Dleksia Game: A Mobile Dyslexia Screening Test Game to Screen Dyslexia Using Malay Language Instruction

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Abstract: Dyslexia screening is an important process to identify a dyslexic child before early remedial intervention program can be given. Current practice in the Malaysian school system is based on the teacher's observation and initiation before the screening process can be implemented. The issue of ill awareness and untrained teacher is one of the constraint in the screening process. The insufficient number of dyslexic students in the Malaysia schooling system is the proof of its inefficiency and therefore, it is a necessity to have a dyslexia screening tool which are simple, accurate and easy to use. Dleksia game, a dyslexia screening tool based on mobile game approach is proposed to overcome this problem. Is use the (multiple-deficit) dyslexia screening mobile game model which combine five different deficit theories of dyslexia. A usability testing conducted toward 11 dyslexic children shows that 81.82% of the respondent feel that they're playing a mobile game instead of being subjected to a screening process. Currently, we are working with dyslexia association of Malaysia to improve the classification model and decision making. This encouraging finding shows that dleksia game can be used as a screening tool to identify the dyslexic child.

Key words: Dyslexia, mobile game, dyslexia screening, multiple deficit theory, classification model

INTRODUCTION

Dyslexia: Dyslexia can be described as difficulties in reading, spelling and writing. The actual definition of dyslexia is debatable among scholar. Some of them adapt the idea of dyslexia as a disability while other identified it as a disorder. According to Ramus and Ahissar (2012), the world health organization define dyslexia as "a specific deficit in reading acquisition that cannot be accounted for by low IQ, poor educational opportunities or an obvious sensory or neurological damage". On the contrary, the Malaysian education recognized dyslexia as a kind of disability and administered by special need education division (Lee, 2008).

Past research (Rahman *et al.*, 2012; Oga and Haron, 2012; Subramaniam *et al.*, 2013) estimated around 314,000 Malaysian schools going student are dyslexic and early intervention is in serious need also claimed that new teachers were not properly exposed to recognise children with special need and sometimes misdiagnose the student condition. Another important fact is that there are also some views claim by Bailey *et al.* (2015) that Malaysian teacher doesn't have enough training and skill to support the children with special need also concluded that generally Malaysian teachers are lack of skills and knowledge when handling dyslexic children.

Malaysian special education: The enrollment statistic of Malaysian special education shows that only 57,637 students enrols in 2014, compared to the whole the Malaysian school population of 4,933,504. This figure represent only 1.17% while the United Nations estimate the average of 10% enrollment in the special need education classes. These students include those who have visual impairment, hearing impairment, speech difficulties, physical disabilities, multiple disabilities and learning disabilities. The learning disability spectrum cover the children with autism, Down's syndrome, Attention Deficit Hyperactivity Disorder (ADHD) and specific learning disability dyslexia.

Adding to this uncertainty is that the number of dyslexic children in Malaysian education system is only 1,681 students from the whole of 4,933,504 students in 2014. This number is unrealistic since the expert estimation of dyslexia is around 5-10% of the world population (Husni and Jamaludin, 2009; Umar *et al.*, 2011;

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Vidyasagar and Pammer, 2010; Wright *et al.*, 2012). In order to overcome this problem, the education ministry has introduced the LINUS program.

LINUS: Literacy and Numeracy Screening is an early intervention program created by the Malaysian government to identify the children with the risk of literacy and numeracy incapability. Bailey *et al.* (2015) explain was meant as an early intervention program to help the weak student to catch up with their peers.

In the LINUS Program, the standard one who are unable to master the basic literacy and numeracy will be placed in a special program and they will be monitored. Ghani *et al.* (2013) quoted the president of dyslexia association of Malaysia, Sariah Amirin suggestion small class sized of 5 students is the best for special education and the screening process should be done as early as 5 years old. On the other hand, Bailey *et al.* (2015) stated that comparison between the Malaysian, the UK and the netherlands special education and dictated that Malaysia is not fully practising the inclusion education. The study claimed that Malaysia is still lack of policy, specialist and resource in this area.

Dyslexia screening tool
Type of dyslexia screening tool: Currently, there are several tools used in dyslexia screening. These tools designed to help the screening process and to standardize the result. It is based on different technique and approaches whether administered manually or assisted by specific technology. The manual approach is done through checklist assessment and/or IQ and reading assessment (IQ test). On the other hand the technologically assisted assessment generally are computer based using existing knowledge in classification technique. The main focus of these tools is to identify the main symptoms that differentiate the dyslexic children and the non-dyslexic children.

Checklist-based assessment: An example of checklist assessment is Senarai Semak Disleksia. This assessment were developed by Malaysian education ministry to help teachers identifying children with dyslexia symptoms. It is basically based on teacher's observation and understanding towards the student. This assessment consists of three part which is the student's mastery of spelling, reading and writing, the student's strengths and the student's weaknesses. This assessment is initiated by the teachers or parents due to dyslexia awareness and based on teachers understanding on the academic achievement of the student. On the contrary, Oga and

Haron (2012) reported that the dyslexia awareness is poor among Malaysians and as the result the dyslexic individual have been subjected to ill-treatment.

IQ and reading-base assessment: Reading assessment is the most popular assessment method to screen dyslexic children. The well acceptance of these assessment method mainly because of the phonological deficit theory. It is believed to be one of the main reason that causes dyslexia (Ramus and Ahissar, 2012; Takala and Kuusela, 2009).

One of the main assessment methods in this category is Dyslexia Early Screening Test (DEST) introduced by Fawcett and Nicolson. It consists of 10 short test including researching memory test, rapid naming, motor skills, auditory processing and phonological awareness test (Carroll *et al.*, 2015). Despite all these tests, Carroll *et al.* (2015) suggest that only the rapid naming and auditory processing give the actual predictive capacity as whole.

The Dyslexia Association of Malaysia (DAM) adopt different strategy in the screening process which include the reading and comprehension, mathematic and numbers, sentence constructions, handwriting, spelling, perception, listening skill and visualization.

In addition, there is also other researcher such as Takala and Kuusela (2009) which used the pseudo-words/non-words to determine whether a student is dyslexic or not. The student were asked to read a passage that has both words and pseudo-words. They concluded that that the test were practical and easy to use. These screening tools need to be administered manually by teachers or practitioner.

Computer-Based Assessment (CBA): Brookes *et al.* (2011) quoted that Singleton explain the benefit of CBA is due to it's standardization and the cost effective compared to manual assessment. One of the examples of CBA is lucid rapid which is widely used in the UK (Brookes *et al.*, 2011). It is a computerized application design to test the children phonological processing, working memory and also phonic decoding of English language. The children native language also play an important role in the screening process. It is because different language has different phonological structure. since lucid rapid is developed else where it cannot fully suitable for Malaysian purpose due to different education and language perspective.

In another, research and develop a computer system that trying to help the teacher to differentiate between dyslexic children and autistic children. It is done through

identification of symptom for both disabilities by the teachers. The data inserted by the teacher will help the system to identify and differentiate each disability. develop the ESSE: learning disability classification system for autism and dyslexia using an expert system. Le-ADS: early Learning Disability Detection System for autism and dyslexia was develop using the esse qualifier with additional finding including from the lucid Cognitive Profiling System (CoPS).

Game based assessment: The game based approach is quite new and most not widely used as dyslexia screening instrument. A serious game developed by Gaggi *et al.* (2012) using series of games to identify children with dyslexia symptoms. The game consists of three different parts which test the children's ability in eye-hand coordination, visual search ability and the ability in rapid identification of visual and sound. Basically, this game is made of the essence of the Rapid Atomization Naming (RAN) testing. RAN testing is one of the three most important testing in dyslexia screening (Takala and Kuusela, 2009). The other two are the phonological and orthography testing.

Another, research by Bartolome *et al.* (2012) is done to diagnose the reading capability of dyslexic children through games at school environment. Using a client server architecture system, it is used to test the children's capability in producing words, the children's memory and working memory, auditory and also word reading capacity. This game approach is the children deficit in phonological, auditory and working memory.

In recent development dytective were develop by Rello and Ricardo (2013) using game approach to detect dyslexic children in Spanish. The goal of the game is to collect points by hitting specific target. The game content is focusing on phonological awareness of the children by testing their ability in letter recognition, syllable recognition and sound to word recognitions. They believe that these tool could be used to screen dyslexia since the result from their experiment towards 40 participant are promising.

MATERIALS AND METHODS

Dleksia Game was develop based on the finding with the aim to simplify the screening process. The researcher of this game shares the same concern with (Oga and Haron, 2012) that the dyslexia is unrecognized population and many students are not properly diagnose. The game was designed using the (Multiple-Deficit) Dyslexia screening mobile game model (Fig. 1) which consist of three element which is the usage of multiple deficit
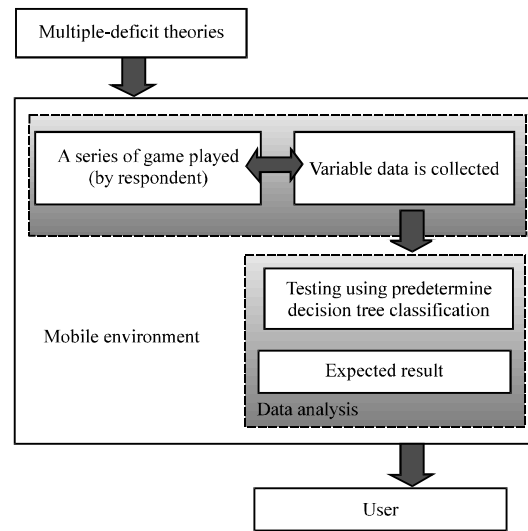

Fig. 1: Dyslexia screening mobile game model (multiple-deficit)

theories the mobile environment and the user. This model combine five different deficit theories of dyslexia which are the phonological core deficit theory, researching memory deficit theory, auditory deficit theory, visual attention deficit theory and cerebellar deficit theory.

Multiple deficit theories: Dyslexia deficit theories are supposedly the theory that explains what is the cause of dyslexia. In literature, there are many different deficit theories introduced and explain as the cause of dyslexia. Thus most of the dyslexia screening will try to incorporate the finding of these deficit theories. To this date, there are more than fifteen different theories of dyslexia (Ramus and Ahissar, 2012). This game cover the knowledge of phonological deficit theory, the working memory deficit theory, auditory deficit theory, visual attention deficit theory and the cerebellar deficit theory.

Each of these theories has a specific symptoms for instance the phonological deficit theories such as problem in decoding the sound-letter association, reversed letter and problems in connecting letters to sounds for non-words and complex words (Takala and Kuusela, 2009). Another example is the researching memory deficit symptoms are believed to be the reason behind poor reading, attentional problem and mathematic difficulties among the dyslexic children (Table 1).

Mobile environment: Dleksia game consist of data collection module and data analysis module. The data collection module start when the game being played by the children. There are ten different mini-games which collect a different kind of information for screening purpose:

Fig. 2: The interface of game 1 and 6

Table 1: Type of deficit theories

Deficit theories	Deficit theories main idea
Phonological core deficit	Phonological decoding is the ability to read unfamiliar words (and/or non-words) and translating them into a sound
Working memory deficit	Working memory is our ability to hold and manipulate information over a brief period of time
Auditory deficit	Audition provides the inputs to the information processing stages that in turn, generate the phonological information that is important to speech perception and thus to reading
Visual attention deficit	The process of visual stimuli not only about the visual perception but also includes the involvement of the attention system
Cerebellar deficit	The cerebellum is supposedly playing important role in timing and in motor and sequence learning

- Game 1 to test the difficulties in understanding instruction
- Game 2 to test the directional confusion
- Game 3 to test the short-term and working memory
- Game 4 to test the sequencing and spatial capability
- Game 5 to test the ability of rapid processing
- Game 6 to test the visual perception
- Game 7 to test the coordination between motor skill coordination
- Game 8 to test the problem in mathematics
- Game 9 to test the auditory perception capability
- Game 10 to test the phonological awareness in Malay orthography (Fig. 2)

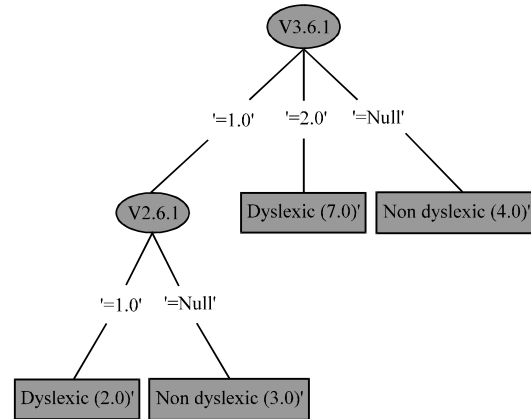The main reason why dleksia game were designed using mobile environment because of its

Fig. 3: Decision tree induction for game 6 using C4.5 algorithm

flexibility. Gaggi *et al*. (2012) reported that touch interfaces are very suitable for a very young child and they will act naturally without the need to learn. Iwabuchi *et al*. (2012) also emphasise that mobile device can offer flexible and personal inclusive approach as an assistive technology for the students with disabilities. Another experiment by Saleh and Alias (2012) on a group of dyslexic children, about the usage of mobile comic as teaching tool found to be very positive. Another important aspect of the mobile environment is that the mobile device rapid evolution has change the way people playing games and mobile game has become part of our daily life (Szegletes and Forstner, 2013).

The data analysis module start after data were collected and responsible for the decision making. The decision is decided through the usage of decision tree classifier. The game will analyse its variable and provide the result in three categories which are high risk, risk and no risk. These results are made based on the number of variables met certain condition or not. Figure 3 shows an example of decision tree induction based on training for Game 6. The training data were collected from a group of dyslexic children studied in dyslexia association of Malaysia in Ampang, Kuala Lumpur.

User: Dleksia game were designed to help the screening process by using mobile game approach. This game has been designed for children between the ages of 6-10 years old with the Malay as their native language. The game will offer an initial result for the teacher, parent and practitioner about the possibility of children having the dyslexia symptom. In order to further verify the children condition they should sit for the second screening process done by the medical practitioner.

RESULTS AND DISCUSSION

A game usability testing were conducted toward 11 dyslexic children from DAM school at Ampang, Kuala Lumpur. The age range are between 6-8 years old and their average age are 6-7 years old. There are also another 3 students ages 5 years old in this test but the result are not considered in the statistic since they are below the age range. This test involving 8 boys (average age is 6-8 years old) and 3 girls (average age is 6-7 years old).

After the students completing the game, they were asked several questions regarding the usability and the design of the game. The three main question is whether they like the game is the game is easy to use and do they think that it is a test or a game (Fig. 4 and Table 2).

For the first question most of the student like the game (81.82%) and only (18.18%) doesn't like the game. There are 2 girls that don't like the game while all boys like the game.

For the second question more 54.6% of the respondent feel that the game is difficult to be used compared to only 45.4% feel otherwise. The average age comparison of the two groups reveals that the first group (the student that saying the game is difficult) is 6.5 years old while the other group (the student that saying the

Table 2: The average age of male and female respondents

Gender	Respondents	Average age (year)
Male	8	6.8
Female	3	6.7
Total	11	6.7

Fig. 4: A children playing dleksia game

game is easy) is 7 years old. This indication tells that the student age also needs to be considered as an important element in the screening process.

The last question about the expectation of the game as a screening tool. Most of the students (81.82%) feel that they are playing a game rather than being screen for specific purpose. This indication is very important since the current screening process involving series of activities.

CONCLUSION

Dleksia game is a novel approach in to detect dyslexic children using Malay language mobile game. Each screening tool will test different language system based on the each language orthography. Other languages such as English and Spanish already have their own screening tool using the game approach (Gaggi *et al.*, 2012; Lyytinen *et al.*, 2007; Rello and Bigham, 2015). The Dleksia game development purposely for the Malaysian student and therefore all auditory instruction is using the Malay language. For future development in order to improve game usability, it is suggested that some of the instruction can be given in simple figure and animation to help the student understand. This is important to ensure that the game can be played by the children out without supervision from the teacher or parent.

The children age and native language proof to be important in the screening process since all instruction is in the Malay language. Some of the children that assume the game is difficult is those who are not fluent in Malay. For future development the non-phonological testing (Game 9 and 10) can also be conducted in an additional language. This is also important since there is Chinese and Indian medium school in Malaysia that can benefit from dleksia development.

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