Development and Usability Evaluation on Individualized Reading Enhancing Application for Dyslexia (IREAD): A Mobile Assistive Application

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Abstract. Mobile Applications Development has been the trend for the previous year to revolutionize the teaching and learning process. These technologies were designed to improve the quality of education for all types of learners, more specifically for learners who have learning difficulties like dyslexia. Learners having this learning disorder oftentimes have difficulty in reading and writing. The use of conventional instruction is challenged for this learner. With the advent of technology, specifically mobile assistive application development helps implement more dynamic, effective and efficient teaching strategies, thus provides an opportunity to improve the learning of the students. This study aimed to develop a mobile assistive application name Individualized Reading Enhancing Application for Dyslexia (IREAD) which primarily implements text-to-speech technology to enhance the reading capability of learners with dyslexia. Unity 3D is utilized in the development of the application and web support is present to manage learning resources of the application. Moreover, usability evaluation is performed to determine the overall usability of the application, with the following dimensions effectiveness, efficiency, and quality of support, ease of learning and satisfaction. The 10 participants who were teachers teaching in specialized education answered the usability questionnaire. Results show that the overall usability of the IREAD application is immensely positive.

1. Introduction
The growth in mobile application technology seemingly provides opportunities in optimizing the Information and Communication Technology (ICT) tools in improving the teaching and learning process with appropriate pedagogy. Among its advantages of using technology in teaching and learning is more personalized learning that would cater to the diverse needs and learning styles and capabilities of learners, thus accelerate and promote learning. The advancement of technology especially in the growth of mobile technologies paved way for the innovation of numerous learning solutions that can be adapted and utilized for specialized education, which focused on the learning pattern of every student. This is also advantageous to the teachers as they can easily collect, synthesize and analyze the voluminous amount of data, and swiftly have feedback on the students' performance and achievements [1]. Mobile Learning combines personalized learning wherever and whenever it is accessed. It provides a different educational paradigm which alters the nature of knowledge and is focused on the user's experience of learning through mobile devices. It gives a wide range of educational and learning material in a uniquely
engaging manner, giving them the freedom to choose what information to deal with which can enrich their knowledge and improve their skills. Mobile Educational Applications motivate children and engage their attention while focusing on problems, improving their memory, reading and writing skills [2]. It has been stressed out that m-learning had created a method of learning that showed differences compared to conventional methods commonly used in teaching and learning [3][4]. Integrating m-learning in a classroom environment would be an effortless action if teachers or educators do not grab the opportunity to use mobile technology in a classroom setting. However, most of the Mobile Applications available in the digital stores did not consider this as a priority, yet they tend to focus only on commercial value. Mobile Application with relevant learning theory is to be used for the sake of dyslexic students learning [4].

There is already a variety of purposes in utilizing technologies especially for individuals who have dyslexia, these technologies provide supports for content area learning and skills practice which enables performing functions that are usually challenging. There was researches that suggest that computer-based programs help younger students learn to read which provides a more holistic approach to reading thus, yielded a better result [5].On the other hand, it was found out that acceptance and readiness among select teachers of dyslexic students at a mild level in a dyslexia center in Klang Valley provide significant information on the impact of M-learning to that teacher perceived, the frequency of utilization of relevant Mobile Application in the classroom setting. Integrating m-learning for dyslexic students requires a big change in attitude and moral support towards dyslexic students themselves. Developing an engaging m-learning environment may be inside or outside the classroom is the actual challenge. Thus, it suggests that every stakeholder in the field should suggest a suitable approached to be implemented to uphold the objective of implementing M-learning for dyslexics [4].

With the above-mentioned statements, this study aims to develop the Individualized Reading Enhancing Application for Dyslexia (IREAD) a mobile assistive application and evaluate its usability to determine the user experience and eventually underscore the attainment of the goals in the development of the application is achieved.

2. Literature Review

Rahim et. al [6] developed a prototype of a mobile application to assist reading in dyslexic children name CinTA. The features provided by the app are modules to learn alphabets and writing. Addressing the instruction, a video is presented in the application to teach the students with several special writing techniques. Teaching alphabets in the application has been categorized through vowels and consonants to which, in each of the categories, the audio of the sound and phonics of the alphabet will be played to the children. However, the application doesn't provide assistive technology to properly help the learners, like text-to-speech technology.

Skiada et. al [2] developed a mobile application named easyLexia which focuses on teaching learners with difficulties with the use of Mobile Learning. The main features of their application composed of a word finder - where children identify the correct letters which address the gaps and choose the best answer from among alternatives, choose it- which enables the children to listen and recognize the work given and lastly, Sound finder, which consists of sentences with missing words while combining phonological recordings of the missing word. Nonetheless, the application doesn't have data logs that track the records of the learners. This allows the educators and parents to assess the learning acquired of the learner using the application.

The literature review conducted by the researchers highlighted some research gaps in the development of an assistive application for dyslexics. The inclusion of text-to-speech technology and data logs is essential for the application. This is to provide historical data analysis which underscores the enhancement in the reading proficiency of dyslexic learners. The application shall be following the specific needs of dyslexics. These are the primary motivation of the researchers to develop the IREAD Mobile Assistive Application.
3. Methodology
The consideration of the use of agile software development methodology for the development of the Individualized Reading Enhancing Application for Dyslexia (IREAD) is in congruence with Agile Patil, Vaishnavi & Panicker, Sanjana & Kv, Maitreyi [7] conclusion that there has been a significant increase in number of mobile application development projects, as the demand for mobile applications is growing and the potential number of different mobile applications is virtually unlimited. Several published pieces of research confirm that Agile methodology practices are naturally fit for the development of mobile applications.

3.1. IREAD Development
The initial stage of the methodology has been initiated through the conduct of an in-depth interview with the Special Education Teachers of Tuguegarao West Central School and the School Principal to elicit the instructional materials used in teaching dyslexic students as well as their strategies in delivering the instruction to the learners. A literature review from published articles and journals from different databases such as EBSCOhost, Elsevier, and Procedia were also being done to support the current practices in addressing the needs of dyslexic students using traditional and ICT based delivery of instruction. Thorough document analysis was also performed to develop the architectural framework of the mobile assistive application for learners with dyslexia. It composed two components, the Mobile Platform, and Web platform. These platforms are designed to address the diverse need of dyslexic students.

The researcher build-up the IREAD, a mobile assistive application using unity 3D, which is a cross-platform game engine that is easy and has a user-friendly development environment. The sample user interface design of the IREAD app is seen in Figures 1, 2, and 3. The IREAD Mobile Application composed of three modules, which includes a learning module consisting of reading lessons and writing lessons, the evaluation module, and the history/reports module. The application was installed in a smartphone operating with android OS.

3.2. IREAD Usability Evaluation
Usability evaluation is a vital criterion to understand and analyze usability issues in any system or application. Usability issues are identified through an evaluation conducted with users [8]. The International Organization for Standardization (ISO) 9241-210 standard [9] and the ISO and International Electrotechnical Commission (IEC) 9126 standard [10] guided the initial user experience design of the IREAD application. Based on these standards, the researcher operationalized usability as the degree to which a user of the application can achieve the goals of the IREAD protocol with effectiveness, efficiency, quality of support, Ease of learning and satisfaction.

The usability questionnaire is composed of 33Likert type questions in which the participants were asked for their level of agreement on the usability of the IREAD app. Specifically, it has 10 questions for the effectiveness of the application, 9 for efficiency, 3 for quality of support, 4 for ease of learning and 7 for user satisfaction. Quantitative analytics was utilized to quantify the data gathered to answer the questions of the usability of the IREAD app. Cronbach's alpha was used to test of internal consistency.

Fig 1. IREAD Main Menu  Fig 2. IREAD Learn Module  Fig 3. IREAD Evaluation Module
of the usability survey tool. The results of the test show that all categories were above .70 alpha value which indicates that the items in the questionnaire are reliable. Table 1 shows the details of the test.

| Category         | Number of items | Cronbach’s Alpha |
|------------------|-----------------|------------------|
| Effectiveness    | 10              | .925             |
| Efficiency       | 9               | .836             |
| Quality of Support | 3          | .936             |
| Ease of Learning | 4               | .833             |
| Satisfaction     | 7               | .709             |

The participants of this study were the 10 teachers of the west-central elementary school, who has direct experience in teaching dyslexic students. The teachers utilized the IREAD app to test the content and overall functionality of the application. After utilizing the application, the usability questionnaire was distributed for the usability evaluation.

4. Results and Discussion
Table 2 shows that all teachers teaching in special education classes were female and most of them graduated with their post-graduate degrees. This attests that women characterized patience and care which is needed in handling learners with special needs. Also, the teacher's educational qualification meets the standards for them to provide quality education to the young.

| Demographic Characteristics | Categories          | Frequency | Percentage |
|-----------------------------|---------------------|-----------|------------|
| Gender                      | Male                | 0         | 0%         |
|                             | Female              | 10        | 100%       |
| HighestEducational Attainment | Bachelors’ Degree | 1         | 10%        |
|                             | Masters’ Degree     | 9         | 90%        |

4.1. Findings on the level of usability of the Individualized Reading Enhancing Application for Dyslexia Application

| Item                                                                 | Weighted Mean | Descriptive Interpretation |
|---------------------------------------------------------------------|---------------|---------------------------|
| The IREAD Application is easy to use.                               | 4.80          | Strongly Agree            |
| The IREAD Application is simple to use.                             | 4.80          | Strongly Agree            |
| The IREAD application lets learners do reading and writing lessons.  | 4.90          | Strongly Agree            |
| People using it once or many times would like it.                    | 4.30          | Strongly Agree            |
| Mistakes can be fixed quickly and easily.                           | 4.20          | Agree                     |
| The learners can use it well every time.                            | 4.20          | Agree                     |

The effectiveness of the mobile application is one of the key considerations for evaluation to meet the expected characteristics and functions of the application. As gleaned in table 3, most of the respondents strongly agree that the IREAD application lets learners do reading and writing lessons, it is simple and easy to use, and it is understandable. This implies that the IREAD application is effective in delivering its desired functions. Relative to Kumar and Karie [11] study which a mobile application was developed for children with speech disabilities. Its features comprise a graphical user interface that implements categorized images and a keyboard. The user clicks on the image and the system sends the image to a
phrase library to convert it to a suitable text. Then, the text-to-speech engine processes the text and produces the sound as an output.

**Table 4. The efficiency level of IREAD App**

| Item                                                                 | Weighted Mean | Descriptive Interpretation |
|----------------------------------------------------------------------|---------------|---------------------------|
| The IREAD User Interface provides appropriate content/information   | 4.90          | Strongly Agree            |
| for children/learners                                               |               |                           |
| The IREAD application is easy to learn for children/learners        | 4.90          | Strongly Agree            |
| The IREAD application provides useful and interesting learning       | 4.80          | Strongly Agree            |
| activities for children                                              |               |                           |
| The IREAD application provide appropriate progress report/evaluation| 4.30          | Strongly Agree            |
| result for assessment of performance in a given activity             |               |                           |
| The IREAD application provide appropriate controls                  | 4.40          | Strongly Agree            |
| The IREAD application provides easy readability for children/learners| 4.20          | Agree                     |

As gleaned in table 4, the respondents’ revealed a high level of agreement on the efficiency of the IREAD application. It provides a well-designed user interface to which, its content and information were sufficient that enables learners to learn efficiently. The application can be understood by the learners as it provides an appealing and satisfaction menu for navigation. The reading and writing activities included in the application were interesting and is useful for the learnings. This implies that the application can be considered efficient. Castañeda D. and Cho M. [12] stated that the use of mobile applications in enhancing students' learning in Spanish classrooms runs high and the results of their study showed that the activities helped students improve not only their accuracy but also their confidence in conjugating Spanish verbs. Thus, mobile application utilization in the classroom enhances students learning.

**Table 5. Quality of Support level of IREAD App**

| Item                                                                 | Weighted Mean | Descriptive Interpretation |
|----------------------------------------------------------------------|---------------|---------------------------|
| The instructions and messages are easy to understand.                | 4.30          | Strongly Agree            |
| The messages to fix problems are clear.                              | 4.20          | Agree                     |
| The instructions and messages are clear.                             | 4.20          | Agree                     |

Table 5 shows the quality of the support level of the IREAD application. The participants strongly agreed that the application instructions and messages are easy to understand. On the other hand, clarity of the instructions and messages needs to be improved to fully have an exceptional quality of support. Shadiey R., Hwang W., and Huang Y. [13] Smartphones, mobile phones, and personal digital assistants were the technologies mostly used, whereas the English language is the most common target language. They also found out that many of the studies did not apply newly acquired knowledge by the students in solving their real-life problems or recently developed intelligent technologies for language were overlooked.

**Table 6. Ease of Learning level of IREAD App**

| Item                                                                 | Weighted Mean | Descriptive Interpretation |
|----------------------------------------------------------------------|---------------|---------------------------|
| You quickly became good at it.                                      | 4.30          | Strongly Agree            |
| You easily remember how to use it.                                  | 4.30          | Strongly Agree            |
| It is easy to learn to use it.                                      | 4.30          | Strongly Agree            |
| You learn to use it quickly.                                        | 4.40          | Strongly Agree            |
As shown in Table 6, the participants strongly agree that the IREAD application exhibits an easy learning environment. This is to support the demanding needs of learners with special needs. Kokkalia G. and Drigas A. [14] concluded that there is a need to support on the design of educational mobile applications for intervention and diagnosis of the learning difficulties in the kindergarten while enhancing the abilities of teachers through training. The effect in the development of preschoolers having such difficulties could be best supported with mobile teaching.

Table 7. Satisfaction level of IREAD App

| Item                                                                 | Weighted Mean | Descriptive Interpretation |
|---------------------------------------------------------------------|---------------|----------------------------|
| The app provides clear and understandable navigation keys such as   | 4.40          | Strongly Agree             |
| back/next buttons to move to the previous/next screen              |               |                            |
| The educational content matches with my course curriculum         | 4.70          | Strongly Agree             |
| The learning approach and activities in-app were interesting and I | 4.70          | Strongly Agree             |
| learned from them                                                   |               |                            |
| You are happy with the app.                                        | 4.50          | Strongly Agree             |
| You would tell a friend about the app.                             | 4.50          | Strongly Agree             |
| The app is fun to use.                                             | 4.50          | Strongly Agree             |
| This app works the way you would want it to work.                  | 4.40          | Strongly Agree             |

As can be seen in Table 7, the participants establish a high satisfaction level. The primary goal of the development of the IREAD application is to support the learners with special needs where its learning content is based on the curriculum provided by the department of education. The utilization of a mobile assistive application provides an innovative way of teaching; thus, it provides engaging and interesting activities.

Table 8. Summary of Usability level of IREAD App

| Category          | Weighted Mean | Descriptive Interpretation |
|-------------------|---------------|---------------------------|
| Effectiveness     | 4.60          | Strongly Agree            |
| Efficiency        | 4.55          | Strongly Agree            |
| Quality of Support| 4.23          | Strongly Agree            |
| Ease of Learning  | 4.32          | Strongly Agree            |
| Satisfaction      | 4.52          | Strongly Agree            |
| Categorical Mean  | 4.44          | Strongly Agree            |

The overall usability results of the IREAD application are presented in Table 8 to which the participants strongly agree to all usability dimensions. Innovation in the mobile app has raised interest to apply the m-learning concept among teachers because it facilitates teaching and learning, as claimed by [15]. Then, they must get ready to utilize the technology associated with m-learning in the teaching and learning process towards dyslexic students.

5. Conclusion

Based on the results of the study, the researcher can attest that Individualized Reading Enhancing Application for Dyslexia (IREAD), a mobile assistive application that can support dyslexic learners can be an alternative in teaching reading and writing lessons for learners with special needs. With the design considerations that specifically address the needs of the learners, it provides individualized learning which composes interesting and engaging activities. The developed application incorporated text-speech technology to aid students in learning how to read. It supports the repeated instruction method of teaching by teachers.
The usability evaluation of the application yielded a positive result, which fulfills the requirements of dyslexic students. The participants immensely agree that the application is effective and efficient in delivering its design and functionalities. Relatively, it is evident that the participants in satisfied with the IREAD app. It can be recommended that the application will be utilized by the school to enhance the reading proficiency of dyslexic learners.

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