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Multimodality User Interface in Mobile Technology: Increase Learning Performance for Dyslexic Students in Sudan

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Abstract— Multimodal user interface (MUI) plays a key role in the future of mobile technology. After having a comprehensive review of the previous researches to determine the research problem, the researcher collected the relevant data by face to face interview with dyslexia students, teachers and experts from learning difficulty domain. This research developed a multimodal user interface in mobile learning application, for dyslexic students. The Researcher implement an Arabic letter mobile application to taught dyslexic students in a Sudanese primary school. Firstly, the application was developed on android platforms. Secondly, the application implemented in students sampling of size 30 students. Finally, the application was evaluated in two stages. The first one is to evaluate the enhancement of student who was taught a multimodal user interface; the second stage is an evaluation by using the technology acceptance model (TAM). The evaluation stage show increasing in education level for dyslexia students in significant degrees. Multi-mode learning has a good effect in dyslexia students on this study, there was a significant difference between student's marks after using the mobile application in teaching alphabet letters and the student's degrees before using the mobile application, which means the multimode user interface improved the reading skills for most dyslexic students who are involved in our study.

Keywords— dyslexic students, multimode, Arabic letters, mobile learning, mobile application.

I. INTRODUCTION

Students with special education needs can be defined as "those who, because of a disability, require special education and related services to achieve their fullest potential [1]. The main objectives of the special education process are to improve the behavior of disabled students and their relationships and interactions with their environment. Also, they must improve their communication, develop cognitive abilities and acquire new knowledge[2]. Using Technology can help a lot in creating new ways of learning and teaching for disabled students, by accessible technologies or assistive technologies, that help people with disabilities to perform activities that who could not do it before[3]. A mobile application has received large interest recently as it allows storage and processing of data outside the mobile device[4]. Assistive Technology (AT) is defined as

"any item, piece of equipment or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of a child with a disability[5]. AT is used to help create opportunities and promote independence for students with disabilities. It also helps empower students with disabilities to take the lead in their education and can help to develop self-determination when students can pick their own apps[6]. Mobile devices are powerful and assistive technologies that may be facilitating the learning process of disabled people, there are many types of research asserts that they can help students with disabilities [7]. A research study about the amount of educational apps available on mobile found that 2 out of every 5 apps could be used to support students' needs in school and the community [8]. One of the major benefits of using mobile devices in the classroom is the ease of use for students and teachers. Many teachers struggle with adapting to assistive technology devices they may be unfamiliar with them. However, most teachers have some type of Smartphone or tablet that operates in the same way as an iPad. Since many teachers already knew how to use the mobile, it makes training professionals use the equipment as AT or instructional technology much easier.[9]

II. MULTIMODAL INTERFACE

Mode means the manner of using the human sensory system to interact in an outer environment; the interaction with one sensory organ is called single-mode and the interaction with more than one sensory organ is called multi-mod [10]. A multimodal interface refers to: "Applications or systems that combine multiple modalities of input and output" [11]. A multimodal human-computer interface is important because the user can choose the method of interaction that is suitable for him [12]. Notably, a system with multiple keys is not multimodal, but a system with a keyboard and mouse input is [13]. Multimodal has three main components figure 1 show the multimodal components:

1) The user: is a person or automated user who enters input into the system and receives information presented by the system.
2) Input: input modes that will be used in multimodal implementation such as audio, speech, handwriting, and keyboarding, and touch screen.
3) Output: is the output modes that will be used in the multimodal implementation such as speech, text, graphics, audio files, and animation

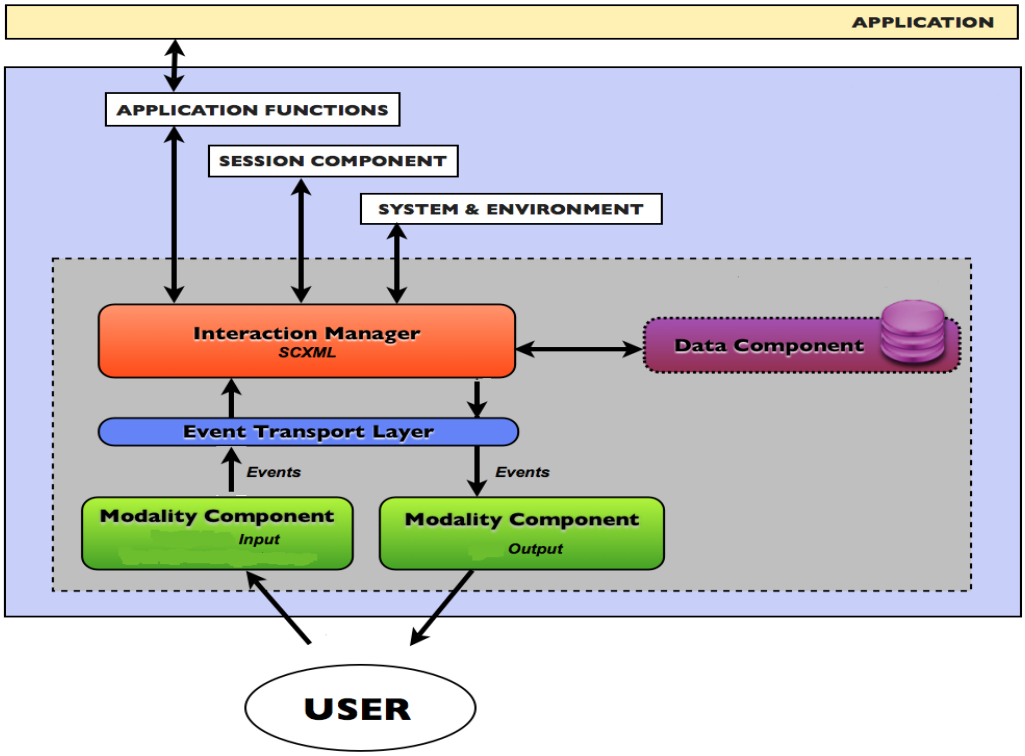

Fig 1: Multimodal three main components

4) Interaction manager: It is the conceptual part that coordinates data and manages execution flow from input and output modality components interface objects.
5) Session component: It produces an interface for the interaction manager to support state management and constant sessions for multimodal applications.
6) System and environment: It enable the interaction manager to find out and respond to changes in device capabilities, such as user preferences and environmental conditions.

III. RELATED WORK

As a result of investigating of comprehensive previous research, below are the related studies which covered using multimodal in a mobile application in the education process with dyslexia students:

Ting-Feng [14]. The author designed a questionnaire to find the effect of information and communication technology (ICT) access and ICT competency. The research covers elementary school students to collect data. The study sample was 117 students with learning disabilities (LD) and compared by 117 students without learning disabilities were recruited in this investigation and were conducted with the questionnaire. The results of the research highlighted that, there was no significant difference to access computers and the Internet at home and at school between children with and without learning disabilities. However, there was a significant difference between children with and without LD in ICT efficiently.

Nicole Quick [15]. The author investigated the literature review in recent years by examined the effectiveness of the use of the assistant device like iPads to support developing and improve achievement for students with disabilities. The analysis covers both sides' benefits and difficulties of using iPads in the classroom. The research concluded that the iPads devices could be improved special education services for students. The result of this research confirmed that assistive devices like iPads were effective technology in the classroom. However, there is a lack of application that best meet the student's needs.

Nisha Sharan [16] English as a second language in learning. The research proved that computer assistance motivated dyslexic students to achieve their goals. The research found that the school and the home environments affect dyslexic students who have Swedish as a second language. The author takes a sample that consisted of four dyslexia students, 13 to 15-year-olds who have Swedish as a second language. Also, the sample contained two Swedish teachers. The author collected the data using semi-structured interviews and analyzed using content analysis. After transcribing the interviews' six themes: and choose the computer as a tool, inclusion, motivation and environment were identified. The research results were that computers are effective tools for dyslexic students who have Swedish as a second language. Assistance devices make these students more independent to find ways to support themselves. It motivates the students to learn more. It was very clear that the students were more efficient in computers compared to the teachers. Maybe, both the teachers and students should be given the same competence and education. Motivation is the most important aspect of learning was very noticeable in all the six interviews. However, the solution did not consider the student's and teacher's background.

Helena Song Sook Yee [17]. The author found that among mobile features there were flexible multimedia content and storage, portability, mobility and affordability. The author investigated previous researches to show the significant role of these devices and proved that it could be enhancing the quality of life of the children with learning disabilities and their families. The study found that there was a lack of published research studies on the use of mobile technologies with children those how had learning disabilities. However, the solution ignores the parents and school whom are assists these individuals.

Samart Jabjone[18]. The author investigated the Mobile-learning and used Thai sign language video tools. The author developed an effective tool to improve learning skills for stakeholder at Nakhon Ratchasima Rajabhat University students in Thailand. The proposed solution implemented in a sample content from seven deaf participations. In this research, the sample covers deaf and hard hearing student who faced the problem when a study in the traditional classroom. The research used a Universal Design for Learning (UDL) technique and met stakeholder and student's expectations. In the practical part, the student can access the lesson by scanning Quick Response (QR) codes. All relative resource can storage using cloud computing technology. The evaluation stage showed that this proposed solution (MLM) increased the learning skills in all sample by using the video to demonstrate and showed the technique which student could follow and practice by themselves. Participants had a positive response to the M-learning. The students and instructors reported enjoying learning with their mobile devices and found the MLM easy to access and use. However, there was a need to expand the scope of the curriculum to include more student participation in a wider range of interactive exercises, thus creating a truly mobile classroom. Table I highlighted the related works in critical review.

TABLE I
RELATED WORKS

No	Author	Approach	Adv+	Limitation
1	Ting-Feng	Investigated and Analysis	No difference to access computers between LD and non LD	Lack of specific designed ICT instruction programs for LD
2	Nicole Quick	Investigated and Analysis	covers both sides benefits and difficulties	A lack of application that meet student's needs
3	Nisha Sharan	Investigated and Analysis	the computer assistance motivated dyslectic students	did not consider the student's and teacher's background
4	Helena Song	Investigated and Analysis	Show the significant role of mobile devices	Ignores the parent and school
5	SamartJabjone	System Tool	using Thai sign language video	A need to expand the scope of the curriculum

IV. Experimental Implementation

Data collection: Figure 2 highlights the scientific qualification of the sample member that collected the data from them. To cover all the stockholders of the dyslexic education the researcher has to cover the entire member that effected in the dyslexic education. The researcher collected the relevant data from 100 people in related fields such as Faculty of Education Special Education Department., ministry of education at Khartoum province, and teachers of Arabic language in special needs school at Khartoum province. Figure 2 highlighted the related experts.

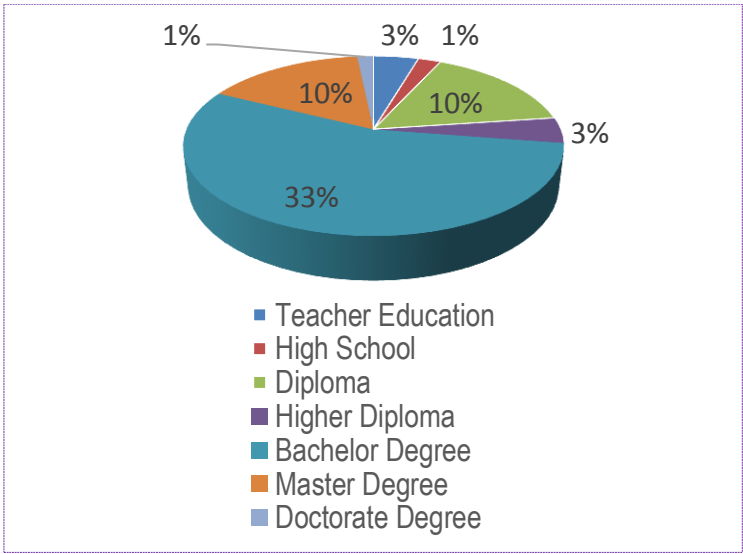

Fig 2: The education qualification of the sample member

V. Analysis

the results showed that the greatest percentages of the stakeholders which they are represent 61% of the sample are agreed that the content of lessons should be rich (more than one data type) than the textbook contents. Figure 3 showed that the greatest percentages of the participants which they are represent 83% agreed that the scientific content should include sound, image and text.

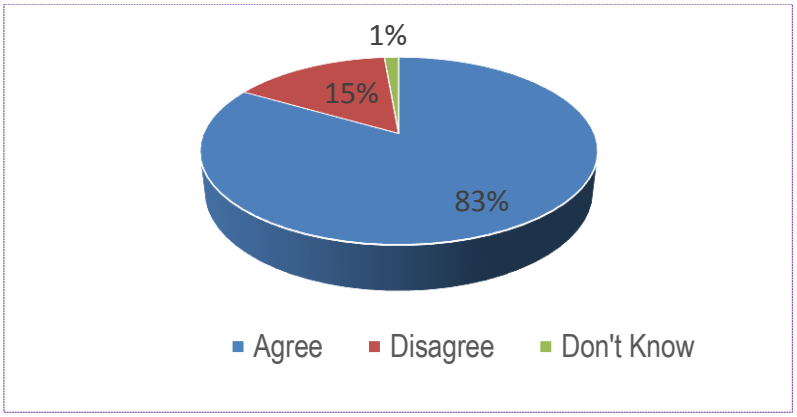

Fig 3: The scientific content is processed with sound, image and text all together.

VI. Design

Design the proposed solution based on mobile learning on the private cloud computing, This solution solved the most important problems of the existing researches. Moreover, this solution take into consideration the most important parts of reading disabilities based on education system in Sudan.

VII. Development and Implementation

The mobile app developed by adopting android platform (Open Source) and PHP, android studio, MySQL. Then the application interfaces and lessons are designed according to the survey results. The mobile app implemented in a private cloud computing environment and used this app in teaching dyslexic students sample size (30 students). The teachers of dyslexic students taught the students for one semester (4 months) using the proposed mobile application. Figure 4 is demonstrating the age distribution curve of the study participants, where the mean age was 11.72 ± 2.6 leading to a curve skewed to the left. This negative skewed is due to the presence of extreme of ages among the participants (15 at grade 8).

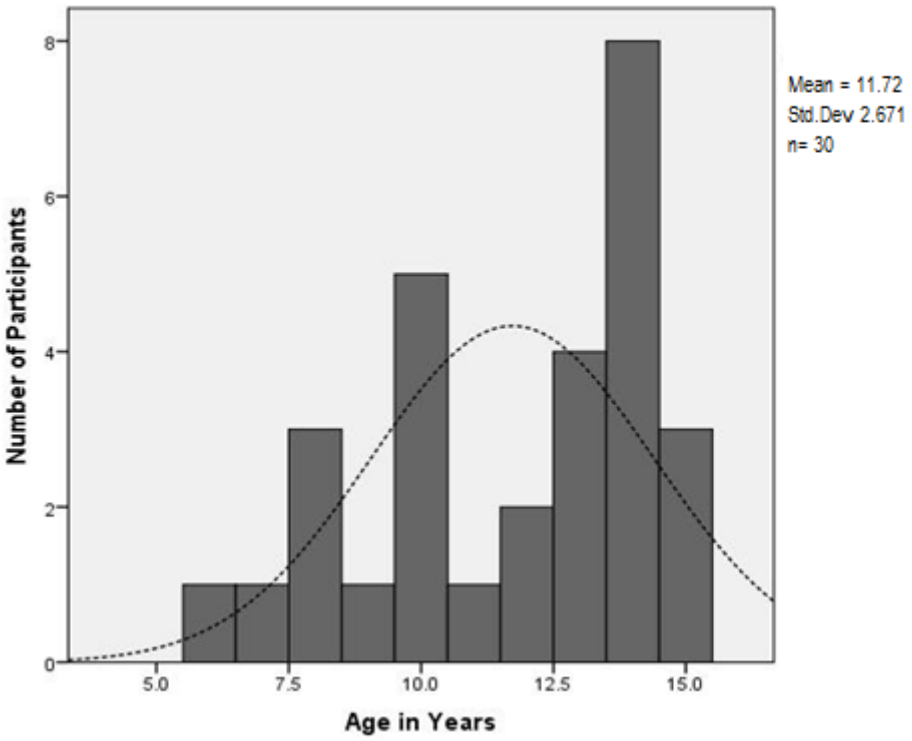

Figure 4: The distribution of participants according to age(n=30)

VIII. Evaluation

The study authors used SPSS to analysis the results table II present the Wilcoxon signed-rank test for the whole group and it shows that there is a highly significant difference between degrees after using the mobile application in teaching alphabet letters and degrees before using the mobile application.

TABLE II

WILCOXON SIGNED RANK TEST OF STUDY PARTICIPANTS (N=30).

		n	Mean Rank	Sum of Ranks	P-value
Degrees After - Degrees Before	Positive Ranks	29b	15	435	0.000

Table II presents Wilcoxon signed Rank test of study Participants by Gender the p-value for both males and females is less than 0.05 and that indicate there a significant difference between students degrees after using the mobile application in teaching alphabet letters and the students degrees before using mobile application which mean the application improve reading skills for most students.

Evaluate the proposed solution and get feedback from the partner of this proposed solution. Sample size (14 teachers, 25 students and 6 educational experts). The researcher used a technology acceptance model (TAM) developed by Davis [19]. The researcher used the last version of TAM to evaluate the ease of use, the usefulness and the behavioural intention of the application figure 4 highlighted that.

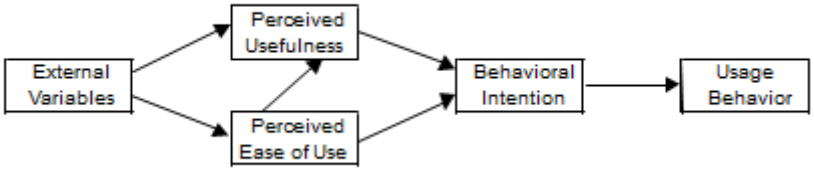

Fig 4: Evaluation model for the mobile application derived from TAM.

Most of the dyslexic students found the Application easy to use although more than half of them were not owned a mobile device. The author noticed that 96% said the application helps them to remember the lesson and this was noticed because the evaluation took place after school holidays (approximately after four months from the experiment finished) when the researcher met them to evaluate most of them were remember the letters they were read by the application and remember the pictures included in the lesson. Table III shows the result of the evaluation tool (The Questioner).

TABLE III

FONT GENERAL INFORMATION OF TEACHERS AND EXPERTS.

Variable	Number	%
Gender(n=20)		
Female	16	80
Male	4	20
Age (n= 20)		
20-29	8	40
30-39	4	20
40-49	6	30
50-59	2	10
Education Level(n=20)		
Diploma	1	5
Master	6	30
Bachelor	7	35

PHD	5	25
Professor	1	5
Experience in using the computer(n=20)		
Excellent	3	15
Very Good	10	50
Good	3	15
Weak	3	15
No Experience	1	5

Table II shows the conclusion of the evaluation stage. Approximately 75% of the teachers and expert extremely agreed that using the multimodal interface in mobile application increase dyslexia students learning level and the rest of the sample agreed also. Figure 5 highlighted the effect of using multimodal in learning dyslexia students by mobile application in Sudan.

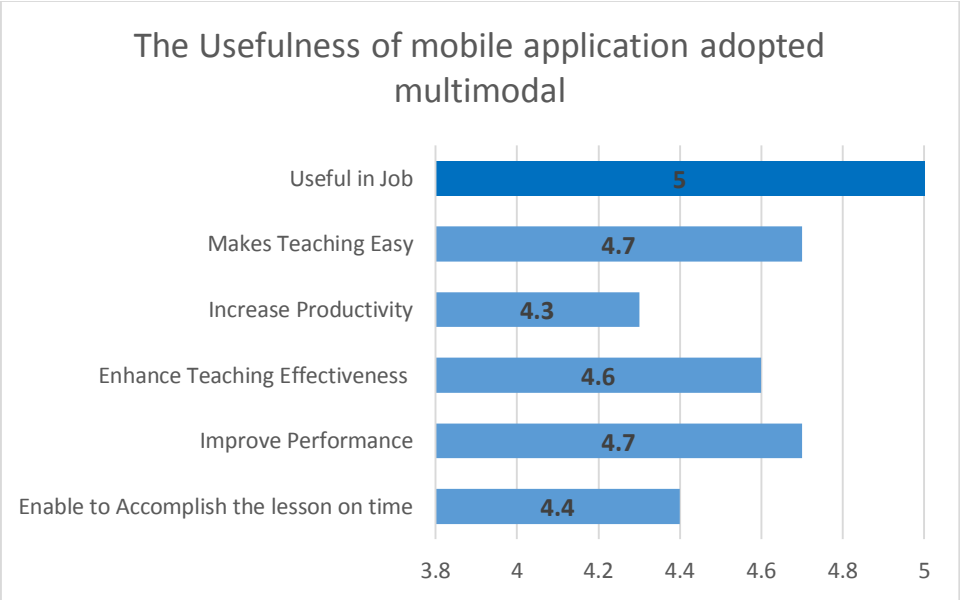

Fig 5: The average of the usefulness

IX. Conclusion and Future Works

Humans interact with multimodal to learn something better and faster. After having a comprehensive review of the previous studies to determine the research problem this study the author collects the relevant data using a number of methods, Firstly, face to face interviews with teachers, dyslexia students and experts, in different dyslexia student's domain as a direct result of the questioner, secondly. the author adopted multimodal (image, sound and voice) interface then the mobile application was developed to learning different dyslexia students by developed Arabic letter mobile application to teach dyslexic students, the application was developed on android platforms and after that used the application to teach dyslexic students at Khartoum Omnia centre for difficulty learning. Finally, the application was evaluated on two stages first evaluate the enhancement of student who was taught through the multimodal interface application and the second evaluation by using technology acceptance model (TAM) which proved that the students learning level increased in a higher rate. In addition, Multi-mode learning has a good effect in dyslexia students in a primary school in Sudan there is a significant difference between student's marks after using the mobile application in teaching alphabet letters and the student's degrees before using mobile application which mean the multimode user interface improve reading skills for all dyslexic students in Sudan. The author highly recommended for future works to the developed multimodal user interface for OSI platform.

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