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# Mobile application on ABACUS

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**Abstract** – *Abacus is an ancient mathematical instrument used for calculation. Abacus calculating tool is compulsory to learn by all the level one (standard one to three) primary school students in Malaysia. However, abacus is a monotonous subject as it requires endless practices and also to memorize the formulas. Furthermore, the abacus related mobile applications at the current market focus only at the addition and subtraction whereas the abacus syllabus covers addition, subtraction, multiplication as well as division. To address this problem, a mobile game, Fun with ABACUS has been developed using App Inventor. The application focuses on addition, subtraction, multiplication and division up to three digits number. The methodology used to achieve the objective is prototyping-based methodology. User testing has also been conducted to evaluate the application. This involve 11 students and 14 parents and teachers. The results show positive feedback among the students, teachers and parents. This application also serves as an alternative to encourage and assist the users in knowing and learning basic abacus calculating method. It is hoped that this mobile game with the suitable learning concept can motivate the children to be interested in learning abacus.* 

**Keywords:** Mathematical instrument, Mobile application, Abacus, User acceptance

## 1.0 INTRODUCTION

Abacus is an ancient mathematical instrument used to perform calculation such as addition, subtraction, multiplication and division [1]. There are three major types of abacus which are the Japanese, Chinese and Russian abacus [2]. Japanese abacus is known as Soroban, Chinese abacus is called Suanpan and Russian abacus is named Stschoty [2]. The similarity between the Chinese and Japanese abacus is that both of them are divided into two levels with the beads on the upper level called 'heavenly' beads and the lower level called 'earthly' beads (Frank & Barner, 2011) [3].

In 1994, Abacus was first introduced in Malaysian education system [4]. However, starting 2004, abacus was made compulsory for students' age 7 to 9 years old [5]. Malaysia former Prime Minister, Tun Dr Mahathir Mohamad supported the teaching of abacus and believed that abacus can train the children's brains to do fast calculation and this skill will contribute much to the skills in business [6].

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### 1.1 Problem Statements

Learning abacus is dull due to the same monotonous way of exercising problems as it involves plenty of calculation which requires the students to be persistent, consistent as well as patience to practice daily [7]. If the students stop utilizing their brain for calculation, their brain function will begin to decline slowly [8]. As the level of abacus becomes higher, its complexity also increases and thus regular practices are necessary for the children to cope with the increasing difficulty of abacus.

In Malaysia, abacus is taught using the traditional way which required students to memorize the calculation method. Students find it very difficult to understand the concept and ends up by memorizing the concepts. Memorizing is not the most effective method of learning but fully understand information at all cognitive levels is more crucial in learning [9].

The abacus game available currently in Google Play Store which targets the children only consists of addition and subtraction whereas the syllabus of abacus in the education covers addition, subtraction, multiplication as well as division [4].

### 1.2 Objective and Scope of the Paper

The objective of this paper is to report on the development of a mobile game on learning abacus. Some of the learning theories have been adopted in the development. A test was conducted at the end of the development. The study is focusing on primary school students from the age 7 to 9. The mobile application covers the abacus syllabus of addition, subtraction, multiplication and division up to 3 digits number.

## 2.0 LITERATURE REVIEW

Greek words ‘abax’ or ‘abakon’ with the meaning table or tablet are the origin of the word ‘Abacus’ [11; 1]. According to [1], abacus is a mathematical device or tool used by the people for performing addition, subtraction, multiplication and division. There are three main forms of abacus that are still using today, mainly the Chinese, the Japanese and the Russian abacus that come with different name [1]. The similarity is that all are composed with rectangular frame together with beads on vertical wires or sticks. Nevertheless, the number of wires or sticks and the beads on the abacus are non-identical. Japanese abacus with (4+1) beads is used in Malaysia’s primary schools to teach the children in learning mathematics.

### 2.1 Learning Approach

#### 2.1.1 Learning Styles

According to [11], there are three dimensions of learning styles which are visual, auditory and kinesthetic. Majority of the population (65%) are visual learners, 30% are auditory learners and 5% are kinesthetic learners [12]. Visual learners learn better using pictures or visualization, auditory learners prefer hearing to understand the contents and kinesthetic learners prefer experiment or hands on activity. The best solution to gain interest of learning from majority of the children is to combine these three learning styles together [12].

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### 2.1.2 Constructive Learning Theory

Constructive learning theory emphasizes on the importance of the active involvement of students in constructing knowledge and building new ideas or concepts based upon current knowledge and past experience [13]. Constructivism in mathematics is an essential learning method for students [14]. Students need to construct their own understanding of each mathematical concept, because the main role of teaching is not to lecture, explain, or otherwise trying to "transfer" mathematical knowledge, but actually it is to create situations for students that will foster them in making the necessary mental constructions [15]. Instead of asking the children to solve mathematical questions based on the usual method, children should be encouraged to develop their own knowledge based on their own understanding [16].

### 2.1.2 Learning Through Play

Play is considered as an activity where the children always smile, laugh and enjoy themselves [16]. Mobile game is considered as a modern play. According to the research done by [17], children spend up to 30% of their time and energy in play. Hence, playing and learning should be combined together so that the learning process of the children is most enjoyable. The cognitive behaviour theory revealed that when children feel happy in their learning, they tend to absorb the contents faster and understand the information easier [17]. [18] stated that play in home is more effective than at school as there is less pressure. Studies have shown that learning via playing at home is preferable by the students and the percentage of subject understanding is higher when the students learn through playing [19].

## 2.2 Technology

### 2.2.1 Technology Trend

The current technology trend is M-learning. M-learning stands for mobile learning which an extension of e-learning is where the focus is on the use of mobile application and wireless technology [20]. According to the digital learning report by Speak Up which is a workshop to encourage people to think innovatively, the use of mobile devices and mobile-enabled content in the classroom have the potential to significantly impact student achievement [20]. Mobile game is a fun and interactive way to learn less interesting subjects. Furthermore, mobile game can attract the interest and attention of the children by using some animation and colourful interface.

### 2.2.2 Mobile Application

According to [21], mobile application is most frequently referred to as an app. It is a kind of application software designed to run on a mobile device such as smart phones, tablets or any touch screen devices. Mobile applications commonly provide users with similar and simpler services to those accessed on computer. They are normally small, light with limited and isolated functionality such as game, calculator, mobile Web browsing and others located on various types of mobile software platforms.

## 2.3 Mobile Games

With the huge improvement of technology nowadays, the mode of playing games has changed to digital [20]. Digital gaming includes computer games, mobile games and many more. According to [22], mobile gaming is emerging very fast and has become prominent segment

of the digital gaming market. Based on the research by [22], people tend to play games to kill off the time and people like mobile games more as compared to other digital gamin due to mobility of the mobile phone.

### 2.3.1 Advantages

Mobile games are now being recognized as an effective tool to teach or further solidify concepts by many researchers as mobile games are more to active learning through cognitive interaction which the traditional schooling lacks of [23;24]. The main advantage of mobile educational game is that it enables the users to learn in non-classroom environment such as home and public areas [25]. Besides, mobile games are interactive because mobile games enable players to interact with the games environment and thus make the games more interesting and the players have the sense of engagement which will draw their attention [26]. In addition, mobile phone is convenient to bring around and apart from mobility, mobile games help people to save money as people do no need to purchase any expensive console or computer in order to play the games [22; 27]. Mobility as mentioned above is the main reason why people play mobile games as compared to other digital gaming [28].

## 3.0 METHODOLOGY

Prototyping-based methodology has been used in the development. The methodology consists of planning, analysis, design and implementation in prototype-based methodology. The design started with the interface of the mobile application. The interface was designed using Photoshop and a virtual application design was developed using Prototype on Paper (POP). Then, basic architecture design of the application was developed. The mobile application was developed using Apps Inventor. Basically, there were two parts of the development, the interfaces and the codes that run the interfaces.

An observation has been conducted to test on the developed mobile application. A total of 11 school students are given the app and the time was taken till they finish using the application. Their feedbacks and reactions during the testing were recorded to make improvement on the mobile application until the mobile application fulfils the requirements of the users. Another usability study has also been conducted with 14 parents and teachers. A set of questionnaire was given to them on the usability of the app.

## 4.0 RESULTS AND DISCUSSIONS

### 4.1 Prototype

The application is called ‘Fun with Abacus’. It is developed in English. The mobile game architecture is as shown by Figure 1. The mobile game contains three activities namely “Tutorial”, “Play” and “About”. Figure 2 shows the interfaces of home page and menus for the application. In “Tutorial” section as depicted in Figure 3, there are five categories. The users will first be taught on how to count the numbers using the beads, next proceed to the tutorial of addition, and followed by subtraction, multiplication and lastly division.

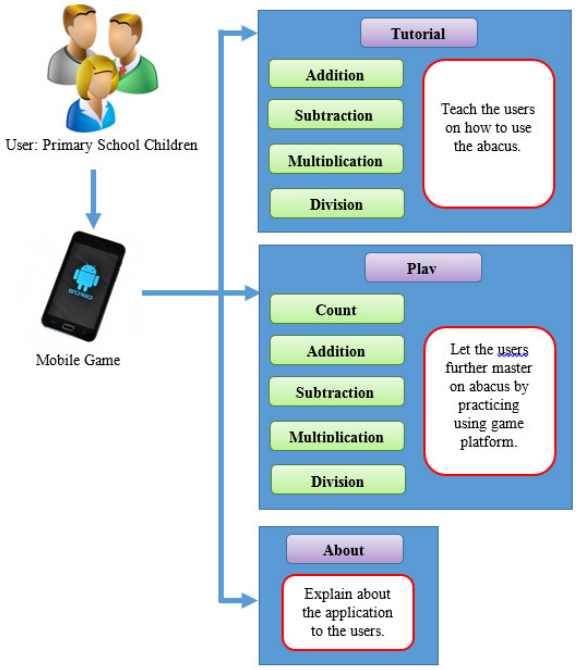


**Figure 1**: Schematic for the leading edge

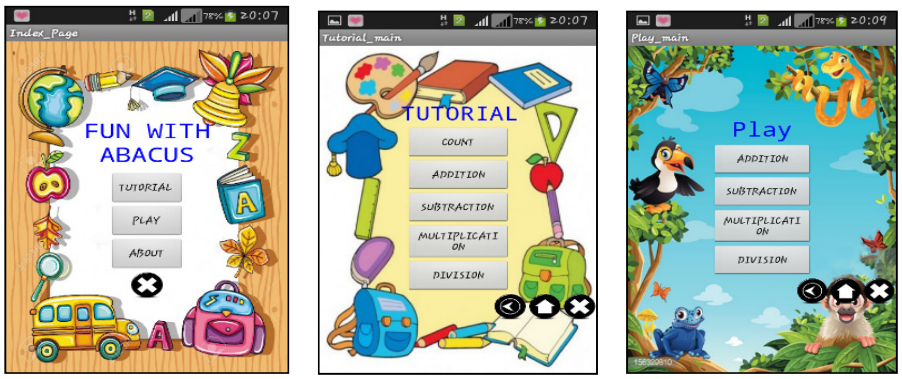


**Figure 2**: Home Page and Menus

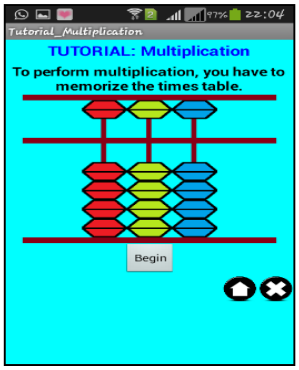


**Figure 3**: Tutorial Page

In the "Play" section, there are four game categories. Users can choose addition, subtraction, multiplication and division. Whenever the game starts, there will be a blue bird moving down

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from top to reach the red target as shown in Figure 4.

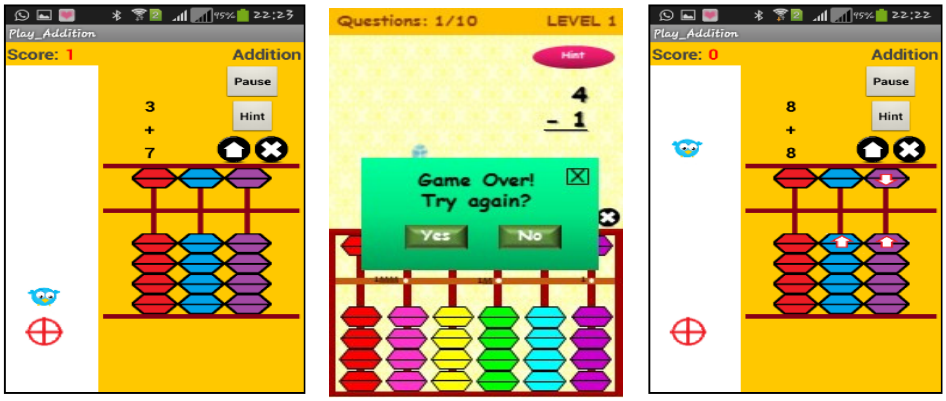


**Figure 4**: Sample of Target, Game Over and Hint

The last section is "About" which users can find the brief description of the "Fun with Abacus" mobile game as shown in Figure 5.

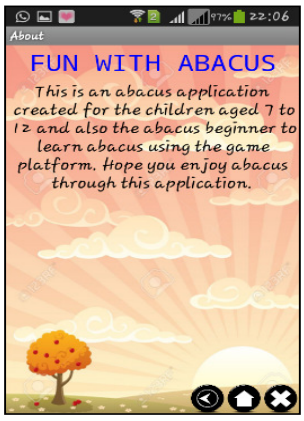


**Figure 5**: About Page

### 4.2 Usability Testing

#### 4.2.1 Testing with Children

Eleven primary school children were asked to use the mobile application while their behaviour were recorded. The objective is to identify the children's reactions towards the mobile application as well as the effectiveness of the application. In order to compare the different between mobile game and manual method on abacus, the children were given the mobile application to use. Then they were asked to complete a set of questions which consists of 10 additional problems. The time taken to solve all the questions was manually recorded. The average time taken to answer manually is around 1.02.19 minutes whereas the average time taken to get 10 score while playing the mobile game is 1.02.07 minutes which is slightly faster.

An observation checklist was designed to record the reactions from the children who have performed the usability testing. The checklist was designed with certain elements. The first element that has been assessed is the respondents' expression. Based on the observation, 45.45% of the respondents were very happy and excited with the mobile application, and only

27.27% of the respondents were not interested in the application. This shows that their emotion varies and difficult to predict. The second element is to identify whether the interface is easy to navigate. From the observation, only 27.27% of the respondents have some difficulties in understanding the menu page and clicked the wrong button. Majority can search and click the correct button by themselves. The third element is to find out whether the Tutorial section is useful in guiding the children to learn abacus. The results show that the majority of the children can follow the instruction and understand the tutorial. Those who have problem in understanding the tutorial are mainly because they are not good with English language. The fourth element is about the game section. From the observation, the colourful setting and sound have attracted the children to be interested with the game. They were able to cope with the game without much guidance needed as compared with the tutorial section.

### 4.2.2 Testing with Parents and Teachers

A total of 14 parents and teachers with the age range from 22 to 61 years old had participated in this usability testing. About 64.29% of them are females and 35.71% of them are males. They all come from different working background. First, the respondents were given the mobile application to play on. After that, they were asked to fill out a feedback form in order to record their opinion. The participants were asked on the suitability of the application in terms of the attractiveness and interactivity. A total of 57.14% strongly agree that the application is attractive, interactive and suitable for the primary school children. Moreover, 57% strongly agree that with the help of this mobile application, the children can learn abacus in a more effective and fun way as shown in Figure 12.

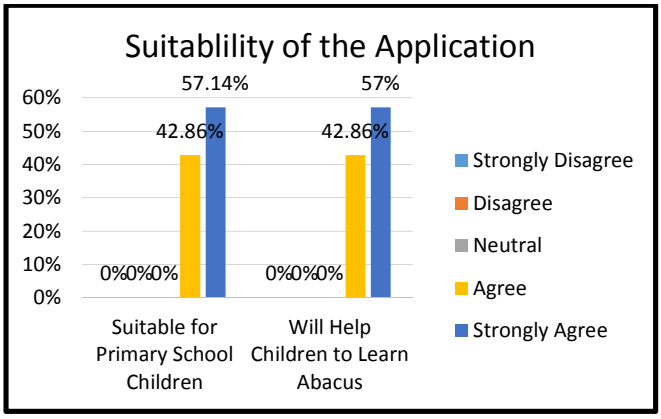


**Figure 12**: Suitability of the Application

Based on Fig. 13, majority of the parents and teachers said that they will recommend this application to the primary school children to act as an alternative to learn and practice abacus.

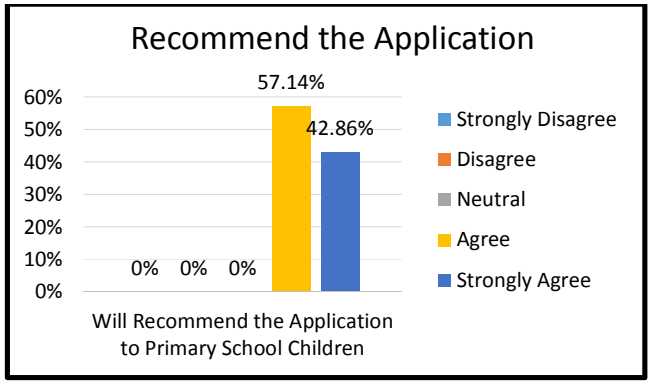


**Figure 13**: Recommendation of the Application

## 5.0 CONCLUSSION

The paper has discussed on the development of the mobile application, 'Fun with Abacus' for primary school children. This development is based on three dimensions of learning styles, constructive learning theory and play learning theory. The application is to study on the development of mobile game as a learning tool for children. This application also serves as an alternative to encourage and assist the users in knowing and learning basic abacus calculating method. It is hoped that this mobile game with the suitable learning concept can motivate the children to be interested in learning abacus. For future improvement, first, the timing of the game need to be adjusted to accommodate the different needs of the children with different levels. In the future version, it is suggested that different game levels such as easy, medium and hard will be added. Next, the tutorial needs to be more details to let the children have a clearer understanding. In addition, a high score function should be added to record the highest score of the user so that they will have the sense of accomplishment and also to drive them to practice more in order to get a higher score.

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