OPEN CROWDSOURCING
PROJECT PLAN

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SUMMARY

DyslexHero is a mobile application which helps to evaluate the cognitive ability of preschool and kindergarten children. Children suspected of dyslexia will be provided various types of games to improve their reading and writing ability in DyslexHero. It serves as a pioneer in facilitating bigger research on dyslexia and tries to discover the weaknesses of dyslexic children by collecting the game results. This project plan explains the design and implementation of the development of DyslexHero. It includes the concept of crowdsourcing to generate new games and machine learning to recognize the correctness of writing.

1. INTRODUCTION

Dyslexia, also known as reading disorder, is a learning disability that affects the brain in processing words and graphics [1]. For children with dyslexia, they have difficulties in reading fluency and accuracy, which will highly affect their efficiency in learning a language [1]. In Hong Kong, there are 9.7 to 12.6% of children were identified as dyslexic [2]. They need a proper intervention and parents' support in order to improve their learning ability.

In this project, a mobile application will be built for training and evaluating dyslexic children. Specifically, the target audience of the project are the children from preschool to kindergarten. Research shows that the earlier intervention the dyslexic children receive, the better the improvement they will achieve [3]. Therefore, the application will focus on improving their phonological awareness, processing speed, orthographic awareness, working memory and memory span before they attend the primary school.

Crowdsourcing plays an important role in this project. A large variety of game exercises will be provided to the dyslexic children. The parents are able to design new game levels for the children and the design will be collected. They are also able to view the average score of the game exercises. For the writing exercise, the children's handwriting will be collected for developing the handwriting recognition function.

The following paragraphs provide the details of the project, which includes the objectives, previous works evaluation, implementation, division of work, schedule, risk and conclusion.

2. OBJECTIVE

There are several objectives to be achieved:

I.   To find effective methods for helping children with dyslexia

II.   To assist in finding the assessment methods for identifying dyslexic children

III.   To discover the weakest ability of the dyslexic children

IV.   To analyze the common mistakes in the children's answers

The intermediate goal is to create a user-friendly application for children and parents. The application could evaluate the children's performance in different abilities. The parents will be able to create game levels for their children. And the hardness of the training game will be adjusted according to the degree of dyslexia evaluated. Improvement will be shown if the dyslexic children complete the game sessions regularly.

The ultimate goal is to discover the weakest abilities of the dyslexic children in Hong Kong and find the most effective training methods to help them. Analyzing a large sample size of incorrect answers allow researchers to define a better assessment method for dyslexia. It also raises the awareness of Dyslexia with the widespread of the application.

3. PREVIOUS WORKS EVALUATION

There are some previous works created for helping the children with dyslexia or other special educational needs.

- Eye Games [4] - It is an Android application that provides many matching games for improving the children's visual perception. They will learn to make connections pictures, letters, shapes and backgrounds. However, there is only a single game mode, which is to select the identical objects. The children may easily get bored.

- Galaxy Maze [5] - It is an Android application of ball rolling game for improving the children's memory. Children need to roll the ball to finish the maze. Parents are able to adjust the game difficulty and starting point of the maze. The idea of parent involvement is good but the variety of the maze is not large enough. Also, the interface could be more colorful.

- Dyslexia Quest [6] - It is an iOS application that provides six different games for testing memory and learning skills. The interface is nice and it provides information about the user's' strengths and weakness. The overall idea and game design are nice but the games are not designed for preschool and kindergarten children.

These are the general problems in the previous works:

I.   Unattractive interface

II.   Few game modes

III. Repeated game contents

4. IMPLEMENTATION

In this session, it explains the major features, technology, methodology and deliverables of this project in detail.

4.1. MAJOR FUNCTIONALITIES
There are three major functionalities:

DIAGNOSTIC ASSESSMENT
Assessment is always available for children to evaluate their abilities and determine their weaknesses. Each child is given a full set of games in 5 specific areas — phonological awareness, processing speed, orthographic awareness, working memory and memory span. Phonological awareness is the ability to manipulate meaningful sounds in human languages [7]. Orthographic awareness is the ability to recognize printed words [7]. Working memory is the ability to remember and transform the information at the same time [7]. Memory span is the ability to receive the verbal information and repeat it in sequence [7]. Those are the correlates of dyslexia. Comparing the result with the children of similar educational standard, parents are able to discover the potential problems on their children. It serves as a simple test for parents to notify the dyslexic symptoms in advance. Then, they can take a standardized assessment from the dyslexia professionals and help the child to adapt to the school environment beforehand. The assessment can also be repeatedly done to evaluate the improvement. The result of assessment will only be shown in parent panel.

INTERACTIVE AND CUSTOMIZABLE GAME EXERCISES
Children are able to train their abilities in the five areas mentioned in the diagnostic assessment. Parents could encourage their children to do more exercises in order to improve their weakness shown in the result of the test.

The game levels can be customized by the parents and deliver it to their kids. In addition, the contents will be uploaded to the database and other users are able to enjoy the games prepared by others. This allows constantly changing of game contents and avoids duplicate game experience to the children. Therefore, it helps the children to consolidate the memory and skills by overlearning, which is practicing through different learning methods and contents.

The game modes are interactive with the help of multifunctional mobile devices, including vibration, motion sensor, sound, drag-and-drop and drawing. The game levels are divided into easy (preschool), intermediate (K1-K2) and Advanced (K3). After sufficient training, children could finish the diagnostic assessment again to measure the improvement.

PARENT PANEL
Parents are required to set a password for accessing the parent panel. There are two functionalities in parent panel, which are customizing game level and viewing children's ability analysis. For the children's ability analysis, they could review children's records in diagnostic assessment and game exercise. The average scores of other children in same age will also be shown for their reference. A

radar chart that showing children's ability in phonological awareness, processing speed, orthographic awareness, working memory and memory span is provided. The measuring method for the radar chart is explained in section 4.3.

4.2 TECHNOLOGY

Unity will be used as the development platform for this project. It supports cross-platform game development for Android, iOS, Windows, Linux, etc.

MongoDB will be used for designing the database management system. The server is planned to use Apache Tomcat.

4.3. METHODOLOGY

DIAGNOSTIC ASSESSMENT

Initially, the application required the users to input the information of the children, for example, age and education background, before they do the diagnostic assessment. It is separated into three sections - preschool, K1-K2 and K3. Children from different sections will receive game exercise with different difficulties. The number of questions for each category is fixed but the questions are randomly generated to ensure fairness of the assessment among the children.

The finished assessment results in scores in phonological awareness, processing speed, orthographic awareness, working memory and memory span. From the score, the system will determine the severity of dyslexia. They are graded from normal, mild, moderate to severe. All the results are uploaded to the database along with children's information. The marks of the assessment are used to calculate the average score. It will serve as the reference for normal performance of that educational level.

HANDWRITING RECOGNITION

The handwriting recognition is important to the games related to reading and writing. It utilizes concept from machine learning to recognize the letters. Before the recognition can successfully determine whether the letter is correct or not, it needs to train "models". The training method requires numerous of inputs of the same digit or letter to build the models. MNIST database has already stored more than 60000 of pictures of digit (0-9) [8] and NIST database has 810000 of letters pictures (a-z, A-Z) [9]. And they are suitable and prepared for implementing the algorithm to train the model. After training the model, the application will keep determining the correctness of the handwriting and also "learn" from the inputs of children's handwriting to reduce the error percentage.

(Figure 4.3.1 Samples of MNIST digit set [8])

GAME LEVEL CUSTOMIZATION

Parents are able to customize the game level at the parent panel. For example, they could decide the question in the matching game and design the pattern in the memory game. The children could play with the game level designed by their parents in game exercise mode. All the customized game levels will be stored in the database. By distributing the tasks of game design to parents, the dataset of game levels and questions will then become larger and larger.

QUESTION GENERATION

Dyslexic children have trouble in processing words and graphics. The orientation and mirroring problem always happen to them when they try to read, for example, they get confused with "p" and "d", "mood" and "doom" (Figure 4.3.1) [10]. In the writing game, the children may write a wrong answer due to this problem. The wrong answers will be collected for generating the other questions, as those wrong answers would best represent the common mistakes happens in children with dyslexia.

(Figure 4.3.2 Ten variations of the word "Teapot" as written by dyslexics [11])

CHILDREN'S ABILITY ANALYSIS

Parents are required to complete the first-time registration for the children. They need to enter the children's information, including their gender, age and education level. Then, the children need to complete the diagnostic assessment before doing any other game exercises. The difficulty of the diagnostic assessment is based on their education level. The result will be shown in the parent panel. It will display the children's ability in radar chart with five area, which are phonological awareness, processing speed, orthographic awareness, working memory and memory span (Figure 4.3.2). The scales is firstly defined by the result of the diagnostic assessment, then the measurement will be adjusted if they do the assessment again. The game exercises are specially designed for training one or more ability. For example, the matching game is for training their orthographic awareness, the logic game is for training their processing time.
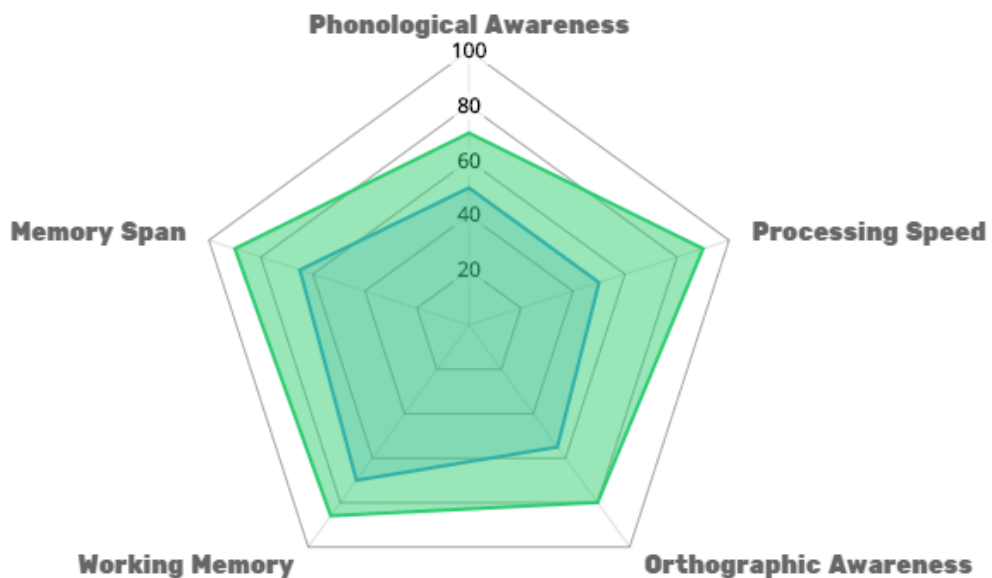
(Figure 4.3.2 A radar chart showing a child's abilities)

4.3. DELIVERABLE

The deliverables of this project are shown below.

Deliverable	Description
Phase 1 (Inception) • Detailed project plan • Project web page	Detailed project plan: It provides the project background, objectives and methodology in detail. Project web page: It provides the update of the project progress.
Phase 2 (Elaboration) • Preliminary implementation • Detailed interim report	Preliminary implementation: The user Interface, database setup, and basic function are implemented. Detailed interim report: It reports the progress and implementation in detail.
Deliverables of Phase 3 (Construction) • Finalized tested implementation • Final report	Finalized tested implementation: The application is tested and optimized. The implementation will be released and finalized. Final report: It includes all the details about the final project.

5. DIVISION OF WORK

Tasks			David Chan	Enid Lam
Research on dyslexia, previous works and feasibility			✓	✓
Project Website			✓	✓
Database design and setup			✓	✓
Prototype			✓	✓
First-time registration				✓
Diagnostic assessment			✓	
Game Exercise	phonological awareness			✓
	Processing speed		✓	
	Orthographic Awareness			✓
	working memory		✓	
	memory span			✓
Parent Panel	Game level customization		✓	✓
	Children's ability analysis	View diagnostic assessment and game exercise records		✓
		Show children's overall ability in radar chart	✓	
Background music and sound effect			✓	
Optimization and testing			✓	✓
Poster design			✓	✓
Finalization of implementation			✓	✓

6. SCHEDULE

Date	Tasks
2 October 2016*	Deliverables of Phase 1 (Inception) • Detailed project plan • Project web page
October - January	Preliminary implementation
9-13 January 2017	First presentation
22 January 2017	Deliverables of Phase 2 (Elaboration) • Preliminary implementation • Detailed interim report
February - April	Optimization and Testing
16 April 2017	Deliverables of Phase 3 (Construction) • Finalized tested implementation • Final report
18-21 April 2017	Final presentation
2 May 2017	Project exhibition

7. RISK, CHALLENGES AND MITIGATION

Risk/Challenges	Probability	Impact	Mitigation
Inaccurate and inadequate data collection	High	High	Better time management to the development. Launch the application to the public at a certain time before final presentation. Try to generate enough statistics to average performance for each educational level.
Poor experience due to too difficult or too easy game exercise	Medium	Medium	Invite more children to test the application. Strictly followed the guideline of the dyslexic document.
Inappropriate customization of the games	Medium	Low	Suggest more guidelines to control the standard of the game customization and abandon the inappropriate one if needed.
Unpredictable educational effect from the game exercise	Medium	Low	Consult dyslexic professional which determine the dyslexic standard in Hong Kong. Seek for advice and improvements to certify the application.

8. CONCLUSION

Development of DyslexHero aims to improve the situation of dyslexic children. Through interactive and interesting games, children learn and train their cognitive abilities in a fun and enjoyable way. The ultimate goal is that customization of the games adds more game levels into the application so the users will not play with duplicate and repeated contents. Their abilities' improvement can be shown as statistics. In summary, the dyslexic children benefit from the concept of crowdsourcing.

Moreover, the data of the result of games is also valuable to the dyslexia researchers. The project would also like to discover the difficulties of dyslexic children and find out a certain method to help the children to improve their cognitive ability. They can be adapt to the primary school environment more easily after playing with this application.

9. REFERENCES

[1] Siegel LS. Perspectives on dyslexia. Paediatrics & child health. 2006;11(9);591–587

[2] DHCAS [Internet] Hong Kong: Child Assessment Service Department of Health, HKSAR; [updated 2014 Jul 11; cited 2016 Sep 26]. Available from: http://www.dhcas.gov.hk/english/health_pro/files/SeriesII_Dyslexia_Eng_Text.pdf

[3] Foorman BR, Francis DJ, Shaywitz SE, Shaywitz BA, Fletcher JM. The case for early reading intervention.Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers;1997

[4] PMQ SOFTWARE. Eye games, Dyslexia (Version 1.19) [Mobile application software]. 2016. Available from: https://play.google.com/store/apps/details?id=com.pmqsoftware.mirroring

[5] 中大四子得獎 app 帶學童走出學習迷宮. Apple Daily [Internet]. 2016 Feb 28 [cited 2016 Sep 27]; Technology:[about 1 screen]. Available from: http://hk.apple.nextmedia.com/realtime/supplement/20160228/54794266

[6] Nessy Learning Limited. Dyslexia Quest. (Version 1.2) [Mobile application software]. 2014. Available from: https://itunes.apple.com/us/app/dyslexia-quest/id448166369?mt=8

[7] Mather, Nancy; Wendling, Barbara J.; Kaufman, Alan S.; Kaufman, Nadeen L. Essentials of Dyslexia Assessment and Intervention. 2011.

[8] MNIST handwritten digit, USA; [cited 2016 Sep 30]. Available from: http://yann.lecun.com/exdb/mnist/

[9] NIST Special Database, USA: National Institute of Standards and Technology; [updated 2016 Sep; cited 2016 Sep 30]. Available from: https://www.nist.gov/srd/nist-special-database-19

[10] Wilcke A, Weissfuss J, Kirsten H, Wolfram G, Boltze J, Ahnert P. The role of gene DCDC2 in German dyslexics. Annals of dyslexia. 2009; 59(1); 1-11.p

[11] TNS [Internet] Travancore National School; [updated 2014 Oct 03; cited 2016 Sep 30]. Available from: http://www.travancorenationalschool.com/what_we_do.php