MathFun: Examining the Effectiveness of Calculic Model in Designing App for Dyscalculia Children

Rizawati Rohizan*, Lim Hean Soon and Siti Azreena Mubin
Asia Pacific University of Technology and Innovation Technology Park Malaysia
Kuala Lumpur, Malaysia

*Corresponding author e-mail: riz@staffemail.apu.edu.my

Abstract. Learning disability can vary from dyslexia (reading), dyscalculia (math) and dysgraphia (writing) where it focuses on certain learning disability that is being faced by the children. Dyscalculia is one of the common learning disabilities where in this category children are lack in ability of studying the math. However, with the enhancement of technologies, variety of application can be created in aiding the children learning process such as mobile learning by using mobile app. This paper focuses on examining the design model (Calculic Model) in designing a mobile app for Dyscalculia children. MathFun is a mobile app created by the mobile app developer while following the Calculic Model approach for Malaysia Dyscalculia children. The outcomes of this paper view on the effectiveness of the model towards building a mobile application for these children. Usability was performed in order to assess the usability and verifying the effectiveness of MathFun. This study involved 3 teachers and three children. Descriptive analysis was performed from the collected data. Based on the outcome, it’s shows that by using the suggested model there is an increased in the acceptance and usability of the application by the children.

Keywords - Dyscalculia, Learning Difficulties, Calculic Model, Mobile Application, MathFun, Usability

1. Introduction
Children with dyscalculia learning issues will definitely have some trouble with a lot of aspects of math. For example, they will not have the ability to understand the notion of biggest against smallest. Moreover, they will also have the limitation of understanding that the numeral 5 is actually the same meaning as the word Five. Working memory is also one of the issues that dyscalculia children will confront. For instance, they will have arduous in holding numbers in mind while executing mathematics functions with several steps. Eventually, they will confront the problem of having difficulty in applying mathematical function when they are solving math problems. Therefore, children with dyscalculia or can be called as mathematics learning disability will definitely have issues with numbers. If it gets critical, dyscalculia may also affect everyday skills such as social interactions skill and time management skill.

However, the good news is that mobile learning capabilities are widely used in aiding special educational practices for children. Therefore, these mobile applications can eventually help in educating and supporting children that have learning disabilities in fundamental abilities of writing, reading as well as mathematics. Therefore, Dyscalculia children should utilize the mobile application
as the supporting learning methods or tools in order to support and educating their learning regarding the fundamental mathematics. In this way, children with have the benefit in learning the fundamental math not only during study in school but in home too as mobile application has the graphic and patterns which can greatly help them to stimulate the brain effectively to learn math which strengthen their fundamental skills in mathematics.

2. Literature Review

2.1. Dyscalculia

Dyscalculia is a form of learning disability where it is caused by visual perception deficit where children are unable to recognize and performing mathematic operations. Based on the research done by (Plerou, 2014), Dyscalculia is the disability of comprehending as well as solving mathematical concepts which consist of fundamental numbers, the name of the numbers, comparing with bigger and smaller number, the number sequence as well as the operations of mathematics. According to (Ferraz & Neves, 2015), they proposed that children with dyscalculia usually distribute into six types, which shows in Table 1.

| Types of Dyscalculia     | Description                                                                 |
|--------------------------|-----------------------------------------------------------------------------|
| Lexical Dyscalculia      | Having troubles in reading mathematical symbols such as operational signs +,−,×,÷ and other numeral numbers. |
| Verbal Dyscalculia       | Having troubles in the name of mathematical symbols and concepts, which will be able to read but unable to talk, remember or even recognize them. |
| Graphic Dyscalculia      | Having troubles in writing the mathematical symbols.                         |
| Operational Dyscalculia  | Having troubles in performing the mathematical operations and calculations.   |
| Practognostic Dyscalculia| Having troubles in manipulating things mathematically as well as comparing objects and pictures. |
| Ideagnostic Dyscalculia  | Having troubles in regarding of the mental operations as well as the concepts of mathematics. |

Table 1. Types of Dyscalculia

Dyscalculia can be detected as early as preschool and the symptom can be very visible, as the children get older. Table 2 elaborate in details the characteristics of Dyscalculia children where in this paper it’s more focusing on the children age 4 – 6 years old [2]. By understanding this characteristic more usable interface and interaction will be made available in the designing any applications.

Table 2. Characteristic of dyscalculia children based on age

| Age        | Characteristics                                                                 |
|------------|---------------------------------------------------------------------------------|
| 4 – 6 years old | • Having trouble in learning basic number operations                             |
|            | • Difficulties in memorizing the sequence of number                               |
|            | • Hard to compare or determine the smaller and bigger number                      |
|            | • Counting objects is difficult for them                                           |
Connecting numbers to the symbolic form is rather difficult for them
- Not able to differentiate whether which objects are bigger or smaller

2.2. Assistive Technology for Dyscalculia Children
Assistive technologies are made available nowadays to cater the needs of the children with learning disability. This Assistive technology is technology that can help dyscalculia children with the compensatory support which to help student to be able to solve mathematical equations easily (Nagavalli & Juliet, 2015). Therefore, any technology from paper-based to electronic devices, which can help dyscalculia children are all described as assistive technology. Based on the research paper done by (Rajkumar & Hema, 2016), there are few others assistive technology tools for dyscalculia children, which can help dyscalculia children such as mobile application, web application and others.

2.3. Mobile App for Dyscalculia Children
In the market it can be seen that there is more mobile application made towards dyslexia children rather than the dyscalculia children. Recently there is one mobile app called as Calculic Kids® has been developed for the dyscalculia children, which with the development of the application it created a model to guide on the design and the interaction of the application for this children [5]. This paper in intended to examine the effectiveness of this model in creating more mobile application for the Dyscalculia children with in mind of improving their performance in the learning process of mathematics.

2.4. Design Model in Guiding Mobile App Developers/ Designers
The need of proper model / framework is needed to guide developers/ designer in building a usable mobile application towards the user. Unfortunately there is less study that proposes a model in guiding the developer in designing any such mobile application for special children since the focus, component and the needs are different form the children which don’t have any learning disabilities. Recently there is one model have been introduced in addressing this gap called as “Calculic Model” by Abd Halim, K.Sugathan & Mohd Arrffin (2017) and have been improvised by Fiqa Azureen Abd Halim, Mazeyanti Mohd Ariffin & savita K.Sugathan (2018). Figure 1 shows the improvised Calculic Model [3].

![Figure 1: Calculic Model](image-url)
components are identified as the crucial component when developing any such application toward the dyscalculia children (figure 2) [1].

Hence this study attempts in verifying the usability and the effectiveness of the Calculic model in developing the MathFun mobile app for the dyscalculia children. Apart from that it also evaluate the performance of the dyscalculia children learning performance after the developers have applied the component addressed in the model.

![Calculic Model Component](image)

**Figure 2:** Calculic Model Component

3. **Proposed Design Based on Calculic Model**
Based on the conducted analysis and following the component suggested in the Calculic model the following storyboards are prepared to introduce the design plan. Table 3 shows the checklist of the component implement inside the design of the MathFun apps. For example for the font component based on the research it has identified that san serif font and roman style is suitable for learning disability children in improving their readability [6]. Therefore fonts, which fall under those categories, are used in the development of the MathFun Apps.

| No | Factors       | Components                              | Implementation |
|----|---------------|-----------------------------------------|----------------|
| 1  | Instructional | Objective                               | ✓              |
| 2  | Example       | Example                                 | ✓              |
| 3  | Practice      | Practice                                | ✓              |
| 4  |              | Error Correction & Feedback             | ✓              |

Table 3: Checklist
Due to the iterative design and development process of the chosen methodology, the design plan might be changed based on the user requirements and further analysis and evaluations. Figure 3 shows some of the sample of the MathFun apps storyboard.

Figure 3: MathFun Storyboard Sample

Figure 4 below show the sample of the finalized MathFun App design.
4. Results

4.1. Usability Testing

Usability testing was done towards 3 Dyscalculia children and 3 teachers at the Special Children Society of Ampang (SCSOA) learning disabilities center Table 4 show the children use in the evaluation process.

![Figure 4: MathFun Design Sample](image)

| Age         | 1st user | 2nd user | 3rd user |
|-------------|----------|----------|----------|
| 6 years     | Severe   | Moderate | Moderate |
| 7 years     | Moderate |          |          |
| 10 years    |          |          |          |
| Dyslexia severity level | 15-20 mins | 10-15 mins | 10-15 mins |

The usability testing was done through observation and distribution of survey forms. System Usability Scale (SUS) have been used for this testing activity. Table 4 shows the results on the usability testing conducted to Dyscalculia children.
Table 5: Result of Usability Testing (Dyscalculia Children)

| Questions                                                                 | Agree (%) | Disagree (%) |
|---------------------------------------------------------------------------|-----------|--------------|
| Q1 I think that I would like to use this System frequently                | 100       | 0            |
| Q2 I thought the system was easy to use                                   | 100       | 0            |
| Q3 I could easily access the various menu option                          | 100       | 0            |
| Q4 It was fun to use!                                                     | 100       | 0            |
| Q5 Messages were always understand                                        | 95        | 5            |
| Q6 I was well supported by help options                                   | 86        | 14           |
| Q7 The next step in my task was always clear                             | 90        | 10           |
| Q8 I likes the overall look and feel                                      | 96        | 4            |

Good responses received from the Dyscalculia children where they enjoy the application and agree that the application is attractive. The children able to use the application with minimal interruption from their teacher and they understand the components included inside the design of the MathFun apps. Form the observation done during the testing with the children, majority of dyscalculia children show keen interest in exploring the application. The children also willing to use the application in the class rather than learning it through the cards, which they are using now in the class.

Table 5 shows the responses from the teacher side after using the MathFun apps. Several comments where given by the teachers where the teachers have suggested some improvement towards the design such as the tooltips design, adding the statistics report for better monitoring done and layout for the placement of the math symbol.

Table 6: Result of Usability Testing (Teachers)

| Questions                                                                 | Agree (%) | Disagree (%) |
|---------------------------------------------------------------------------|-----------|--------------|
| Q1 I think the apps is helpful                                            | 100       | 0            |
| Q2 I’m willing to use the MathFun apps in class                           | 100       | 0            |
| Q3 I could easily access the various menu option                          | 100       | 0            |
| Q4 I likes the overall look and feel                                      | 80        | 20           |

Both teachers and children agree that the MathFun application is easy to use, match with the children needs and it improves the learning capabilities of the children. The MathFun apps also increase the interest of the children in learning math in a more fun approach.
5. Conclusion

Based on the testing conducted it shows that the design of the MathFun is effective where it able to help the children in learning math in a much better way. Hence it indicates that by implementing and following the Calculic Model in designing, it help developers to understand the crucial component to be included in the design which eventually leads to more usable application when it’s user that have certain limitation in processing information.

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