

# Cognitive Remediation Game of Selecting Tools Independently for Mentally Disordered Patients

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## Abstract

*Cognitive impairment is one of the negative effects of schizophrenia. To treat this, cognitive remediation could serve as an option to improve the cognitive performance of the sufferers. In this line, Doctor Herdaetha developed a computer-based game module to assist psychiatrists in performing cognitive remediation treatment during the recovery period of patients. However, patients could not utilize the game module without the assistance of psychiatrists, making it ineffective and inefficient. Given these considerations, a mobile Selecting Tool game was created as an independent cognitive remediation medium for schizophrenia patients during their recovery period. The game was created using a waterfall model and involved multiple review and discussion sessions with psychiatrists. The results revealed that the game was well-functioning and could be played independently.*

**Keywords:** *Android; Cognitive; Game; Independent; Remediation; Schizophrenia*

## 1. Introduction

Schizophrenia is a chronic mental illness characterized by several symptoms, including positive, negative, and cognitive symptoms. Some manifestations of symptoms are hallucinations, delusions, restlessness, and strange behavior [1]. Schizophrenia affects 1–1.5 percent of the population and is most common in productive age groups, specifically 25–35 years and 17–24 years [2]. As a result of impaired cognitive function, sufferers have difficulties in motivation and cooperation, as well as in their way of thinking, a resulting in irregular thought patterns [3]. Inevitably, it will impact the everyday lives of the sufferers and the people surrounding them, such as family members or relatives. In addition, schizophrenia has relapsed, necessitating long-term intense therapy and evaluation [4]. Schizophrenia patients require treatment to recover, whether through the use of medications (pharmacotherapy) or psychosocial and comparable measures (non-pharmacotherapy) [5].

Rehabilitation is a type of non-pharmacological treatment that can be utilized to aid with recovery. Rehabilitation works to assist sufferers in restoring their roles in their surrounding environment, such as family and society, allowing them to maintain their previous standard of living. In this case, cognitive remediation is one type of remediation that can be employed [6].

Cognitive remediation is a technique for improving the cognitive abilities of sufferers, helping them to recover functionally, both in terms of productivity and in their daily lives [7]. This method aids in the restoration of the sufferers' problem-solving abilities, memory, and focus, making it especially beneficial for those in the recovery stage. If the healing stage is completed successfully, the sufferers can subsequently engage in social training and other activities to reintegrate into

society. Cognitive remediation can be accomplished by a direct training system that restores cognitive function under the supervision of psychiatric medical personnel. The methodologies utilized in remediation also vary and include distinct interventions; each approach focuses on components of problem resolution, management, thinking, and social views. Each remediation training employs repetition approaches and varied methodologies, including working on questions, grouping objects, discussing, and also using electronic programs [5]. Cognitive remediation is often repeated by a field expert in 36–40 sessions, each lasting one hour [8]. This remediation is administered in a rehabilitation facility or at the patients' home.

The rapid advancement of technology enables innovation in cognitive remediation. One example is the use of virtual reality (VR) for simulation [9] or gaming [10]. However, VR equipment is expensive, and its usage preparation takes time. To address this, Doctor Herdaetha [5] developed a cognitive remediation module that includes a number of simple computer-based games. This module has characteristics comparable to non-computer ways of addressing patients' cognitive impairment. Aside from that, the module is easier to prepare than using VR.

To use this module, patients must play it on a computer under the supervision of psychiatric medical personnel and in a clinic. It remains one of the module's weaknesses. Sufferers cannot utilize the module unless they have a computer and access to medical personnel. Those suffering from this illness must visit a clinic. In fact, the majority of sufferers spend their time at home with their families. Indeed, it would be preferable if the patients could carry out the therapy independently at home, with regular monitoring from a psychiatrist when they visit the clinic. Therefore, a game that sufferers can play independently is necessary.

In this case, smartphone devices emerge as an excellent option for a cognitive remediation gaming platform because they are widely owned by individuals, including sufferers and their families. Sufferers can utilize the module at home on a regular basis utilizing their smartphones. Besides, the preparation is short because the sufferers only need to play it.

The cognitive remediation module created by Doctor Herdaethas has numerous games [5]. However, this study focuses on only one game, Selecting Tools. In this game, patients must organize tools according to their function. This game consists of four questions, each with six answer choices. A question can have more than one valid answer. Before proceeding to the following question, the players must select all of the correct answers.

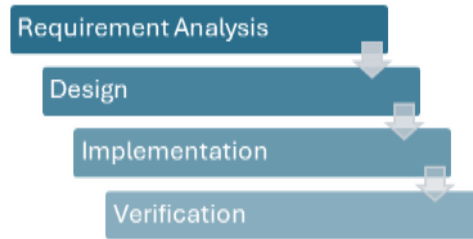
Therefore, this research aims to create a mobile game called Selecting Tools based on the game module created by Doctor Herdaetha. This smartphone game is aimed at schizophrenia patients in recovery and is intended to be employed as a medium for independent cognitive remediation. It should be mentioned that the term "independently" in this study refers to the ability to play the game without the direct presence of a psychiatrist. However, before determining who can play the game, patients ought to seek direction or advice from a psychiatrist.

## 2. Method

In this research, the game was developed by following the software development life cycle (SDLC) with the waterfall model [11]. This research underwent four stages, as displayed in Figure 1.

The requirement analysis stage was carried out by having discussions with psychiatric medical personnel and a thorough assessment of existing research [5] to determine what requirements the Selecting Tools game must meet. The design stage was then completed by designing the gameplay, followed by the interface. During the implementation stage,

the game was developed with Unity as a game editor, Visual Studio as a code editor for game programming, and Adobe Illustrator as an asset creation tool. Finally, the verification phase employed black-box testing to determine whether the game could operate as planned.



**Figure 1. Research Method**

### 3. Results and Discussion

#### 3.1. List of Requirements

Following discussions with psychiatric medical personnel and an evaluation of the game module by Doctor Herdaetha [5], several improvements were required to make the game be played independently. To begin with, in prior games, sufferers could be asked questions and given directions directly. However, the accompanying psychiatrist is still responsible for evaluating whether the response is correct or incorrect. Hence, the game being built must be capable of automatically providing answer scores, allowing it to be played independently. The score is also expected to motivate sufferers to play.

**Table 1. List of Game Requirements**

Code	Requirement
R01	A game of Selecting Tools
R02	The game must display questions or instructions.
R03	The game must provide feedback to the user on whether the selected answer is correct or incorrect.
R04	The game must count and display the number of correct answers.
R05	The game must count and display the number of incorrect answers.
R06	The game must calculate and display the player's score.
R07	The games must have a timer.
R08	The game must accept player name input and then display it.
R09	The game must display the game time.
R10	The game must have a page to view the game results.
R11	The game must have three levels with different levels of difficulty.
R12	The game must randomize the choice of tool and the location of the answer every time it changes to a question.
R13	The game must increase the number of correct answer choices by one each time the player moves the question.
R14	The game must differentiate the order of questions from previous user games but still adjust the level.
R15	The game must have a leaderboard feature sorted by the number of errors.
R16	The game must have a guide on how to play.
R17	The game must send results to the database.

Additionally, when the game is played again, the questions remain the same. As a result, there is no mechanism to boost the game's difficulty level, even though this

method is vital to enhancing sufferers' cognitive capacity. Hence, the new game must include a level system that gradually increases in difficulty. Moreover, because there may be only a limited number of questions, the game must have a system for changing the sequence of the questions as well as the location of the correct and incorrect answers, preventing patients from answering by memorizing the correct answers.

Furthermore, in order for psychiatrists to monitor patients' development, a leaderboard mechanism displaying the game results on a regular basis is required. Furthermore, because the growth of cognitive capacities is linked not only to the capacity to answer questions but also to the speed with which they are answered, a timer should be included. Like the score, the timer aims to boost sufferers' motivation to play.

These numerous changes subsequently resulted in a list of game requirements, as presented in Table 1.

### 3.2. Implementation

Figure 2 depicts the level selection page. Following requirement R11, this game offers three levels, each with increasing difficulty. Initially, only level 1 can be selected. If the player completes level 1, he can only proceed to level 2. The same thing goes for opening level 3. It aims to prevent players from working on levels inappropriate for their cognitive abilities at that time.



**Figure 2. Level Selection Display**

Figure 3 illustrates an example of a problem at level 1. At this level, following requirement R01, players are asked to select all tools meeting the question criteria (for example, gardening tools in Figure 3). There may be more than one valid answer to one question. Each level contains four questions as displayed at the top of the screen (requirement R02). When the players replay the level, the number of questions remain the same. However, the question will be different but still conform to the level difficulty (requirement R14). In addition, the tool and its position will be randomized (requirement R12). As the number of questions increases, so does the number of the answer choices. For example, question number one has three answer options, whereas question number four has six (requirement R13). Additionally, as the level starts, the timer also starts (requirement R07). Players can see how much time has passed by looking at the top left of the screen (requirement R09). For level 2 (Figure 4), the difficulty of the questions is enhanced by requiring players to select both the appropriate tool and the appropriate color. Finally, at level 3 (Figure 5), players are also required to select appropriate flat shape.



Figure 3. Level 1 Display



Figure 4. Level 2 Display



Figure 5. Level 3 Display

To answer the question, players need to select a tool that meets the criteria. Following requirement R03, if the answer is correct, the game will display a green box indicator next to the player's choice and increase the player's score by 10 points, as seen in Figure 6. In contrast, if the player's answer is incorrect, the game will display a red box indicator (Figure 7), but the player's score will remain unchanged. To avoid demotivating players, it was decided not to assign a -1 score for incorrect answers.



Figure 6. Correct Answer Display



Figure 7. Incorrect Answer Display

If all of the questions have been answered, the timer will end and players can view the results of their efforts (requirement R10), as demonstrated in Figure 8. In this page, players can see the number of correct answers (requirement R04), the number of wrong answers (requirement R05), their final score (requirement R06), and their name (requirement R08). These data are automatically send to the database (requirement R17) for storing purpose. Following that, players can compare their current results to their past results on the leaderboard page (Figure 9). The leaderboard page are created following requirement R15. Psychiatrists can utilize this leaderboard page to monitor players' cognitive development.



Figure 8. Game Result Page



PERINGKAT	NAMA	SKOR	BENAR	SALAH	WAKTU
1	Muhammad Farid Yoda	100	10	0	8
2	Akhar Bilal Khair	100	10	1	16
3	Alifah Niya Mafiah	100	10	2	12
4	Yusuf Ammar Abigali	100	10	3	16
5	Altama Abbiyya Abbas	100	10	3	21
6	Hokta Zahvatasakomah	100	10	4	16
7	SA Nuraisyah	100	10	5	58
8	Aydan Almahalin	100	10	6	22
9	Amrad Alzam Amadi	100	10	6	111

Figure 9. Leaderboard Page

Finally, if the players do not know how to play the game, they can access the instruction page, as demonstrated in Figure 10. This page is created following requirement R16.



Figure 10. Instruction Page

### 3.3. Verification

Verification was performed to determine whether the game can run and function effectively as intended. It utilized the black-box testing method, which included 12 test scenarios. It involved testing two distinct smartphones to discover whether the differences may cause issues in the game. Testing is considered successful if all verification steps in each scenario function as intended. Meanwhile, the test is considered to have failed if one or more failures occur while carrying out the scenario. Table 2 exhibits the test results.

Table 2. Test Results

No.	Test Scenario	Expected Result	Obtained Result	Status
1	Opening the game	The Menu page is successfully displayed after opening the game.	The Menu page was successfully displayed after opening the game.	Success
2	Pressing the Play button	The Select Level page is successfully displayed after pressing the Play button on the Menu page.	The Select Level page was successfully displayed after pressing the Play button on the Menu page.	Success
3	Pressing the Level button when it opens	The Loading Screen and Level Preparation page are successfully displayed, respectively.	The Loading Screen and Level Preparation page were successfully displayed, respectively.	Success
4	Pressing the Level button while the button is locked	The game stays on the Select Level page.	The game stayed on the Select Level page.	Success
5	Checking the timer	The timer runs successfully.	The timer ran successfully.	Success
6	Pressing the correct answer button, and other correct answers remain	The game successfully displays a green indicator box, and the score increases by 10 while remaining on the same question.	The game successfully displayed a green indicator box, and the score increased by 10 while remaining on the same question.	Success
7	Pressing the correct answer button, no other correct answers are left, but the	The game successfully displays a green indicator box, the score increases by 10, the next question is displayed, and the choice of tools will be randomized.	The game successfully displayed a green indicator box, the score increased by 10, the next question was displayed, and the choice of tools was randomized.	Success

No.	Test Scenario	Expected Result	Obtained Result	Status
8	next question remains. When pressing the correct answer button, there are no remaining correct answers or other questions.	The game successfully displays the green indicator box, the score increases by 10, and the name input page is displayed.	The game successfully displayed the green indicator box, the score increased by 10, and the name input page was displayed.	Success
9	Pressing the wrong answer button	The game successfully brings up the red indicator box and remains on the same question.	The game successfully brought up the red indicator box and remained on the same question.	Success
10	Randomizing the questions and the location of the answer options	The questions and tools to be selected are successfully randomized.	The questions and tools to be selected were successfully randomized.	Success
11	Displaying results	The user's game results are successfully sent to the database, and then the Loading Screen and Menu pages are successfully displayed in sequence, and the Next Level button is successfully opened.	The user's game results were successfully sent to the database, and then the Loading Screen and Menu pages were successfully displayed in sequence, and the Next Level button was successfully opened.	Success
12	Pressing the Leaderboard button when an internet connection is available	The Leaderboard page, along with level 1 game data, is successfully displayed after the Leaderboard button on the Menu page is pressed.	The Leaderboard page, along with level 1 game data, was successfully displayed after the Leaderboard button on the Menu page was pressed.	Success

Table 2 displays the test results, demonstrating that all test scenarios are successful when the obtained results match the expected ones. Therefore, the Selecting Tools game appeared to be operating and functioning properly.

### 3.3. Research Limitations

Even though the game design has been demonstrated to work as intended, this study is not without limitations. To begin with, while the leaderboard function has enabled psychiatrists to track the progress of patients, this data feature was only accessible through the patient's account. It implies that psychiatrists can only watch patients by borrowing their smartphones when they visit the clinic. Based on this limitation, a new



development is required to separate the sufferers' reports from the psychiatrist's account. Later, psychiatrists can access their accounts directly, without having to borrow the patients' smartphones, to view the leaderboard of all patients under their care.

Furthermore, the leaderboard was still ordered based on best performance but not by playing date. Sorting by date would make it easy for both patients and psychiatrists to identify progress. Besides, the top performance listed on the leaderboard was determined by the amount of incorrect answers the patient provided. In the future, a leaderboard sequence must be developed by considering the amount of time it takes to work.

#### 4. Conclusion

This study was successful in producing a cognitive remediation mobile game, *Selecting Tools for People Living with Schizophrenia at the Recovery Stage*, based on Doctor Herdaetha's module [5], which could be played independently. The game has also been tested, and the findings revealed that it functioned as planned. However, development, particularly on the mental side, still provided numerous potential to improve this game. The objective is that in the future, this game will be able to assist psychiatrists and patients undergoing cognitive remediation during recovery.

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