Game Based Learning on Android Platform: Cognitive Remediation Therapy Games

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Abstract—**Many mental illnesses cause cognitive problems. For example, schizophrenia and other psychotic disorders cause a decline in attention, memory and problem solving skills. Cognitive remediation is intended to help people who have experienced a decline in their cognitive skills, or who were not able to fully develop their skills because of illness. Cognitive Remediation helps improve the underlying neuropsychological functions that help patients think: attention, memory, planning, organization and abstract thinking. Cognitive remediation often uses the computer to provide exercises to improve neuropsychological skills. The study have been made by the experts in this field. Based on their study, game based learning could improve the patient's cognitive skills. Cognitive Remediation Therapy Games is one of the alternative to treat the patient especially children who have cognitive problem by using gadgets because it can be used anywhere and everywhere. Play is children's nature. There are many game options that patients could play in Cognitive Remediation Therapy Games to improve their cognitive skills. This application has been developed based on the requirements that have been elicited from the Occupational Therapist.**

Index Terms—**Cognitive, neuropsychological skill, memory, games based learning.**

I. INTRODUCTION

Cognitive Remediation Therapy (CRT) is a treatment that focuses on the process rather than the content of thought and perception [1]-[4]. Presently, almost all hospitals have been using the CRT games to treat their mental illness patients. Special care need to be given in treating children having cognitive problems [5]. There are three types of CRT games. The first one is the traditional way. Therapists use real objects to treat the patients. Second, the use of computer assisted software where it can be used by one patient at a time. The third way, therapists use mobile based gadgets to treat the patients. There are many suitable games for the mental illness patients to test the ability in paying attention, language use, planning, organization, memory, perception, problem solving, speed of information processing, creativity and thinking.

Even though a traditional way is useful for patients and therapist, it is still has a few drawbacks. One is number of objects that need to be prepared prior to the therapy session. Second is the cost incurred to purchase many different objects is substantially high.

The use of computer assisted software in CRT games has

overcome the problem with the traditional approach. However, to purchase personal computers is quite costly and each personal computer can only be used by one patient at a time. Besides that, therapy session can only be done formally in the presence of therapists at a specified time.

With gadget based CRT games, patients can undergo therapy session informally without constraints of time or place.

II. RELATED WORKS

To facilitate the development of CRT games, a study has been carried out to meet the criteria of CRT. CRT is a toolkit, or a cupboard of resources for the therapist to pick what they like from, when they want to. The CRT intervention has no set length or style or, therapists can design their intervention around their personal preferences, their available resources, and the patient themselves. This is in terms of how many sessions of CRT therapists provide, how they are spaced, whether they are 'stand-alone' or mixed in with other work, how long they last and what cognitive domains therapists focus on [2].

Three existing systems have been chosen to be reviewed are Re-habilitation Games for Use at Home and Clinic, Brain Training by Mobitech and Brain Training by Tolan. The following is a brief review of those systems:

1) Re-habilitation games for use at home and clinic

Re-habilitation Games for Use at Home & Clinic is an application that has many simple and interesting games to improve cognitive skills. This application runs on a personal computer. Fig. 1 shows the main interface of Re-habilitation Games for Use at Home & Clinic.
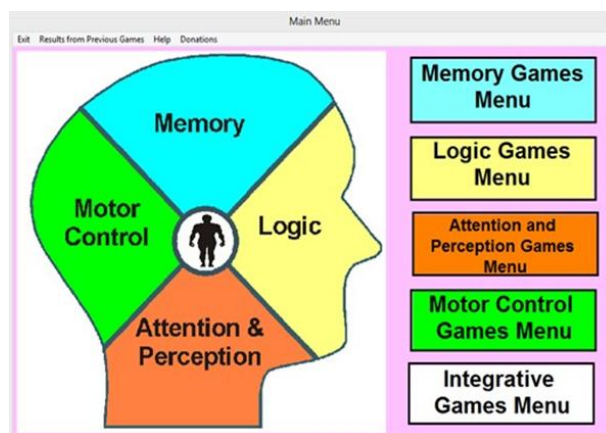

Fig. 1. Interface of re-habilitation games for use at Home & Clinic.

2) Brain training by Mobitech

Brain Training by Mobitech only has one mini game unlike

Re-habilitation Games for use at Home and Clinic. The games provided are simple games. Users just need to remember the sequence of numbers in nodes at certain time. Then, users need to connect the numbers by tapping the nodes in sequence. Before starting the game, user can choose three level of difficulties which are easy, normal or hard. At the end of the game, final score will be displayed. Users can view their ranking by tapping the "Leaderboard" button on the menu. Users can share their score on social media such as Facebook and Twitter. These two features need internet connection to perform those actions. Fig. 2 shows the main interface of Brain Training by Mobitech. This game can be downloaded from Google Play Store.

Fig. 2. Interface of brain training by Mobitech.

Fig. 3. Interface of brain training by Tolan.

3) Brain training by Tolan

This game is as simple as Brain Training by Mobitech. It has only one mini game. Users just need to remember the position of the node's colour. Then users need to tap the nodes that have same colour with the instruction given. Before starting the game, users can choose among three level of difficulties of the games which are easy, normal or hard. More colours will appear when the difficulty of the game increased. At the end of the game, final score will be displayed. Users can not share their score on social media such as Facebook and Twitter. The advantage of this game is that it has training mode and quick mode. Fig. 3 shows the main interface of Brain Training by Tolan. This game can be downloaded from Google Play Store.

Both Brain Training games by Mobitech and Tolan run on Android platform, with small interface which suit the average size of the screen of smartphones. In addition, the applications also provide interactive interfaces which are user friendly to cater for users with different backgrounds.

III. METHODOLOGY

Software development methodology is normally used in software development projects. Common used methodologies are Software Development Life Cycle (SDLC), Joint Application Development (JAD), Rapid Application Development (RAD) and many others [6]-[8]. For this project we apply Waterfall SDLC. Fig. 4 shows Waterfall model of CRT Games development. There are five phases in the development of this system based on the Waterfall model.

This section outlines the system requirements for development of the CRT Games. It covers the functional requirements and non-functional requirements.

Fig. 4. Waterfall model.

IV. SYSTEM REQUIREMENT

This section outlines the system requirements for development of the CRT Games. It covers the functional requirements and non-functional requirements.
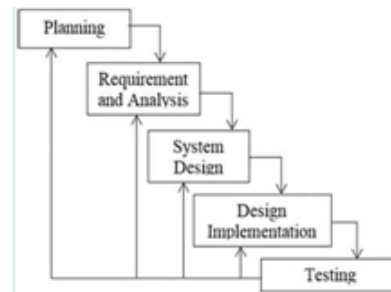
A. Functional Requirements

There are three functional requirement for CRT Games which are:

1) Answer The Question: The user will be able to submit their answer to the system.

2) Update Score: When the user answers the question, the data will be processed by the system. It will update the score at the end of the game.

3) Retrieve Answer: System will retrieve the answer from user. It validates whether the answer given by the user is correct or not.

B. Non-functional Requirements

The non-functional requirements of CRT Games are *Performance, Correctness and Testability.*

V. SYSTEM ANALYSIS

The purpose of analysis is to identify the needs of the system and translate it into diagrams. The analysis process is described through the use of use case diagram, activity diagram, sequence diagram, collaboration diagram, class diagram and CRUD matrix [8], [9].
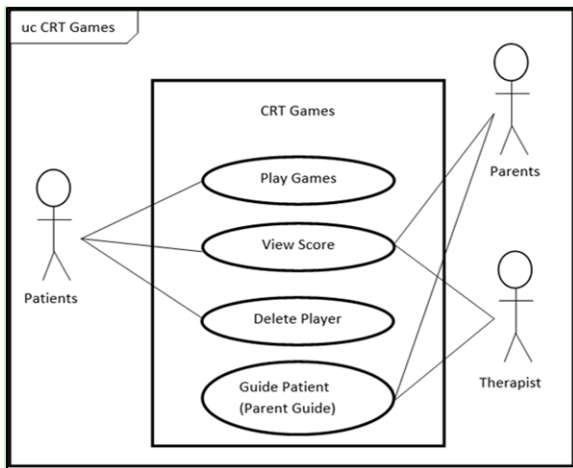

Fig. 5. Use case diagram of C.

Use case diagram is used to visualize the real situation and it shows how the elements of the system interact with the surrounding components. Use case diagram also visualize the activities that will be done by the actor of the system. Fig. 5 shows the use case diagram for CRT Games. There are three actors and four use cases in the system. The role of patients are 'play the game's, 'view score' and 'delete player'. Both parent and therapist have the same role in this system which are 'view patient's score' and 'guide the patients'.

1) Insert name

In Insert Name feature, patients can insert their name before playing the game for the first time.

2) Play game

In Play Game feature, patients can choose any games they like. There are three types of games provided in CRT Games which are IQ Test Games, Memory Game and Eight Puzzle. The score will be displayed after they complete their games.

3) View score

In View Score feature, three actors are involved which are patient, parent and therapist. They can see the achievement of the patients at the end of the games. For IQ Test Games, it will display the correct answers, wrong answers and accuracy. The accuracy will be displayed in percentage (%). For Memory Games, it will display how many tries the patients do to find the same pictures. For the Eight Puzzle Game, it will display how many moves the patients do to solve the puzzle.

4) Delete player

In Delete Player feature, patients can delete their player name if they want to. The player name will be cleared.

5) Guide patient

In Guide Patient features, this system provides the instruction to the parents and the therapists. It explains what they should do during the game play. It also displays information about cognitive remediation.

VI. SYSTEM IMPLEMENTATION

Android platform has been chosen to implement this CRT games. Android is widely used on mobile phones as compared to other platform such as IOS and Windows [10], [11].

A. Menu Hierarchy

A system menu hierarchy is a top-down modular design tool, constructed of squares representing the different modules in the system, and lines that connect them. The lines represent the connection and or ownership between activities and sub-activities as they are used in organization charts. Fig. 6 shows the system menu hierarchy of CRT Games.
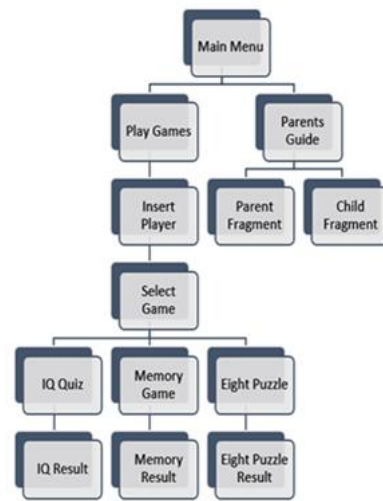

Fig. 6. Menu hierarchy of CRT games.

B. Sample Interface

This part explains each of the interfaces in CRT Games:

1) Splash screen

After the user tap the CRT Games icon on Android home screen, the splash screen will be displayed. Various splash screen techniques can be found in [12]. Progress bar represents as a visual indicator of progress.

Fig. 7. Splash Screen.

2) Main menu

Fig. 8 shows the main menu. Four options have been provided which are Play, Parents Guide, Music Options and Quit buttons. User can choose whether they want to turn on or off the music. The background music is played in a loop when the application is running. If the users want to exit the application, they can tap the Quit button at the bottom of the screen. It will return to the Android home screen.
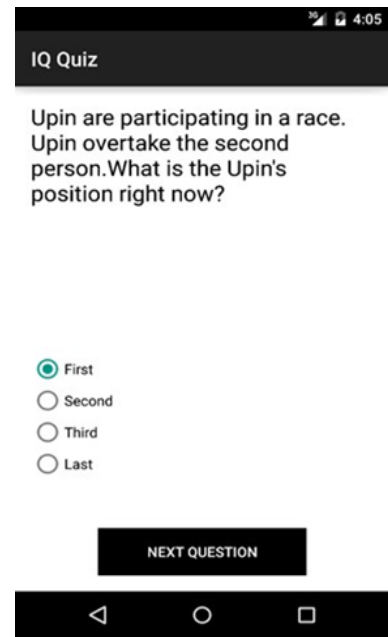

Fig. 8. Main menu.

Fig. 9. Select game.

Fig. 10. IQ Quiz.

3) Select game

Fig. 9 shows the select game screen. There are three games provided in this CRT Games which are IQ Quiz, Memory Games and Eight Puzzle. The following figures explain each of the games.

4) IQ quiz

In Fig. 10, users need to answer the question. The term "IQ" is an abbreviation for the term "intelligence quotient". There are twenty questions in this game. These questions are intended to assess a variety of mental abilities and skills, and therefore cover a wide range of different types of intelligence.

5) IQ Quiz result

final score. The final score is set in percentage. From this screen, the user can choose whether they want to restart the IQ Quiz or return to the main menu.

6) Memory game

Screen in Fig. 12 will be displayed when the user tap the Memory Game in the select game menu. In this game, the user needs to find two same pictures for each pair.

7) Level of memory games

When the user tap the "New Game", the spinner (drop down menu) will be displayed. User can choose the level they want as shown in Fig. 13. The higher the level, the harder the game. The total number of multiplication must be an even number because all the picture are paired.
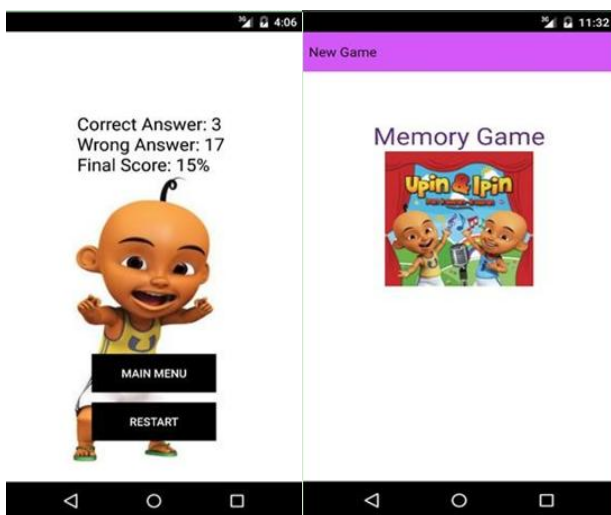

Fig. 11. IQ Quiz result.

Fig. 12. Memory game.

Fig. 11 will be displayed after the user has completed the IQ Quiz. It displays the correct answers, wrong answers and

Fig. 13. Level of memory game.

Fig. 14. Memory game demo (part 1).

8) Memory game demo (part 1)

Screen in Fig. 14 will be displayed after the user select the level from Fig. 13. It will display the number of tries to find the cards and the box that contain the cards.

9) Memory game demo (part 2)

Fig. 15 shows the number of tries increased every time the user tap the pair of question mark picture in the box. In this game, users need to find two same pictures for each pair. They need to find all the pairs. The lesser the number of tries, the better the memory of users brain. They can repeat this game to improve their memories. If they need more challenging game, they can try level 4×9 at the bottom of spinner.

10) Upin eight puzzle tutorial

Fig. 16 will be displayed when the user tap the Eight game button. Users need to move the tiles to solve the puzzle to get the Upin picture. After the user understand the tutorial, they can click the "Play" button at the bottom of the screen to play the game.

Fig. 15. Upin eight puzzle tutorial.
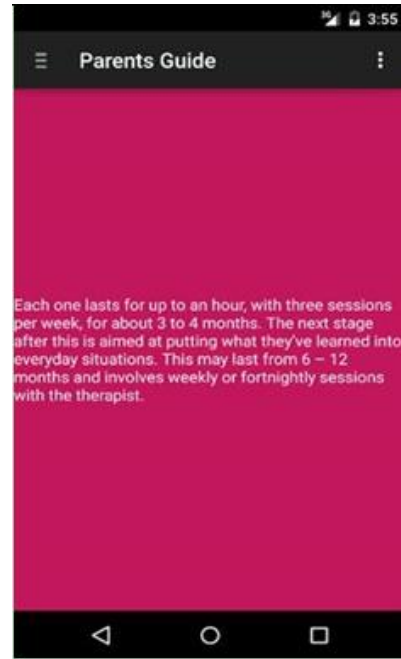

Fig. 16. Upin eight puzzle.

Fig. 17. Parents guide.

11) Upin eight puzzle

Fig. 17 shows the interface of Upin Eight Puzzle. Users need to move the tiles to solve the puzzle. The tile numbers will guide them of the movements. At the beginning of the games, the moves are set to 0 and the feedback is set to "Tap the tile to play!"

12) Parents guide

When the user tap the Parents Guide button at the home screen, screen as in Fig. 18 will be displayed. This screen only displays the information about CRT and parents guide. It uses navigation drawer. The background colors are different for each information.

13) Parents guide navigation drawer

To open the navigation drawer, user just need to tap the icon at the top-left of the screen. There are twenty nine information in this parents guide. They can scroll down to find the topics that they want and tap it to read the topics. Fig. 19 shows the navigation drawer of parents guide.

Fig. 18. Parents guide navigation drawer.

VII. DISCUSSION

CRT Games has been developed to help patients especially children who suffer cognitive problems. CRT Games help them to increase their thinking skills especially in attention, language use, planning, organization, memory, perception, problem solving, speed of information processing, creativity and thinking. Using CRT games, therapists will act as a facilitator in choosing right games for the therapy. Patients will work on their own for the rest of the session or they can do it at home. Besides that, parents and therapist could use parents guide module in this CRT Games to gain more knowledge about cognitive remediation therapy and what

they should do to help their children.

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Mohd Pouzi Hamzah was born in 1962 in Terengganu. In 1986, he was appointed as a tutor at Universiti Kebangsaan Malaysia (UKM). He continued to further his study in 1986 at University of Glasgow and obtained his master in applied science (computer science) in 1987. In 2006, he obtained his PhD in information retrievals from Universiti Kebangsaan Malaysia. He left UKM in 1996 to join management team of Terengganu Advanced Technical Institute in a call to establish skilled Diploma in Industrial Automation recognized by government of Switzerland. He then joined Universiti Putra Malaysia (Branch Terengganu) in late 1998 as a lecturer. He holds several administrative positions namely coordinator of Computer Centre, head of Computer Science Department, deputy dean, director of Computer Center and director of Academic Development Center. His main research interests are information retrievals involving forensic data, speech retrievals, question-answer systems, deep knowledge retrievals and game based learning.