

# Digital Game as A Media to Increase Cognitive Intelligence of 13-18 Years Old Teenagers

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**Abstract** - Nowadays, Cognitive Intelligence plays an essential role especially on making decisions. The growth of digital media makes public thinks that video games are addictive. They think that video games are addictive and damaging. Games are design to refresh, challenge and help people to train their problem solving. In this research, the researcher explored the cognitive development of teenagers aged 13-18 with a puzzle-based digital game. Participants were 15 students studying in junior and senior high school. Participants were given three tests: pre-test and post-test by IQ test and a Game Engagement Questionnaire (GEQ) to explore the game's engagement from the participants' perspective. The average of Pre-Test is 113.2, while the Post-Test is 118.33. This Show that after playing the games it increases the IQ of the students. The researcher also discovered that many factors could influence the outcome of participant IQ. The GEQ shows that the participants agreed that some of the puzzle-based game might be a good or bad influence on them.

**Keywords:** Cognitive Intelligence; Digital Games; Formal Operational Game-based Learning; Jean Piaget's Theory

## I. INTRODUCTION

Cognitive intelligence plays an essential role in making decisions [1]. In decision making, someone should understand and process the information they received. By using hypothetical thinking, the decision made by someone will become a reasonable one [2]. Based on Piaget's theory, there are four stages in cognitive development: sensory-motor, pre-operational, concrete, and formal-operational [3]. Digital media has been overgrown throughout the

years. It has led to public concerns that video games are possibly addictive [4]. Online video games have made the public think that the game is addictive and damaging. Several studies research the harmful effects of video games, especially online games [5], [6]. Games are made to refresh and challenge us to solve problems. We can find positive things from games that can increase cognitive development by solving a problem in a game [7]. In this research, we want to connect a non-serious game and cognitive skill development to determine whether these two things have a close relationship [8].

There are many methods to increase cognitive intelligence, and one of the methods is by playing games. With proper development, games can be fun and educational simultaneously, which will affect someone's cognition [9]. In the era of technology, the game's outcome is one of the things greatly influenced by technology. Combined with the technology, these fun elements of a game can be explored more and make the game more immersive to build a more motivative environment for learning [10]. Technology can open more possibilities for game design, and it is also more possible to reach everyone of all ages. [11] Digital games are often used to stimulate development and increase cognitive intelligence in early childhood because they have already proved to be an efficient tool to help positively impact cognitive development [12].

In this study, we tried to prove that digital games can be used as a tool to increase the cognitive intelligence of someone between 13 and 18 years old [13]. Based on Piaget's theory, this age range is in a formal-operational stage, in which the main characteristics are hypothetical, abstract, deductive, inductive, logical, and probability [14]. Previous research studies have proved that digital game is an

effective and efficient tool to increase cognitive intelligence in early childhood or as an effective tool in game-based learning for learning one or more topics [15][16][17]. This study aimed to examine the effects of digital games on hypothetical, abstract, deductive, inductive, logical, and probability thinking.

In this research, there are four sections. The first section explains the introduction of the research and previous research that has been conducted. Section 2 discusses the research methodology in this study. Section 3 will present the result and discussion of this study. The last section will be conclusion that conclude this study and the limitations of the work.

## II. METHODS

Before the test was done, the researcher had to determine the participants. In this research, the participants are teenagers ranging from 13 to 18 years old. The reason why we chose these ranges of age is that they are in the formal operational stage of cognitive development. For the treatment in this research, the researchers used a mobile game called “Tiny Room,” a story-puzzle game at each level. The difficulty of the puzzles varies and gets more complicated as the player goes to the next chapter because the steps to complete the chapter are also increased [18]. The game has a storyline that supports the player in solving the puzzle. It will trigger the brain to work harder to solve the puzzles and force the player to think logically and hypothetically, enhancing their problem-solving ability [19].

At the beginning of the game, players are presented with a prologue, where players are introduced to how to play the game (controls, buttons, etc.). However, even when the players are still in the prologue scene, the game has already prepared some puzzles for the players to solve. Moreover, after finishing the puzzle in the prologue, the player will advance to chapter one, where the real game begins. Figure 1 is an example of the Puzzle Prologue.



Figure 1. Puzzle Prologue

The puzzle in this game focuses on how to get into another room and receive things essential to the game’s storyline. Players can interact with objects in this game to find valuable tools to open another room. For example, instruments are usually placed in a place players can see in real life. Players must also crack code to enter another room or open an object to retrieve the tools. Figure 2 and Figure 3 are examples of tools and puzzles that need to be solved by the players.



Figure 2. Case 1



Figure 3. Case 2

This research applied the one-group pretest-posttest design, a type of experiment where the outcome is measured twice, once before and once after a group of participants are exposed to a specific treatment. These designs are widely used to compare groups or measure change resulting from experimental treatments [20]. First, the result of the pre-test and post-test will be reached. Then, after the participant does the post-test, the participant will be directed to fill out the Game Engagement Questionnaire (GEQ), which is used to assess the game engagement in video game playing [21] [22]. Table I shows the question used for GEQ.

Table I. Game Engagement Questionnaire (GEQ) items

1	I lose track of time
2	Things seem to happen automatically
3	If someone talks to me, I don’t hear them
4	Time seems to kind of standstill or stop
5	I feel spaced out
6	I don’t answer when someone talks to me
7	I can’t tell that I’m getting tired
8	Playing seems automatic
9	My thoughts go fast
10	I lose track of where I am
11	I play without thinking about how to play
12	Playing makes me feel calm
13	I play longer than I meant to
14	I really get into the game
15	I feel like I just can’t stop playing

## III. RESULTS AND DISCUSSION

There were 15 participants of age 13-18 years old who researchers randomly picked to complete this experiment. After asking about their availability to participate in this experiment, we first instructed them to take an IQ test as a pre-test. The results are shown in Table 2 in the column “Pre-test,” with an average of 113.2. The next day after taking this pre-test, we asked them to do the

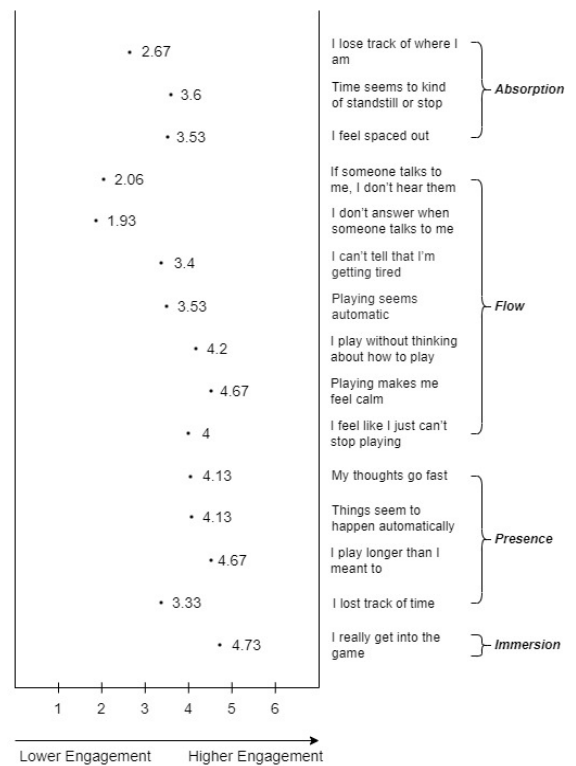
primary treatment of the experiment, which was playing the game “Tiny Room” until they finished chapter 1. Then right after they spent playing, we instructed them to take another IQ test as a post-test, which the result can be seen in the column “Post-test” of table 2. Here can be seen after the treatment was done, their average IQ was 118.33. It shows a slight increase compared to before the treatment, in which the results show that their average IQ was 113.2. The detailed information of the test result is shown in the Table II below.

**Table II.** The result of the Pre-Test and Post-Test

No	Pre-test	Post-test
1	114	111
2	132	145
3	142	147
4	106	124
5	112	122
6	128	131
7	111	117
8	132	136
9	108	131
10	106	120
11	99	96
12	98	92
13	109	116
14	97	80
15	104	107
<b>AVG</b>	<b>113.2</b>	<b>118.33</b>

From Table II, 11 out of 15 participants improved their IQ test results after the treatment was done compared to before, while the other 4 participants had a slight drop in their results. It concludes that most participants developed cognitive intelligence as the IQ test is a tool to measure human intelligence.[23] The Tiny Room game focuses more on memory, attention, logic, and reasoning. Therefore, throughout the game, the brain is stimulated to process new information in learning how to examine the puzzle and construct the steps needed to solve the puzzle. We believe this is why their IQ test result went up, as it gives them a similar kind of experience when trying to solve the IQ test question [24]. On the other hand, 4 participants had a drop in their results on the IQ test after the treatment was done. Motivation in learning plays an important part in the eagerness to seek and process new information, such as reasoning and decision-making. [25] We assume that they may have experienced mental and cognitive fatigue due to brain training that is too difficult for them, resulting in a slight drop in their score. [26][27].

After the whole experiment was carried out, participants were given a GEQ form we had prepared before and asked for the last time to answer them. The result of this GEQ form is presented in Figure 4.



**Figure 4.** GEQ Result

From the Game Engagement Questionnaire (GEQ) results, we divided the engagement into four types: Absorption, Flow, Presence, and Immersion. First, In the absorption section, the game has positive results in the absorption of the game’s content[28]. The participant agreed that sometimes they feel that the time is standing still and sometimes felt spaced out while playing the game. In the next section, which is flow, participants tend to disagree with the first and second statements that they did not answer when someone talked to them while playing, but participants agreed that playing the game could make them feel calm. Even though the game storyline is science-fiction, the game style and approach to solving the puzzle are related to everyday life, making the participant feel familiar and, to extend, calm [29].

In the presence field, the average of the participants agreed that when playing this game, they had fast thoughts and claimed to finish this puzzle-based game automatically. The game applies the schema concept that engages participants in learning through the game without cognitive load that will cause mental fatigue.[30] Participants also agreed that they played longer than they meant to because, for a puzzle game, we cannot estimate the time we spent finishing some puzzle. Also, the experience of completing the challenges in this puzzle game might be fun and enhance their motivation, so they decided to continue playing the game [31]. This game also provides hints to help the participants feel stuck to prevent them from feeling frustrated when solving the puzzle, which automatically improves the game’s satisfaction. However, if not used correctly, it harms players who rely too much on the hint [28].

## IV. CONCLUSION

From this experiment we held, we would like to know whether playing games could increase someone's cognitive skills, as other previous research showed. We picked 15 random teenagers aged 13-18 years old and asked them to participate in several procedures: pre-test, playing games, post-test, and finally taking a GEQ form. Although the main interest in this research is looking at cognitive improvement, we also want to know if this kind of puzzle-based game is interesting enough for kids nowadays compared to other online games that are more popular. That is why we decided to add a GEQ to the research. This GEQ result concluded that most participants agree that the game is engaging enough for teenagers.

The result of the IQ test showed that most participants had an increase in their cognitive ability. For information, the pre-test was given one or couple of days before the treatment was done, while the post-test was done immediately after the participants had finished playing the game. We did this to anticipate the participants being exhausted when taking the post-test.

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