, dialogue with others, experience of doing and experience of observing. As a result, learning will be meaningful and effective as every student can participate actively in class. Table 1 shows the mapping of active learning instruction using smart board program.

Table 1. The mapping of active learning instruction using smart board program

Steps	Model of Active Learning [20]	Smart Board Activities	Examples of Smart Board Activities
Set Induction (≈5 minutes)	Experience of observing	Using visualizer and smart board software such as Flipbook, Sphere 2, as well as IQ Interactive Education Platform to demonstrate a divergent event or phenomena by showing pictures or diagrams, a short practical activity, present a problem to be thought through, a video clip or film show through internet and experiment.	Teacher shows two containers of the same size with different volume of liquid under the visualizer. (Experience of observing)   Teacher asks students to equalise the volume of liquid in both containers under the visualizer. Next, teacher adds in more containers of the same size with different volume of liquid and asks students to equalise the volume of liquid in the containers under the visualizer. (Experience of observing) Teacher explains to students that they need to find the average volume of liquid in the containers.

Step 1 (≈10 minutes)	Dialogue with self Dialogue with others Experience of observing Experience of doing	Using visualizer and smart board software such as Flipbook, Sphere 2, as well as IQ Interactive Education Platform Discussion during experiment, discourses in small groups, brainstorming, concept mapping, practical work, practical work, question-answer session, interview of events, drawing pictures to illustrate science phenomena and presentation.	Teacher shows a short video through smart board about the questions a boy needs to solve in 3 days from https://www.youtube.com/watch?v=ZlwnrUSbvv0&t=52s (0:00time to 0:23time). (Experience of observing) Teacher asks students to try to calculate, reflect and discuss the questions in the video. Example of discussion: How many questions need to be solved by the boy daily? (Experience of doing, dialogue with self, dialogue with others) Teacher solves the question using drawing tools in the "IQ Interactive Education Platform*"* software. (Experience of observing) lllllllllll lllllllllll lllllllllll Teacher shows the answer from https://www.youtube.com/watch?v=ZlwnrUSbvv0&t=52s (0:23time to 0:41time) and asks students to solve the question using drawing tools in the "IQ Interactive Education Platform*"* software again. (Experience of observing) Teacher asks students, what is the similarity between both methods, drawing and simple calculation method? (Dialogue with self, dialogue with others) (Both methods provide same answer for average.) Teacher advices students to spend their time wisely.
Step 2 (≈25 minutes)	Dialogue with self Dialogue with others Experience of observing Experience of doing	Using visualizer and smart board software such as Flipbook, Sphere 2, and IQ Interactive Education Platform during small group discussion, project, investigations, experimentation, demonstration, practical work, simulation and presentation.	Group activity Teacher asks students to form 8 groups. Teacher asks students in the groups to gather all the money from the group members (RM10, RM5, RM1, 20sen, 10sen, and 5sen). (Experience of doing) Each group is given 10 minutes to find the average amount of money belong to each group and write down the vocabulary related to average on a piece of paper. (Experience of doing, dialogue with self, dialogue with others) Teacher randomly picks a few groups. Selected group members need to present their work with smart board. Using drawing tools in the "IQ Interactive Education Platform*"* software. (Experience of doing, experience of observing) Dual-user Mode: Select "Tools , then Dual user" on Menu Bar, or Click  on Common Tools toolbar.

			 Click on the freehand drawing tools. Teacher discusses with students the correct answer. (Dialog with others) (Vocabulary related to average= Add, divide)
Step 3 (≈15 minutes)	Experience of doing	Using visualizer and smart board software such as Flipbook, Sphere 2, and IQ Interactive Education Platform to solve problems in various but related circumstances, innovating, and worksheets.	Worksheet (Group activity) Teacher gives a worksheet to each student. Teacher gives 10 minutes to solve the worksheet in groups. (Experience of doing) After students complete the worksheet, teacher randomly picks a group. The group members present their work with smart board. Using drawing tools in the "IQ Interactive Education Platform*"* software. Dual-user Mode: Select "Tools , then Dual user" on Menu Bar, or Click  on Common Tools toolbar.  Click on the freehand drawing tools. Teacher discusses with students the correct answer.
Closure (≈5 minutes)	Dialogue with self Dialogue with others	Using visualizer and smart board software such as Flipbook, Sphere 2, and IQ Interactive Education Platform during group discussion.	Teacher asks students to reflect and discuss the meaning of average. (Dialogue with self, dialogue with others) Teacher explains that average is a number expressing the central or typical value in a set of data.

2 Methodology

This study used quantitative and qualitative research approaches to identify the effectiveness of active learning using smart board program to enhance learning among primary school students. It was conducted in a Malaysian primary school. The topic of

Data Handling was selected in this study due to several reasons such as the importance of Data Handling in our daily lives and also career, its instrumental role in other disciplines, as well as the main role of Data Handling in developing critical reasoning [12], [13]. Five teachers who are experts in Mathematics Education and possess more than twenty years of teaching experiences were involved in the process of validating the program. Thirty year five students were involved in this study. The selection of students in this study was based on purposive sampling. They were from different classes with average academic achievement in mathematics. The samples were 46.7% (14) male students and 53.3% of them were (16) female students. Twenty percent of them were Malay students (6), 63.3% were Chinese (19), 6.7% (2) were Indian and 10% (3) were other races. This study used a set of interview protocol and a set of questionnaire to collect data. All thirty students were asked to answer interview questions and questionnaire. The questionnaire is about their perceptions towards the learning practices used in Data Handling. It consists of sixteen items and developed based on the theory of social constructivism [28] and active learning [20].The questionnaire uses Likert scale measurement which consists of five points, range from 1 (strongly disagree) to 5 (strongly agree). The findings of the questionnaire were analysed based on descriptive and inferential statistics by using Winsteps Version 3.72.3. Meanwhile, thematic analysis was used to analyse the qualitative data [4].

3 Findings of The Study

3.1 Questionnaire analysis

The purpose of the questionnaire was to study the method used by students to learn HOTS in Data Handling and their perceptions towards the learning practices used in Data Handling. A total of thirty year five students were asked to answer the questionnaire. Table 2 shows mapping of questionnaire items based on theory of social constructivism [28] and active learning [20].

Table 2. Mapping of questionnaire items based on theory of social constructivism and active learning.

Theory	Items	What are the students' perceptions towards the learning practices used in Data Handling?
Vygotsky's social constructivism [28] Students are active learners. They construct meaning from reality but do not passively receive what they are taught in their learning environment. Learning often happen and cannot be separated from social context.	B1	During the learning processes, I attempt to make connection between the concepts that I learn.
	B2	When I do not understand any mathematical concept, I find relevant resources that will help me.
	B3	I can easily illustrate a mathematical concept through mathematical software applications in smart board.
	B4	I like to solve Data Handling mathematical word problem with friends in group.
	B5	I consider thoughts from others during group discussion.
	B6	I am willing to present my thoughts during the classroom discussion.
	B7	I am willing to share my knowledge of mathematical concepts to

		other friends.
	B8	At the end of learning a topic, I can explain a mathematical concept to another friend clearly.
	B9	I enjoy learning when a teacher performs Data Handling mathematical word problem through smart board.
	B10	I could apply what I had learnt in class to my daily life.
Active learning [20] Students are active in the learning process by understanding and constructing knowledge in response to learning opportunities provided by their teacher. All learning activities consist of dialogue or experience.	B11	I am willing to attend and make contribution in class.
	B12	I am able to communicate effectively with my classmates.
	B13	I feel like a part of the class. I always make collaboration with my classmates.
	B14	I am interested in the learning topics. I could think more critically about the learning topics.
	B15	I have greater flexibility to learn the way I want through various learning activities.
	B16	I learn more from doing than from listening.

Figure 1 below shows analysis of the perceptions of students towards the learning practices used in Data Handling using Winsteps Version 3.72.3 software. Based on the findings to find out the perceptions of students towards the learning practices used in Data Handling, overall students had high level of perception. The mean score was 3.69 and this showed that students agreed that the use of smart board program while learning Data Handling in class was effective.

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PT-MEASURE CORR.	PT-MEASURE EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%	ITEM
10	53	30	5.28	.30	.68	-1.5	.69	-1.5	.16	.24	70.0	57.5	B10
12	64	30	4.29	.30	1.34	1.4	1.34	1.4	-.15	.25	56.7	60.1	B12
13	68	30	3.94	.30	.86	-.5	.86	-.5	.17	.25	60.0	57.0	B13
8	75	30	3.31	.30	1.54	2.0	1.59	2.2	.51	.24	53.3	53.0	B8
5	111	30	-.14	.28	.70	-1.4	.70	-1.4	.65	.26	53.3	51.5	B5
6	113	30	-.30	.28	1.21	1.0	1.20	.9	.34	.26	43.3	52.7	B6
4	117	30	-.61	.28	.71	-1.4	.70	-1.4	.08	.26	70.0	54.1	B4
11	117	30	-.61	.28	.92	-.3	.92	-.3	.23	.26	56.7	54.1	B11
14	123	30	-1.07	.28	1.40	1.7	1.47	2.0	.18	.26	36.7	55.1	B14
15	123	30	-1.07	.28	1.24	1.1	1.24	1.1	-.02	.26	46.7	55.1	B15
1	125	30	-1.23	.28	.99	.1	.98	.0	.37	.25	53.3	54.3	B1
2	126	30	-1.31	.28	.85	-.6	.85	-.7	.20	.25	63.3	53.7	B2
7	139	30	-2.55	.35	.71	-1.1	.70	-1.1	.45	.20	66.7	65.6	B7
9	139	30	-2.55	.35	.81	-.7	.94	-.1	.15	.20	66.7	65.6	B9
16	139	30	-2.55	.35	.77	-.9	.78	-.8	.31	.20	73.3	65.6	B16
3	141	30	-2.81	.38	.82	-.6	.80	-.6	.29	.19	76.7	71.0	B3
MEAN	110.8	30.0	.00	.30	.97	-.1	.99	-.1			59.2	57.9	
S.D.	28.2	.0	2.58	.03	.27	1.1	.28	1.2			10.9	5.7	

Fig. 1. Analysis of the perceptions of students towards the learning practices used in Data Handling

Item B3 which states "I can more easily illustrate a mathematical concept through mathematical software applications in smart board" showed the highest mean score of 4.7. This result indicated that students strongly agreed on the effectiveness of smart board usage in class. In addition, item B9 which states "I enjoy learning when a teacher performs Data Handling mathematical word problem through smart board" and item B16, "I learn more from doing than from listening" also recorded high mean

score of 4.63. Thus, most of the students agreed that they enjoyed learning using smart board and would learn better if they were learning actively in class. However, item B10 "I could apply what I had learnt in class to my daily life" showed the lowest mean score of 1.8. This indicated that the students could not apply their knowledge and skills in their daily lives if they learn passively in class. Moreover, most students in the class faced difficulty to communicate effectively and work together with friends to accomplish mathematical tasks as item B12 "I am able to communicate effectively with my classmates" and item B13 "I feel like a part of the class. I always made collaboration with my classmates" showed low mean score of 2.13 and 2.27 respectively.

3.2 Interview analysis

An in-depth one-to-one interview was conducted by the researcher with students who used active learning using smart board program. The interview started with short briefing about the interview protocol before the actual interview sessions. Findings from the students' interview data are as follow:

Feedback from the students who used active learning smart board program

- The students suggested that there should be user manual provided for them when they were asked to use the program.
- The students highlighted that the program made Data Handling lessons to become fun and interesting.
- The interactive white board really helped the students in learning Data Handling. They stated that the whiteboard was not only a giant touch screen but also a tool to build virtual reality world.
- Students needed to be familiar with the use of smart board before conducting the active learning using smart board program.
- Active learning using smart board program provided the students with strategies or alternative approaches to calculate and this helped to boost their general mathematics understanding.
- Active learning using smart board program has built-intelligence which allowed the s students to visualise all data in table, charts and graphs clearly.
- Active learning using smart board program showed various Data Handling questions and able to define relationships between each data clearly.
- Active learning using smart board program helped the students in making better and faster decisions as it provided a systematic way to create, retrieve, update and manage data.
- Active learning using smart board program showed clear steps to create various graph.

Most of the students who used active learning using smart board program shared similar interest on the features in the program. Active learning using smart board program made learning Data handling to be fun and effective. In addition, the program has the attributes to encourage active, meaningful and thoughtful learning among students. As a result, knowledge and skills learnt in class could be successfully

retained in memory. Another advantage of active learning using smart board program was that students were able to turn data in understandable information, involved themselves in various interactive activities which train and help them to understand better the concept of Data Handling. Active learning using smart board program encouraged the students to be active learners in the learning process as well as encouraged students to reflect their learning.

3.3 Excerpts from the experts

Five teacher experts in Mathematics Education and possess more than twenty years of teaching experiences were asked to validate the active learning using smart board program. Table 3 shows the feedback from the experts about the lesson plans of active learning using smart board program.

Table 3. Feedback from experts about the lesson plans of active learning using smart board program

No.	Correction required	Correction made
1	No time located for each lesson plan.	Time located for each lesson plan was written.
2	Answer sheets for student's worksheets were not prepared.	Answer sheets for the students worksheets was prepared.
3	Meaning of each symbol of active learning activities was not stated.	Note for active learning activities was written.
4	Active learning activities should be written clearly in the lesson plan.	A column for active learning was written in the lesson plan.
5	Active learning activities embedded in the lesson plan was not stated clearly.	Sample of active learning activities was written clearly in the teaching and learning activities.
6	Higher order thinking skills should not be written in the remark column.	Higher order thinking skills written in the remark column was removed.
7	Grammar mistake was found in the lesson plan.	Grammar mistake found in the lesson plan was corrected.
8	Questions in the student's worksheets should generate students thinking skills.	For the student's worksheets, fill in the blanks questions were replaced with open-ended questions.
9	Guidelines should be prepared for the active learning using smart board program.	Active learning using smart board program handbook was prepared for the program.
10	The year of primary school students was not stated.	The year of primary school students was written in the cover of the program handbook.
11	Active learning using smart board program should be associated with the active learning using smart board program handbook.	All lesson plan and worksheets of active learning using smart board program were written in the active learning using smart board program handbook.

Generally, all the experts strongly agreed with the features of the active learning using smart board program. They believed that the program could enhance and engage students' higher order thinking skills, reduce time in preparing teaching and learning materials, encourage active learning activities, as well as encourages student to participate in all classroom learning activities. Aside from promoting discussion and presentation among students, the program also encouraged students to put more effort to complete all the learning activities. In addition, students were prompted to have internal dialogue in which they verbalized understanding. Besides, all the experts also

strongly agreed that smart board played an important role in the active learning using smart board program. Smart board allowed students to experience a range of new learning tool which encouraged engagement with course content and able to serve as an alternative to passively listening to lecture or simply reading texts. The touch-screen technology of smart board provides greater flexibility in the presentation of materials. It provides a large work space for hands-on activities with various multi-media resources, having a display surface huge enough to encourage high level of student interaction.

4 Discussion of Findings

Findings from questionnaire, interview s and excerpts from experts indicated that students and experts agreed that the use of active learning while learning Data Handling in class was effective. Active learning requires students' active participation, do meaningful learning activities and think about what they are doing. Active learning is prerequisite for effective and meaningful learning and help to achieve academic and other outcomes, such as critical thinking skills, openness to diversity, and growth in leadership and other job related skills [22], [26].

Nonetheless, the findings also indicated that the students and experts agreed that the use of smart board while learning Data Handling in class was effective. Studies that examined the use of technology in schools and its effectiveness found that use of technology is efficient for students [3]. The use of smart board in class has the potential to enhance students' knowledge and skills in Data Handling. As noted by [6], smart board has the advantage of adapting the manner in which the study material is conveyed to students' personal learning styles. It affords choices on various topics, develop knowledge, organize information, provide self-efficacy in carrying out assignments in a friendly environment, as well as support representation of products which generate a sense of success, pleasure, and contribute to a more creative and higher standard learning product [11]. Besides, students also claimed that smart board encouraged motivation to learn, raised the level of concentration, and had strong effect on behavior [25].

When smart board is incorporate with active learning environment, new pathways for students with varying learning styles can be developed. Compared to note-taking and traditional lectures, combination of active learning with smart board offers students with greater chances to directly participate with the content. A student and a teacher can interact with the smart board in front of the class, and the rest of the students remain involved. Having a display surface huge enough for everyone in the class to see encourages high level of student interaction. On the contrary, a lot of time is wasted on drawing of diagrams on blackboards, whereas by using a smart board, diagrams are drawn easily, and thus time is utilised more for active learning. In addition, students can read and manipulate information easily through the smart board. Instructor-mediated use of the smart board in academic libraries also clearly increases effective learning by increasing students' emotional involvement, engagement, social interaction, and self-esteem in library classes.

5 Conclusion

To put in a nutshell, findings from the questionnaire, evidence from interview sessions with the students as well as excerpts from the experts showed that the active learning using smart board program could enhance primary school students' learning. Active learning provides opportunities for learners to think critically about learning content through a range of activities which help to prepare learners for the challenges in their daily lives. Active learning promotes higher order thinking skills which enables students to develop deep understanding of skills and content [14]. In addition, effectiveness of learning methods can be enhanced by using technology in class. Technology tool such as smart board is widely used in primary school nowadays. Most teachers in primary school agree that at present students prefer learning through smart board. Smart board allows students to experience a range of new learning tool which encourage engagement with course content, serve as an alternative to passively listening to a lecture or simply reading a text. Smart board using active learning program provide scaffolding for students to increase their higher order thinking skills levels. In addition, students can increase focus throughout the lesson, understand and learn better when smart board is used in class. In conclusion, active learning using smart board program is successful in providing active learning environment which can promote students to be active learners. Moreover, it provides an opportunity for students to share their learning using technological tools, develop advance thinking skills and cultivate lifelong learning. Therefore, active learning using smart board program should be widely introduced and used in schools to enhance learning among students.

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The Needs of Collaborative Tool for Practicing Pair Programming in Educational Setting

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Abstract—Pair programming is a technique which is introduced for helping programmers to develop high quality codes. Beside technical aspects, collaboration and working in team are the important skills needed in practicing the technique. These skills are essential to be instilled among our engineering students. Pair programming (known as PP) is one of Agile software development technique which introduces collaborative ways for programmers to develop software. Many advantages have been reported when one practiced the technique, which include improve team communication and productiveness, reduction in defect counts, and at the same time lessen development time. Among students, the technique was also reported to enhance students' learning and satisfaction, as well as students' learning skills. In order to get the full benefits of pair programming technique, however, correct guidance must be provided to the students. In this study, we proposed a collaborative pair programming tool for students in practicing the technique. The tool offers all features required to allow the collaboration for the pair programming technique to work. The tool is designed and developed using Visual Basic Studio software. A database is incorporated to store students' information. An experiment was conducted to evaluate the students' performance with and without using the tool. Results showed that the tool can help improving students' performance in terms of quality of codes, and lessen their time in completing their coding. These are the consequences of collaboration and team work skills that they have been practicing when using the tool.

Keywords—Pair Programming technique; pair programming tool, collaborative tool, engineering students, educational tool; engineering education

1 Introduction

Pair programming (known as PP) is one of Agile software development technique under Extreme Programming [1, 2]. It is a technique in which two programmers work together [3]. PP is when two programmers work collaboratively on the same algorithm, design and programming tasks [3, 4]. One person is called a 'driver' which controls the mouse or the keyboard and is developing design or code [3, 4]. The other person is called an 'observer', continuously and actively examines the work of the

'driver', watching for defects and thinking of solutions for any problems found in the coding [4]. In pair programming, the two programmers will actively switching their roles [4]. There are two types of pair programming in software development, which are:

- Traditional pair programming
- Distributed pair programming.

The traditional PP consists of two persons sitting side by side on the same computer, in the same place while the distributed PP is where the two programmers work on the same programs but using different computers and can be in different locations [5, 6]. The practice of distributed pair programming can be automated with a tool that providing all features for the collaboration to occur, even though the programmers are in different location.

Most of an engineer's time in software industry is spent working with other programmers [7] and programmers can be from different location and even in different time region. Furthermore, they need to develop the ability to comprehend the programs developed by other programmers or software engineers [8]. Therefore the need to learn PP is essential not only for software developers but also to engineering students as the benefits they can get from practicing PP can help them when working in the industry later. These students need the skill of team work which can be obtained by practicing pair programming [9]. Knowing the benefits PP can offer, educators were also expressing their interests in applying PP in educational institutions [4]. In this paper, we present the development of collaborative tool for practicing pair programming technique. Our focus is on distributed pair programming (DPP) which allowing two persons to work at different computer while working on the same coding. The tool is very essential to be introduced in educational setting as it allows and automates the process of performing the technique correctly. The tool, at the same time can provide the right environment for practicing PP to students.

2 Background and Motivation

Many have reported benefits of practicing pair programming in educational setting [10, 11]. The benefits outweighed the disadvantages when students practicing the technique. A study conducted in computer science classroom showed that students were found to be more confident in their work [11]. Knowledge is consistently being shared between partners [11]. The students also had minimal questions for the teaching staff when practicing the technique. Survey showed that 74% of the students were satisfied working with their partners as they could figure out almost everything [11], while 84% of the class agreed that they have performed better when using the pair programming[11]. There was also one study published on the benefits of implementing pair programming in classroom [12]. The implementation which was well monitored and regulated by instructors at a given time has proved that pair programming enhanced students problem solving skills, improved quality of their works and increased teamwork [12].

At educational setting, introduction can be provided by educators prior to its practice. The practice can be automated with a tool which incorporating all the features needed for practicing the techniques. This is important as it can assist to provide the students with correct environment to practice the technique. Although there are tools available to be used in industry, however from our investigation, none of the tools provide complete features needed in practicing the pair programming particularly in educational setting. In this study, we proposed and developed a pair programming tool with the important features to practice the technique. The tool includes screen sharing application, collaborative work support, floor control, communication channel and platform. Workspace window is for programmers to write their codes whereas screen sharing applications is mainly to support the collaborative activities required in the pair programming. Besides, in order to enhance the collaboration, several communication channels such as text-message, voice call and video call are also included in the tool. The features and functions are needed to provide the right environment to meet the educational setting. Since the focus of this tool is for students, therefore a database is also incorporated. The database stores students' information and tasks (assignments) for educators to check and comments.

3 The Needs for the Tool

Correct guidance to use the technique must be introduced to students. It is essential to have a tool which can automate collaboration among students to the practice PP. This can help students to be independent and having minimum supervision from their instructors. Currently they are several tools available (i.e Gobby, COPPER, VNC) however the practice requires an effective tool support to address new challenges like communication, distributed collaboration and data exchange [12]. Some of the basic requirements for pair programming particularly distributed pair programming (DPP) are workspace control and awareness, screen sharing enables, floor control, gesturing and various communication channels. Furthermore, although most of the tools mentioned are currently being used in industry [12] but none of the tools investigated are suitable to be used by students. To the best of our knowledge, we could not find any tools that provide all the features which are required by the students. For example, VNC does not have collaborative works support which is needed by students when doing their tasks. In addition medium for communication is also not supported by the VNC. In practicing the technique, students need to share and exchange information between them. While for other tools such as ACE, MoonEdit, GrewPEdit and Gobby, they do not have the screen sharing applications like VNC [12]. Screen sharing applications is crucial to be included in the tool as students need them in order to communicate (between partners) when doing the programming tasks separately or virtually. Table 1 shows the summary of the features provided by the existing pair programming tools.

Table 1. Difference in Features for Existing Tool

Tools' features	Existing PP Tools				
	ACE	***MoonEdit***	***GrewpEdit***	***Gobby***	***VNC***
Screen Sharing Application	NO	NO	NO	NO	YES
Collaborative Work Support	YES	YES	YES	YES	NO
Floor Control	YES	YES	NO	NO	YES
Communication	YES	NO	YES	YES	NO
Platform	YES	YES	YES	YES	YES

4 Methodology

The project applied an evolutionary process model; a prototyping methodology. It is a software process model which allows development of increasingly more complete version of the software [13] and can help to obtain the requirements for the system [14]. This section presents the development of the tool. Flow of the tool is shown as in Figure 1.

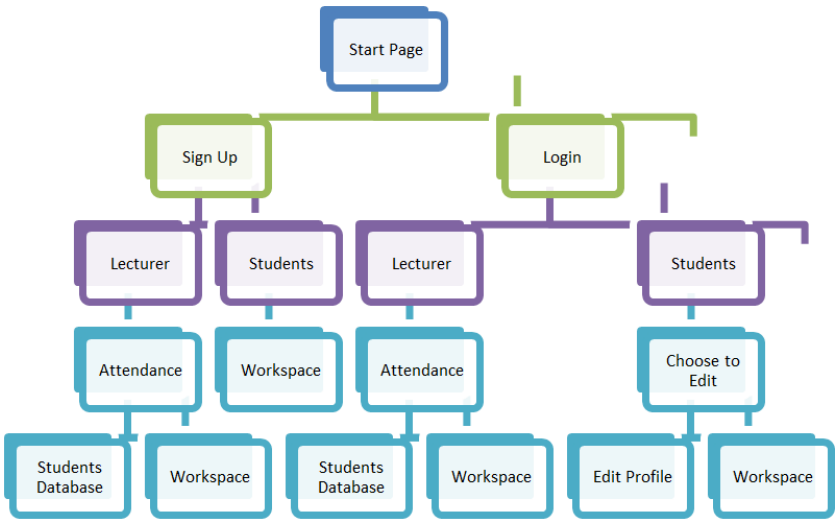

Fig. 1. Flow Design of Pair Programming Tool

As in Figure 1, the tool is designed with signup and login button for both students and lecturers. The tool has features for students' and lecturers' usage. A workspace is provided for students to do coding and there is a platform for lecturers to check students' attendance (from students' database) and their students' coding (workspace). The tool is designed and developed using Visual Basic Studio (VBS) and a MySQL database is incorporated together using C# programming language. The start page for the tool is shown as in Figure 2.

Fig. 2. Start Up Page for the Tool

In the start page, there are two buttons to choose; (i) signup button; if they are using the tool for the first time and (ii) login button; if they have already stored their information. In the signup page, students need to key in all of their information as shown in Figure 3 below. The data is stored in the database for their lecturers' reference.

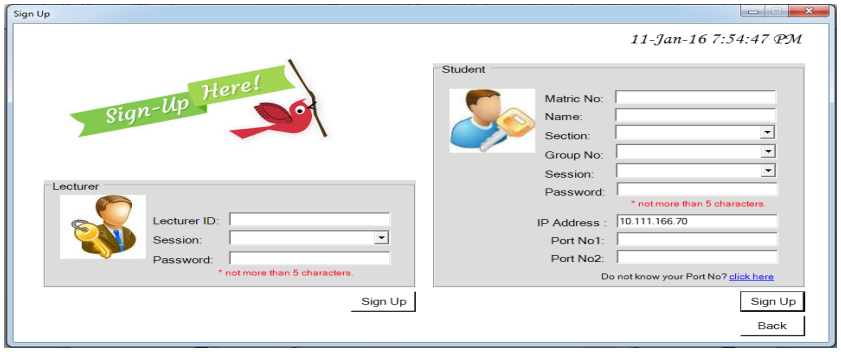

Fig. 3. Sign Up Page

Next, is the login page (Figure 4), which students can enter their matric number and password to start using the tool. The login page will retrieve data from the database. Then students will be directed to the workspace window. From here, they can choose development software to start working on the programming.

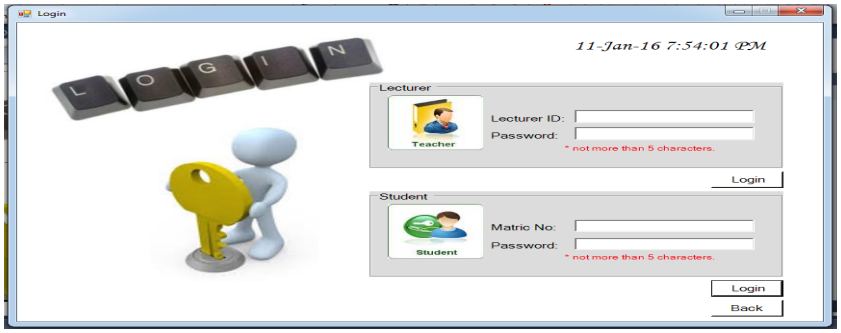

Fig. 4. Login Page

The students' workspace is shown in Figure 5 below. In this page, there are six buttons at the upper row. The buttons include 'software', 'communication channel', 'screen sharing', 'google', 'microsoft office' and 'survey'. These buttons have their own functions that will be discussed in this section. The workspace shows the page of the programming software for students to write their coding in completing their programming assignments.

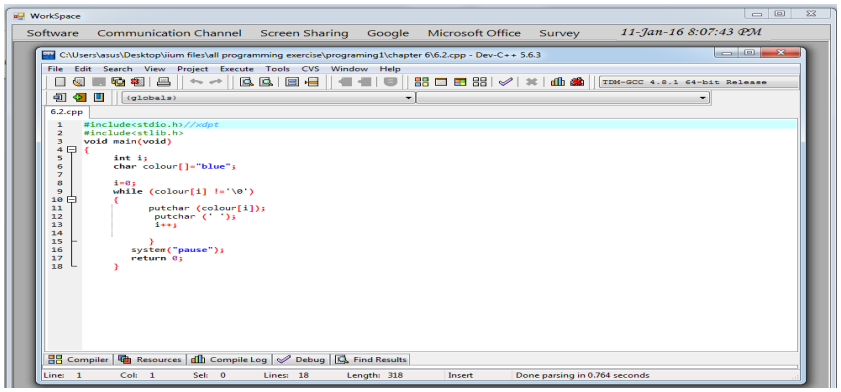

Fig. 5. Workspace

Together in this tool, there are four types of communication channels attached to the workspace. They are text message, voice call, video call, and email. Students can select their preference for communication channel when using the tool. Figure 6 shows a text message channel i.e one of the communication channels included in this tool. Students can communicate with their partners while doing their programming tasks using the communication channel. Students just need to enter their matric number and their partner's matric number before sending the message. The IP address and port number will be retrieved from the information given earlier when they signed up (from Fig 3). Then, they need to click on 'connect' button to be linked to their partner (on different computer).

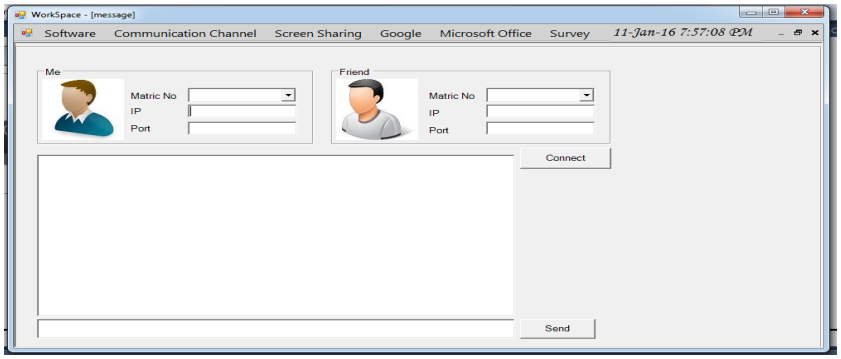

Fig. 6. Communication Channel Workspace (Text Message)

Figure 7 is the voice call application where students can communicate with their partners. Same as before, they only need to enter their matric numbers and their partner's matric number.

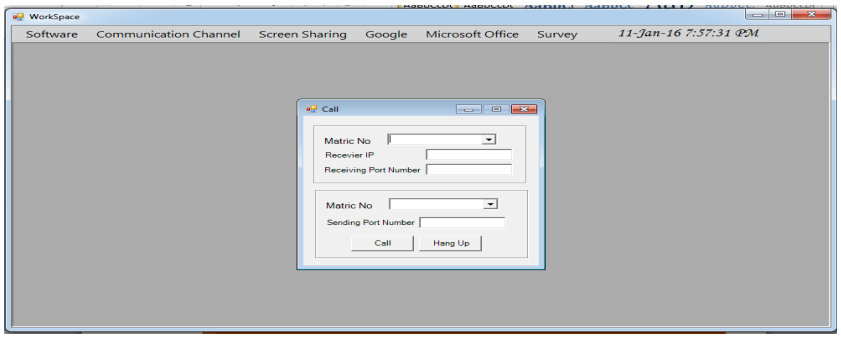

Fig. 7. Communication Channel Workspace (Voice Call)

The video application is shown in Figure 8. Using this page, students can communicate with their partners through video call/webcam.

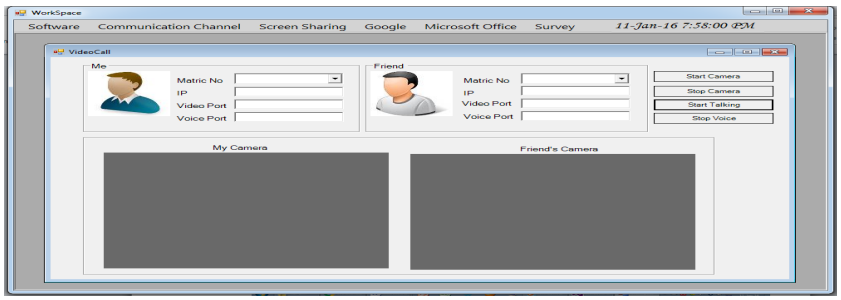

Fig. 8. Communication Channel Workspace (Video Call)

At the same time, students using the tool can also communicate through email. They can submit their completed assignments to their partners or instructor (as shown in Figure 9).

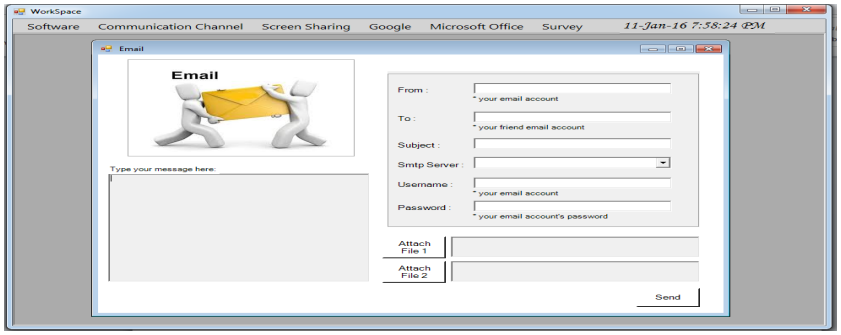

Fig. 9. Communication Channel Workspace (Email)

Figure 10 shows screen sharing page, which direct students to share their desktop screen with their partner to perform the pair programming. This way, students can see their partner's coding activities. Practicing PP, the person who acts as a navigator can observe any errors that occur in the coding, while his/her partner is developing his/her code.

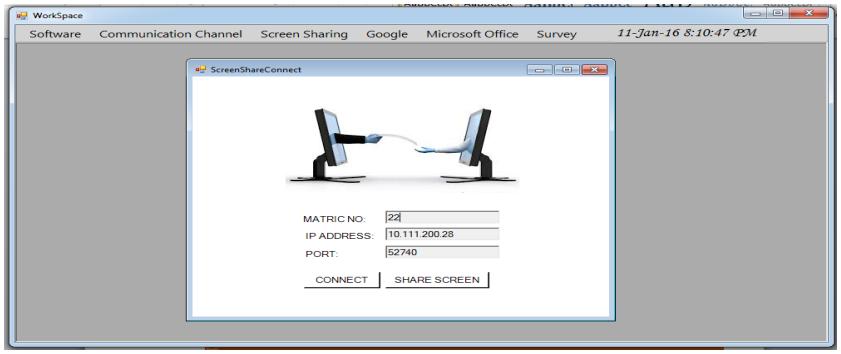

Fig. 10. Screen Sharing Page

In addition, the tool includes Google tab thus allowing students to search any information they require in completing their assignment. This can save students' time as everything can be obtained from this tool.

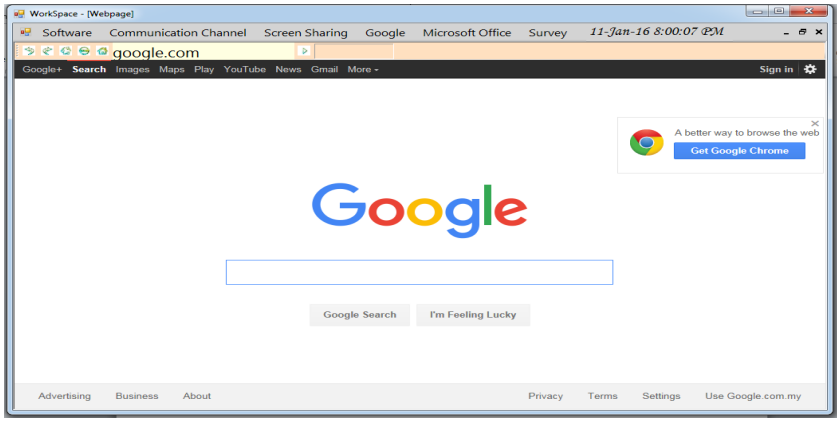

Fig. 11. Google

Furthermore, students can have access to Microsoft Office directly when using the tool. Figure 12 presents one example of directing student to Microsoft Office (Power Point), when using the tool. Microsoft Office Excel and Word are included together in this tab.

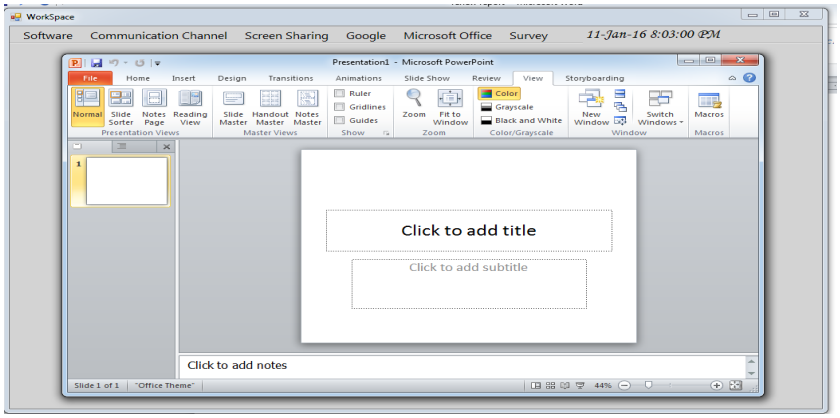

Fig. 12. Microsoft Office

Finally, after finishing their work using the tool, students can give feedback by clicking on the survey tab. Our proposed tool provides all features required to support collaboration activities when practicing the pair programming technique. The tool assists the instructor in focusing to the programming subject whereas the collaboration and pair programming activities are automated by the tool.

5 Results and Discussion

In order to evaluate the effectiveness of the developed tool, an experiment was conducted with first year students from programming class, ECE 1322. In this experiment, nine students were chosen by their lecturer. Five of them were moderate students and another four were excellent students. They were chosen based from their midterm examination's results. A programming question was given to them. Duration of half an hour was allocated for them to complete the program. Prior to the experiment, an introduction about pair programming and the developed tool were given. It is important to provide understanding about the pair programming technique to students and how the tool can help them in performing the PP technique and completing their programming tasks.

They were three categories for the experiment:

- Two groups using the tool (different computer)
- Two groups of traditional partnered but without using the tool (TPP)
- Solo (only one student- without the tool).

Each group (excluding solo) consisted of 2 students (pairing).
In the first category, we had two pairs which were:

- Moderate and moderate
- Excellent and moderate

The second group consisted of:

- Excellent-excellent
- Moderate-moderate students

While in the solo category we placed only one excellent student in it. Summary for the category is shown as in figure 13.

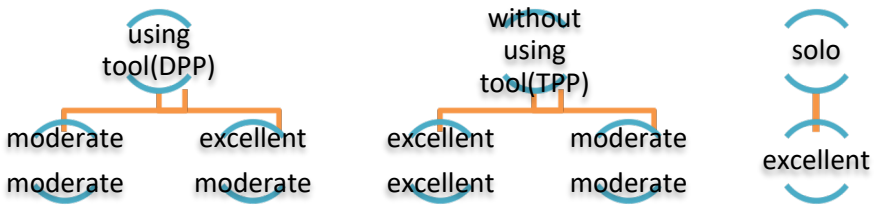

Fig. 13. Categories for the Experiment

The experiment was conducted in order to investigate students' performance when using and not using the tool. The performance was measured in terms of

- The difference in students programming marks between groups.
- The difference in the amount of time spent by the students to complete the programming.

Based on the experiment and from the descriptive analysis, students that used our proposed tool were identified to receive higher marks than those who were doing the programming traditionally partnered (without tool) or solo (without tool). Figure 14 displays the difference of marks among the groups (full marks is 20).

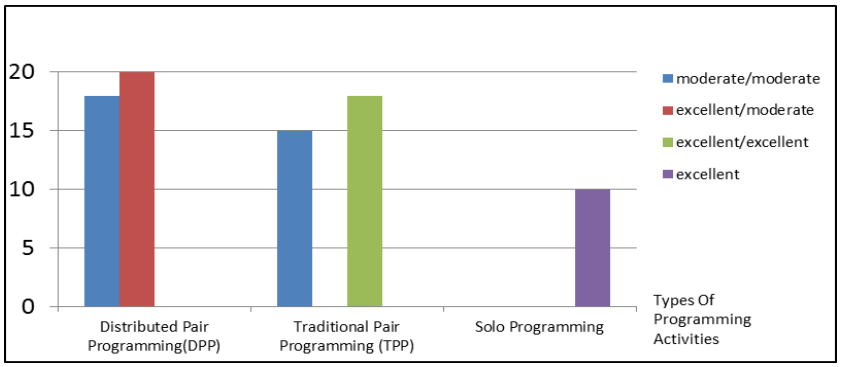

Fig. 14. Difference in Students Programming Marks between the Group

The students using the tool obtained the expected output for the problem given. In addition, their codes were neat and tidy and also they only had few lines of coding when compared to the students without using the tool. From the graph, we can see that in general students using the tool obtained higher marks. It is also observed that the pair of 'excellent/moderate' students received full marks compared to the pair of 'moderate/moderate' students. Their marks (using tool) were higher than the groups without using tool (TPP) and in solo.

Figure 15 shows the time spent by the group using the tool (i.e DPP) was shorter (30minutes) than the solo students (40 minutes). From the results, we can say that the students with tool performed their work quicker than the solo student (without using the tool). Although we assigned an excellent student in the 'solo' category, he did not perform his work well as in comparison to the students working in pairs (with tool and even without tool). The results for using TPP and DPP were obtained from the group of moderate/moderate students (same level).

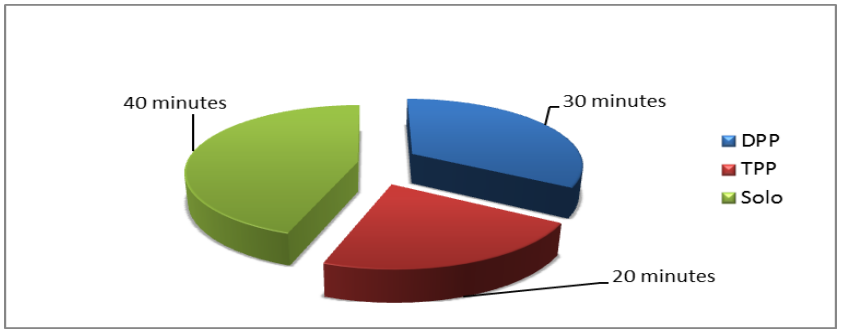

Fig. 15. The amount of Time Spent by the Students to Complete the Programming

Interestingly, the time spent when using the tool (DPP) was longer than the group that was traditionally partnered (TPP- without tool), as shown in Figure 15. From our observation, this might due to students' familiarity with the tool. They were (group of DPP) still new with the tool, which required more time for them to get used to it, resulting to longer time compared to traditionally partnered students (without tool). From the experiment, we did not see any drawbacks from the students practicing pair programming. This is because the students were selected from the same level of studies. Even though there was a group of student having 'excellent-moderate' partner, however the excellent student was not being dominant towards the moderate student. The experiment also showed that pair programming has helped students in getting better marks. This is the result from teamwork activities and collaboration they had when practicing the pair programming technique.

At the end of the experiment, the students were asked to answer the survey questions related to the tool (included as the tab button in the tool). As a result, overall, students were very satisfied with the easiness when using the tool. They found that it was easy to find any information needed through the tool. The interface was pleasant. They also agreed that the tool had all the functions and capabilities that they needed. Furthermore, the tool has assisted them to complete their programming tasks. Finally they have recommended for the tool to be used in programming class. The tool can be introduced to students in completing their programming assignment. (Please email the main author to get the survey questions and detailed results).

6 Conclusion

Educators and engineering educators particularly are always looking for ways to incorporate activities that would increase students' learning and at the same time students' collaborative skill. The main objective of this project was to develop a collaborative pair programming tool for students. The tool was developed to help students practicing the pair programming technique in completing their tasks. Pair Programming was chosen because of the reported benefits it can delivered [15-17] and the same time it can help to expose students to the real working environment. The features we developed in the tool were found to help students to achieve better com-

munication with their partner when doing the programming tasks. Furthermore, the tool has been assisting students in practicing the technique of pair programming with less supervision from their lecturers. The tool provides benefits and has impact in educational setting, for both students and educators. As we all realize, besides the academic aspects, it is very important to instill collaborative skills, team work and communication skills to our engineering students. We want to prepare our engineering students not only to be good in technical aspects, but also in soft skills. From the experiment, the findings showed that the tool can help to improve students' performance in terms of time (reduced) and also their grades (higher). When compared to solo, students practicing pair programming (traditionally partnered, without tool) has shown to receive better marks while when pair programming is practiced with tool, the performance of the students is better than those without using tool. The findings showed that students with tool received almost the full benefits PP technique can offer. For the future, we recommend educators to familiarize students with the tool prior to its usage and increase number of participants in the study. This is to ensure fair results to be produced when evaluating the effectiveness of the tool. We also suggest educators to conduct the evaluation in a full semester; hence can provide inferential analysis from the results.

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Teaching Fundamental Programming Using Augmented Reality

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Abstract—To learn a programming language, the students have to understand the logical flow of the commands as well as the syntax. The logical flow might be more difficult to understand when compared with a syntax which can detect easily. The primary flow of commands or the control structures includes the sequence, condition or selection, and iteration. The students construct the program flowchart by using these control structure. They also have to understand the result of each command execution, step by step. In this research, we propose the technique for developing the learning tool (AR flowchart) to simulate the result of the commands in program flowchart by using augmented reality (AR), so the learners can visualize the result. With this tool, the students can construct a program flowchart as a series of commands by using AR markers. The result of the execution of these commands can be displayed so the students can see whether the logic of the program is correct or not. The design of this tool aims at increasing student engagement and helping them to understand program logic better. The evaluation of the concept results by the group of university students supports our propose.

Keywords—Augmented reality, learning tool, program fundamental teaching, control structure, flowchart

1 Introduction

Computer programming may be easy for someone, but lots of students find it is difficult to accomplish, especially for non-science student. The concept of programming relies on the understanding of programming logic. To teach program logic without having to worry about the syntax, program flowchart is introduced. Program flowcharts consist of a set of symbols connect to form the series of commands for the computer. After drawing program flowcharts, the students should check the correctness of the diagram. Since there are no tools available, students have to do deck checking by themselves to get the result. However, for a beginner, it is still hard to understand without visualization of the result. Augmented reality (AR) is used to provide visualization. AR flowchart is designed and developed to help the students to better understand programming logic by delivering the result of each command that the student can see.

Augmented reality is a technology that provides us with merging the real environment with digital data. There are two types of AR, i.e., marker-based AR and markerless AR. Marker-based AR uses a camera to identify visual markers or objects, to showcase an overlay only when the device detects the marker but marker-less AR relies on a GPS or digital compass, to provide data about the location and the AR visualizations are activated based on these inputs. In this study, the marker-based AR is used, since we want the system to identify each command that the student put into a flowchart by hand. In our design, the symbols in flowchart such as start/end, decision and process will be represented by markers. By aligning the notation (with information) or command in the form of a flowchart, the AR system can read the first symbol (marker) then forward the function or parameter to the next symbol and so on, just like reading each line of the program. After finish reading all of the symbols (markers), then the system compile and generate the result in the form of visualization. Using this technique, students can understand the logical concept of programming logic easily and also enjoy doing them.

2 Related Works

The applications of AR were developed in many areas including advertising and marketing, architecture and construction, military, and travel [1]. The examples of using AR in marketing are 3D catalogs where customers can try out the merchandise and postal box with different displays during the holiday seasons such as Christmas decoration [2]. AR applications are used in military training and war to enhance the ability of the commander in different situations such as the Battlefield Augmented Reality System (BARS) [3]. The examples when applying AR in the travel or tourism industry are AR travel guides and AR museum where additional information can be provided for tourists [4].

There were also many studies that focus on the use of AR in education. In these studies indicates that there are many benefits from using AR such as student outcome improvement [5], enjoyment enhancement, learning motivation enhancement, a better understanding in learning concepts, positive attitude providing, collaboration opportunities providing, and promote self-learning [6]. AR also provides a better tool in prototype development. Students can use AR technology to display digital architecture in the real-world environment without having to build physical construction [5]. With the 3D model, AR will help the students when they are learning of orthographic view [7]. The uses of AR in education are in different approaches such as book, game, discovery-based learning, object modeling, and training [1, 8]. The areas that AR was applied were several include medical education, chemistry, mathematics, biology, physics, and history [9].

To develop the AR application for education, the learning experience should be focused. The factors that are related to learning experience are those about hardware, software, and content. AR can be applied to different types of display device such as the head-mounted display (HMD), handheld device, overhead projectors, and PC monitor [10] Santos et al., 2014.

There are several models to design the instructional tool. The ARCS model is used in this study. The ARCS model is a model that focuses on the motivation of the learner. It is believed that to success in learning, the learner should have the motivation to learn first. The model consists of 4 factors including attention, relevance, confidence, and satisfaction [11]. There is also research which emphasis on using AR to replace the real learning experience that student gained from experimenting in the laboratory using real-time interaction of marker-marker interaction [12].

The attention strategy, for this research, aims at how to get the student attended, and the second factor, the relevance is based on the relationship of the instructional tool and the conceptual understanding. The third strategy is confidence that the students can get when applying the different amount of effort to get the correct result while the final policy is satisfaction where the students can see the success and can help the others.

3 Problem Definition and Requirement Analysis

Programming is the way to create a set of command to do some activities to get the result or to solve the given problem. When the students start to learn how to program, they should understand basic concepts first. One of those concepts is control structures that include sequence, condition, and iteration [13]. The learners got the tasks or problems that they should create a set of commands using the control structure to achieve it. Without worrying about programming language syntax, program flowchart is the graphical presentation that used to represent the sequence of the commands. The difficulty of using the program flowchart is that the students have to understand how each command works and what will be the result when running commands on the flow. If the result is incorrect, the students have to fix the use of commands in the flowchart. Again, they have to check after executing the commands, whether the result is correct or not. For some students, this may be a difficult task because they cannot see the result. If the students have a tool that they can visualize the result of the command, they can understand how commands on the flowchart work better.

To design and develop a tool to help the students to understand better how the flowcharts work, we can divide it into four components, i.e., concept, content, software, and hardware.

3.1 Concept

The idea of teaching fundamental programming where the students can visualize the output from the flowchart diagram can be done using interactive AR. With this concept, each flowchart notation can be replaced by the AR marker and flow of process can be visualized by using marker-marker interaction. Since we can implant the functions or data into AR markers, then programming these markers to interact with others, the final output of the flowchart can be visualized using AR technology. Imagine that we have three markers, A, B and C, placed in respective order. Marker A is set to be the input data, marker B as the function and marker C as the output; These can be shown as the equation (1).

$$y = f(x) \tag{1}$$

From Equation 1, x is marker A or the input; f is marker B which is the function or operation, and y is marker C which is output. The example of the AR marker-marker interaction shown in Figure 1 is the operation of the logic gate. From this figure, the input is zero, and the function is "NOT" operator, then the output from the operation is equal to 1.

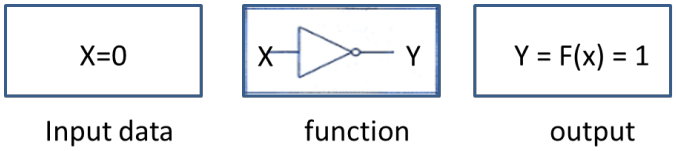

Fig. 1. Marker-marker interaction for NOT gate

When implementing Figure 1 with the real markers (Figure 2(a)), the input or Marker A is zero or off, Marker B indicates NOT operator, and the result of the interaction between Marker A and B will show on Marker C. When running the program, the simulation is shown in Figure 2(b). The same technique will be used in simulating the flowchart diagram.

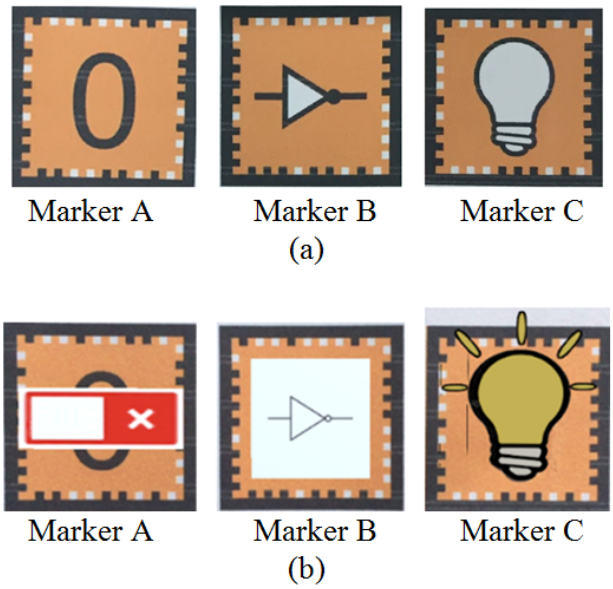

Fig. 2. Implementation of the marker-marker interaction in logic gate (a) and the visual simulation (b)

3.2 Content

Content will cover the problem that students have to solve and the solution that the students have to find out. To learn programming skill, the students have to practice solving many problems, so some different problems should be able to set when using this tool. They must understand the problem first, and then design the logic or sequence of commands to solve the problem which means that the students can set different problems based on this tool.

Building a flowchart to solve the problem is like setting the flow of command. Students should be able to show that they understand types of command as well as the order of command in the flowchart. The primary control structures that included are sequence, condition and repetition or loop as shown in Figure 3. These structures will be used to construct a series of command to provide the result for the problem. Moreover, the tool has to support the use of variable such as they may require setting the initial values for the variables and setting Boolean expression for the condition.

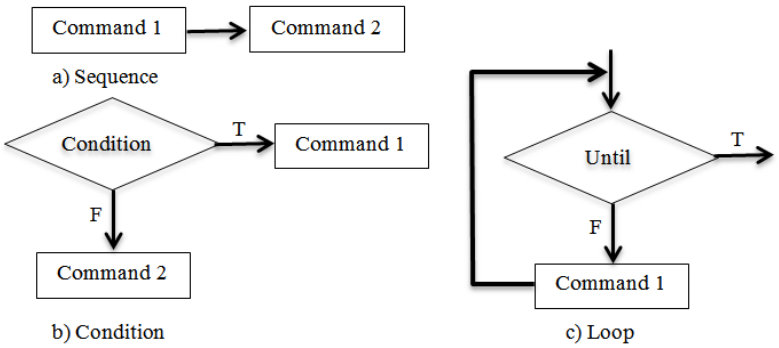

Fig. 3. Basic control structures

3.3 Software

The software application is developed to capture the image of the flowchart that student construct, process the program and show the result of command execution. From the capturing image, it should be able to identify the command, the value of the variable and Boolean operator. Then the software should simulate the result of each command. Since the commands are connected, the output from the previous command will be sent to be the input of the next command as mentioned in 3.1. The user interface of the application should provide enough information for the students to understand what to do, or what is the result.

In this research, the software required for developing the AR applications consists of Unity 3D cross-platform game engine along with Vulforia AR Software Development Kit (SDK) for mobile. We also used Xcode, which is an integrated development environment (IDE) for macOS, for building applications file for iOS devices.

3.4 Hardware

There are two groups of hardware used, one for generating AR applications and the second one for running the applications and visualize the output. For developing applications program, MacBook Pro with Intel core i7, 16 GB memory and Intel Iris Plus Graphics 650, was used along with Logitech Brio. For running the applications, the device should be able to use as an input device to track the commands in a flowchart. It is also used as an output device to display the digital image over the real world object. The output is display in real time, so it should be able to display smoothly. In this case, iOS devices, such as iPads or iPhone was used for this purpose.

4 The Design of AR Flowchart System

The theme for setting the problem, in this case, is the parcel delivery. The reason for selecting this theme is that the objective of the problem is clear to everyone. The delivery person has to send the right parcel to the right destination. We can also add more condition when the learner understands the basic one such as when there is nobody at the destination the delivery person has to take the parcel back to the office. The board in Figure 4 is showing the map of the road that used as the main ground for the experiment. The environment of the roadmap can easily set by placing houses on a different position on this map.

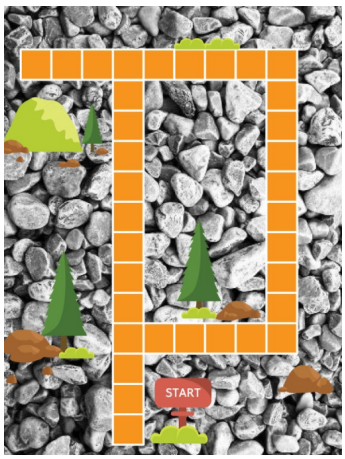

Fig. 4. Roadmap

The commands for this case are commands for delivery the parcel and commands that give the direction to the delivery truck such as go straight, turn left, turn right, and U-turn. There are many variables used for this problem domain such as the color of the house or absentee of the receiver. For example, the delivery person has to send the parcel to the house with the same color, i.e., he or she has to send the red parcel to the

red house. Another condition for parcel delivery is that the delivery person cannot deliver the parcel to the empty house.

Figure 5 shows the example of the markers which are the blue house destination, the receiver, the delivery truck, go straight command, and the blue parcel. With these markers, the students can construct the flowchart that contained a series of the marker. The students can also create the condition statement by setting the condition of the color of the parcel that has to be matching the color of the house at the destination.

Fig. 5. The Markers

(a) (b)

Fig. 6. A simple delivery problem and the solution

For example, if the problem is "give the instruction (to the delivery person) to send the parcel to the blue house," the roadmap should contain two markers that indicate the parcel and the destination as shown in Figure 6 (a). The learner is then constructing the flow of instruction as a solution by using the set of markers as shown in Figure 6 (b). Figure 6 can represent question and answer or solution to that question. The problem can be changed differently by moving the markers on the roadmap.

The flowchart should be constructing in a top-down approach. With the house marker, students can set their roadmap environment by placing the house marker on this map. The AR flowchart software is designed to detect the new environment of the roadmap, the series of command and variable in the flowchart, and the input (color of the parcel to deliver). The red or green color is used to indicate the completeness of marking tracking process as shown in Figure 7. Besides the use of color, the learner can also check the integrity from the list of markers that have been scanned showing on the left-hand side as shown in Figure 7 (b).

(a)

(b)

Fig. 7. Tracking the markers in a flowchart

For the hardware factor, Apples' iPad has been used as a handheld device to capture the marker images and show the result of the command execution. From Figure 8(a), the 3D animated picture of the truck with parcel will display after the capturing processes of the roadmap environment, the flowchart, and the delivery parcel are completed. Figure 8(b) shows the truck on the move according to the command after the Start Button is selected. Figure 8(c), (d), and (e) shows the process of delivery and the truck returns to the starting point.

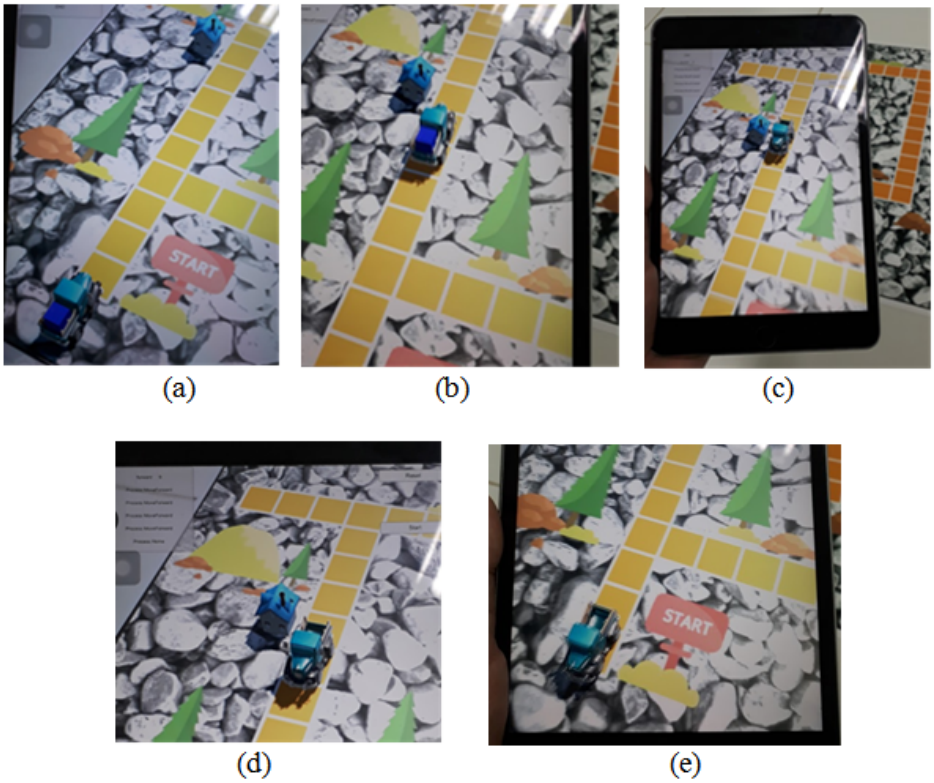

Fig. 8. The visualization showing the result from commands in flowchart

5 Evaluation

The experiment was conducted at Walailak University (Figure 9). The sample size for this experiment was 20. The participants were students who take the study program that offering Programming Language course from School of Informatics and School of Science. They were the students in Information Technology (IT), Software Engineering (SWE), Computational Science (CSC), and Multimedia Technology and Animation (MTA) study program as shown in Table 1.

Fig. 9. Students are experiencing the AR flowchart

Table 1. Number of student from the study program

Study program	Number	Per cent
IT	10	50
SWE	2	10
CSC	3	15
MTA	5	25

The experiment starting from setting both simple and complex problems that students have to find the results such as how to deliver the parcel to the destination with the condition that the parcel can only deliver if there is the receiver or person at the destination. Next, explaining the meaning of the markers and show them how to connect the makers to form the flowchart. After the flowchart was constructed, we showed them how the application on the handheld device works and how they can see the result. Then we set the new task or problem and ask each student to construct a new flowchart that can give the result for that task. When the students finished the test, they were asked to answer the questionnaire that consists of six close-ended questions and one open-end question. The Likert scale was used to answer the closed end questions. The highest score is five, and the lowest score is one.

6 Result and Discussions

Table 2. Response from closed-end questions

Question	Mean	SD
1. The use of the symbol in the flowchart is easy to understand	4.60	0.50
2. The ease of flowchart construction using the markers	4.35	0.67
3. The ease of using the application to simulate the result	4.45	0.60
4. The understandable of the result from the simulation	4.50	0.61
5. The improvement of understanding the control structure by using the flowchart	4.70	0.57
6. Overall satisfaction of the user	4.70	0.47

The results from 20 students are summarized in Table 2, and the average scores for each question from the students in different study program are shown in Figure 9. The highest mean value is 4.7 from question 5 and 6. For the first question, the students found that it is easy to understand the image on each marker. When they were asked about the ease of flowchart construction in question 2, the mean value for this item is 4.35 which indicate that it is easy. The students found that the use of the software application is also easy (mean value is 4.45). The visualization showing the result of the command is also easy to understand. It is found that the students were highly agreed that using this AR flowchart will improve their understanding of using control structure. They are very satisfied with using it.

For the open-end question that asks the students to express their opinion, there were 11 responses from 20 students. Some of the opinions are similar; they can be grouped into four categories:

- This project should continue
- Sometimes it is difficult to use the iPad to track the markers
- Wonderful technology
- It is fun

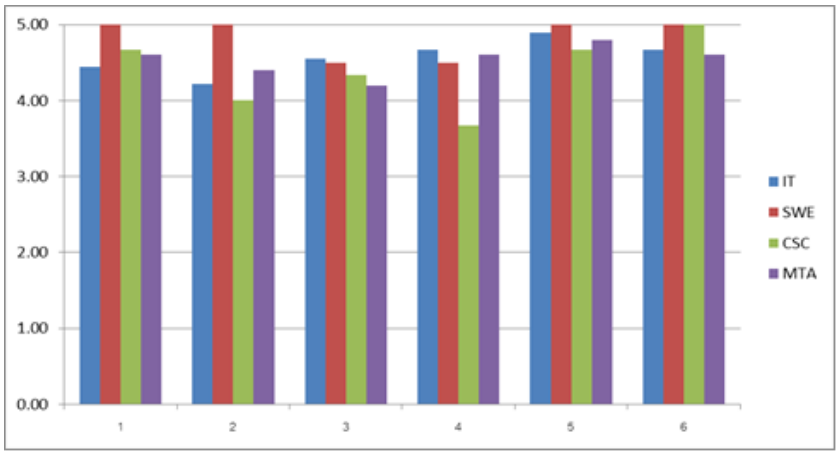

Fig. 10. The response from students in different study program

7 Conclusion and Future Works

The AR flowchart can help the students to visualize the result of the command execution. From observation, the students enjoy setting several problems and observe the results. When the result is not correct (i.e., deliver the parcel to the incorrect receiver), they can adjust the diagram and check the result. The AR flowchart can be considered to support the student-centred approach because the student can set the task or problem that they want to solve. AR flowchart also enhances student engagement since the student try to find the set the command that the delivery truck complete the delivery

mission successfully. When one student had finished the experiment, they did not leave the class but prefer to observe other students' experiment.

The future work for building this AR flowchart will be the focus on upgrading the code on tracking the maker and add the complexity of condition and iteration control structures.

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Understanding the Level of Self-Directed Learning and Decision-Making Style of Construction-Related Workers

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Abstract—Current serious game framework still lacks in fulfilling the user's requirements. This is due to the framework elements which only focus on the process of delivery. Hence, this study was carried out to determine user's ability in self-directed learning and their styles in making a decision. This study forms part of a larger research on a framework for serious game frameworks for hazard identification training modules. A set of questionnaire consisting of three sections which are demographic, decision-making styles and levels of self-directed learning was designed. In decision-making styles, 49 items are measured representing eight styles in decision making such as vigilant, dependent, avoidant, anxious, confident, spontaneous, brooding and intuitive. Meanwhile, a self-rating scale consisting of 50 items was used to measure the level of self-directed learning such as awareness, learning strategies, learning activities, evaluation and interpersonal skills. Data was collected from 319 construction-related workers and analysed using mean comparison and ANOVA. Findings confirmed that their style of decision-making is inclined to 'vigilant' and 'brooding' types. The results revealed two levels of self-directed learning, namely, the moderate level for supervisor and high level for general workers, skilled workers, consultants, management teams and safety trainees. This level of self-directed learning is influenced by their level of education and working experiences. The findings also highlight that decision-making style has a moderate relationship with the level of self-directed learning among construction-related workers. The study contributes to the understanding of the construction workers' needs in enhancing their skills in becoming independent and lifelong learners

Keywords—Decision-making style; Self-directed learning; Construction-related worker; Adult learning

1 Introduction

Nowadays, training using application from technology has become a trend. As a result, some researchers have explored other methods to improve the delivery of training modules especially in terms of the usefulness of technology in creating interactive training [1], [2]. By using technology, training has become more flexible in

terms of time management, cost and experience [2]. Thus, this study was made to assess the decision-making style and the ability to learn by themselves so as to ensure the serious game training module can be practiced in the industry. This study will be further extended to develop an interactive training module. In sum, the results of this study will not only contribute to a better understanding of construction workers' needs in the area of continuous learning but the findings are also expected to have significant implications on the Malaysian construction industry at large.

2 Literature Reviews

Adult learner as individuals which be able to take his/her own responsibility regard-ing their life matter (Illeris 2007; p.16). One of the characteristics of the adult learner is self-directed, self- direction or "self-directed learning"; which is the second "pillar" to the field of adult learning and education [4]. Self-direction can be described as a process which learners take initiative by their own self to fulfil their learning needs to achieve their goals [5]. However, in order to train adult learner in making decision, their decision-making styles need to be identified. Hence for the purpose of the study, two main elements which are level of self-directed learning and decision-making styles were determined.

2.1 Self-directed learning

Self-directed learning can be summarised as a process which learners take their own initiative to achieve their goals especially to improve their ability in the working environment. According to Brookfield (1995) the individual which enjoyed self-directed learning have high qualities in moral, emotional and intellectual autonomy. He further asserted that individual who are ready to learn by themselves is a context-free person. This individual already mastered technical skills and consists of three major components which have the ability to identify learning purposes, locate learning resources and manage learning endeavors (p. 155). However, many researchers try to address these characteristics of the self-directed learner Cazan & Schiopca (2014), Mayhew (2008); Abdullah (2001) have reviewed the literature resulted in a slightly different set of characteristics of self-directed learning which are [1] demon-strate a heighten sense of awareness of their responsibilities in their learning; [2] moti-vation and willingness that drives the decision to participate; [3] learners exercise independence; and [4] the ability to transfer knowledge to new situations. However, the characteristics identified by Abdullah (2001) are congruent with the characteris-tics by Garrison (1997). Garrison (1997) identified characteristics which are self-management, self-monitoring, and motivational dimensions as the foundation for his comprehensive self-directed learning model. Based on the characteristic, he indicates that adult learners become involved in self-directed learning because of their ability to control when, where and the type of learning that takes place. In addition, self-directed learning requires increased levels of effort, focus, direction, motivation, self-control and readiness [11].

2.2 Decision-making style

The efficiency of decision-making styles lies in telling us something about the deci-sion-maker. Scott & Bruce (1995) in their study sought to understand how people differ in arriving at a choice, how satisfied people are with their choice Crossley & Highhouse (2005), and how people arrive at good decisions [14]. Understanding how people arrive at good decisions would provide guidelines to help us eliminate potential errors in judgment. The decision-making style is considered to be a habitual response pattern, which is influenced by characteristics of both the individual and the situation [12]. As such, it appears that, although people generally use one style most of the time based on their individual characteristics, this may vary as required by the situa-tion. Various researchers have classified decision-making style in different perspec-tives. Harren (1979) in this work indicates that there are three decision-making styles in choosing carrier i.e. [1] dependent, [2] rational, and [3] intuitive. Followed by Scott & Bruce (1995) which has extended the decision-making style categories by added two more styles which are avoidant and spontaneous decision making. Mann et al. (1998) in his study add five subscales which are self-esteem, vigilance, defensive, avoidance, and hyper vigilance. The latest study carried out by Leykin & DeRubeis (2010) developed The Decision-Making Style Questionnaire which consisted of nine styles, they added five more types of styles which are respected, confident, dependent, brooding and anxious.

3 Methodology

This study sought to determine the construction-related worker's ability to learn by themselves and style in making decision. Hence, the inferential research approach is applied. This type of research study is associated with describing the characteristics of a specific individual, group or phenomenon. Inferential research process most common procedures involving developing research objectives, collecting data, and making statements about a population based on sample analyses [17]. Thus, in this phase, each variable is solely discussed on determining the level of self-directed learn-ing and style in making decision. This characteristic is determined to understand the ability of the construction-related workers to self-directness. It is also to understand their willingness to learn by themselves to ensure the practicability of serious game training module in Malaysia construction industry.

A questionnaire is an instrument used to determine the level of self-directed learning and decision-making styles among construction-related workers. The purpose of this data collection is to understand construction-related workers capability in making decision and self-directness learning. Therefore, the questionnaire was designed to discover the level of self-directed learning (SDL) and type of decision-making style (DM) in establishing the user characteristics for the serious game training module. The questionnaire is divided into three sections [a] Demographic detail, [b] Decision-making style and [c] Level of Self-directed learning. Data were then analysed using compare means methods. Spearman correlation test also conducted to determine

whether there is or not the relationship between decision-making styles with a level of self-self-directed learning.

4 Results

Table 1 shows the mean comparison between the construction-related worker's groups. The result shows that the highest mean for General workers and the Semi-skilled workers is brooding style (M=17.69). Thus, it reflects that they are always worrying when they have to make a decision. Meanwhile, the highest value for Skilled workers (M=17.61), Supervisor (M=19.00), Consultant (M=20.74), the Management team (M=20.22) and Trainee (M=19.58) falls into vigilant style. The vigilant style means they are being too careful when making a decision. They considered the pros and cons before making a decision. General workers and Semi-skilled workers are the only groups which is categorised under brooding style for making a decision. These findings gave new perspectives towards these groups because the brooding style is described as a serious thinker who is always worrying when they need to make a decision. The brooding style is also known as a serious type which realistically is aware of their own capabilities. Serious people are responsible for their actions, but in the decision-making, they always worry when they need to make a decision. Hence, this finding is surprisingly different from their role on the site. Both groups are following the orders from the top management on the construction site, they do not require to make a major decision and have a limited scope of work. However, both groups are the riskiest groups that always are involved in accidents on the construction sites. Hence, all these findings will become guidance in designing the flow and level for serious game training framework.

Table 1. Compare means for decision-making styles

	General & Semi-skilled workers	Skilled workers	Supervisor	Consultant	Management team	Safety trainees
Avoidant	15.48	14.61	13.83	14.09	13.17	15.01
Dependent	17.24	15.96	16.81	16.13	16.54	18.44
Confident	16.59	16.65	16.77	16.13	16.17	17.16
Anxious	16.59	16.04	15.13	16.00	13.29	16.51
Vigilant	17.66	17.61	19.00	20.74	20.22	19.58
Spontaneous	17.14	16.39	15.98	16.78	15.43	16.58
Intuitive	13.93	13.74	11.98	13.48	12.24	13.72
Brooding	17.69	16.61	16.50	16.13	16.03	17.34

Descriptive statistics with a mean score between the group of construction-related workers and level of self-directed learning are shown in Table 2. The results show the respondents' level of self-directed learning based on five broad areas. For awareness, the area is measured according to the ability of the respondent to understand the factors that contribute to becoming self-directed learning, for example, internal motivation, self-motivation, and decision-making. Results show that all groups of workers

like General workers and Semi-skilled workers (M=37.28), Consultant (M=40.26), the Management team (M=38.83), Supervisor (M=36.98), and Safety trainee (M=38.48)] except for Skilled-workers (M=35.09) group have a high level of awareness in self-directed learning. It is relatively easy to describe that respondents are aware of the importance of continuous learning and always attend various training to enhance their learning according to the needs of the industry. All respondents were able to identify their learning needs, keep up-to-date with available educational resources and have a high level of self-motivation. Furthermore, the respondents believe that they have the ability to plan and select the learning methods for themselves. Thus, it can be concluded that construction-related workers have a high level of awareness and responsibility in anticipating a lifelong learning process.

Table 2. Compare means for the level of self-directed learning

Group of Workers	N	Mean				
		Awareness	***Learning Strategy***	***Learning Activities***	***Evaluation***	***Interpersonal skills***
General & Semi-skilled workers	29	37.28	37.66	36.62	37.52	38.83
Skilled workers	23	35.09	36.83	36.52	36.52	37.30
Supervisor	48	36.98	37.10	37.71	38.63	38.17
Consultant	23	40.26	39.78	39.35	40.57	41.65
Management team	63	38.83	38.56	38.52	38.71	39.00
Safety trainees	133	38.48	39.02	38.75	39.14	39.74
TOTAL :	319	38.10	38.41	38.24	38.75	39.24

Learning strategy is the second area of self-directed learning that needs to be measured. This area would determine the ability of construction-related workers in adopting various strategies in their learning process. Group discussion, 'role plays' learning, case study, and learning aid with technology are the examples of learning strategy that could apply to self-directed learning. The results show all group of workers have a high level of learning strategy. Consultant group are the highest scorers (M=39.78), followed by the rest. The next area is related to the required learning activities that construction-related workers should actively engage to become self-directed in their learning process. For this area, all groups of workers have a high level of the mean scores which is above 36.00. Consultant (M=39.35) had the highest mean scores, followed by Safety trainees group (M=38.75), the Management team (M=38.52), Supervisor (M=37.71), General workers and Semi-Skilled workers (M=36.62) and Skilled workers (M=36.52). Based on the results, it can be concluded that all construction-related workers have the ability to make notes by using mapping concept, make a summary of learning, be able to use information technology, pose relevant questions in teaching-learning session and related experience with their learning.

In determining the level of self-directed learning, construction-related workers not only participate in their learning but also they need to have specific attributes to help monitor their learning activities. They should be able to make self-assessment, criti-

cism, review and find a new challenge in learning. For this area, evaluation, the results show that the construction-related workers have a high level to make an evaluation for their study. As expected, the Consultant group is the highest with a mean score of 40.57, followed by Safety trainees group (M=39.14), the Management team (M=38.71), Supervisor (M=38.63), General workers and Semi-Skilled workers (M=37.52) and Skilled workers (M=36.52). The last area of self-directed learning is the interpersonal skills which are related to the Skilled in the interpersonal relationship. This area is a pre-requisite to the construction-related workers in becoming self-directed learners. Analysis of the data reveals that all groups of workers have a high level of mean scores in this area. Consultant group (M=41.65) is still in the lead with the highest mean score among the other group of workers. Followed by Safety trainees group (M=39.74), Management team (M=39.00), General workers and Semi-skilled workers (M=38.83), Supervisor (M=38.17), and Skilled workers (M=37.30). The construction-related workers especially the Consultant group can interact with others without having any problems. They share information with others and can express their views clearly and also they can make use of any opportunities when it is available.

All mean scores from five broad areas were computed and transformed into a single variable which is self-directed learning. Three levels of self-directed learning (low/dependent, moderate/interest and high/independent) were determined. Finally, it was inferred that Consultant group (M=40.32) has the highest mean score, followed by Safety trainee group (M=39.02), Management team (M=38.72), Supervisor (M=37.71), General workers and Semi-skilled workers (M=37.57), and Skilled workers (M=36.45).

After that, the Spearman rho correlation test was carried out to determine whether there is or not the relationship between decision-making styles with a level of self-self-directed learning among the construction-related workers. This relationship will determine whether the level of self-directed learning influence the decision-making style among construction-related worker. Spearman correlation test analysis results in Table 3 and Figure 1 indicate that the relationship between decision-making styles and level of self-directed learning is significant ($r = .37$, $p < .05$). Thus, it shows that there is a relationship between decision-making styles and level of self-directed learning among the construction-related workers. The strength of the relationship between the decision-making styles and level of self-directed learning is moderate ($r=.37$). Based on the results, it can be concluding that the decision-making styles are related to the level of self-directed learning within the population of the construction-related works.

Table 3. Correlation between self-directed learning and decision-making style

			SDL	TDMS
Spearman is rho	Level of Self-directed learning	Correlation Coefficient	1.000	.373**
		Sig. (2-tailed)	.	.000
		N	319	319
	Decision-making Styles	Correlation Coefficient	.373**	1.000
		Sig. (2-tailed)	.000	.
		N	319	319
**. Correlation is significant at the 0.01 level (2-tailed).				

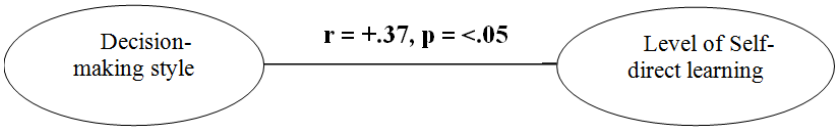

Fig. 1. Correlation between level of self-directed learning and decision-making style

5 Discussion

The result of the findings indicates that General workers and Semi-skilled workers fall under brooding styles and the rest are under vigilant styles. It shows that General workers and Semi-skilled workers are not only low profile but always think deeply before making a decision. Usually, they will regret the actions or decisions that they have made. However, they are always responsible for the action they have taken. Meanwhile, for skilled workers, Supervisors, Consultants, Management teams and Safety trainees, they are more vigilant in making a decision. These findings show that they are independent people who have insights and very careful in protecting their own interest. Despite this, they are loyal and always alert to criticism. Both of these styles need to be improved and changed toward spontaneous styles in making a decision. Time is the essence in handling the hazard especially when the unexpected hazard emerges during the working environment.

The construction-related workers need to be able to take immediate action to prevent accident occurrence on the construction site. These findings will guide the designer or trainer to design an appropriate decision-making process to train the construction-related workers to make immediate and wise decision in handling hazard on the construction site. In terms of self-directed learning, all groups of workers have the ability to self-directness. They have the aptitude to take initiative in identifying their learning needs.

Besides, they are capable of formulating their learning goals and choose resources for learning. Moreover, with their expertise, they are able to employ suitable learning strategies and assessing the learning outcome according to their needs. It shows that the construction-related workers have the capability to choose their own needs of learning and learn by themselves. This is where the level of self-directed learning among construction-related workers can bridge the missing link between the needs for knowledge and hands-on training. In evaluating the self-directed learning among

construction-related workers, this study has identified five broad areas of self-directed learning (i.e. awareness, learning strategies, learning activities, evaluation and Interpersonal skills).

As a summary, in term of making a decision, General workers and Semi-skilled workers are more on serious (brooding style) in making a decision. The rest of the groups are categorised under the vigilant style. For self-directed learning, the construction-related workers are an independent learner who has a high level of self-directness. Table 4 below shows the summary of findings of user characteristic for the construction-related workers.

Table 4. Summary of user characteristic

User character	Scope of character in making decision	User character
General workers and Semi-Skilled workers (brooding style)	No pretentious - low profile Accountability – responsible Cogitation – thinking deeply Contrition – regret	The learner has the ability in: taking the initiative in identifying their learning needs formulating learning goals choosing learning resources employing suitable learning strategies assessing learning outcomes
Skilled workers (vigilant style)	Autonomy – Independent Caution - careful Perceptiveness - insightful Self-defence – protect own interest Alertness to criticism Fidelity – loyalty	
Supervisor (vigilant style)		
Consultant (vigilant style)		
Management team (vigilant style)		
Safety trainees (vigilant style)		

6 Conclusion

It is an anticipated result because the development of game training module would be a great significance in enhancing knowledge. The construction-related workers will be encouraged to keep developing themselves and to keep up with the industry requirements. By adopting serious games as training tools, it will provide a good prospect for the construction industry. The serious game offers an affordable, interactive and entertaining module. It also provides a flexibility training module which can be easily accessed at any time and anywhere according to the needs of the construction-related workers.

7 Limitation and Future Study

In developing the games training modules, there are three elements that should be considered which are the input, process and outcome. All these three elements gave significance in terms of the body of knowledge, especially in training delivery for hazard identification. This is ongoing research which this output will be integrated with other elements to design the serious game framework for the hazard identification training module.

8 8 Acknowledgement

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Framework for Developing a Mobile Augmented Reality for Learning Chemical Bonds

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Abstract—This paper presents the framework for developing a Mobile Augmented Reality (MAR) for learning Chemical Bonds, which is believed to reduce misconceptions among the students. Misconceptions always occur in classrooms, especially in science subject's which consist of abstract concepts. It is very important that these misconceptions be reduced, because they may affect the student's understandings of topics they have learned about. These may interfere with the student's education, and may also affect the student's performances afterwards. Visualization is one key approach that has been proven to help when seeking to improve the understanding of students, which has consequently led to a reduction in misconceptions. There are many technologies that have been integrated within education, and that show strong potential for producing visualizations. One of the recent popular technologies that have the potential for visualization is Mobile Augmented Reality. Mobile Augmented Reality has the ability to visualize abstract concepts through 3D images

Keywords—Mobile augmented reality, chemical bond, misconceptions, visualizations

1 Introduction

One of the electives science subject that less interested by students is Chemistry because students' found that Chemistry is hard to understand. Chemistry is actually the core to the others part of sciences that will equip the student with the knowledge that can help them to think critically and scientifically in order to find a solution while making decision and solving problems. According to Uzuntiryaki and Geban [1], students will fall in misconceptions when students have difficulties in understanding most of the concepts in chemistry which then will lead to prevention of meaningful learning.

There are several definitions of the terms 'concept' and 'misconception'. Eggen and Kauchak [2] have stated that an understanding of what happens around us through ideas, objects or events, is a concept. Misconceptions, on the other hand, can be described as ideas that provide an incorrect understanding of what happens around us. Misconceptions are also known as mixed conceptions, or conceptual misunderstandings [3].

Misconceptions are more complex and prevalent than simple misunderstandings, or the receiving of incomplete information [3]. There are multiple methods for arriving at misconceptions. They can occur as a result of a misunderstood vocabulary, or because of the result of combining several ideas into one [3]. Misconceptions also represent an important factor that affects learning. They can be acquired prior to enrolling in any school program, or they can be triggered at any stage of formal education [4].

According to Palmer [5], misconceptions among students have to be taken into account, because they can interfere with a student's learning of scientific principles and concepts. Therefore, the selection of teaching methods plays an important role in avoiding students' misconceptions [5]. There are many studies that have been conducted as a means of identifying students' misconceptions within the Chemistry field ([6], [7] & [8]). The problem of misconceptions always occurs in regards to the topic of chemical bonds, because students have difficulty visualizing and understanding the related concepts [9]. As example in chemical bonding, students will tend to craft an alternative conceptions as students try to figure out the meaning from what is said by the teacher or what is written in the textbooks because the concepts of this topic is abstract [10].

Abstract concepts that consist in the topic of Chemical Bond cannot be directly applied to everyday life. Consequently, students faced difficulties in understanding the chemical bonding concept [1]. Based on the results of Sijil Pelajaran Malaysia, there are a lot of students still confused in answering simple questions regarding the topics of chemical bonding [11]. The common problem among the student is they cannot write the sequences of electron for the ionic bond and covalent bond and also difficult to create mental diagram about the formation of the bond [11].

Moreover, a conclusion has been made by Mohd Nor and Nur Afza [11] in their research that there are few problems in the study of chemical bonding that lead to the misconception among the students. The findings show that students still have difficulties in differentiating between ionic bond and covalent bond and cannot identify the conditions of every chemical bond that form between the elements. Besides, students also not confident in drawing the diagram of the electron sequences for the ionic compounds and covalent compounds which lead them to answer wrongly. Other than that, the problems in the topics of chemical bond that exist among the students are they cannot draw the Lewis structure in the right way because they faced difficulties in visualizing the abstract concept [11]. Therefore, students need visualization tools in order to build their understanding and help them to prevent the misconception.

It has been proven by Sanger and Badger that a visualization tool can positively affect students' conceptual understanding [12]. In the research by Taber [13], he suggests that school curriculum should include representations of science such as animations and videos. There is also research by Jones et al. [14], which found that many students are able to correct their misconceptions after viewing either static molecular visualizations or animations [14]. Visualization is significantly important, especially in Chemistry, because the subject involves atoms and molecules than cannot be seen by the naked eye, making visualizations important [15][16].

Vavra et al. [17] identified three important distinctions within the conceptualization of visualization objects. Visualization objects can be pictures, three-dimensional mod-

els, schematic diagrams, computer-generated displays, simulations, animations, geometrical illustrations, videos, and so on. Objects can be displayed in a variety of media formats, including on paper, slides, computer screens, interactive whiteboards or videos, and some can be accompanied by sounds and other sensory data. Introspective visualizations are mental objects pictured by the mind. They can be considered imagined visualization objects. Interpretive visualization involves taking meaning from visualization objects or introspective visualizations, in relation to one's existing network of beliefs, experiences and understandings. This will then lead to the prevention of a misconception problem.

When visualization is utilized within Chemistry education, students can reflect on different concepts of Chemistry which they have learnt about during their learning process [15]. According to Nahum et al. [9], understanding many concepts and topics in Chemistry is essential because, recently, there have been difficulties regarding students' understanding of the concepts of Chemical Structure and Chemical Bonds.

There are many new technologies serving as visualization tools that have emerged, and that have a potential to be integrated in order to reduce misconceptions within sub topics, such as Chemical Bonds. An example of a particularly advantageous visualization tool is Augmented Reality (AR).

According to Shelton and Hedley [18], AR has a lot of advantages, and great potential for enhancing instructions and improving student understanding of complex concepts and contents. Therefore, these advantages can be applied to the topic of Chemical Bonds, in order to prevent misconceptions that result from students' inability to visualize bonding. Besides, AR also allows for detailed visualization and object animation, through which students can view and interact with the 3D images during learning processes [18]. This is because AR is displayed through different ways and angles of view, which enable students to understand the subjects better.

Based on meta-analysis from previous studies that have been conducted in regards to AR, there are many applications that have been developed within several fields, but are not limited to education. However, the number of studies and applications of Mobile Augmented Reality (MAR) are still low. According to FitzGerald et al. [19], the use of AR in education, particularly within mobile learning, is still in its earliest phase. This is still a phase of changing and improving, but studies have shown that AR can be used successfully within constructivist learning, that involve collaboration and student inquiries. Collaborative learning is claims one of the most effective learning strategies in polishing students' communication skills and also providing supportive environment for student [20]. Besides, it seems possible that mobile phones can be used in learning processes, as only a small percentage of students do not own or use mobile phones [21]. According to Chee et al. [22], the smartphones is currently the most widely devices that been used in mobile learning which this proven that mobile phone is relevances to be use in learning process.

Furthermore, mobile phone/tablet computing is associated with a higher degree of comfort and familiarity, with the size and practically of the technology making it more portable than laptops. This fact is supported by research conducted by Oostveen et al. [23], in which students tended to frequently bring tablet PCs to class. Mobile

technology also shows a positive outcomes and proven can motivate the students to actively engaged in learning [22][24].

Therefore, the main objective of this research is to develop a MAR application that will help students to visualize abstract concepts within the topic of Chemical Bonds. This may lead to the prevention of misconceptions within student learning processes in regards to the particular topic, and will also encourage students to learn in a way they prefer. However, in order to make sure that the process of developing the MAR is undertaken in parallel with research objectives, a proper framework is referred to as a guideline. Thus within this research, there is a cognitive theory of multimedia learning [25], and the principles for developing visualizations tools within the field of Chemistry [26] are being followed.

2 The Cognitive Theory of Multimedia Learning

Multimedia presentations represent an effective means of delivering information to learners, regardless of whether they prefer visual presentations or verbal presentations, as illustrated by Mayer and Moreno [27]. Therefore, multimedia has been recognized as a good medium for delivering information. Besides, Mayer and Moreno [27] have also stated that the multimedia instructional environment has been widely recognized as one that has great potential for improving learning processes. Figure 1 presents the framework of the Cognitive Theory of Multimedia [25]. There are four phases within the theory, which include multimedia presentation, senses, working memory and long-term memory.

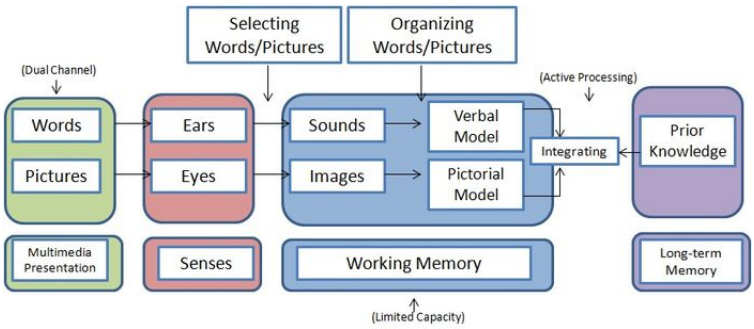


Fig. 1. The Cognitive Theory of Multimedia [25]

In Mayer [25], there is statement regarding how cognitive theory contributes to the suggestions of Multimedia Design Principles. There are three assumptions in regards to how people learn through the use of pictures and words. The first assumption is that of the dual channel assumption in that there are two channels including the visual-pictoral channel and the auditory-verbal channel ([28] & [29]). The next assumption is the limited capacity assumption, in which each channel has a limited capacity for holding and manipulating information ([28 & [30]). Lastly, the third assumptions is the active processing assumption, which is that meaningful learning is believed to

occur when learners have an active processing relationship with the channel, and are involved in the process of selecting pictures and words, organizing them and integrating them, utilizing the prior knowledge that they possess [31]. The Cognitive Theory of Multimedia Learning evolved from these three assumptions, and was introduced by Mayer [25]. Several principles were highlighted by Mayer which have been taken into consideration during the designing and development of meaningful multimedia learning [32].

Table 1 shows the five principles that have been highlighted by Mayer, and have been utilized when designing and developing meaningful multimedia learning [32]. There were other principles mentioned by Mayer, but only five main principles are highlighted [31]. This study is about designing and developing the MAR, which uses multimedia tools within the Chemical Bond topic. In addition to considering the guidelines involved in designing and developing a meaningful multimedia learning tool, the principles for designing Chemistry education tools have also been considered. This is because different subjects require different strategies for designing and developing visualization tools. Therefore, this paper suggests the use of the Principles for Designing Visualization Tools in Chemistry as outlined by Wu and Syah [26].

Table 1. Five Multimedia Principle [32]

Principles	Descriptions
Coherence Principle	People learn better when extraneous words, pictures and sounds are excluded, rather than included.
Signaling Principle	People learn better when cues that highlight the organization of the essential material are added.
Redundancy Principle	People learn better from graphics and narration compared with a combination of graphics, narration and on-screen text
Spatial Contiguity Principle	People learn better when corresponding words and pictures are presented closer, rather than further apart on a page or screen
Temporal Contiguity Principle	People learn better when corresponding words and pictures are presented simultaneously, rather than successively

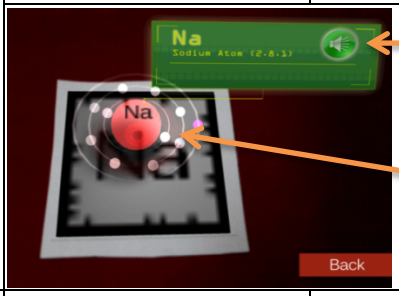
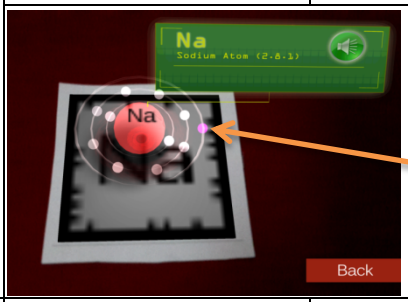
3 The Principles for Designing Visualizing Tools in Chemistry

The design stage is important for the development of multimedia tools for teaching and learning. Every tool that has been developed has followed certain criteria, which must be considered in order to make sure that the developed tools really make sense, and can achieve their objectives. Shariffudin et al. [33] has stated that the methods used for designing learning materials, and the pedagogical aspects of teaching and learning, have to be taken into consideration before development processes are undertaken. AR is one of the learning materials which act as visualization tools, which may aid teaching and learning processes. Therefore it is important to properly design the AR before developing it. Within this research, AR is utilized in the form of a MAR, applied as a visualization tool that assists in the process of learning about Chemical Bonds. The designing of the MAR, regarding to Chemical Bonds, has involved the consideration of several important concepts in order to ensure that the learning pro-

cess regarding the particular topic is smoother. This is because students have varying abilities to visualize concepts.

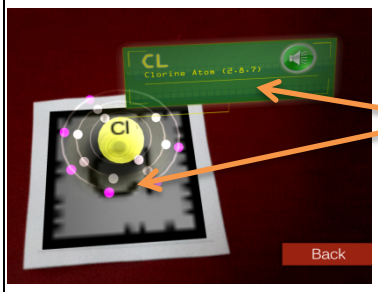
Table 2 below presents the details on how the implementation of the Cognitive Theory of Multimedia Learning and Table 3 presents the details on how the implementation of Principles for Designing Visualizing Tools within the Chemistry field on designing MAR for learning Chemical Bond.

Table 2. The implementation of Cognitive Theory of Multimedia Learning on designing the MAR.

Principles in Cognitive Theory of Multimedia Learning (Mayer, 2005)	**Descriptions**	**How the Principles applied in developed MAR**
Coherence principle	People learn better when extraneous words, pictures and sounds are excluded rather than included	This coherence principle has been applied which the visual displayed the visual objects with label without extraneous words, pictures and sounds
	 Words that describe the visual object (without extraneous words) Visual object	
Signalling principle	People learn better when cues that highlight the organization of the essential material are added.	The developed MAR provide hints or visual triggers which it's highlighted the valence electrons in pink colour, differences with the others electrons.
	 These are the hints or visual triggers that the student need to focused on because the knowledge about the valence electron important to be used for the next subtopic.	
Redundancy principle	People learn better from graphics and narration than from graphics, narration and on-screen text.	The Redundancy principle is applied in the developed MAR which it provides visual and on screen text. The narration just provided if the students need a better explanation.

<table>
<tr><td></td><td colspan="2">This is the on screen text that displayed when the compound is formed. The sound or narration is optional if the students need a more explanation.

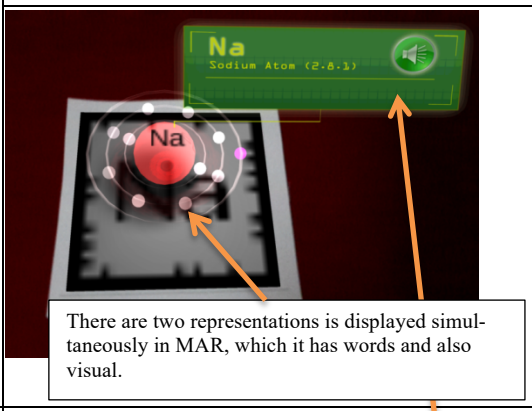
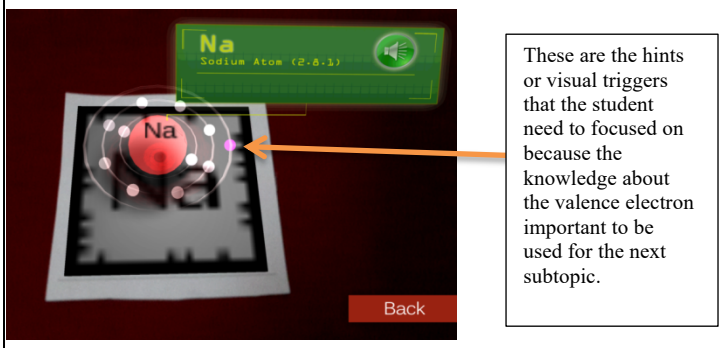
This is the visual objects or graphic display by the developed MAR.

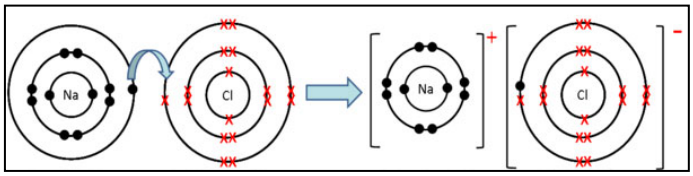
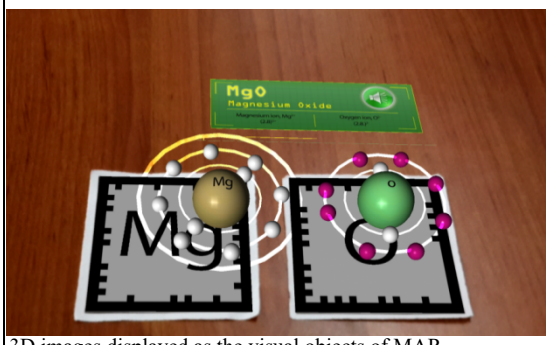
 
</td></tr>
<tr><td>Spatial contiguity principle</td><td>People learn better when corresponding words and pictures are presented near rather than far from each other on the page or screen.</td><td>The developed MAR apply the spatial contiguity principle by provide the visual objects and words closed to another.</td></tr>
<tr><td></td><td colspan="2"> 

This is the visual objects and corresponding words are displayed closed to each other which it's applied the spatial contiguity principle.</td></tr>
<tr><td>Temporal contiguity principle</td><td>People learn better when corresponding words and pictures are presented simultaneously rather than successively.</td><td>The temporal contiguity principle is also applied in this developed MAR which the corresponding words are displayed simultaneously. For the formation of compound part, the corresponding words will be appeared simultaneously once the compound is formed.</td></tr>
<tr><td></td><td colspan="2"> 

This is the visual during the formation of sodium chloride compound. The visual objects and the corresponding words simultaneously displayed once both atoms are being put closed to another to form sodium chloride compound.</td></tr>
</table>

Table 3. The implementation of the Principles for Designing Visualizing Tool on Chemistry (Wu & Syah, 2004) in designing the MAR

<table>
<tr><th>Principles for Designing Visualizing Tool on Chemistry (Wu & Syah, 2004)</th><th>How the Principles applied in developed MAR</th></tr>
<tr><td rowspan="2">Providing multiple representation and descriptions.</td><td>This principle which is provides multiple representations and description in the visualization tools because the ability of the student in visualize is differences. So, by provide other representation such as audio and text, the student can understand better rather than just learning by using visual or words only.</td></tr>
<tr><td> 
</td></tr>
<tr><td rowspan="2">Making linked inferential connection visible</td><td>Making linked inferential connection visible is similar with the signalling principles in the Principles in Cognitive Theory of Multimedia Learning (Mayer, 2005). The developed MAR provide hints or visual triggers which it’s highlighted the valence electrons in pink colour, differences with the others electrons.</td></tr>
<tr><td> 
</td></tr>
<tr><td>Presenting Dynamic and interactive nature of Chemistry</td><td>Presenting the dynamic and interactive nature of Chemistry is important in attract the students to entering into the process of learning. The MAR in this study has an advantage which the visual shows are dynamic and the atoms are represent in differences colour and in 3D images. This will easier for the student to differentiate the atoms that being shows to them.</td></tr>
</table>

	 The dynamic and interactive nature of chemistry is shown during the subtopic of formation of Chemical Bond which the atoms will move closed to each other and the valences electron with differences colour will be transferred or shared to form a new compound.
Presenting transformation between 2D and 3D	According to this principle, to make the students easier to relate what they learn previously with what they learn using the visualization tools the 2D visual should be provide together. For learning using MAR, the visual displayed is in 3D and Chemistry's textbook that been used in the school, mostly the visual will be formed shown in 2D images.
	 Example of 2D images in textbook
	 3D images displayed as the visual objects of MAR.
Reducing Cognitive load and making information explicit and integrated.	The content of the information's that being delivered by MAR is followed the syllabus of KBSM on the topic of chemical bonding. So, the syllabus will be definitely already considered the cognitive load to make sure that it can be understand by the students.

This research has designed the MAR learning environment based on these two principles as discussed above. Once the MAR is successfully designed, meaningful

learning will take place, and this will have a positive impact on the achievements of students. In regards to this study, the MAR has been developed and the effects of the developed MAR on students' achievement in the topic of Chemical Bond are being investigated. The methodology has been describes in the Methodology part.

4 Methodology

To investigate the effects of the developed MAR on student's achievement on the topic of Chemical Bond is the objective of the research. Thus, the Pre and Post Test on the topic of Chemical Bond are being conducted. After about 4weeks treatment using MAR, the Post Test is being given to the students to be answered. The Test is consists of 3 parts which are the objectives questions in Part A, structured questions in Part B and essay questions in Part C.

4.1 Sample

The samples are involved 16 students in Form 4 who taking chemistry subject in secondary school at Johor Bahru. The students that selected are the students who have skills in using technologies and already exposed with latest learning technology such as online learning, mobile learning and others.

4.2 Data analysis

The data were analyzed using the *Statistical Package for the Social Sciences (SPSS)*. There is descriptive analysis and inferential analysis was being conducted in the analysis part of the research.

4.3 Descriptive analysis

The scores of each student were being computed and student's achievement were analyzed and compared between the two tests that conducted which are the Pre and Post for Chemical Bond. The comparison for minimum scores for the Pre Test for Chemical Bond Test is 10 (39-29) while for the Post test the comparison between minimum and maximum scores are 13 (71-58). The mean score for the Pre Test is 41.69 with a standard deviation of 9.070. The mean score for the Post Test is 52.45 with a standard deviation of 9.638. The mean for the Post Test is higher than the mean of Pre Test. It shows that, on average that scores in the Post Test is higher than the scores in the Pre Test. The mean differences of the mean percentage of the Pre and Post Chemical Bond Test are 10.76%. The details descriptive analysis for each test is shown in Table 4.

Table 4. Descriptive statistics for pre and post chemical bond test

Type of test	N	Min	Max	Mean Percentage	Std. Deviation
Pre Chemical Bond Test	16	29	58	41.69	9.070
Post Chemical Bond Test	16	39	71	52.45	9.638

4.4 Inferential analysis

Instead of the descriptive analysis, the inferential analysis also conducted. This inferential analysis is conducted to compare the means between the two groups of variables which is the pre chemical bond test and post chemical bond test. However, non-parametric test have to be performed as alternatives to the parametric test because the number of sample is not enough to run the parametric test. Thus the non-parametric test of the Wilcoxon Signed-Ranks Test is used to investigate whether there is a significance difference between the Pre Test and Post Test scores.

The Wilcoxon Signed-Ranks Test (Wilcoxon Test) is been used to compare the mean scores between both test. The hypotheses involved were:

- $\mathbf{H_0}$: There is no significance differences between the mean of the Pre Test scores and the Post Test scores in Chemical Bond Test.
- $\mathbf{H_1}$: There is significance differences between the mean of the Pre Test scores and the Post Test scores in Chemical Bond Test.

Table 6 below shows the ranks for Wilcoxon Test and "a" in the table is refer to the number of observations or number of students (N) with Post Test scores lower than the scores in the Pre Test. "b" refers to the N with Post Test scores greater than the scores in the Pre Test and "c" refers to the N with Post Test scores equal to the score in the Pre Test. This mean none students have scores in the Post Test lower than the Pre Test (Negative Ranks). 15 students have scores in the Post Test greater that the Pre Test (Positive Ranks) and only one student have the same score in both Pre Test and Post Test (Ties).

Table 5. Ranks for the Pre Test and Post Test

Ranks				
		N	***Mean Rank***	***Sum of Ranks***
Pre Chemical Bond Test - Post Chemical Bond Test	Negative Ranks	0[a]	.00	.00
	Positive Ranks	15[b]	8.00	120.00
	Ties	1[c]		
	Total	16		

The result in Table 7 below shows that the values of Wilcoxon Test where "d" refers the value based on the negative ranks. The significant value, 0.001, is lower than the value of alpha, .05, thus the Ho is rejected. This means that the Pre Test scores have a significant difference from the Post Test scores (z= -3.412, p= 0.001). These

results suggest that MAR have a significant in improving the achievement of the students in the topic of Chemical Bond

Table 6. Wilcoxon Signed-Ranks Test Statistics of the Pre Test and Post Test for Chemical Bond

Test Statistics[a]	
	Pre Chemical Bond Test - Post Chemical Bond Test
Z	-3.412[d]
Asymp. Sig. (2-tailed)	.001

5 Conclusion

In conclusion, misconceptions are common problems that are faced within today's learning processes, especially in science education that often involves abstract concepts. Visualization is one of the proposed ways that has the potential to reduce misconceptions. One tool with proven visualization advantages is the MAR. However, in order to achieve the objectives which is to develop the framework for developing a Mobile Augmented Reality (MAR) for learning Chemical Bonds, certain principles and theories should be followed. The Cognitive Theory of Multimedia Learning (CTML) [25] proposed within this study will be a good source of reference, because the MAR developed accordingly consists of words and pictures. Additionally, 'The Principles of Designing Visualization Tools in Chemistry' by Wu and Syah [26] also provides strong principles that have to be taken into consideration, as this research focuses on Chemical Bonds. Therefore, the research framework is important in studies, in making sure that the process of designing and developing meaningful multimedia learning tools can be undertaken systematically and successfully, and so that the research objectives can be achieved afterwards accordingly. This proven by referring to the findings that gathers which shows that MAR have a significant in improving the achievement of the students in the topic of Chemical Bond. For further action, the study on the effectiveness of the developed MAR will be conducted to investigate its influence towards visualization skill. This application will be tested within future studies, in order to determine the effectiveness of the developed tools.

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Android Application for Children to Learn Basic Solat

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Abstract—The existence of mobile learning application has provided an opportunity for Islamic knowledge to be delivered widely. Accordingly, Muslim application developers have been developing Islamic-based applications for learning about hadith, prayer (*solat*), and Quran recitation, to list a few. The solat is the pillar of worship that helps Muslims to become better people. Therefore, it is the responsibility of parents to teach their children about solat, particularly when the latter reach the early age of seven. This study aims to (i) develop and incorporate a prayer-learning application that has multimedia elements in order to attract young users and (ii) assess the reliability of the application for children. A learning application can serve as a new method for learning about how to perform a solat. In this approach, solat can be taught digitally using a portable platform, including Android. In this study, an android learning application was developed using Waterfall methodology which consists of five phases: idea, analysis, design, development, evaluation, and final product. Adobe Flash Professional CS6 was chosen as a development platform. The application consists of four modules: "Let's Pray," "Five Times Prayer," "Doa' After a Prayer," and "Mind Test." To authenticate the application, the researchers collected data from expertise (lecturers) from the Faculty of Technical and Vocational Education and Faculty of Science, Technology, and Human Development. These respondents were selected through targeted sampling. The result concludes that the application is suitable for new learners to learn about performing a solat.

Keywords—Android application; Learning Basic Solat, Childhood

1 Introduction

In the modern-day sophisticated era, a learning process can take place with a great array of learning-oriented gadgets, including computers and smartphones. The smartphone particularly has become a necessity for every human being because its applications (apps) can complement almost all aspects of human lives. In 2011 alone,

over 300 million apps were developed for smartphones that run on Android and Iphone operation system (iOS) [1].

According to [2], the development in multimedia technology promises great potential in changing, among others, (i) the way people learn, (ii) the means to obtain information, and (iii) the measures to customize information. The multimedia technology also provides various opportunities for educators to apply various teaching techniques, and learning with the use of multimedia teaching aids can attract children.

The application distribution platform on Google Play categorizes apps into 27 types, among which are religion, education, social, and games. Nevertheless, Islamic religious applications have been poorly develop, despite the increasing demand [3]. The Islamic applications for the practices of Shafi'e sect are even more scarce, necessitating thus an application that can serve as a fundamental guide for students in shafi'ah schools to learn the practice of solat.

2 Prayer Basic Learning

The five daily prayers are obligatory in Islam. According to Prophet Muhammad S.A.W (narrated by Tarmizi, Abu Daud, Ibn Huzaimah in Mutawalli Sya'rawi, 2007), children need to learn to pray when they are seven years of age, and they can be beaten when they refuse to do so at the age of ten. This hadith upholds that obligatory prayers must be implement by childhood at 7 years old and above.

In the book Mutawalli Sya'rawi (2007), Abu Daud narrates that the Prophet S.A.W said that "the difference between Muslims and non-Muslims is solat, therefore whoever abandons the prayer means infidelity." This narration attests that solat is a crucial obligation. Therefore, in performing a solat, one must fulfill its thirteen pillars (rules), which are (i) the stand for the capable, (ii) intent, (iii) takbiratul of ihram, (iv) reading the Surah Al-Fatihah, (v) bowing, (vi) iktidal, (vii) prostration, (viii) sitting between two prostrations, (ix) sitting the final tahyat, (x) reading the final tahyat, (xi) making salawat to the Prophet, and (xii) greeting first, and (xiii) orderly (Shamsul, 2014). Deserting any of these pillars will annul the prayer.

Many hadiths of Rasulullah emphasize the command to improve a solat in terms of practice and khusyuk (concentration) [4]. Therefore, an android application will be designed to display the playback of every solat in detail using animated graphical display. The application is in line with today's technological developments that make applications accessible at any place and time [5].

3 The Approach of Behaviourism Learning Theory

The behaviourism theory proposes that learning is an externally observed behavior. Learning can occur when there is a correlation between stimulus and response. According to [6], repeated stimuli and responses serve as the grounds for learning to take place. The premise of the behaviourism learning theory is to prioritize elements, a mechanism, the role of the environment, reactions or responses, and the importance of the role. Learning outcome is the result of the desired behaviour. According to [7], the

development of a person's personality or behaviour is due to his or her response to external stimulus.

The use of computer-based teaching methods often involves behaviourism. For example, a mind-test activity found in an android solution learning application with the use of mobile software requires a step-by-step learning process until the learner fully understands the concept. This process also takes place when the user interacts with the computer using a learning-based application.

Besides that, for children to understand or learn how to pray is a self-learning process. Children will focus on sight, sound, and treatment, and thus the behavioural theory (behaviourism). This theory is a thought approach that emphasizes the role of a controlling behaviour. For example, learning is a behaviour that can be observed, controlled, and predicted and learning is a common process because relationships between external stimuli and individual responses can be built to produce consistent behavioural changes.

4 Problem Statement

The increasing popularity of gadgets, children are becoming more vulnerable to influence and parents are taking the opportunity to educate their children with the use of applications. Through applications, children can learn not only how to read and write but to calculate and learn religious knowledge, such as reading jawi (Arabic handwriting) and performing prayers.

Hence, the learning of solat from books is ineffective for children nowadays because in the current era, children are influence to learn something from android applications. According to [8], one of the ways to improve the effectiveness of communication in teaching is through technology applications. The use of applications or equipment can also improve learning at school level because such method can motivate students and increase their understanding on the practice of solat [3]. The necessary resources include Islamic basic manuals and Islamic-based applications. Prayer lesson using essential andoird apps among children as it is the main holding of the Muslims to apply prayer lesson from 7 years old. This is because, the five times prayer in a day is required by 'His Creator' on every human being to become the noble and responsible person.

5 Research Objectives

The objectives of this study thus are to:

- Develop a basic android application with multimedia elements for learning how to perform a prayer that can attract childhood;
- Test the functionality of the android application in learning basic solat for childhood by experts and respondents (children).

6 Research Methodology

The Waterfall Model founded by Winston Royce as a guideline in this study. The model proposes six phases, namely idea, analysis, design, development, test, and final product [9]. The idea phase is the most important stage because this phase will cover the issues concerning the development of the android application. In this phase, the background of this study and the problem statement are identify. The appropriate goals and means to produce quality products are also established. The analysis phase is crucial for the researcher to understand the weaknesses and advantages of the existing technology systems. These systems have been used as references to facilitate the analysis of the collected information. The purpose of studying the technology systems is to develop an android application that can meet the needs of users. In this phase, the researchers also studied the information of the learning of basic prayers with expert in this learning (expert in islam religion such as ustaz and ustazah at UTHM). In particular, content analysis was performed by comparing existing apps with the developed application in terms of features that need to be improved to meet the needs of target users. Software and hardware requirements were identified and the media elements for the application were also determined.

The design phase of the application was implemented by developing storyboards, creating flow charts, forming navigation structures, designing content structures, and graphing designs. The storyboard was produced by guiding a concept and storyline that corresponds to the target users. Complete storyboarding results were used as preliminary guideline for the project development phase. Predictive solitaire Android apps were designed based on the content structure. The main menu consists of four main modules namely "Let's Prayer," "Five Prayers," "Prayer After Prayer," and "Test of Mind." Each module conveys the importance of useful applications to users. The graphic designs included the character design, the concept selection, and the themes created, which include the menu buttons and backgrounds used for the application. The colors for the application were determined by the features and concept of the animation.

In the development phase, modern technology was used to develop the application. This phase was carried out by installing the application in an Android mobile device. The application was first published using Adobe Flash Professional CS6 and was exported to the appropriate .apk format prior to installation. In the testing phase, the application was tested to the target users. The initial testing phase took place during the development phase. This phase served to identify whether the objectives of the project were achieved in terms of the criterion of meeting the needs of consumers. In this phase, knowledge on how to improve the performance of the application is required. According to [10], listed two types of evaluation: formative evaluation and summative evaluation. In this study, formative assessment was used throughout the development phase and each stage was evaluated during the design.

The application was assessed to ascertain whether the functionality of Andorid Basic Solution Principles have met the project requirements. After the product was used by the consumers, a summative assessment was carried out through user reactions. Results from the evaluation were considered and any shortcoming of the appli-

cation was corrected in order to conform to user's needs. Users' reactions were assessed through interviews and questionnaire survey. The respondents consisted of ten (10) randomly selected children aged between seven and ten. Learning with the application was assessed by experts in application-based application technology development and religious knowledge. The questionnaire form contains items that seek the experts to evaluate the application in terms of design, interaction, and interface. The responses were analyzed by the frequency of "yes" responses.

The questionnaire contains four sections: Section A, which contains three items (respondents' demographics), Section B, which contains five items (informative design), Section C, which contains five items (interaction design), and Section D, which also contains five items (interface presentation). The final product is then presented to the general users, including the supervisor and the appraisal panel who will rate the score for the application. In this phase, errors or weaknesses of the application were fixed. The product was assessed in terms of its effectiveness for use by the community, particularly children. The Basic Learning Android Application of this prayer was developed to become a reference for people to learn the routine of solat at any time and place. The assessment can indirectly enhance the community's understanding of the importance of prayer.

7 Research Findings

The experts interviewed consisted of lecturers from Universiti Tun Hussein Onn Malaysia (UTHM), and the target consumers were represented by ten (10) children, aged between six and nine, who were randomly selected from two schools. The data obtained were calculated using percentage of frequency values. The three lecturers were involved in evaluating the functionality of the application. The experts involved were two lecturers from the Faculty of Technical and Vocational Education (FPTV) and a lecturer from the Faculty of Science, Technology, and Human Development (FSTPi). Two experts from FPTV were engaged to evaluate the application's interaction designs, multimedia presentation elements, and user interface. The lecturers from FSTPi were requested to evaluate the content of the application. Interface for android app main menu was shown in Figure 1 which consist of four menu developed (Let's Pray, Five Times Prayer, Doa' After a Prayer, and Mind Test).

Example of the interface for the learning material within the android apps is shown in Figure 2.

Fig. 1. Main menu of the Android Apps

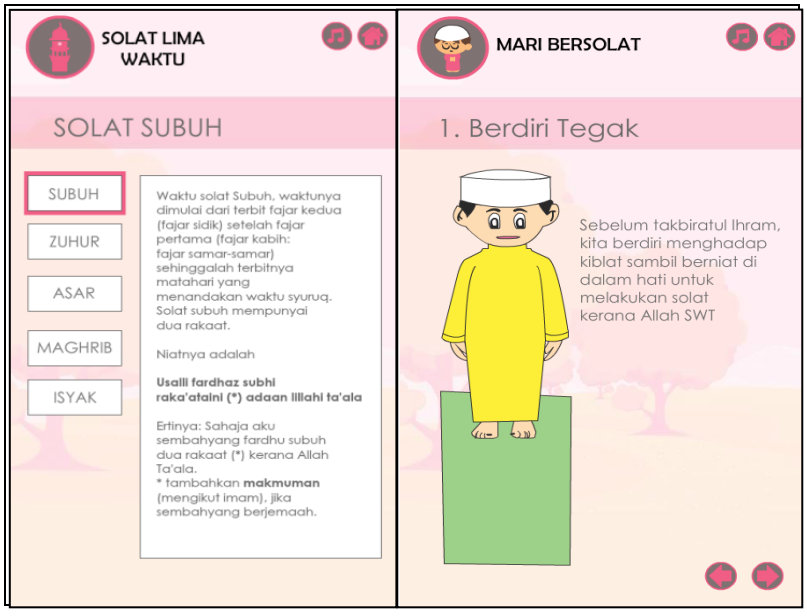

Fig. 2. Interface of the Learning Basic Solat

Table 1 shows results from the content analysis. The three experts test in functionality of android apps. For item 3, the content of this android application corresponds to different user cognitive levels shows two from three expert no agree with this item. In general, the respondents stated that the content is well organized, and all of them (three experts) agreed that the information is presented accurately. Next, all of experts agreed that the content and texts used are simple and easy to understand.

Table 1. Analysis of Content Design

Item	Statement	Frequency	
		Yes	*No*
1	The content of this android application is clear	3	0
2	The content of this android application corresponds to the learning needs	3	0
3	The content of this android application corresponds to different user cognitive levels	2	1
4	This android application content is well organized	3	0
5	The information in this android application provided is accurate	3	0
6	The text used describes the contents of the lesson to be submitted	3	0
7	The text used in this android application simplified is easy to understand	3	0
8	The articles used can be read easily	3	0

Table 2 shows the analysis of multimedia elements of the presentation. Two from three experts mentioned that the graphics used in this android application could attract user's attention. Otherwise, for other items all experts agreed that the presentation design suitable with android apps.

Table 2. Analysis of Presentation Design

Item	Statement	Frequency	
		Yes	*No*
1	The graphics provided can increase user interest	3	0
2	The graphics provided can improve user understanding	3	0
3	The provider of android application can help increase user interest	3	0
4	The provided android application helps to increase user understanding	3	0
5	The graphics used in this android application can attract users attention	2	1
6	The music background of this android application used is appropriate	3	0

Table 3 shows that the interface display contains four items. Only one item from analysis of interface design show that item 17, two from three experts mentioned that the position of the text in this android application interface is consistent. Otherwise, for other items all experts agreed that the interface design suitable with android apps.

Table 3. Analysis of Interface Design

Item	Question	Frequency	
		Yes	*No*
1	This android application interface design is appealing	3	0
2	The design of this android application interface is appropriate	3	0
3	The position of the text in this android application interface is consistent	2	1
4	The position of the graphic in this android application interface is consistent	3	0

Table 4 shows that analyse (respondents) children's acceptance of content design. By using structure interview include of 10 respondents (among children). All item from analysis of content design show that all respondents agree that suitable with the content.

Table 4. Analyse respondent's acceptance of content design

Item	Question	Frequency	
		Yes	*No*
1	Submission of interesting subject matter	10	0
2	Organized and interesting content	10	0
3	The content of the lesson is in line with my level of understanding	10	1
4	I can understand the contents of the lesson clearly	10	0

Table 5 shows that analysis of respondents' acceptance of interaction design. By using structure interview include of 10 respondents (among children). All item from analysis of interaction design show that all respondents agree that suitable.

Table 5. Analysis of respondents' acceptance of interaction design

Item	Question	Frequency	
		Yes	*No*
1	The graphics provided can increase user interest	10	0
2	Audio can be heard clearly	10	0
3	Interestingly used music	10	0
4	The control button works fine	10	0
5	The resulting animation is age-appropriate	10	0

Table 6 shows Analysis of respondents' acceptance of interface design. By using structure interview include of 10 respondents (among children). All item from analysis of interface design show that all respondents agree that suitable.

Table 6. Analysis of respondents' acceptance of interface design

Item	Question	Frequency	
		Yes	*No*
1	Interesting interface display	10	0
2	Background color is appropriate	10	0
3	The layout shown on the screen is appropriate	10	0
4	The graphics used are appropriate	10	0
5	The colors used are appropriate	10	0

8 Discussions

The Waterfall Model was used to guide the development of the android application which contains lessons of basic prayers for childhood. The development involved six phases namely idea, analysis, design, development, testing, and final product. In the design stage, Adobe Flash CS6 and Sound Forge were used to develop a basic An-

droid application for teaching children the basic routine of solat. The application was designed with graphics, audio, and text. All the teaching materials are developed in the design phase using appropriate hardware and software [11]. The application was then published in an apk format and hence can be utilized using the the Android Manager app.

Results from this study showed that the layout and design of the application had attracted the respondents' (children) interest. Majority of them agreed that the design and background of the application are appropriate for target users. Therefore, with this android app learning basic prayers in the children, parents do not have to worry about letting kids have smartphones with interesting and useful learning content anytime. As mentioned by Othman [12], the availability of mobile applications has made it easy for users to access the contents at any time and place.

According to [13], residents in an interior without schools, teachers, and students use wireless technology to facilitate the access of information. Technology plays an important role in delivering all instructions and information as well as in facilitating the learning process. In the application developed in this study, the materials are delivered in graphics, texts, animations, and audio. As pointed by [14], a facility for learning offers better technology approaches to education. The use of visual graphic media refers to the images used to make information more interesting and easy to understand. Visual graphs are able to describe concepts that are difficult to be explained by texts. Graphics like drawings, pictures, and charts can also convey information more effectively.

The content of each module is presented in a form of text that facilitates the user to receive the intended message. As pointed by [15], text is one of the major media needed in a multimedia software that intends to deliver its content clearly. Text is the most effective way of bringing ideas to users. In the case of the application developed in the study, the text was intended to deliver comprehensible information to students. In Android apps, an animated media presentation interface in the sequence of two-dimensional static images is used to create motion illusion. The use of animation is also an ideal strategy to attract and engage children. As pointed [16], animation is a form of technology-based learning that can provide a comprehensive learning experience to children.

Another form of media used in the application is audio. Audio is one of the most frequently used media in the interaction between computers and humans. In regard to the application developed for this study, the element of music plays a role in creating a more prominent and exciting interface. As pointed by [17], audio in a multimedia presentation plays a crucial role in bringing an atmosphere to the appropriate learning method.

9 Conclusion

In conclusion, the development of an Android-based learning application for teaching solat to children can provide a new learning experience with the use of interactive multimedia elements. The application thus can serve as a tool for teachers and parents

to teach children about solat from any place and at any time. The researcher therefore hopes that the study can fulfil the needs of children in learning the basics of performing solat and reciting its doa's.

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Development of Jawi Spelling Skills Applications, '*Oh Jawiku'*

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Abstract—In the past, Jawi script was the main medium of intermediation in Malaya. However, since the emergence of the Roman script, the use of Jawi script has been marginalized causing less awareness among some of the younger generation on the uniqueness of Jawi script. Therefore, 'Oh Jawiku' mobile application has been developed to attracting students to explore Jawi script especially the spelling of Jawi words. This 'Oh Jawiku' mobile application used constructivism approach and ADDIE model during the development process. This study used quantitative one group pre-test and post-test research design that conducted among 20 students of a primary school. The result shows that the mean value of the post-test was higher than the pre-test which is 89.00 while the percentage of students who liked the 'Oh Jawiku' application was high. In conclusion, the application of mobile games 'Oh Jawiku' able to attract students to learn Jawi indirectly raised the dignity of Jawi script in the future besides supporting the 21st- century education.

Keywords—Jawi Script, Mobile Applications, Game based learning, Spelling Methods, Student's Attraction

1 Introduction

In the past, Jawi script plays an important role in society as an important intermediary in all matters such as the administration of government, diplomatic relations between the state of affairs, Malay customs, trade, and also in the education system [1]. However, since the Roman script introduced in Malaya, most businesses have been using the Roman script for official purposes and Jawi script is given emphasis on matters related to Islam only. The uniqueness of Jawi has been forgotten by the younger generation nowadays even some of them do not know how to write in Jawi and others do not recognize the letters in Jawi [2].

The objective of this study is to develop Jawi spell-playing game applications based on constructivist theory. Besides that, this study also to identify the effect of 'Oh Jawiku' mobile applications towards year two primary school students in Jawi learning. The mobile application was also built to inculcate students' interest in Jawi writing so Jawi writing is not forgotten by the younger generation.

1.1 Background of the problem

This study has been conducted based on the support from the observations made based on previous studies.

The Problem of Learning Jawi Script among School Students: The education system in Malaysia which emphasizes the use of Roman script directly diminishes the use of Jawi script because the Jawi's writing is used only in Islamic Education subjects [3]. Not only that, the problem is also due to the fact that the Malays themselves do not apply the use of Jawi in their lives [4].

According to [3], the Jawi script gradually marginalized and disliked as most of the today's youth are *'buta Jawi'*. Among the factors that school students cannot master Jawi writing today is the problem of less skillful teachers using Jawi writing while teaching. According to observations by [5], many Islamic Education subject teachers use the Roman script as a teaching medium to achieve teaching objectives.

According to [3], in his study stated in the past, most books or religious books are written and printed using Jawi script but now most of the books or religious books used in schools are written using Roman script that causes students to lack resources in reinforcing mastery of Jawi. To further enhance Jawi writing among the younger generation, especially the students, teaching methods by teachers need to be improved so as to attract students to explore the Jawi script as adding creative features of the innovation in the teaching method [6] and [5].

In addition, teaching methods delivered by teachers also lead to students' level of control and interest in Jawi Education. According to the study conducted by [6], the teaching method used by Islamic Education teachers cannot help students to master Jawi learning because teachers have no special skills in Jawi teaching as well as the teaching and learning process is teacher-centered and does not focus on students' understanding. This is supported by a study conducted by [5] where students' understanding and interest in Jawi Education has proven to increase as teachers use different and more creative methods during the teaching process.

The Effectiveness of Mobile Application Use in Teaching and Learning Systems: According to [7], the use of mobile devices in the education sector provides students with the ability to share information while conducting group work in line with online learning or better known as m-learning. In addition, [8] also stated in their study that mobile-based learning or m-learning learning is a self-directed learning process where learning can take place everywhere and not just in the classroom.

Among the advantages of the mobile application that described by [9] is that it is easy to use by students as most of the menu and directions available in mobile phones are user-friendly. Additionally, it also helps students not to feel embarrassed when learning because of online learning conceptually 'alone'. This can help students to continue sharing ideas without having to deal with everyone and they can make them more aggressive when studying.

Jawi Learning Approach through Multimedia Applications: An innovative approach has to be incorporated into the teaching and learning method of Jawi to attract students to continue learning Jawi. The study conducted by [10] shows that students

need something interesting and interactive to stimulate their minds while studying Jawi. This is also can avoid students to get bored in the class.

The results of the study by [11] found that users or students are more interested in using multimedia technology as Jawi learning medium. The response from users can be concluded that the use of such applications plays an important role in the education system including Jawi education. In addition, the Jawi multimedia application needs to be designed more creatively to attract users.

So, the mobile application is selected to help resolve problems in learning Jawi scripts due to its ability to attract students and due to more affordable technology and improving digital networks, many people turn to mobile devices as their first choice for connectivity. In addition, the game elements by [12] is used in this app development such as play, fun, interactive, levels, direction, challenge, adaptive, successful, results, and video to make the application more interactive. According to[13], game based-learning will help the student to the deep understanding about something that they learn because they will have their own chance to explore and study about something when playing.

2 Methodology

The ADDIE model is used as an instructional design to help in the development process of 'Oh Jawiku' mobile applications. Five phase of the development process which is analyzed, design, develop, implement, and evaluation. Each phase of the process conducted based on the respondent criteria that are year two of primary school.

2.1 Analysis phase

In the analysis phase, the problems need to identify and solved to set the objectives in the study. After that, the factors or causes of the problem that involve the aspects of the user or the student, the learning environment, and the teaching objectives need to be identified besides analyzing learning theories, determine content, and determine learning objectives.

This mobile learning application used constructivism and game-based learning approach. Constructivism learning theory is referred to the active and dynamic learning among students where they will be more creative in solving the problem and makes them more aggressive while thinking besides adapting the new knowledge from the constructivism learning approach [14].

Each student will go through this constructivism learning theory where they can build ideas and knowledge with their own efforts and not with the help of others. In addition, this method helps students to explore and aggressively think about problem-solving. Students will have their own instincts by linking existing information in their minds to new ideas to be useful information [14]. Through the research conducted, the 'Oh Jawiku' app will enhance the student's effort in developing ideas to answer the

questions provided in the app. In this study, all constructive theoretical elements are adapted in the app.

Game-based learning can help students develop brain thinking and language skills [15]. In addition, through the method of play, learning becomes more fun and challenging as students gain a high-level thinking process. There are ten game elements adapted from game elements [12] into 'Oh Jawiku' application that will be developed like play, fun, interactive, level, command, challenging, adaptive, success, result, and video. The combination of these elements can generate a game app that can attract users.

2.2 Design phase

After all the analysis phase, the second phase will be carried out the design phase. Through this phase, the process of designing mobile game applications will be carried out as well as explaining the four main elements:

- Information Design
- Interaction Design
- Presentation Design/ Interface
- Application Flowchart Design

Each process carried out in this second phase will have a relationship with each other to ensure that the process is not dropped. Additionally, the quality of work needs to be ensured performed will meet the needs of end users as well as the stated objectives. In addition, each design will be applied through the process of designing mobile game applications using constructivism learning theories.

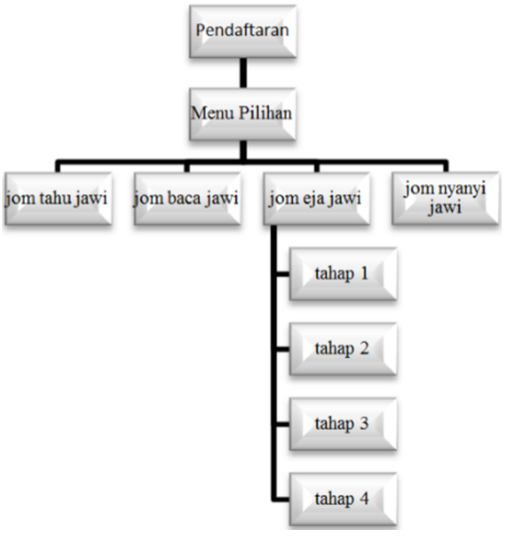

Fig. 1. Flow Chart of the Mobile Apps

Figure 1 shows the flowchart of the process of the 'Oh Jawiku' app developed. This application is simple and consists of just a few pages with clear visual content so that students can easily browse and use this app without any help. There are four levels of the game in the 'jom eja Jawi' section designed according to the syllabus of Jawi year two primary schools.

Fig. 2. Game Interfaces (Drag and Drop)

Figure 2 shows the design of drag and drop game method used for this 'Oh Jawiku' app is one of the puzzle game approaches where constructivism theory is implemented when undergoing cognitive processes where they incorporate new information and existing information to solve all these questions. This game requires students to answer questions by compiling the Jawi letters to be the desired word. Students need to complete the entire answers box with the correct answer. If a student chooses a wrong answer, the student cannot fill the answer box. This concept can train cognitivism and creativity of the students to solve every question given.

2.3 Development phase

'Oh Jawiku' app development uses Adobe Flash CS 5.5 software and AIR for Android player as a platform to play 'Oh Jawiku' app by Android platform. Therefore, students must download Adobe AIR software before downloading the 'Oh Jawiku' app. Besides that, ActionScript 3.0 has been used to develop this 'Oh Jawiku' app and choose a screen size of 480 × 800 pixels.

2.4 Implementation phase

Through this phase, the experiments are conducted on the selected respondents at the beginning of the study. Respondents are likely to use the mobile app and every respondent response will be taken into account for the purpose of upgrading. The implementation Phase of this study was done during the Pilot study.

2.5 Evaluation phase

This study used pre-experimental research design one group pre-test and post-test to identify the effectiveness of Jawi spelling skills app developed. The study was conducted among 20 students of a primary school. The selected students are from the first class in the school and get the grade A in the subject of Islamic education during the final year examinations in 2016. The criteria for respondent selection are to ensure that all respondents are able to control the application developed and able to read, write, and spell using Jawi script.

The pre-test will be answered by the student before they expose to the 'Oh Jawiku' mobile applications. This pre-test is to measure the ability of students towards Jawi spelling skills. After that, the researcher will test the 'Oh Jawiku' mobile applications to the students and the students will be answering the post-test questions. Table 1 explains the one group experimental research design that used in this research.

Table 1. One Group Experimental Research Design

Group	Pre-test	Treatment	Post-test
Treatment	T1	X	T2

Explanation:

T1 : Pre-test before the respondents use 'Oh Jawiku' mobile applications

X : Using 'Oh Jawiku' mobile applications

T2 : Post-test after the respondents used 'Oh Jawiku' mobile applications

Figure 3 shows the research procedure where the last step that needs to be done by the respondent is to answer a set of questionnaires aimed at getting the respondents' views of the application that has been developed before the data being analyzed.

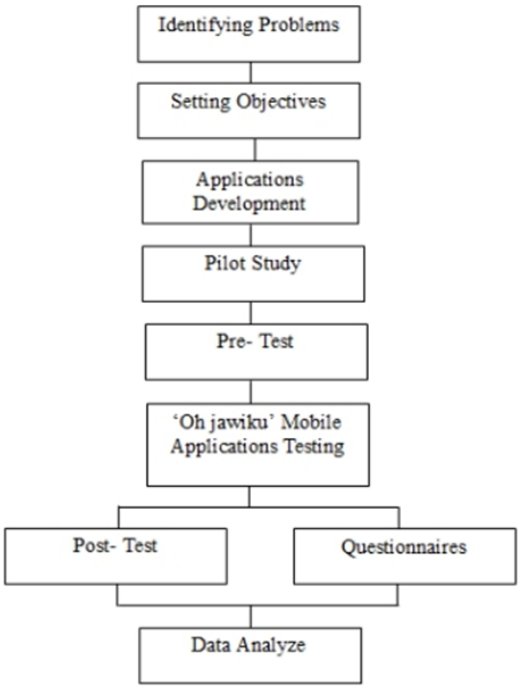

Fig. 3. Research Procedure

3 Results

The results of the pre-test and post-test that conducted on the respondents are as in Table 2 below.

The table shows the mean value for the pre-test is 72.25, while the mean values for the postal exam are 89.00. This result clearly explains that the mean of post-test was higher than the mean of the pre-test. Table 3 contains the correlation of sample pairs.

Paired sample correlation values for the test scores of pre-test and post-test scores is 0.627 while the significant value is 0.003. This proves that there is an improvement in learning process towards respondents after using the 'Oh Jawiku' mobile applications when answering test post.

Table 2. Mean and Standard Deviation of Pre-Test and Post-Test

Test	Frequency	Mean	Standard Deviation
Pre- Test	20	72.25	12.08
Post- Test	20	89.00	11.43

Table 3. Correlation of Sample Pairs

	Frequency	Correlation	Sig.
Pre-Test Score & Post-Test Score	20	0.627	0.003

This finding is in line with the results of the study from [16] who also found that the learning method of play was more helpful to the student's cognitive power than the usual learning method.

3.1 Students' opinion on jawi learning in the 'Oh Jawiku' mobile Apps

Table 4 shows the findings of data collected from students' opinion on Jawi learning in the 'Oh Jawiku' mobile application.

Table 4. Students' Opinion on Jawi Learning in the 'Oh Jawiku' Mobile Application

No	Items	Yes (%)	No (%)
1	The application is suitable to learning Jawi.	95.00	5.00
2	The Jawi script used in the application is interesting.	100.00	0.00
3	My knowledge about Jawi improves after using the application.	95.00	5.00
4	Jawi letters easy to combine to making one word.	100.00	0.00
5	Jawi spells is easy.	95.00	5.00
6	I can improve my Jawi spelling skills after using this application.	95.00	5.00
7	I am more interested to learn Jawi after use this application.	85.00	15.00
8	This game application helps me to memorizing Jawi letters.	100.00	0.00
9	I am interested to using this application for learning Jawi.	100.00	0.00
10	My Jawi spelling quality will be improve by using this application.	90.00	10.00

Overall, data shows a selection of answers 'yes' has a higher percentage than the possible answers 'no'. This clearly shows that students' belief in the 'Oh Jawiku' application is positive and suitable for use by them. In addition, the results for the overall data show that a high percentage of the possible answers 'yes'. This means respondents from among students were satisfied with the development of 'Oh Jawiku' applications in terms of content applications and learning of Jawi in the application.

4 Discussion

The idea of the development of the 'Oh Jawiku' app is based on a recent study that said the younger generation today are far behind the Jawi writing that some of the students do not recognize Jawi letters due to lack of interest in Jawi writing [17]. Overall, 'Oh Jawiku' app development shows a positive effect towards student performance after using it. The mobile apps also received positive responses from the students on using it for learning Jawi Script. Students can get the beneficial activity by using this app during their leisure times. Not only getting excited, they also get a lot of knowledge and their Jawi skills will be improved day by day. The fun element applied in the 'Oh Jawiku' game app can attract students or users to continue using the app because the fun elements of a game will make the game more interesting even if it is just a simple game [12].

Hopefully, this development can benefit many students, teachers and the community in learning Jawi writing and spelling. 'Oh Jawiku' app development can help young people in cultivating an interest in studying Jawi in more depth. Hopefully, Jawi script

will not be buried if there is more effort in restoring the glory of Jawi script such as the development of 'Oh Jawiku' mobile app.

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Digital Game Based Learning of Stack Data Structure Using Question Prompts

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Abstract—Data structure and algorithm is an important course in computer science and information technology programs, applied in almost all courses. Failure to master it will affect student's academic performance during study, getting job interviews, passing job interviews, and create an inefficient information technology worker. However, learning data structure is a worldwide problem because of its complex nature. Gameful visualization of data structures' algorithms has been gaining momentum as it resulted in increased motivation, engagement and learning outcome. But effectiveness of game-based learning could be hindered if improper learning strategies used. Instructional scaffold in game-based learning in the form of question prompts have been found to be the most effective way to scaffold self-learn in computer-based learning. Thus, a game-based learning of stack data structure using question prompts was designed, developed and tested based on an adopted model to help students understand the algorithms of stack's insert and delete operations for array implementation with gameplay that could create meaningful learning. A pre-game and post-game test was conducted to compare students' performance on the topic. Results indicated a generally positive outcome.

Keywords—Algorithm, data structure, game-based learning, stack

1 Introduction

Data structure are ways of organizing data in computer [1] which can be operated on by using various algorithm [2]. It is a core course in Information Technology (IT) programs in tertiary education as it is a fundamental knowledge applied in various areas [3]. Unfortunately, it is commonly difficult to comprehend [4], making teaching and learning challenging [5]. The main factor for low performance is the nature of the course itself, where students are required to learn the abstract concepts of various data structures, with each data structure having various operations, and each operation having its own algorithm. Understandably, students often unable to remember, let alone understand them all, hence mixing them up during informal and formal assessment, negatively affecting their overall mark and grade. Students lose interest in learning [6] and teaching requires much explaining and illustrating. Static [1], dynamic [7], and interactive visualization [8] failed to engage learners continuously, fre-

quently, and actively [9]. Since [4] did a comprehensive study on how computer games can be used in algorithm learning and visualization, this research area has flourished as it has shown promising results.

Game-based learning (GBL) combine game elements with defined learning outcomes in gameplay [10]. It is popular because of advancements in computer games technology [11], increased number of people playing games, and the benefits of game itself which makes learning interesting [12] and easier thus more effective [13]. Data structure and algorithm have many concepts, elements, and rules that are suitable for designing and developing educational games [4]. GBL connect abstract concepts in algorithms with objects from real world [6], making understanding easier. However, effectiveness of games on learning is still unclear [14], and may be compromised [15] if improper learning strategies used. Therefore, [16] suggested inclusion of instructional support in GBL environments to enable students' to apply game knowledge to real life problems.

One type of external scaffolds in GBL is question prompts, which have been found to improve learning outcome [15]. [17] subcategorize cognitive learning outcomes into three; declarative knowledge, procedural knowledge, and strategic knowledge. Data structure learning involves algorithmic problem solving where students need to know how to perform data structure operations according to their respective algorithm. Hence the cognitive learning outcome of data structure learning is procedural knowledge, which prompt can help apply [18].

A stack data structure has a last-in-first-out (LIFO) structure where values can be inserted (pushed) onto a stack or removed (popped) from the stack, and the value that was pushed on the stack most recently is the first to be popped from it. Common stack operations are pop, push, peek (get the top element without removing it), isEmpty (checks whether stack is empty or not), and isFull (checks whether stack is full or not). One way to implement a stack is using array-based. Stack is one of the most covered data structure in curriculum [19] and are often used when there are interrupts to handle, or when having recursive functions, or even when constructing a rudimentary AI for games [20].

This paper presents an alternative way of designing data structure GBL, which is through the use of question prompts, to create a gameplay that leads to meaningful learning of data structure algorithms. Stack data structure GBL with gameplay that simulates algorithm of array implementation of insertion and deletion operation using LIFO principle was designed, developed, and tested.

2 Literature Review

The use of e-learning motivates user to learn [21] thus could be adopted at higher education institutions [22] and can be integrated across many disciplines, such as language [23]. [19] created Stack Ship Activity where user navigates a space ship through space by touching desired values to Push a number in a stack (the main body of the ship) and tapping a POP button to Pop a value from the stack until the stack overflows or underflow. An undergraduate from Winston-Salem State University

created a stack game where a robot has to walk home facing different obstacles on land and sea that challenge its knowledge of the Stack data structure (by pushing and popping blocks) after its spaceship crashes [24]. [25] asked students to design and implement a program that allows them to play a simplified version of a card game with the computer. A shuffled deck of cards is dealt (push) between the computer and the player's draw piles. Each draw pile begins with (isFull) 26 cards and each winning pile starts out empty. For each round, the computer and player each place the top card from (pop) their draw pile onto (push) the center of the table. If the player's card has a higher value, the two cards are taken (pop) and placed at the top (push) of the player's winning pile, vice versa. In the case of a tie, the two cards are left in the middle of the table, to be picked up by the next round's winner. When one of the two players runs out of cards (isEmpty) in their draw pile, the game is over. The player with the highest total number of cards in their two piles (draw and winning) is declared the winner.

[26] separates question prompts into procedural, elaboration and reflection, where each serve different purposes for learners. Reflection prompts can be broken down further into knowledge prompts where learners reflect on the conceptual understandings of the underlying knowledge within game [27] and application prompts where game knowledge is applied outside of game [28]. Prompts have been found to scaffolding students' high-order thinking in various domains and contexts, and help in knowledge integration [29], focus, articulating thoughts, reflection of learning processes [26] and improve self-regulated learning competence [30].

3 Methodology

There were four phases in conducting this research. In the first phase, a literature review was done on data structure learning, GBL, and question prompts. The second phase was designing the stack game based on identified constructs. This research is based on a game model by [17] where there are three phases; Input, Process, and Outcome. The objective is to design an instructional program that incorporates certain characteristics of games that trigger a cycle that includes user judgments or reactions, user behaviours, and further system feedback. The extent to which this cycle results in engagement in game play which leads to the achievement of learning outcomes depends on the success of pairing instructional content with appropriate game features. The model was combined with data structure game design by [4] which consists of general game design elements, game appearance design, and game mechanics design.

3.1 First-general game design elements

1. **Game idea**: Stack and unstack array of stones.
2. **Game goal**: Simulate insertion (push) and deletion (pop) operation of array implementation of stack data structure using LIFO principle.
3. **Game topic**: Array implementation of stack requires checking whether stack is full before each push (see Figure 1) and whether stack is empty before each pop (see

Figure 2). Push is not allowed if stack is full and pop is not allowed if stack is empty.

4. **Game start**: Head-Up-Display (HUD) on top of screen shows Maximum Player Lives (5), Minimum Player Score (0) and Maximum Time (100 seconds). Text narratives of story overview displayed under HUD. Game starts after story overview ended. Four empty slots presented.
5. **Game end**: Game ends when player finish within allocated time or when life or time equal to zero.
6. **Game milestone events**: Score increased by 10 for each correct action and Lives reduced by one for each wrong action.
7. **Game exit**: Game can be exited from the close (X) button on the game window. User will be asked for confirmation.

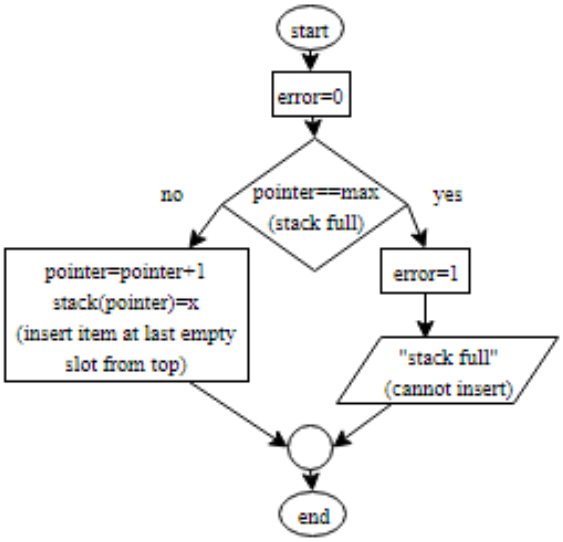

Fig. 1. Push algorithm for array implementation of stack

Definitions: **max:** maximum elements in stack. **pointer:** pointer to last element to be pushed or next element to be popped. **stack:** stack array. **x:** value to be pushed or popped

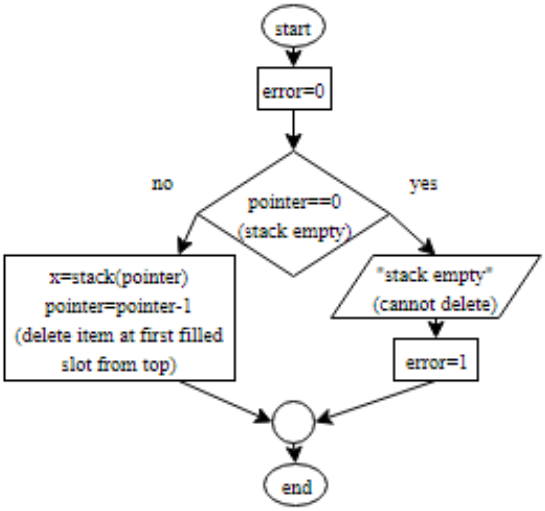

Fig. 2. Pop algorithm for array implementation of stack

Definitions: **pointer:** pointer to last element to be pushed or next element to be popped. **stack:** stack array. **x:** value to be pushed or popped.

3.2 Second-algorithm game appearance design

Graphics design

1. **Game Graphic Items**: 2D sprites, each with name, texture, size, and position.
2. **Node**: Item used to visualize one node of the algorithm data structure, which is stone.
3. **Collections**: A set of similar nodes organized according to specific rules. A collection is used to visualize an algorithm data structure, which is stack of stones.
4. **Playing tools**: Items used to play game, which are stone and bomb.
5. **Buttons**: Non animated graphic objects used in screens design. Yes, No, and Arrow buttons used during game.

Game assets

6. **Texture**: Stone, Bomb, Buttons.
7. **Sounds**: Background audio during game and sound effects during game opening, mouse click, correct action, incorrect action, game won, and game lost.

3.3 Third-Algorithm Game Mechanics Design

1. **Input Design** handles game input from mouse. Each player input event in game has a feedback in terms of Score, Lives, or sounds.
2. **Game Properties** are parameters initialized at start of game; Maximum Player Lives, Maximum Level Time, and Minimum Player Score. Other game attributes

are calculated and displayed to show game current state; Player Remaining Lives, Current Level Timer, and Current Player Score.

3. **Gameplay** is responsible for implementing playing rules of game according to visualized algorithm behavior. General gameplay of the game is depicted in Figure 3. While levelTimer and playerLives are more than zero, and while tasks are not finished, each incorrect action will decrease playerLives, while each correct action will increase playerScore. If player finishes game within given levelTimer and playerLives, player wins, vice versa.

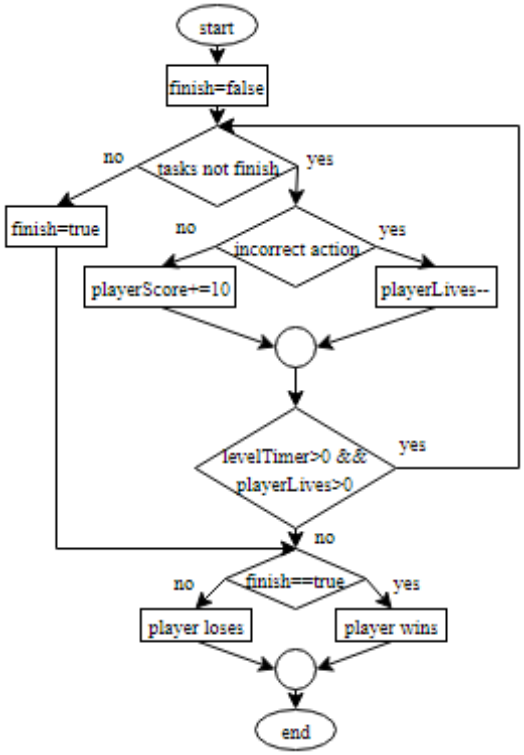

Fig. 3. General algorithm of gameplay

Specific playing rules that simulate the algorithm steps (see Figure 4) are as follows:

Screens design

1. **Title** screen displays the game title which is Train to Kluang, inspired by South Korea's blockbuster movie titled Train to Busan, with similar storyline; main character running away from zombies.
2. **Main menu** screen displays game main menu options and handles player choices. It is separated into three sections; Notes, Demo, and Play.
3. **Start** screen displays story overview, which can be skipped.

4. **Play** screen displays game for player to play, including HUD that shows game properties; Player Remaining Lives, Current Level Timer, and Current Player Score.
5. **Exit** screen allows player to stop and end game at any time.
6. **Won Game** screen displays won message when player wins (player finish within allocated time).
7. **Lost Game** screen displays lost message when player loses game. There are two; lost because of no lives left and lost because time is up.
8. **Game Demo** screen displays self-running demo of game.

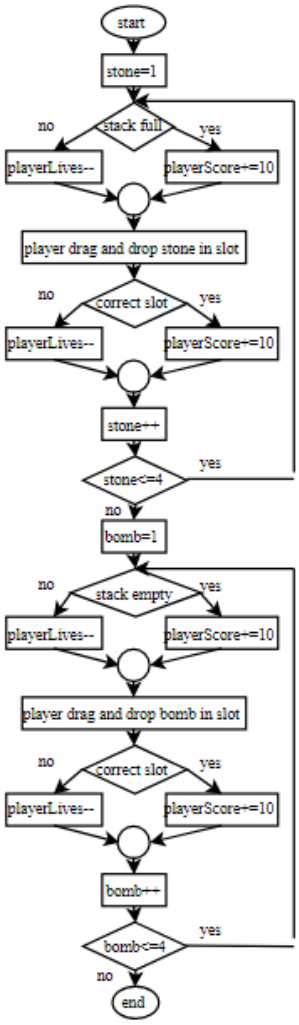

Fig. 4. Algorithm of array gameplay

Player need to stack (push) and unstack (pop) four stones. Before each stacking, player will be asked whether the stack is full (see Figure 5). Player then drag and drop stone in slot (see Figure 6).

Fig. 5. Checking whether stack is full before each push

Fig. 6. Push stones (data) in slots (stack)

Before each unstacking, player will be asked whether the stack is empty (see Figure 7). Player then drag and drop bomb in slot (see Figure 8).

Fig. 7. Checking whether stack is empty before each pop

Fig. 8. Pop stones (data) from slots (stack)

The series of questions are actually a replication of the thinking process that a student should undergo to solve problems regarding array implementation of stack data structure. Because game can be used as a training as it can be repetitively played, the idea here is for the students to ingrain the problem solving process in their mind until the point that they are able recreate (self-ask) the series of questions (process) when solving problems of similar nature.

The third phase of the research is the development of a prototype based on the design. Adobe Photoshop was used for graphic creation and editing, while Adobe Flash was utilized to integrate the multimedia elements text, graphic, audio, animation and video.

In the fourth phase of the research, the game was tested to measure its effect on learning outcome. A sample consisting of 29 first-year Diploma in Information Technology students who had taken the course in the previous semester was chosen. Players were required to answer a pre-game and post-game test that have the same stack topic questions before and after playing. Players were given time to study before playing. They were then separated into three groups to play the game.

If the game is successful, the gameplay triggers repeated cycles of user judgments (e.g., enjoyment) which leads to behaviour (play until won or play until lost or replay), and feedback (HUD, correct and incorrect audio, won and lost screens). Debriefing is the review and analysis of events that occurred in the game whose process allows players to transform game events into learning experiences. Successful debriefing leads to the achievement of cognitive learning outcome of the game which is the procedural knowledge (knowledge about how to perform a task) whereby the players demonstrate the ability to apply knowledge of stack to solve a specific problem.

4 Results and Discussions

Results from testing are summarized in Table 1. There are eight multiple-choice questions regarding stack data structure in pre and post-game tests. The first question asked players to choose the structure of stack. Second and third questions require players to select the name of the insert and delete operations in stack correspondingly. Fourth and fifth questions need players to pick stack operations in array implementation that occur before push and pop operations respectively. Sixth and seventh questions want players to determine the location of a new node during push and which node is removed during pop figuratively. Eighth question inquire whether there is a limit on the number of nodes that can be pushed in array implementation of stack.

Table 1. Comparison between pre-game and post-game test

Question number	Question	Correct		Change
		Pre	***Post***	
1	Principle	13	27	+
2	Push	26	28	+
3	Pop	27	26	-
4	Check full	14	17	+
5	Check empty	12	19	+
6	Push (array)	26	27	+
7	Pop (array)	17	22	+
8	Number of nodes (array)	25	26	+

Based on the results, all questions but one showed positive changes where number of correct answers after playing game (post) is higher than before (pre). Only one

question had negative change where number of correct answers decreased after playing game. But this result is not a major problem as the difference is only one.

To evaluate game usability, players answered 14 five-point Likert scale questions ranging from strongly disagree to strongly agree which consists of three sections; user interface, user friendliness, and interactivity. Results are summarized in Table 2.

Table 2. Game usability

Question number	Question	1	2	3	4	5
1	Effective use of screen area	0	0	11	16	2
2	Consistent layout	0	1	11	16	1
3	Attractive interface	0	2	6	19	2
4	Active buttons clearly highlighted	0	3	6	15	5
5	Easy to use	0	0	4	24	1
6	Easy navigation	0	1	10	16	2
7	Provision of Exit and Menu	0	0	9	17	3
8	Clear instructions	0	1	17	9	2
9	Meaningful icons	0	2	10	16	1
10	Consistent and readable text	0	1	7	15	7
11	Creative animations	0	0	6	15	8
12	Video enhances instructional effect	0	0	10	15	4
13	Graphics enhance instructional effect	0	0	13	14	2
14	Clear audio	0	0	4	20	5
Average (%)		0.00	2.46	30.54	55.91	11.08

1 - Strongly Disagree (%)
2 - Disagree (%)
3 - Neutral (%)
4 - Agree (%)
5 - Strongly Agree (%)

Players' opinions were mostly positive for all questions. But there are some issues with layout (question 2), interface (question 3), button (question 4), navigation (question 6), instruction (question 8), icon (question 9), and text (question 10). In term of layout, players may felt it is inconsistent as there are many screens in the game application, each with a different layout. We admit that attractiveness of interface may be low, as the graphics were not designed by professional graphic designers, but by final-year diploma students with limited skills. Therefore we understand when players suggested a "more creative" interface with "more animation", such as "motion for zombies". We are not sure why some players have issue with active buttons, as all buttons in the game increase in size or changes colour when mouseover, clearly highlighting them. We think that the game has a simple navigation, but may be some players were confused with the icons used. Some players thought that the instructions were general, making it ambiguous, and suggested for them to be "more detailed". In our opinion, fonts used in the game are consistent and readable, as the size is big and "colourful". Thus we are not sure why a player had an issue with it. Players also recommended an increase in Time and Lives. Provision for "Level" is proposed to add "difficulty" for "more challenge".

5 Conclusion

This research attempted to simplify learning of array implementation of stack data structure operations through game-based learning with question prompts. Educators could use the game to diversify teaching method and students can use it to self-assess understanding. Testing calls for improvements in terms of game design, appearance, and mechanics.

6 Limitations and Future Studies

The game developers have limited skills, thus compromising the attractiveness of the game. Furthermore, the game was tested in groups, thus not all students have direct interaction with the game. Some became passive participants, or merely an observer, or worst, an onlooker. These may affect their understanding of stack and opinions of the game. Future recommendations include application of GBL to other data structure topics using various game genres with more challenging and exciting gameplay to make learning more meaningful.

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Personalized Reading: Developing User-Describing Profile for Slow Learner Children

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Abstract—Personalization is a good supplement for learning process. It has been claimed that personalization has a huge potential of providing solution to facilitate the learning path based on children ability and preferences. Diverse research on personalized learning for children have been conducted which, are commonly concerns on the development and implementation of personalized learning products and services. However these researches have little emphasized in exploring slow learner personalized learning process particularly on their reading ability. With that, this paper aims to highlight two key important processes of personalization for slow learner children which are construction of user profile and scenario. The scope of this study is on personalization of reading for slow learner children. There were 13 slow learner children with reading difficulties from primary school participated in this study. The key findings from this study are the construction of user profile and scenario that represent the personalization for reading. These user profile and scenario construction then provide guidelines for the development of personalized interface design for slow learner reading application.

Keywords—Personalized Reading, User Profile, Scenario, Slow Learner

1 Introduction

There are tremendous changes on how children learn and how knowledge is delivered. The changes can be attributed to the extensive use of the technology that knowledge is accessible anytime anywhere. However, there is limited research that examines the effectiveness of the technology that assists delivering knowledge to learners, especially children who are slow learners and require special attention. The first consideration is to understand the whole pictures of the slow learners and the second consideration is to determine the best approach of using technology to tackle the root of the problem. Difficulties in reading is identified as the leading problem related to literacy among slow learners. Difficulty in reading will negatively influence their academic performance at school.

Personalization is identified as the best solution. It is capable of providing a personalized approach based on the reading ability and preferences of the slow learners. There is a minimal discussion in the literature of user profile as a personalization process, especially for the children who are slow learners. However, it is debatable that the user profile construction plays a vital role in personalization. [1] indicate that there are three (3) main directions in the development of personalization. These three directions are similar to the current study which encompass understanding the student's personality (user profile) and personalization approach as a feasible solution. [2] mutually agreed with the fact the knowledge on the user provides a better approach to personalization. This paper describes the personalization processes which is important as it leads to the development of personalized interface design. The identified processes is the construction of slow learner profile which describe the information of the slow learners. As the development process of the user profiles requires a deeper understanding of slow learner's explicit and implicit information, several steps are provided to develop the slow learner profiles to cater to both information by employing qualitative approach in the data collection process. With that, this paper aims to highlight a key important processes of personalization for slow learning-children which is the construction of user profile as it is provides step by step guidelines to the successful personalization. Section 2 of this paper discusses the related literature review while describes the methodology of the study. Section 4 present a detailed explanation of the key process of personalization which is the construction of the slow learner profile. Finally, Section 5 concludes the study.

2 Literature Review

The last decades has witnessed significant changes in education due to the enhancement in educational technology that has provided opportunities for all learners to learn any time. These advancements and increased use of technology are popularised the shift from the traditional one-fits-all approach to a personalized experience. Personalization technology is a powerful tools in enhancing user experience, yet simultaneously provide a personalization tool that meets the needs, preferences and knowledge of users. The personalization technology also promises a high potential that enables a technological tool to be accessible by users according to individual requirement by providing a solution to facilitate the expression of user needs [3]; [4]. However, looking at the personalization as a technological solution is inadequate. The concept of personalization is more than a simple process of providing personalized services based on gathered and observed activities. Research on personalization has demonstrated that personalization provides a broad view by changing human lives.in education, personalization is found to be a good supplement for the learning process.

Not only that, personalization has been widely applied in several areas such as e-learning, adaptive learning and web [5]; [6];[7];[8]. Various studies have attempted to utilised personalization as a tool for learning [9]. For example, [10] provide personalisation in searching information in the digital library, personalisation of a storybook to improve distance communication by [11], and personalisation of learning algebra by

[12]. Although technology has significantly impacted society and is ubiquitous at all levels of education, some categories of people in need are unfortunately left behind. The minority category focused on this study is slow learner children. In general, they are the minority of students who struggle with literacy problem, especially reading. Their existence in primary school is considered one of the biggest challenges that school teachers face nowadays, especially in order to achieve the school's aim of producing zero illiteracy among students. Zero illiteracy explains that every child at the school must be able to perform basic literacy skills including reading, writing, and calculating. Ensuring basic literacy seems like an easy task, but requires excellent and thorough planning. The implementation of zero illiteracy programmes might be possible for normal children, but teaching all children to read in school is a challenging process [7]. One of the challenges pertains the way to ensure all children who have reading difficulties, including slow learners allocated at normal classroom setting in primary school, have the ability to read like normal children. One of the ways to help slow learner children is by fully understanding them and by providing a better tool that can assist them to read better. Although personalisation has been identified as a better approach in learning, a growth in personalisation studies that present personalisation as just a product was identified. Adamantly, limited studies have focused on the understanding process of the unique profile of the users and describing how the process of the personalisation is implemented from sketch to the end product. A detailed understanding of user profile leads to a better design of the personalised materials. User profile is important for personalised information access. [13] presented that user profile provides several ways on building, managing, and representing information personalised for each user.

3 Methodology

User profiling can be defined as the data identification process of a user's interest domain [14]. Realising the criticality using user profile to understand slow learners, this paper presents how a concept-based user profile technique is used to develop a user-describing profile. This work also adapts the user profile development methodologies by [15] which build user profiling based on the type of users' information, either explicit or implicit information. A similar approach using explicit user feedback and implicit user feedback was also explored by [16] and [15]. The user profile and developed scenario are vital in determining the personalisation features in the personalised interface design. These two elements supplement each other in ensuring that all user needs are well-translated in the form of understandable step-by-step personalised design. In this study, the researchers' present personalisation as one of the supplements embedded in the reading materials to assist slow learners to overcome their reading difficulties. The slow learner children are selected as users due to the reading problem that the slow learner children faced in primary school. Although the data from 13 slow learner children were collected qualitatively, only one user profile and one scenario presented are in this paper to provide a better understanding of how the personalisation process was carried out. Two methods of user construction techniques

are employed in this study to cater to two types of information of the user, namely, explicit and implicit information. These two methods are explicit user information collection methodologies, often called explicit user feedback and implicit user information collection methodologies, also known as implicit user feedback. These two techniques are important in the construction of user profiling construction where explicit and implicit information of users are incorporated. Fig.1. depicts the several steps required in implementing these two methodologies of user profile construction which are the explicit user feedback and the implicit user feedback:

- Information collection process
- Construction of user profile
- Use of user profile in the application

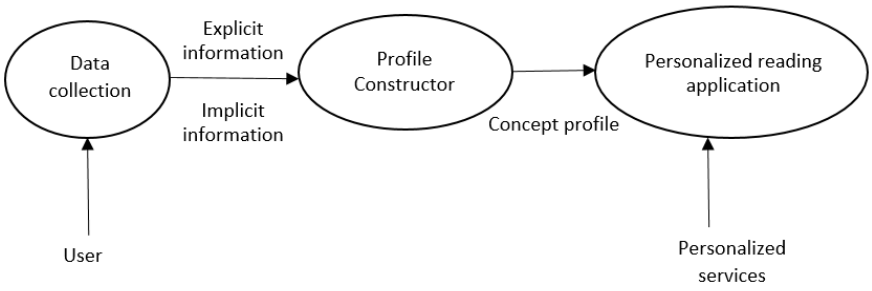

Fig. 1. Overview of user profile concept-based personalization. Adapted by [13]

The framework of our proposed approach is illustrated in Figure 2.

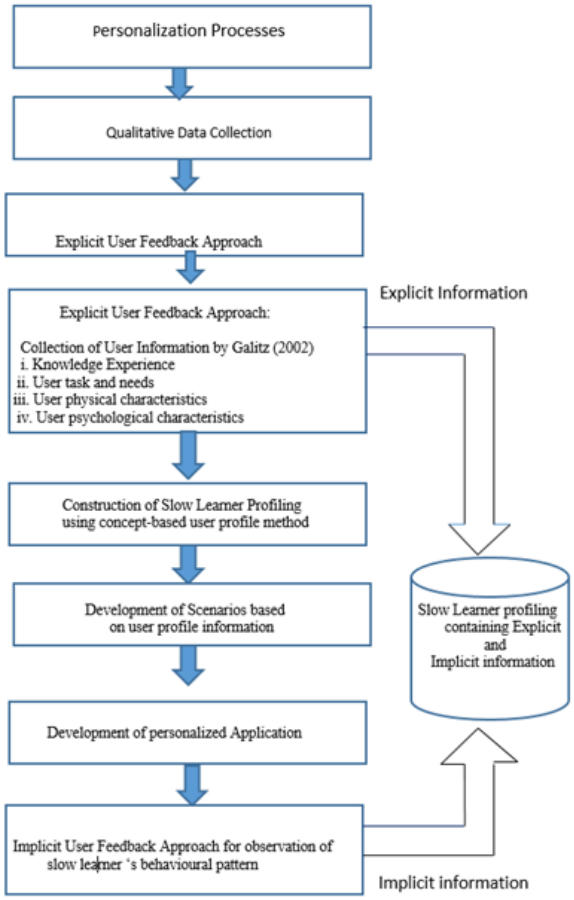

Fig. 2. Personalization process

3.1 Collecting explicit and implicit information of slow learner

The collection of information using explicit user feedback and implicit user feedback involves different activities. The explicit user feedback approach requires the researcher to collect information directly from the intended users. The explicit user feedback approach relies on the user's input, thus, explicit information gathered in this process requires direct communication with the user. Particularly, in this research, three (3) main activities are utilised to gather information which are interview, observation, and data analysis. Meanwhile, the implicit user feedback approach gathers implicit information of the user by analysing the information when the user is performing an activity while using the personalised application. To clarify, the total number of respondents involved in this study is 13 slow learner children and one remedial teacher who manages the children in their remedial class.

Collecting explicit information of slow learner through a qualitative research approach: Different user profile construction technique is utilised based on the type of user information. In this study, the explicit information of the user is collected by gathering the required information in a primary school setting. Personalisation of content is described in this paper due to the importance of identifying the right reading content material for the slow learner children who have difficulties in reading. Hence, a qualitative approach was conducted to collect the explicit information of reading performance of the slow learner children (prior knowledge in reading), reading needs, reading preferences as well as personal information of each slow learner child in order to identify suitable content for personalisation. All the gathered information is essential as provides an in-depth understanding of the real factors that contribute to the reading difficulties and to identify specific needs and preferences of each child for a personalised design. The figure below provides information on the qualitative research approaches conducted and outcome(s) from each activity performed.

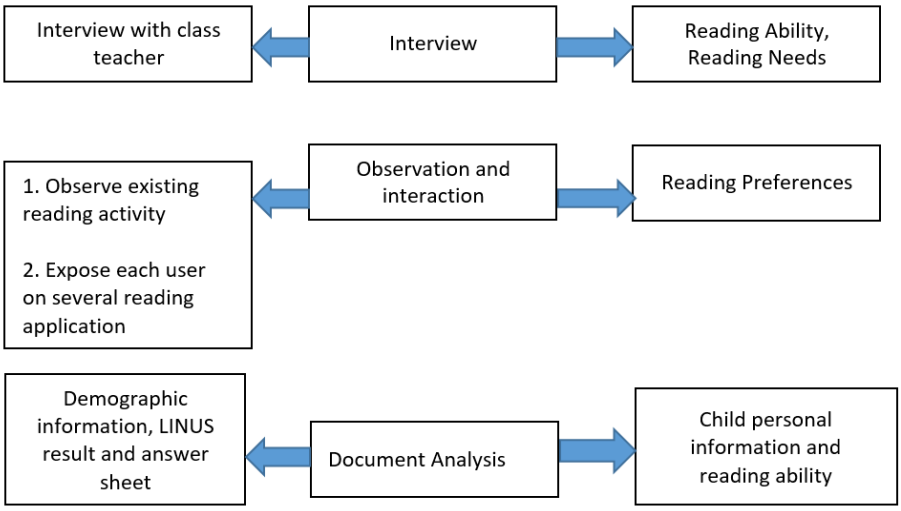

Fig. 3. Data Collection Process

Collecting Implicit information of slow learner through monitoring user reading activity: Implicit user information feedback approach focuses on the incorporation of implicit information in the construction of user profile. Gathering implicit information of slow learners while using the application does not require any intervention. The use of implicit information is important as it determines the changes in the personalisation feature embedded earlier which would take place using explicit information. Implicit information gathered from user behaviour while performing a reading activity determines the preferences and the needs of the user in the next usage of the reading application.

Capturing the implicit information from users is vital as it enriches the dynamic user profile information. Unlike the explicit information of the user which will not have

an effect over time (static), the dynamic information provides useful information that will ensure that the user profile is updated. The combination of explicit and implicit information enables the developed user profiles to cover all beneficial information that can support the construction of a comprehensive user profile. The information on the implicit user feedback approach and based on the activity performed when the slow learner children using the reading application are provided for the personalisation purposes. However, in the construction of the user profile, the preliminary information while performing something similar (reading activity) is used as a foundation in collecting real implicit information of the user.

Table 1 summarises the implicit data collection technique which specifies how the implicit information is collected, type of implicit information, and category of information for user profiling, and also the relationship between the implicit information and personalisation.

Table 1. Implicit user feedback

Collection Technique / Activity	Type of information Captured	Category of information for user profiling
Login	User registration	User name / login info
Test	Test on reading ability result	Reading ability
Native activity, Selection of preferred colour, Selection of preferredd reading buddy	Browsing activity, Preferred background colour, Preferred reading buddy	Navigation information, colour preferences, Reading companion
End test	Test on reading ability result	Changes on Reading ability

4 Findings

The outcome from the data collection process is divided into four (4) criteria. The four criteria are

- Slow learner demographic information
- Slow learner prior knowledge in reading
- Slow learner reading needs
- Slow learner reading preferences. Brief information of the required explicit information and its relation to the design aspect before the development of user profile will be described in the next section.

4.1 Slow learner raw information

Slow learner demographic information: One of the elements in user profile development is by gathering rich information on the slow learner demographic information. Many previous studies have also considered demographic information in understanding user as part of user profile design and development. Examples include studies by [17];[14]; and [18]. Slow learner demographic information refers to the personal information of the slow learner children including age, gender, hobby, cartoon characters, reading style, and interesting topics in reading. The demographic

information leads to a better design interface in personalisation. It is interesting to identify the personal traits of an individual in designing personalised reading materials so that personalisation can be developed according to their preference. For example, a cartoon character that a specific slow learner child prefers can be used as a reference in developing a preferred reading buddy in the personalised reading materials.

Slow learner prior knowledge: As described previously, one of the criteria in building the slow learner profile is understanding the existing knowledge of slow learners. Strong comprehension of the knowledge of the slow learners is the foundation that will assist the designer or even a school teacher to determine suitable or personalised reading content. Inability to provide necessary information based on each slow learner's ability will negatively influence the learning performance of the slow learner children as gathered from the analysis of the interview session conducted with one of the primary school teachers. Thus, it is required to understand the assessment of reading implemented at schools to understand the existing knowledge of the slow learner children. In Malaysian primary schools, the Ministry of Education has provided an effective tool to measure the ability of all primary school children in reading performance through the Literacy and Numeracy Screening (LINUS) programme. This assessment is gradually conducted to monitor children's performance from 7 years old to 9 years old. The reading ability for primary slow learner children is then categorised according to their reading performance. In brief, the LINUS programme is conducted to analyse children's progress in literacy learning. Table 2 indicates the LINUS assessment as determined by the LINUS constructs:

Table 2. Reading construct by LINUS assessment

Construct	Description
K1	Ability to sound and write vowels and consonant
K2	Ability to sound and write open syllable
K3	Ability to read and write open syllable
K4	Ability to sound and write close syllable
K5	Ability to read and write close syllable
K6	Ability to read and write words which contain 'ng' closed syllable
K7	Ability to read and write words which contains single vowel syllable
K8	Ability to read and write words which contains diphthong and cooperative vowel
K9	Ability to read and write words which contains digraph and cooperative consonant
K10	Ability to read and write word is with prefix and suffix
K11	Ability to read and write simple sentences
K12	Ability to read and understand stimulation material orally and in writing

The result in Table 3 describes the reading ability of the slow learner children based on a study conducted in a primary school in Malaysia. Among all 13 slow learners aged 9, the results indicated that 6 slow learner children are able to master word recognition, 2 can master the decoding stage in reading, and 5 were already mastering the semantic stage of reading which is related to the comprehension of the meaning of a word or sentence.Consequently, this study provides a feasible solution that can cater to the reading ability of these children categorised by word recognition, decoding, and semantic categories. However, due to the personalisation approaches

that require us to observe the needs and preferences of the slow learner children, the identification process of the suitable aspect of the design does not stop once the existing knowledge of the slow learner children is identified. The next section explains the reading needs and reading preferences of the children as another consideration that should be catered in this study for the development of the personalised design content.

Slow Learner Reading Needs and Reading Preferences: Approaching slow learner children is different compared to how we communicate with other children at a similar age. The difference can be attributed to the characteristics of the slow learner children which require different approaches. The importance of handling slow learner children has been captured in several books which have provided several intervention strategies such as [19], [20] and [21]. Collecting information on reading needs and reading preferences of slow learners is an interesting part of this study. Not only the information determines the interactivity and the attractiveness of the user interface, the first process of finding the information is also a worthwhile experience. Finding information on reading needs and reading preferences of the slow learner children requires the researchers to be a part of the reading process in the primary school classroom. The slow learner children that were observed in this study are positioned in the remedial class in order to receive intensive practice on reading in the particular case study that was conducted. Slow learner children have poor self-image [22] and have low self-esteem, [23]. In order to communicate effectively with them during the interaction and observation session, a teaching and learning session was conducted and the researchers acted as new teachers. This requires the researchers to build a good reputation and establish trust with them. Although the observation session took longer, the results of the observation are very worthy to this study. All information on the reading needs and reading preferences with the one-to-one reading activity of each slow learner children have been successfully gathered. Several reading needs and preferences are depicted in Table 2.

Table 3. Matching criteria of personalization in reading

Reading needs	Design strategies	Read Preferences	Design Strategies
Reading buddy or teacher companion	Provide animated and preferred reading buddy	Reading book based on interest	Develop book with identified interest
Repetition	Allow repetition	Reading with or without music	Enable / diable music
Familiarized objects	use familarized theme to promote understanding	Reading coloured book	Coloured animation book
Read-aloud mechanism	Provide narration	Moving objects / images	Provide suistable images / animation to avoid distraction in reading

4.2 User profile construction

The user profile is not a new term. Apparently, a few years back, it has been used widely as a foundation for the implementation of personalized approach due to the importance of understanding a user [24]. User profile or user model is one feature that is important in personalization. The information stored in the user profile is essential

to determine the different personalization effect on each individual user needs. In the development of personalized user Interface for slow learner children, the information of user profile is important to determine how the user interface is presented. In this particular study, the user profile was constructed by gathering explicit and implicit information of the users only. Due to the qualitative data collection technique implemented, as well as considering only reading activities are concerned, the user profile construction only focus on 4 important aspects that need to be considered in the design as proposed by [24] in his book entitled The Essential Guide to User Interface Design. All four aspects adapted in the construction of user profile in this study are:

- Knowledge/Experience
- User task and needs
- user psychological characteristics (motivation, expectation and cognitive style)
- user physical characteristics (name, age, cognitive processing, gender)

There are various ways of presenting user profiles such as keywords, semantic networks, or concepts, or association rules. In this particular study, the concept of user profile was used to identify related user profile features as proposed by [24]. Concept-level models of user interests are generally more powerful than keyword-level models. Compared to keywords, concept-level models allow a more accurate representation of interests. Concept user profiles are presented in the format of the node. The concept of user-describing profile describes using concept user profile that focuses on the in-depth understanding of a user for developing a personalised design. A good understanding of the user provides a clear explanation of the three important aspects of the user profile which are the existing knowledge of the user, reading needs, and reading preferences. In addition, the user profile also contains information on the personal explicit information of a particular user and the behavioural pattern which captures implicit information of a particular user while the user is performing a reading activity. The user profile is an important aspect of the personalisation tool. The type of information stored in the user profile is categorised into two (2) categories which are the static type of explicit information, and dynamic type of implicit information. All the necessary information is stored and the changes made by a particular user are recorded and updated to keep track of the user's reading pattern when using the application. Firstly, the data from the user are gathered and classified according to the reading ability based on the LINUS test result. The reading ability (RA) is used as a foundation for user profile classification. Grouping the children through similar RA would provide a solution for the children reading difficulties.

Elements for content design:

- Reading ability (RA)
- Reading needs (RN) are divided into 2 categories, one for the content design, another one for interface design
- Reading preferences

All information for content personalisation is related to reading ability, reading needs, and reading preferences. Only related information to the reading of slow learn-

er children is considered as an element in the content design due to the understanding of slow learner difficulties in reading leads to better design. In this paper, only one user profile which falls into the K12 reading construct is presented as an example to provide a better understanding of the importance of developing the user profile for a better design.

Table 4. Focused categories of slow learner based on reading ability (K12 Reading Construct)

Reading Construct	Categories of Reading ability	Description on reading Ability	No of slow Learner
K2	Phonology	Decoding	1
K3	Orthology	Word Recognition	5
K4	Phonology	Decoding	1
K6	Orthology	Word Recognition	1
K11	Semantic	Meaning	2
K12	Semantic	Meaning	3

In brief, there are three (3) user profiles created based on the identified slow learners' reading ability. Each user profile is designed to cater to each slow learner application. Three interface designs were also developed to cater to a specific user profile. However, due to the limitation in decryption capacity, only one user profile is presented in the form of graphical information as shown in Figure 5.

Fig. 4. User profile with K12 reading ability

5 Conclusion

This study concludes that the development of personalisation approaches is a long process. The development requires a strong understanding of two important elements which are the specific user profile and personalisation design methods that are needed to be embedded as a solution. Understanding the user helps the designers to cater to specific problems or issues while understanding personalised design methods such as the development of the scenario helps the designers in understanding the method to develop a task or an activity in the development of artefact. Combining these two elements in the design process promises the possibility to provide workable personalisation as a design solution.

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Digital Storytelling as a Creative Teaching Method in Promoting Secondary School Students' Writing Skills

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Abstract—With the current needs of shaping 21st-century classroom in schools, the use of technology has now become compulsory for teachers to incorporate in the classroom. The exposure to technology is highly necessary for the current generation to prepare them for the future ahead. Digital storytelling is one of the tools available in the market for learning. There is no much research yet found in Malaysia that investigates the usefulness of the digital storytelling in promoting secondary school students' writing skills. Therefore, this research tries to implement one digital storytelling tool in teaching Writing for English Form 1 and tries to identify the elements of digital storytelling tool that might be able to promote students' writing skills. This research involved fifteen Form 1 students. The data was collected through four (4) time series tests in a pre-experimental research study. The students' performance in each treatment were marked according to the Rubrics to Assess Digital Stories and were analysed using Friedman Ranks Test. The finding shows that there is an improvement in students' performance after four treatments of using the Digital Storytelling tools. For the elements of digital storytelling tool that affected after using the digital storytelling tool, the student respondents always applied six elements: 'Overall Purpose of the Story', 'Dramatic Questions', 'Choice of Content', 'Pacing of the Narrative', 'Quality of the Images' and 'Good Grammar and Language Usage'. Furthermore, there is an improvement in student respondents' post-test marks after four treatments of using Storybird. The study shows a relationship between elements of digital storytelling tool in the four treatments and students' writing performance in post-test. All of the elements shows a significant relationship with students' writing performance except for 'Dramatic Questions'.

Keywords—Digital Storytelling, creative teaching, 21st-century learning, web 2.0

1 Introduction

In this information age, there is an abundance of computer tools that can be used in the language classroom with the concept of the integration of technology. The fast-paced technological changes over the last few years have increased the interest of educators towards the convergence of technology in education. More and more educators have a tendency to shift their teaching style from the familiar medium of the textbook to the medium of the computer screen. Moreover, the birth of Web 2.0 tools has multiplied the possibility of educators in integrating computer technologies in the language learning classroom [1].

[2] emphasised that the integration of Web 2.0 tools will bring a positive effect in the teaching and learning process especially for language learning since they are able to provide multiple opportunities for students' engagement, communication, active learning, self-directed learning and collaborative learning. Thus, teachers are encouraged to use the Web 2.0 tools in their teaching process. Through these Web 2.0 tools, student learning spaces can be extended beyond the walls of the classroom as the web tools bridge the learning spaces across the school, home and even wider community [3]. On top of that, Web 2.0 tools not only support a virtual learning environment but also offer students the opportunities in practicing their language skills in a fascinating way [4].

Digital storytelling is one of the web 2.0 tools that can be used in the language classroom to promote teaching and learning process. Numerous researches in foreign countries have proven that digital storytelling can bring benefits to students. In basic schools in Oya state, [5] discovered that digital storytelling was able to improve kindergarten pupils' achievement in moral instruction. Whereas, in Portugal, [6] proved that the use of digital storytelling among secondary school students encouraged multimodal literacy in education. Additionally, in southern Taiwan, [7]'s research showed that project-based digital storytelling technique improved elementary school students' learning motivation, problem-solving competence as well as their learning achievement.

Despite all of the benefits, schools have yet to give their full attention to the use of digital storytelling in teaching students [8]. At the same time, teachers are still seen as reluctant to integrate technology into teaching [9, 10, 11]. This is due to the reason of using technology in the classroom might spend a lot of time. Lack of the facilities such as LCD and projector as well as the time-consuming in fixing projector and laptop impede the teachers in school from the use of technology in their lesson. One of the respondents in [9]'s study reflected that her primary school students became extremely excited when she was using digital storytelling in her lesson. The class that out of control made her think twice to integrate technology into her lesson again. Nonetheless, it was undeniable that students had positive response and attitude in spite of the problems.

Even though the digital storytelling tool is born to develop students' writing skill, it still has to compatible with current Malaysian English classroom context as well as cater the students with different language proficiency level. On top of that, the digital stories created by the students are needed to assess using an effective grading rubric

such as the digital storytelling elements that suggested by Robin and Pierson (2005). The elements of digital storytelling are essential and should take into the consideration because they are the one that work in promoting students' writing performance.

2 Research Objective

The objective of this research is

- To identify if there is a significant difference in students' writing skills after using the digital storytelling tool.
- To identify the elements of digital storytelling tool that affected after using the digital storytelling tool.

3 Methodology

The researcher applied the research design of pre-experimental design which called one group time-series test. The student respondents' writing performance would be measured before and after each four treatments were implemented. 15 Form 1 students were involved in this study. The accounts of chosen digital storytelling tool had been signed up beforehand by the researcher for each student respondent. The student respondents were then involved in a tutorial session that lasted for two hours. They were first requested to explore the basic functions of digital storytelling tool independently. Then, the student respondents were asked to produce three pages story with a minimum 10 words per page individually based on the thematic tag given which is 'people'. This introduced the student respondents to the basic features and functions of the chosen digital storytelling and also the steps to do in the treatments later on. The process of conducting four treatments was presented in Figure 1 for an easier glance.

For each treatment, the student respondents were required to produce a five pages story with a minimum of 15 words per page individually. Everyone was provided with a laptop each. The student respondents were requested to write the stories based on the thematic tags given which are 'celebration' for the first treatment, 'technology' for the second treatment, 'sick' for the third treatment and 'shopping' for the fourth treatment. The thematic tags were fixed by the researcher based on the KSSM themes which are 'People & Culture', 'Science & Technology', 'Health & Environment' and 'Consumerism & Financial Awareness'. The student respondents were encouraged to use their own imagination and creativity in developing the stories. They were given two hours to complete their stories for each treatment. The researcher only assisted them in solving technical problems faced during the activities. Furthermore, during and after the writing activities with the implementation of chosen digital storytelling, two English teachers used the rubrics to assess digital stories created by students. The comments based on the rubrics were given by the English teachers to the student respondents after they completed the first story so they could correct their mistakes thus

improve their next stories. This step was repeated from the beginning of first treatment until the end of fourth treatment.

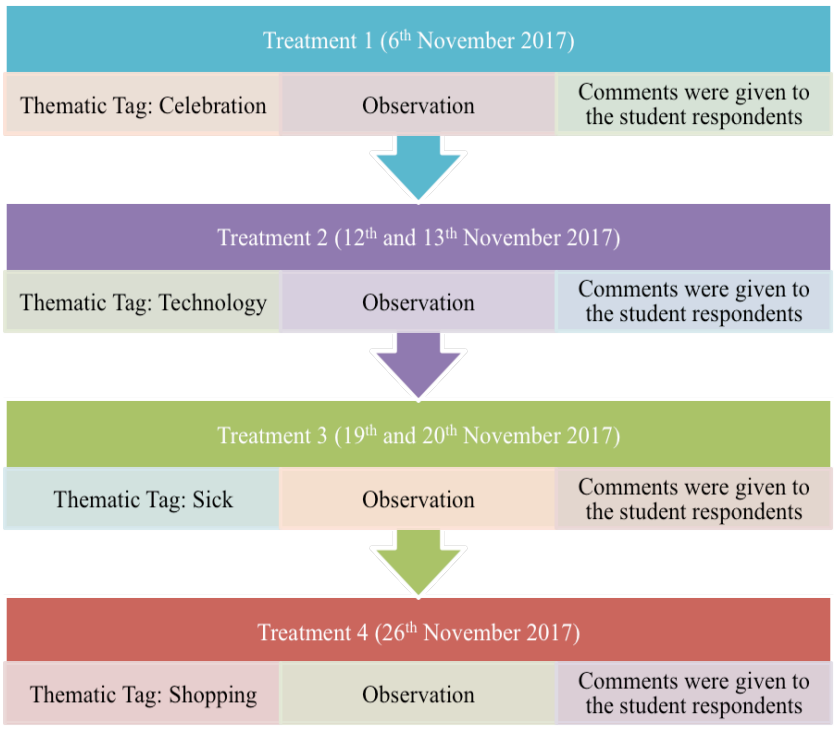


Fig. 1. Process of Conducting Four Treatments

4 Data Analysis and Finding

This section focuses on the elements of digital storytelling tool that promote students' writing skills. The Center for Digital Storytelling has published seven elements which they believe are the keys in making digital stories to be effective. [12] modified and expanded this traditional version of the seven elements of digital storytelling to the ten elements so it is more applicable to the types of digital stories that created by the students nowadays. Furthermore, another rubrics was prepared based on the previous work done by [13] to help the researcher in assessing the digital stories created by the student respondents thus identifying the elements of digital storytelling tool used.

Additionally, in the effort of improving the observation checklist and rubrics to achieve the research objective, the items had been reduced from ten to eight items. The elements of digital storytelling on 'Clarity of Voice' and 'Use of a Meaningful Audio Soundtrack' were eliminated because there is no audio supported in chosen digital storytelling tool. As a result, only a total of 8 items on the elements of digital storytelling would be given points according to the Rubrics to Assess Digital Stories

created by Students [12], after each four treatments. To be more details, the four treatments refer to four writing activities that had been conducted with the incorporation of a Digital Storytelling Application named Storybird among 15 student respondents. Besides, each item was corresponding to 1 point, 2 points, 3 points and 4 points. On top of that, the higher the point, the more the student respondents applied that specific element in their digital stories created.

One of elements is the element on dramatic questions. Figure 2 and Figure 3 show an example of 'Dramatic Question' element.

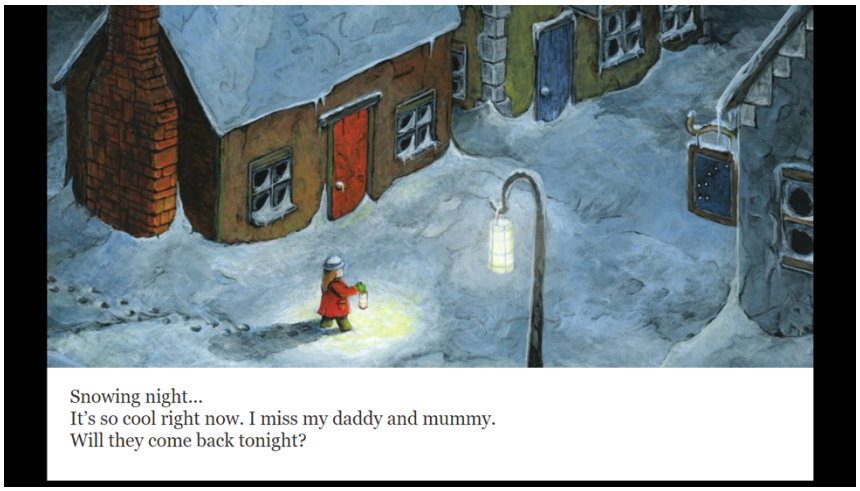
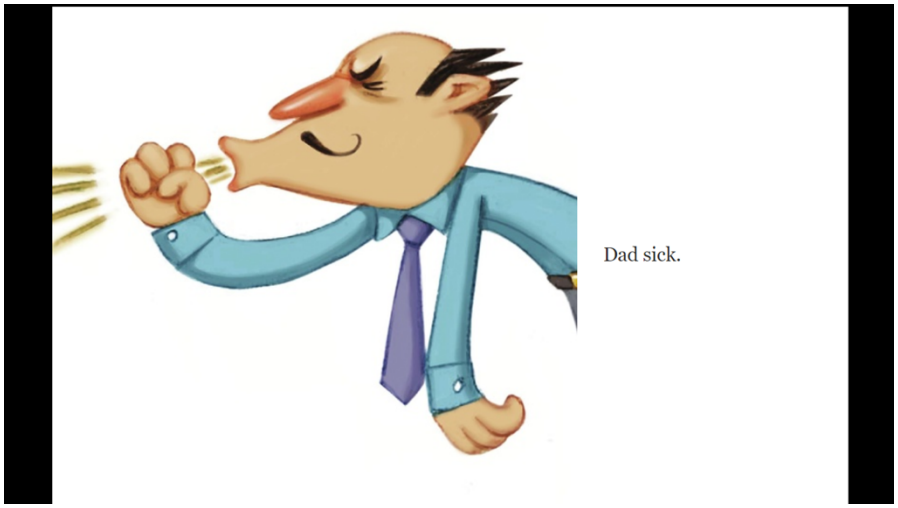


Fig. 2. Example of 'Dramatic Question' Element (Page 1)

Fig. 3. Example of 'Dramatic Question' Element (Page 2)

Based on Figure 2 and Figure 3, it can be clearly seen that a meaningful dramatic question 'Will they come back tonight?' is asked and answered within the context of the story. Hence, the student respondent was awarded with full 4 points since he fulfilled the element on dramatic question.

Example of the rubric for the element on quality of the images with Point 1 and Point 4 was shown in Figure 4.



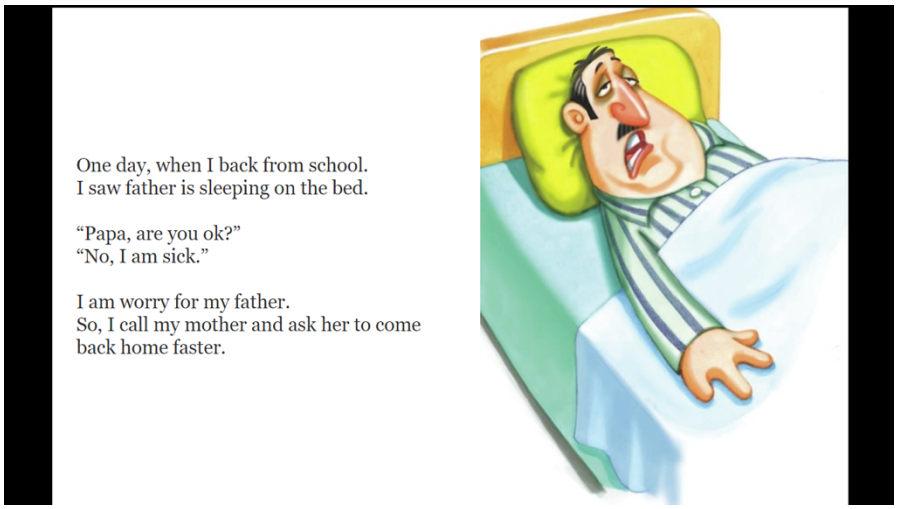


Fig. 4. Example of 'Quality of the Images' Element (1 Points and 4 Points)

Based on Figure 4, it can be clearly seen that there is a noticeable difference between the attempts made by the student respondents. The student respondent who only made a little attempt in using images to create an appropriate atmosphere was award-

ed with merely 1 point in accomplishing the element on quality of the images. Whereas, another student respondent was awarded with full 4 points in accomplishing the element on quality of the images as he used the images to create a distinct atmosphere that matches with different parts of the story. The images may communicate symbolism and metaphor.

Another example of the rubric for the element on good grammar and language usage with Point 1 and Point 4 were shown in Figure 5 and Figure 6.

Fig. 5. Example of 'Good Grammar and Language Usage' Element (1 Point)

Based on Figure 5, it can be clearly seen that errors in grammar and usage distracted greatly from the story. Thus, the student respondent was awarded with only 1 point in performing the element on good grammar and language usage.

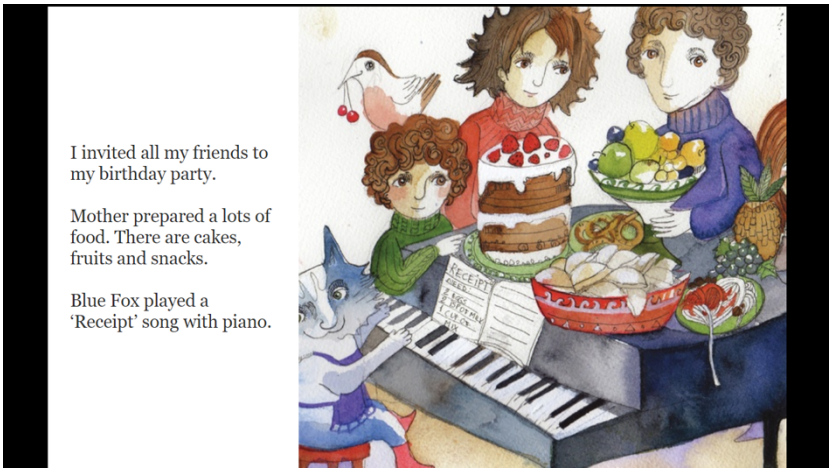


Fig. 6. Example of 'Good Grammar and Language Usage' Element (4 Points)

Based on Figure 6, it can be clearly seen that grammar and usage were correct and contributed to clarity, style and character development. Thus, the student respondent was awarded with full 4 points in performing the element on good grammar and language usage.

Subsequently, the points of each element of digital storytelling were calculated and keyed in to SPSS program for the purpose of statistical analysis. On the other hand, there were only fifteen student respondents involved in this research. The number of observations (N) is less than 30 and too small to assess normality adequately. For that reason, the non-parametric test of the Friedman Test is used to compare the elements of digital storytelling tool applied by the student respondents throughout the four treatments. The results of the findings as shown below for easier glance.

Table 1. Summary of Elements of Digital Storytelling Tool in Four Treatments

	Overall Purpose of the Story	**Narrators Point of View**	**Dramatic Question or Questions**	**Choice of Content**	**Pacing of the Narrative**	**Quality of the Images**	**Economy of the Story Detail**	**Good Grammar and Language Usage**
Chi-Square	12.660	2.400	11.909	27.142	8.846	22.710	4.661	9.429
Df	3	3	3	3	3	3	3	3
Asymp. Sig.	.005	.494	.008	.000	.031	.000	.198	.024

Table 1 summarises the Friedman test statistics of the elements of digital storytelling tool in four treatments. The elements of digital storytelling tool that showed a significant difference between four treatments are determined as the elements of digital storytelling that promote student respondents' writing skills. Based on Table 1, it can be clearly seen that the elements of digital storytelling on 'Overall Purpose of the Story', 'Dramatic Question or Questions', 'Choice of Content', 'Pacing of the Narrative', 'Quality of the Images' and 'Good Grammar and Language Usage' have the significant value of $p = 0.005$, $p = 0.008$, $p = 0.000$, $p = 0.031$, $p = 0.000$ and $p = 0.024$ respectively. The significant value of p which is less than 0.05 indicates that there was a significant difference on 'Overall Purpose of the Story', 'Dramatic Question or Questions', 'Choice of Content', 'Pacing of the Narrative', 'Quality of the Images' and 'Good Grammar and Language Usage' between the four treatments. Therefore, it can be concluded that all of the elements of digital storytelling tool are the elements of digital storytelling that promote student respondents' writing skills except for 'Narrator's Point of View' and 'Economy of the Story Detail'.

5 Discussions

In term of 'Overall Purpose of the Story', the students should create a purpose early on and maintains a clear focus throughout [12]. Thru the four treatments, the student respondents improved themselves from unable to deliver a fairly clear purpose of the story until establish and maintain the clear purpose from beginning to end of the digital story. [14] claimed that a digital story can only be addressed as a good text

writing if and only if the author establishes a meaningful purpose for the story and maintains the consistency until reaching a reasonable ending.

In term of 'Dramatic Questions', the students should pose a question to arouse the reader's curiosity and gives an answer or explanation by the end of the story. Throughout the four treatments, the student respondents were encouraged to generate questions to draw readers' attention in reading their digital stories. According to [15], students who include the element of asking questions in the creation of digital stories will develop advanced communication skills through the learning on organising ideas, asking questions, expressing opinions as well as constructing narrative stories. It also benefits the students in the way of presenting their thoughts and knowledge in an individual and meaningful way.

From the aspect of 'Choice of Content', the students should make the attempt to use the contents to create a distinct and appropriate atmosphere or tone that matches with different parts of the story [12]. This element is similar with one of the requirements in Pentaksiran Tingkatan 3 (PT3) marking scheme, where the ideas should be well-developed and well-organized with main ideas and supporting details for students to score high marks in their English writing section. Hence, student respondents were trained to establish the connection to the topic given as well as to the different parts of the story. This skill had been boosted up in this research with the use of Storybird. [16] stated that digital stories help to actualize abstract concepts, reconstruct conceptual content in a more comprehensible way and also conveying content in a fascinating way.

In term of 'Quality of the Images', the students should make the attempt to use the images to create a distinct and appropriate atmosphere or tone that matches with different parts of the story. The images may communicate symbolism or metaphors [12]. In other words, student respondents used the appropriate content in describing the images thus create a coherence story. Moreover, with the use of the images via a visual platform, Storybird in the four treatments provides a positive impact on the student respondents. According to [17], the verbal codes (words) and non-verbal codes (images) are functionally independent and can have an extra memory response. Therefore, the combination of words and digital pictures are considered to have a positive impact on language learning such as increase the students' interests as well as their willingness in acquiring the English writing skills through the use of Storybird. To be more precise, the stunning artworks in Storybird and the online writing activities are easier in engaging student respondents in the situation of learning the target language skill compared with the normal classroom activities. Thus, the motivation of the learners in the process of learning language can be enhanced with the using of Storybird [18].

From the aspect of 'Good Grammar and Language Usage', the students should use correct grammar and usage in story writing thus contribute to story's clarity, style and character development [12]. This element is similar with two of the requirements in Pentaksiran Tingkatan 3 (PT3) marking scheme, where the language used in writing should be accurate with few first draft slips at the same time vocabulary used should be wide and precise for students to obtain higher grade in their English writing section. Therefore, student respondents were actually trained to produce the writing pieces with minimum grammatical errors as well as use varied and good-choice of vocab-

ulary in describing the incident or character in the writing. These two skills had been polished again in this research with the use of Storybird. This is then supported by the researches done by [19, 20, 21]. They verified that students' grammar, vocabulary along with writing skills were improved after using Storybird.

Ultimately, through this research, it has been proven that the elements of Storybird play a substantial role in cultivating secondary school students' English writing skills, thus promote their writing performance. [22] claimed that a good digital storytelling tool should cover most of the elements of digital storytelling. [23] also declared that elements of digital storytelling play a role in improving students' writing skills. That is to say, the students were able to create a digital story with exactly the right amount of detail throughout. Furthermore, in case Storybird is not available anymore in the future market, teachers should select the new digital storytelling tools that must have at least the same digital storytelling elements suggested and identified by this research in promoting students' writing performances.

6 Conclusion

In conclusion, the student respondents were able to have a hands-on experience of writing a digital story with the artworks provided by Storybird. This was a brand new yet fascinating activity in student respondents' English writing lesson. Also, they recognized their weaknesses in English writing thus tried to amend those flaws and improved their performance through the treatments or known as writing activities with the implementation of Storybird.

As a result, this research has provided a clear picture to the respondents on the integration of digital storytelling, Storybird in promoting writing performance. Similarly, it also proposed a new teaching approach for Malaysian English language teachers in the efforts of improving students' writing skills through the incorporation of technology. Teachers in school are then suggested to enhance their computer self-competence through in-service training. The basic usage of digital storytelling, Storybird should be introduced to all the English teachers as the simplicity of technology use will motivate teachers' implementation of ICT in their classroom [24].

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Vocabulary Learning Through Mobile Apps: A Phenomenological Inquiry of Student Acceptance and Desired Apps Features

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Abstract—Vocabulary plays a great role in language learning as learners would face difficulties in language learning if they have insufficient vocabulary knowledge. The advent of new technologies has encouraged the development of mobile assisted language learning (MALL) and the increase in mobile apps for vocabulary learning. Nonetheless, it would seem that there is a dearth in research on the use of mobile apps for vocabulary learning especially in our local contexts. Capitalising on the strength of phenomenological inquiry and a model for technology acceptance, this study investigated several existing mobile apps for language learning. In particular, it looked into students' acceptance and the features of mobile apps conducive for vocabulary learning. This study employed in-depth interviews and surveys as instruments. Using purposive sampling technique, thirty-three students were selected as participants to experience using mobile apps to learn vocabulary on self-directed basis for a specified duration. At the end of the trial stage, all participants responded to the surveys, and three were interviewed. The accounts given by participants indicated positive acceptance and several desired features. Interestingly, this study also revealed several challenges in learning vocabulary through mobile apps which should be the concern of both apps developers and language teachers.

Keywords—Vocabulary learning; Mobile Assisted Language Learning; English as a Second Language; Apps features

1 Introduction

Many studies conducted regarding the implementation of mobile learning in language learning also reported positive acceptance by learners [40][7][5]. Learners are willing to download educational materials and finding information when required through their mobile phones. They also believed that the use of mobile phones helps in facilitating and increasing their effectiveness in communication for learning. Mobile learning is also convenient and practical. Several studies conducted on the use of mobile phones for vocabulary learning also leaning towards positive as far as learners' acceptance and experience are concerned [9][23]. Despite the positive acceptance by learners, there are still challenges faced by them in adopting mobile phones for

language learning. The use of mobile phones in classroom is still limited even the learners like to use them due to the discouragement by teachers. Learners also faced difficulty in storing large files in mobile phones and some of the learning apps make their mobile phone's battery low continuously. Some of the learners also stated that they are not comfortable in reading and writing in small screen on mobile phones as compared to laptop. Learners are also tempted to chat with their friends or playing games instead of learning [1][24][15].

2 Literature Review

Review of literature as follows shows the general acceptance of students in Malaysia in MALL and the indicated findings leaning towards the positive as far as learner acceptance is concerned. As cited in [40] reported positive perceptions of postgraduate ESL students in Universiti Kebangsaan Malaysia towards the use of mobile phones in learning. The students believed that MALL helps enhance learners' proficiency of English due to several features, i.e. accessibility to various learning materials and activities, increased opportunities to interact with their peers and lecturers. Meanwhile, a lack of acceptance among students in two local universities, University of Technology MARA and Universiti Kebangsaan Malaysia, due to low level of readiness; overall, the respondents welcomed the integration of M-learning but currently preferred the use of blended learning [22].

The students' acceptance in using mobile app in language learning could be influenced by the mobile application being used and the features of them. A study conducted by [2] on learners' readiness for mobile learning reported that there are several preferable mobile learning features chosen by the learners such as reminder for important events, helpful tips for their study and audio learning modules which can ease the learners especially learners who are working adults. Meanwhile, in a study conducted found that most ESL mobile app were targeted for adults and young adults' use which seems closely related to population of mobile phone owners [25]. The major focus of ESL mobile apps are on words where most of the applications have activities on learning vocabulary followed by spelling and pronunciation. The other language skills highlighted in ESL mobile apps are reading, grammar, listening, speaking and writing in order. The findings shows that the current ESL mobile apps focus more on receptive language skills as compared to productive language skills.

3 Theoretical Framework

The Technology Acceptance Model proposed by [18] evaluated the influence of four internal variables upon the use of technology in learning. The internal variables used in the original model are perceived ease of use, perceived usefulness, attitudes towards use and intention to use as shown in Figure 1.0.

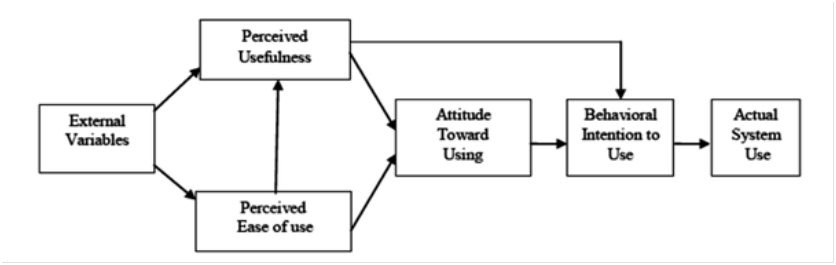

Fig. 1. Technology Acceptance Model (Davis et al., 1989)

This model assumed that the intention of students is a result from the cognitive processes. In this context of study, the students' intention to use mobile apps in the future is influenced by the acceptance in using the apps. This model is used to be applied in this study because it reflects the environment of using mobile apps in learning vocabulary. There are two other internal variables added to this study which are self-efficacy and compatibility. Thus, based from this model which has been adapted in this study, it is proposed that the acceptance of students in using mobile apps to learn vocabulary is influenced by the students' perceived in the usefulness, ease of use, self-efficacy, compatibility and intention to use. It is also proposed that the students' intention to use mobile apps in vocabulary learning in the future is influenced by their acceptance in the use of mobile apps in vocabulary learning. Hence, they are assumed to use the apps in the future if their acceptance towards the use of the apps in vocabulary learning is positive.

4 Methods

In order to gather the data of the students' acceptance and experience in the use of mobile apps in vocabulary learning as well as the preferable features of language learning mobile apps for vocabulary learning, phenomenological research design was used in this study. This study aims to

- To identify students' acceptance towards the use of mobile apps in learning vocabulary
- To determine the preferred features for vocabulary learning mobile apps
- To identify students' experience in using mobile apps to learn vocabulary

5 Methodology

In quantitative approach, a set of questionnaire was used in which some of the items were adapted from previous research to elicit information about the acceptance of students. The adapted items comprised of closed-ended items which consists of Likert-scale items range from Strongly Disagree to Strongly Agree. Meanwhile for the qualitative approach, phenomenological research approach was used because this

study involved exploring a phenomenon and a group of individuals who have experience the phenomenon as cited in [16]. Interview session was conducted with three participants to gain an in-depth understanding on the students' experience. The participants involved in the questionnaire survey study have the same MUET band 3. Meanwhile, the participants involved in the semi-structured interview are TESL students since they have pedagogical background related to this study. They were interviewed regarding the use of mobile apps in helping learners to learn vocabulary. As for the survey, 30 postgraduate students with MUET band 3 were involved.

6 Data Analysis

For the analysis of data, a total of three variables were taken into consideration namely the acceptance of students towards the use of mobile apps in vocabulary learning, the features for a vocabulary learning mobile app and the experience of students in using mobile apps to learn vocabulary. Some of the data from the questionnaires were analyzed through the use of Statistical Packages for Social Sciences (SPSS Window Version 16.0) by using descriptive statistic, to organize, display, describe and explain a set of data with the use of tables, graphs and summary measures [28]. The frequency, percentage and mean value of the data were also determined by using SPSS 16.0. From the Likert Scale in Section B, the acceptance level of the students was determined. The levels were divided into three levels which are high, moderate and low. The high level was determined from the value of 1.00 to 2.33 while the moderate level was determined from the value of 2.34 to 3.66. Meanwhile, low level was determined from the range of value between 3.67 and 5.00. As for the open-ended items in Section C and Section D, the students' views were categorized into emerging domains themes and were analyzed accordingly.

Meanwhile, the qualitative data from the interview session were used to support and give meaning to the quantitative data analysis.

7 Results

Table 1. Students' Acceptance towards the Use of Mobile Apps in Learning Vocabulary

	Statements	**Likert Scale**				**Mean**
		SD	***D***	***A***	***SA***	
	Ease of Use					
1	Learning vocabulary through mobile apps is easy for me.			18.60 %	12.40 %	1.60
2	Learning vocabulary through mobile apps saves time.			17.57 %	13.43 %	1.57
3	Learning vocabulary through mobile apps is convenient.			15.50 %	15.50 %	1.50
4	The mobile apps for vocabulary learning are easy to use.		3 %	18.60 %	11.37 %	1.67
	Usefulness					
5	Learning vocabulary through mobile apps is not restricted by time and place.		13 %	16.54 %	13.43 %	1.60
6	Learning vocabulary through mobile apps can help me access the information I needed.		2.7 %	13.43 %	15.50 %	1.57
7	Learning vocabulary through mobile apps enhance my			20.67 %	10.33 %	1.67

	effectiveness on my learning.					
8	Learning vocabulary through mobile apps provides helpful guidance in performing tasks.			21.70 %	9.30 %	1.70
	Efficacy					
9	I could complete learning vocabulary tasks through mobile apps if there is no one around to tell me what to do.		2.7 %	18.60 %	10.33 %	1.73
10	I could complete learning vocabulary tasks through mobile apps if someone had helped me to get started.		6.20 %	18.60 %	6.20 %	2.00
11	I could overcome the difficulties encountered when I used mobile apps to learn vocabulary.		2.7 %	23.76 %	5.17 %	1.90
12	I could complete vocabulary tasks through mobile apps no matter how difficult it is.		6.20 %	20.67 %	4.13 %	2.07
	Compatibility					
13	By learning vocabulary through mobile apps, I do not have to change anything I currently do.		5.17 %	17.56 %	8.27 %	1.90
14	Learning vocabulary through mobile apps does not require significant changes in my existing work routine.	13 %	27 %	22.73 %	5.17 %	1.97
15	Learning vocabulary through mobile apps is same as using other software I have used in the past.		517 %	2273 %	310 %	2.07
16	Learning vocabulary through mobile apps can reinforce from computer.		3.10 %	23.77 %	4.13 %	1.97
	Intention of use					
17	I am willing to use mobile apps to learn vocabulary.		1.3 %	22.73 %	7.24 %	1.80
18	I will continue using mobile apps to learn vocabulary in the future.		1.3 %	23.77 %	6.20 %	1.83
19	Overall, I will learn vocabulary through mobile apps.		1.3 %	24.80 %	5.17 %	1.87
20	I will recommend others learning vocabulary through mobile apps.			21.70 %	9.30 %	1.70

Table 2. Preferred Features for Vocabulary Learning Mobile Apps

Features	Frequency (f)	Percentage (%)	Examples of students' responses in open-ended questionnaire
Games	23	77	"It is fun and it triggers me to learn more on vocabulary each day"
Test / quiz	1	3	"It helps me to learn new word"
Media	1	3	"I can know the pronunciation of a word"
Word list	5	17	"I learned best by looking at examples and how it is being used in a sentence"

Table 3. Challenges in Using Mobile Apps in Learning Vocabulary

Category	Examples of students' responses in open-ended questionnaire
Vocabulary are challenging	"Even though the level setup is easy, the words seem difficult"
Not interesting	"It does not consists of any games, it focuses on quiz and learning"
Instruction is not clear	"I could not understand the instructions at the beginning of using this app"
Needs internet connection	"If the internet connection is slow, the features are also slow"
Game is demotivating	"Fly High game ends too soon when I answered wrongly. It demotivated me to try again"
Features need to be bought	"Some app functions needed to be bought with real money"
Design is dull	"The interface is quite boring and unattractive"
Too many ads	"There are many advertisements in this application. Waste of time and concentration"

Input is not given	"It does not introduce the vocabs first, it goes straight to the quiz"
Too many notification	"It has too many notification"
Not working properly	"Not working properly with me"
Time and credit based	"Time and credit based so I can't just play freely whenever I want"
Internet connection	"I hope to learn vocab without using my internet data"

8 Discussions

The findings show that the students have a positive acceptance towards the use of mobile apps in learning vocabulary. The major factor that influence the positive acceptance of the students on the use of mobile apps in learning is due to the ease of use offered by the tools with m= 1.59. The students agreed that it is convenient to learn vocabulary through mobile apps since it is accessible anywhere and at any time. Hence, they are able to access to the apps according to their preferred time and place which makes it easy for them to learn and are able to saves their time. This is also supported by the data from the interview as learners are able to save their time and energy in using mobile apps to learn vocabulary. It is also easy to use since the mobile apps can just be downloaded in their mobile phones which is easy to carry everywhere. This finding is in line with another study by [40] which also reported positive responses from UKM students towards mobile technology as convenient and practical to be used. A study reported positive acceptance by students in using mobile devices for language learning because of the portability and convenience offered by the tools [24]. Other than that, it was also found that the students are willing to use mobile apps to learn vocabulary in the future with m= 1.80. They also are willing to recommend learning vocabulary through mobile apps to the others. This finding shows that students have interest to learn language through the use of mobile apps in the future. Hence, the implementation of mobile apps in language learning, especially for vocabulary learning is welcomed by the students.

The most preferred feature in vocabulary learning mobile apps is the feature of games. They also chose this feature as the most useful feature among the others. Possible explanation to this is because this feature helps them to learn in a fun and enjoyable way. The feature also triggers them to learn more and motivates them in learning. This is also supported by the data from the interview which stated that learners are able to learn vocabulary in a stress-free environment through games. The exciting and fun element in the games also could motivate learners to learn better. This is also supported by [6] which stated that the feature of game is helpful to promote excitement to learners as they are more excited in learning.[15] added that learners preferred to learn vocabulary through meaningful context such as online game since it is more appealing to them. It is also found that the other preferred feature for vocabulary learning mobile apps is the feature of word list with definitions and examples. This feature is also selected as the most used feature by the students. Possible explanation to this is because students learn vocabulary better when they know the definition of a word and how the word is being used in a sentence. The data from the interview also supported this finding as this feature is beneficial in helping learners to understand better. In addition, the students also preferred the feature of media to be included in

vocabulary learning mobile apps. The feature of media such as audio pronunciation is useful in helping them to learn new words. This is also supported by the data from the interview in which stated that the use of audio pronunciation is able to help learners to pronounce a word correctly. According to [13], audio recording feature is helpful as pronunciation guide for learners who are not familiar with a new word. Besides that, the use of images is also useful in helping learners to understand the meaning of a word better. Sometimes, students still have difficulty in understanding the meaning of a word even though the definition is provided. The use of images is able to help them to get the clear picture of the meaning of a word and helps them to remember the word.

The most challenging problem faced by the students in using mobile apps to learn vocabulary is due to the complicated vocabulary. The students claimed that the vocabulary provided in the apps are too hard for them and they were having difficult time to understand the vocabulary in the apps. They also claimed that they are unfamiliar with the vocabulary provided as the words are usually used by them in their daily basis. This is supported by the data from the interview which stated that even students with high English proficiency level were having difficulties in understanding the vocabulary. This situation could makes learners to feel demotivated to continue learning and it also might makes the students to lose confidence in using the apps to learn vocabulary. Possible explanation to this is because most of the existing vocabulary learning mobile apps were designed to prepare students for international preparation exams such as IELTS, TOEFL and GRE. Hence, the words provided might be a little bit difficult especially for students with low or medium English proficiency level.

In addition, it is also found from the findings which stated that the apps are not interesting to be used due to several reasons. One of the reasons is the requirement of internet connection in using the apps. Internet connection is needed for the students to access to the apps and they also found problems in accessing the apps when their internet connection is slow. This is also supported by the data from the interview which stated that it would be challenging for learners to access to the apps if there is no internet connection or when there is poor internet connection. [24] supported that students show frustration in using mobile technology in language learning since not all of the, have consistent access to mobile technology.

9 Conclusion

In this study, the findings indicated that students have positive acceptance towards the use of mobile apps in learning vocabulary. The reason on the positive acceptance by the students is influenced by ease of use and usefulness of mobile phones in learning. Apart from that, it is also found that games feature is the most preferred feature to be used in vocabulary learning. The use of games which is fun and enjoyable managed to motivate and trigger the students to learn more. There are few suggestions of improvement proposed by the students to overcome the challenges in using mobile apps for vocabulary learning. They suggested to lower down the difficulty of the vo-

cabulary and varies the definition of the vocabulary. More interactive games also should be added to the apps as well as media elements such as video and images. The advertisements in the apps should also be lessen and the design of the apps should be using more graphic and colourful icons and pictures. Other than that, clearer instruction should be used and a guide should be provided for new users of the apps.

Lastly, the students managed to list out some of the benefits of using mobile apps in learning vocabulary such as it is convenient to be used in learning. They are able to learn vocabulary anywhere at any time by accessing through the mobile apps instead of dictionary or books. This will save their time and energy to learn. Other than that, the use of mobile apps also helps in promoting new vocabulary to them which is helpful for academic purposes. Varieties of words learned by the students help to improve their writing task. The use of mobile apps also is able to motivate them to learn as it is more enjoyable and interesting than the usual lecture based lesson.

The implications of this study are separated into two categories which are level of difficulties of vocabulary and games feature. It is found from this study that the students have positive acceptance towards the use of mobile apps in learning vocabulary. Nevertheless, there are still challenges faced by them in using the apps for vocabulary learning. The main problem is the challenging vocabulary provided in the apps which are too difficult for them. They claimed that the words are unfamiliar for them even in the easiest level. Since the students involved in this study are students with medium and low level of English proficiency, it could be assumed that the vocabulary provided in the apps are not suitable for their level. The continuous challenge faced by the students may hinder them from using mobile apps for learning in the future. Thus, the list of vocabulary should be revised so that it can cater the needs of students with low or medium level of English proficiency.

It is also found from this study that the most preferred feature to be implemented in vocabulary learning mobile apps is games feature. Majority of the students preferred to learn vocabulary through games. Possible explanation to this is because games offer meaningful learning, in which students are able to learn in a context. They are able to learn a word implicitly, without them knowing that they are actually learning the words. Numerous exposure to the words through games will implicitly exposed the students to the use of the words. They might not be able to state the exact definition of the word but they are able to use the word in an appropriate context. Therefore, this feature should be embedded in more language learning mobile apps, specifically for vocabulary learning. This feature does not only provide interesting and fun learning, but it can also motivate the students to learn more through mobile apps in the future.

10 Limitations and Future Studies

There are several limitations that have been identified in this study. The limitations have been divided into several categories, which are participants involved in the study, the period of study and the tools used in the study. Based on the study that has been conducted, several recommendations have been made. The number of partici-

pants for future study should be increased in order to obtain more accurate results. Since the number of the participants involved in this study is very limited, it hinders the researcher to explore more on the topic and set more objectives. However, when the number of participants is increased, it would widen the scope of research hence producing better outcomes and results.

Besides that, the scope of study can also be widened through the involvement of participants from various range. As a suggestion, future research should involve a wide range of participants consists of students from different range of age, English proficiency level and experience in using mobile apps in language learning. By involving a wider range of participants, the study could be more significant since it involves a lot of variables to work with. The acceptance of students could be viewed in different perspectives such as the age of students, their English proficiency level and their experience in using mobile apps in language learning. Other than that, it is also suggested that future research could employ more learning mobile tools to be used in future study. In this way, a more variety and in-depth information regarding the preferred features could be collected and researcher could recognize more on the challenges faced by students in using mobile apps in learning vocabulary. Future study could also employ experimental research to see whether the use of mobile apps in learning vocabulary is effective to the students or the otherwise.

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A Rasch Model Analysis on Junior High School Students' Scientific Reasoning Ability

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Abstract—Science education that emphasizes only the count is not relevant at the moment. Students must make scientific reasoning in answering the problem. This study aims to determine students' scientific reasoning abilities in light matter. The method in this research was the descriptive method by using the survey technique. The instrument used is a description test consisting of 8 items of light matter. This test was conducted on 201 students from the eighth-grade junior high school in Banjarmasin selected at random. The RASCH model is used as a processing stage of data from raw data into logit numbers that provide information related to infit, outfit and unidimensionality using a winstep program to achieve this goal, this study investigated the quality of items from Item and person measure, Item Bias, item and person reliability, and variable map. The findings show that the scientific reasoning ability of the eighth-grade students can be at a low level. So researchers should strive to improve students' scientific reasoning abilities in future research.

Keywords—Rasch Model, Construct Validity, Test, Scientific Reasoning

1 Introduction

Physics can be interpreted as a science of measurement because everything we know about the world of physics and the principles governing its behaviour has been studied through observations of natural phenomena. Physics is a science that requires more understanding than shipping (Siregar, 2003). The purpose of learning physics is the formation of reasoning ability in students reflected through the ability to think logically, critically, and systematically in problems solving, especially in the field of physics (Rangkuti, 2015). In the Curriculum 2013, it is explained that one of the core competencies in learning, especially for grades VIII and IX SMP is to cultivate, decorate, and reason in the realm of concrete and abstract realms as studied in schools and other sources in the same point of view/theory.

Scientific reasoning is one of the 21st-century skills that is expected to be taught in the science classroom in an effort to prepare students for their success in facing the challenges of globalization. Scientific reasoning is highly emphasized in new science education standards (Zhou, et al., 2016). In the PISA test, the skill is also one of the skills tested (Salz, 2009). The scientific reasoning could be an effective predictor of

student success and thus could potentially be used in practical decision making for the course (Thompson, et al., 2018). Students who are used to solve problems indirectly develop the thought process of reasoning (Rizta et al., 2013). In a series of studies, they showed that the scientific reasoning of preadolescent children was severely deficient (Kuhn & Franklin, 2006).

Georg Rasch developed an analytical model of the response theory of grains (or Item Response Theory, IRT) in the 1960s (Boone et al., 2011). IRT is an alternative test measurement theory in addition to Classical test theory. Classical tests of these theories enable the presumption of test results such as the difficulty of items and the ability of people. IRT focuses on the pattern of responses given by the person to the test item and background person. IRT has many advantages and is more complex than the Classical test theory (Chan et al., 2013). Rasch measurement model or one parameter model is the simplest IRT model, and it has strong measurement properties (Afrassa, 2005). Raw data in the form of dichotomous data (in the form of right and wrong) that indicate students' abilities, Rasch formulates this into a model that connects students and item (Sumintono and Widhiarso, 2014). The benefit of Rasch's analysis is its ability to estimate the total score for clients even when not all items have been managed. This is especially useful when working with children who may not adhere to all the constraints of standard testing situations (Avery et al., 2003).

Scientific reasoning is very important for students. It is related to the role of scientific reasoning in the process of solving problems in physics. Thus, this study was conducted to describe the students' scientific reasoning abilities using the Rasch measurement model.

2 Methodology

The method in this research was the descriptive method by using the survey technique. In this study, the participant was 201 eighth grade students from 3 junior high schools in Banjarmasin. They were chosen at random. Their age was between 14-15 years old. The study was conducted in April 2017. All participants had studied light material before the test. The instrument used in this study is a scientific reasoning test on light material with eight questions. The purpose of this test was to test students' scientific reasoning abilities. Students are given time to answer the test for eighty minutes. The test results are then used as data in this study. Each student is labelled with codes A, B and C for the representation of the origin of the school. The description described students' reasoning abilities gained after students completed the reasoning ability of reasoning instruments on the Light material. The result data will be included in the winstep software which is one of the series in the Rasch model with the data polytomy. Output in this software that is in the form of the Item Measure table, Person Measure, Variable Maps and Reliability which have been converted before becoming a logit number. This logit number must qualify the Mean Square Output (MNSQ), Outfit Z-Standard (ZSTD), Point Measure Correlation (Pt Mean Corr) and Reliability values according to Rasch modelling.

Output winstep is in the form of Item Measure table, Person Measure, Variable Maps and Reliability which have been converted before becoming logit number. This logit number must qualify the Mean Square Output (MNSQ), Outfit Z-Standard (ZSTD), Point Measure Correlation (Pt Mean Corr) and Reliability values according to Rasch modelling. The parameters used are infit and outfit of the mean square and standardized values. According to Sumintono and Widhiarso (2014), infit (inlier sensitive or information weighted fit) is the sensitivity of response pattern to target item on respondent (person) or vice versa; while outfit (outlier sensitive fit) measures the sensitivity of the response pattern to the item with a certain degree of difficulty on the respondent or vice versa. According to Sumintono and Widhiarso (2015) of the logit numbers obtained from the Ministep software output, there is an interval scale (logit rule) which describes the state of the number. The scale is:

- The value of Mean Square Outfit (MNSQ) received: 0.5 <MNSQ <1.5
- The accepted Z-Standard Output (ZSTD) value: -2.0 <ZSTD <+2,0
- Point Measure Correlation Value (Pt Mean Corr): 0.4 <Pt Measure Corr <0.85

Therefore, the respondent would be qualified based on the value relating to the entry and absence of respondents in the modelling. Reliability questions with Rasch modelling were analyzed using individual separation values and grain separations as well as Cronbach Alpha values displayed in Rasch program outputs. The higher the value of individual separation and the value of the grain separation and the Alpha Cronbach value the better the reliability of the problem. The criteria for interpreting the value of individual separation and the separation of an instrument's grain can be seen using Table 1 (Sumintono and Widhiarso, 2015).

Table 1. Interpretation of individual separation values and Instrument separation items

Criteria	Value of separation individual and item
Weak	<0,67
Enough	0,67-0,80
Nice	0,81-0,90
Very Good	0,91-0,94
Special	>0,94

The Cronbach Alpha values used to measure interactions between individuals with whole grains can be interpreted using Table 2 (Sumintono and Widhiarso, 2015).

Table 2. Interpretation of Cronbach Alpha values

Criteria	Alpha Cronbach
Bad	< 0,5
Ugly	0,5 – 0,6
Enough	0,6 – 0,7
Nice	0,7 – 0,8
Very Good	>0,8

Problem level of difficulty with Rasch modelling is analyzed by using logit number contained in the measurement column problem, the higher the logit value than the higher the difficulty level of the problem. In the measurement of the problem, there is also information on the standard deviation value. If the value is combined with an average logit score, the difficulty level of the items can be grouped according to the difficulty level as in Table 3 (Sumintono and Widhiarso, 2015).

Table 3. Interpretation of Problem Exchange Index

Interpretation	Criteria
Difficult	0,00 logit + 1SD
Very Difficult	>+ 1SD
Easy	0,00 logit – 1SD
Very Easy	<- 1SD

3 Result and Discussion

Table 4. Results summary of the winstep program output

Item number	Infit		Outfit		PT-Measure		Prob	Measure
	MNSQ	*ZSTD*	*MNSQ*	*ZSTD*	*CORR*	*EXP*		
1	1.15	1.5	1.15	0.8	0.59	0.64	0.4915	-0.81
2	1.03	0.3	0.92	-0.6	0.68	0.67	0.0001	-0.26
3	0.79	-2.0	0.81	-1.7	0.69	0.65	0.2022	0.13
4	1.05	0.5	1.22	1.5	0.55	0.6	0.5853	-0.20
5	0.61	-2.8	0.6	-2.7	0.77	0.7	0.2197	0.64
6	0.5	-4.1	0.52	-3.7	0.81	0.71	0.4565	0.63
7	1.38	2.7	1.47	2.7	0.49	0.58	0.0031	-0.14
8	1.18	1.3	1.29	1.6	0.6	0.63	0.0111	0.01
S.D								0.45

Person Reliability 0.79
Iem Reliability 0.99
Cronbach Alpha 0.85

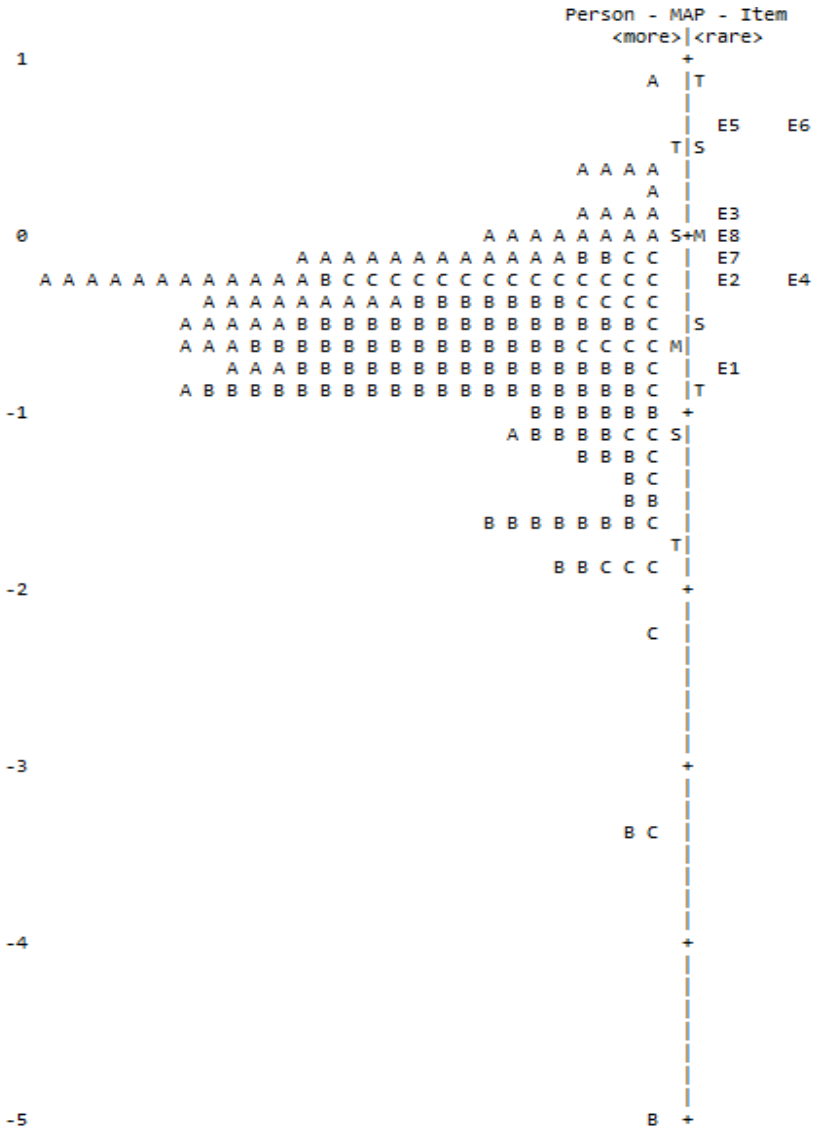

Fig. 1. Variable map

Based on Table 4, it can be seen that the top item is item 7 has a tendency that is less fit. When viewed from three criteria, item 7 only does not qualify at ZSTD outfit value that was equal to 2.7 or unpredictable data, but for MNSQ outfit value that was equal to 1.47 still, meet good criteria for measurement. The value of Pt Measure Corr also meets the criteria of 0.49. Therefore, item 7 can be maintained and did not need to be fixed. This is similar to the items 5 and six that have ZSTD values of -2.7 and -3.7 or too small, so data was too predictable but can still be maintained to measure

students' reasoning abilities. As for the items other items have the value of MNSQ, ZSTD, and Pt Measure Corr by the criteria, so it does not need to be repaired. However, according to Sumintono and Widhiarso (2015), the value of the grain conformity consisting of Outfit MNSQ, ZSTD, and Pt Measure Corr is strongly influenced by the size of the sample size.

A point item is called bias if it is found that one individual with a particular characteristic is more favourable than that of an individual with another characteristic (Sumintono and Widhiarso 2015). An item is said to contain bias if it is found that the probability value of the item is below 5%. In Rasch modelling to detect the biased problem can be seen in Table 4. There were three items that are biased, and five items are unbiased. So, there were five items that can be directly used to measure students' reasoning ability and three items that need to be improved to make good measurements were items 2, 7 and 8. This indicates that these three items need to be improved so as not to harm a particular school.

Reliability problems developed for the criteria of person reliability into the category was nice, the criteria of the reliability of the item entered into the category special, and Cronbach Alpha criteria into the category of very good Thus, overall these questions can be trusted to measure students' reasoning abilities. It also shows that the reliability of the items was very good. In Table 4, it can be seen in the Item Number column that item 5 was the hardest problem with a logit value of 0.64 and question number 1 was the easiest problem with a logit value of -0.81, it corresponds to the cognitive domain of the reasoning problem developed. Items 5, 6, and 3 had Cognitive domains C5, items 8, 7, and 4 had C4 cognitive domains, and item 1 has C3 cognitive domains. Item 2 had Cognitive domain C5, but it was not by the results of research analysis that shows the problem is entered in the category very easily with a logit value of -0.26. It was also shown by the number of students who can correctly answer the question.

The variable map shows the distribution of student ability and item difficulty on the same logit scale. Students' abilities are listed on the left side of the map while the item difficulty is on the right side of the map. The higher logit represents students with higher abilities (the left side) and more difficult items (right side) and vice versa (Iramaneerat, Smith, and Smith, 2008). Through the variable map, it allows us to identify whether the item matches the student's abilities. The relation of ability possessed by students with problem level in figure 1, on the left side shows the distribution of students' reasoning ability and the right side shows the difficulty level of the item. The left side of the map shows the higher level of the reasoning problem. This means the student could get the maximum value of all questions.

On the right side of the map are eight items that have difficulty levels that from item 5 was the most difficult to item1 the easiest to do. This means that there is no problem that accumulates in one line only, it shows the problem of having various levels of difficulty, ranging from the most difficult to the easiest. Logit 0 is set as the average test item (Iramaneerat, Smith, and Smith, 2008). From the variable map, we can see that most students are below the average of the exam items. Few students with higher abilities are above logit 0 and very many students are below average. Low logit indicates low ability. Thus we can argue that the students' ability in scientific reason-

ing is low, as most of them cannot solve the problem of scientific reasoning. In other words, items are deemed less able to fit the student's abilities. This is because students are not familiar with the scientific reasoning items in this study and they are not taught to answer these kinds of questions in school.

Training in scientific reasoning may also have a long-term impact on student academic achievement (Bao, et al., 2009). Scientific reasoning has an important role in the problem-solving process (Khan and Ullah,2010). When students have high problem-solving skills, it can have an impact on achieving more effective student learning outcomes (Nieminem et al., 2012; Stephens and Clemen, 2010). Low scientific reasoning ability makes learning outcomes low, so media, learning and teaching model, and learning materials are needed to improve student learning outcomes. This is supported by the results of the study (Wati, et al., 2018; Erika, et al., 2018; Jatmiko et al., 2018; Limatahu, et al., 2018; Prahani, et al, 2016; Prahani, et al., 2018; Sunarti, et al., 2018; Suyidno et al., 2018) that the media, learning and teaching model that is qualified will be able to improve and achieve the learning outcomes.

4 Conclusions

Scientific reasoning abilities among eighth-grade junior high school students are still at a low level. It is, therefore, necessary to improve students' scientific reasoning.

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