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HOW EDUCATIONAL GAME CAN IMPROVE THE PLAYER'S METACOGNITIVE SKILLS

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Abstract

Gamification is a basic concept of game mechanics which apply into non-game environments. Games as joyful playing is widely used in daily life, including in education. Game was assembled by fundamental elements which regulate not only how it was played but also what is the final goal of their mechanics. When a game is operated; the player's cognitive, affective, and psychomotor aspects are involved. Involving three domains was integrated into an environment which stimulated the cognitive dimension. By using more complicated mechanics it will cultivate the metacognitive of players. This paper investigated how educational games can improve the player's metacognitive skill. Investigating was done by theoretically analysing. The invention of this work is that educational games can improve a player's metacognitive which consist of several stages, namely goal setting and planning, selection and strategy selection, monitoring and evaluation, organization and self regulation, and attention. So, learning the effort of clearing stages of Cat Mario would encourage students to memorize knowledge and pattern of question so they could clear the question and learn new stuff through metacognitive skills that are obtained by their gaming experiences.

Keywords: *gamification; game, education; learning; cognitive metacognitive.*

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1. INTRODUCTION

To make a good game that has a lot of players and a good community fanbase to play the game, developers need to brainwash new things that were never introduced to the gaming community and that idea would blow out and make new culture to gaming, or mimic other games that have been trending this day. There are two general types of games, namely, (1) free to play games, and (2) non-free games. The type of free to play games usually make players must pay to win so they could be relevant at their game. The game could be played for free, not paying anything, but usually make it harder to be relevant. Then the type of non-free games, needed to pay first to play the game. Usually after the game is purchased, the player wouldn't need to pay again to make the player relevant at the game. After the game is purchased, there are still items or unique downloadable content (dlc) that could be bought, that could be gotten if players that have not bought the item play the game more time than the player that paid one. These types of games, non-free games, are usually needed for improving metacognitive skills.

There is a lot of research and proof that gaming could improve learning, such as the effect of learning with games was positive in 52 percent of studies examined. In meta-analysis it was shown that simulation games players have 20 percent more confidence in learning their information.

There are differences between cognitive and metacognitive. Cognitive is more about thinking, metacognitive is already known what task, strategy and actor that could do to think what needs to be changed or kept. Some processes of metacognitive, might not always be noticeable. The best time to arrange metacognitive skills is at the age of under 10 or at elementary schools.

Metacognitive is a process of understanding and pattern behind them. Metacognitive skills allow us to organize or strategize what next needed to do for understanding and clearing the task. There are three

metacognitive skills that usually would use all of them, planning, monitoring, and evaluation.

Metacognitive skills are important because they help individuals understand their learning processes and how they learn effectively. Further, metacognitive skills help people learn information quickly and retain information for their educational or professional development. This is because they understand the methods, they need to use to educate themselves and overcome potential learning barriers. Metacognitive skills asking students to create a plan for what they would do to finish their task or achievement. Let's say that students must run a 5 kilometres (km) marathon. From the start time of a marathon, there is no way that students would run with their top speed and stay at their top speed till the end of marathon, no way a mere human could run a 5 km through with their average top speed 10-13 km/hour, even with that, they could finish a marathon quicker than the other. So, to clear the marathon faster, students need to strategies their way at the marathon, such as maintain their speed limit run that could run through till the end of marathon, timing of a little walk rest from top speed so they could take a breath to make their run again.

The concept of metacognition has caused a change in the way we understand learning, mainly by shifting attention from the cognitive to metacognitive processes, and from the application of algorithms to "thinking about thinking", particularly to the importance of the planning, monitoring, control, and reflective systems that regulate one's cognitive activities [1]. The implementation of the "metacognitive engine" is essential in performing cognitive tasks including those in mathematics [1]. Research has been shown that metacognitive is relative with problem solving, including for mathematics [1].

In the previous works, they investigated the relationship between games for education directly to the main part of metacognitive skills [2][3][4]. Based on the stage of the learning process, however, before coming to metacognitive skills the cognition processes should be examined as the critical steps to promote metacognitive skills [5].

Basically, playing games can stimulate cognitive processes (cognition), and simultaneously improve the player's metacognitive skills. Therefore, this paper was focused on a theoretical analysis of how games for education can improve the player's metacognitive skills.

2. FUNDAMENTAL CONCEPT

2.1 Manuscript Length (Bold)

Gamification is the use of game play mechanics for non-game applications, particularly consumer-oriented web, and mobile sites. Gamification is using game-based mechanics, aesthetics, and game thinking to engage people, motivate people, promote learning, and solve problems. Game for education is a part of gamification which is widely played in daily life for almost all students. In the other word, they are created through the gamification of traditional learning content. Indeed, gamification in learning and education is a set of activities and processes to solve problems related to learning and education by using or applying the game mechanics.

Before designing a game, let's review who would play this game. Should the game be more competitive? Or should just be casual to fill empty time? For developing metacognitive skills, there is a level of difficulty that needs to be set and set up a competition. If the game is too difficult, the player will not want to play it, and if the game's difficulty is too easy, the player will quickly get bored of the game for not getting challenging. In fact, for the purpose of developing metacognitive skills, the game needs to be challenging that the player could clear if the player acknowledges the pattern of difficulty.

Since its inception, video games have captured the imagination of millions. As gamers, we've always been captivated by the expansive open worlds, immersive stories, and the ability of video games to help us escape reality. It's the reason we constantly find ourselves endlessly exploring the wonders of The Elder Scrolls, or happily lost in unexplored natural forests. For some, the world, environment and story are everything.

But, for others, something more is needed. For some gamers, it's about the competition. For these players, story and lore offer little value. Instead, it's the game's skill limits and the drive to be the best that keeps them coming back. Throughout video game history, competitive gaming has always been a prevalent force. Even early in the history of the industry, gamers wanted to be recognized as champions. Whether this is through a tournament or a simple high score on an old arcade machine, humanity has always had a fundamental desire to come out on top.

It was this desire that led to the creation of the formal competitive landscape we now know as esports. Esports has come a long way since the first tournament in the Stanford university backroom in 1972. It is no longer held in the university, basements and garages or old LAN parties. Their reach is wide, filling stadiums and arenas or taking center stage at week-long exhibitions and conventions. These events take place all over the world – wherever there are players who have the urge to compete.

Playing interactive digital games is a popular student activity. The current study examines the metacognitive abilities provided by digital games for children aged 6 to 10 years. Fifteen games from five different genres were coded for interactivity features, including level control, feedback, and adaptation. Parents reported time their child spent on each of these games, and children completed a measure of metacognitive awareness. Student's preferences for different play environments were also examined. The results show that exposure to games with high interactive features is positively related to children's

metacognitive awareness. However, exposure to games with less interactive features is not associated with metacognitive awareness. Game preferences do not differ by age or gender. These results support the hypothesis that different digital games provide children with different opportunities for metacognitive experiences and have implications for future research investigating interactive media and children's cognitive development during middle childhood.

Current research increasingly confirms that video game learning and classroom learning work in the same way. Like performers, students who excel are more adept at identifying and analyzing what they don't know. Both activities require participants to have metacognitive skills to recognize weaknesses in their own thinking. Through self-reflection, they identify mistakes and adjust their behavior to overcome their deficiencies through practice.

Teachers need to understand that the more accurately a learner can assess his own knowledge and devise strategies to reinforce that knowledge, the easier learning will be. Metacognition is the foundation of good study skills.

In the classroom, when students struggle with metacognitive skills, teachers must step in and facilitate:

Modeling a good learning strategy.

Demonstrating continuous evaluation and constant feedback so that metacognitive iteration eventually becomes a habit of independent practice for students.

Focus on isolating the necessary skills and building the necessary support for the intentional acquisition and practice of knowledge.

A good strategy is to use video game metaphors when talking to students and let them see that each failure is like losing a life playing Pac-Man. These are just repeated steps on the road to ultimate success.

2.2 Manuscript Organization

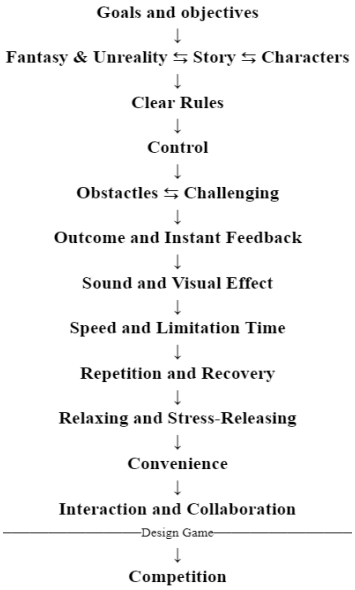

Figure 1. The Elements of Game

Figure 1 explains what are elements of the game and what step by step first to do. Here are the explanation of all the steps.

Goals and Objectives

Every game has goals and objectives to accomplish. Without that, new players wouldn't get baited to play the game. Especially online games that update every certain time with new items or dlc, players still need to maintain being an endgame player even if all stages are cleared to compete with other endgame players.

Fantasy, Unreality, Story, and Characters

With goals and objectives settled, next is to create a character in the story that shows fantasy, unreality or a story that can take it from a true story. There will be two types of character, playable character, and Non-Playable Character (NPC).

Clear Rules

Chess is a two-player board game using a chessboard and sixteen pieces of six types for each player [6]. If the piece of the king gets a checkmate, the player loses the game. That is an example of solid rules for chess. Main goal is to checkmate their opponent king. To achieve that, players need a pawn, fortress, bishop, queen to move to build a strategy. And every pawn has their ability and because of that clear rule, chess is still relevant till this day. The game should have clear rules that relate to every player, otherwise, the game could not be relevant.

Control

Control of the games depends on what type of game that is going to be developed.

Obstacle and Challenging

To reach the goal, players need to maintain their stage step by step, from easy to harder and harder. For when newcomer's first time going to gym, newcomer wouldn't recommend pulling heavier dumbbell, the newcomer would recommend pulling 1-4 kg dumbbell and then after a month or two weeks, if the dumbbell not heavy enough, could take more heavier dumbbell.

Outcome and Instant Feedback

When players have main goals to achieve, it will take time. So, before the player becomes bored, every clearing stage should grant the player a value to make them want to clear the next stage again until they reach the final stage.

Sound and Visual Effect

For developers, this element is the important part because without good sound and visual effects, the game can't show the player how good the character is and how the story meant to them.

Speed and Limitation Time

Games need to have a time limit to play. Not just games, in life there are various things that need a time limit. Test of Final Semester takes time limit, football just play it 45 minutes times 2 if between doesn't have same score.

Repetition and Recovery

It takes multiple days for clearing all stages of the

game, and for online games, players should achieve daily rewards for login and playing the game for circumstance time every day.

Relaxing and Stress-Releasing

A study conducted by Porter and Goolkasian in 2019 compared the stress responses of two groups, one that played the fighting game, Mortal Kombat, and another group that played the puzzle game, Tetris [7]. The researchers found that the Mortal Kombat group experienced a cardiovascular stress response while Tetris players did not. The study also found that video games reduced negative emotions, such as frustration in stressed individuals [7]. The participants reported playing video games for stress relief purposes [7].

Convenience

This element is dependable, if the game is compatible to play on a personal computer (PC) or mobile. There is a game that can be played on PC or mobile.

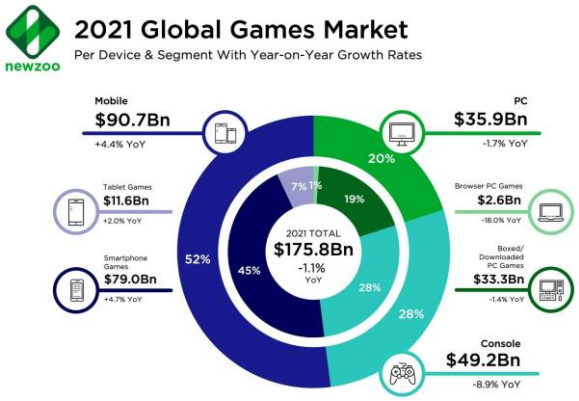

Figure 2. Global Games Market Revenue in 2021 from Newzoo Projections

Figure 2 resources from Newzoo's Projections, explain that in 2021 they discovered that for gaming platforms, there is 52% of mobile gaming, 28% of console games and 20% for PC Gaming [8]. By 2020, the revenue of mobile gaming is 46%, console games at 31% and PC gaming at 23% [8].

Interaction and Collaboration

After all, people are social creatures. With games, people could interact with each other. Or making new friends and joining a new community to interact with other people. Interaction can be done even not between players, games provide NPC (non-player character) that can interact with the player. Reaching this element of games means the game is already relevant and playable. New games usually do not reach the next element because the next element needs time to reach the element of the game.

Competition

Amount of community and players that experience the game creates new business. Such as being creator content on YouTube, and making an event to compete with each other to win the tournament. Games that have many audiences would create more competition events to compete with each other.

2.3 Theories for Gamification in Learning and Education

The application of game principles in learning and education developed and maintained by some theories, i.e., motivation theory, self-determination theory, achievement goal theory, social learning theory and situated learning theory. Those theories work the entire game elements.

Motivation Theory

There are no exact theories that motivation is the key to success of gamification. Motivation refers to the mental or emotional state of everyone depending on their perspective and culture. Motivation Theory divided by two types: intrinsic and extrinsic motivation. Intrinsic motivation is a motivation type that can be caused by an individual's own pleasure, curiosity, or interest. Extrinsic motivation is influenced by environmental and external factors, such as rewards, pressure, or punishment.

Self-determination Theory

Growing is the key for self-determination theory. individuals tend to grow by their innate psychological needs: autonomy, competence, and relatedness. To experience growth, individuals should:

Feel that they can control their behaviors and consequences

Perceive that they have sufficient ability to accomplish tasks

Have a sense that they belong to a group or interact with others

Achievement Goal Theory

In education, how do educators evaluate students' achievements? Educators are probably familiar with criterion-referenced tests and norm-referenced tests.

Social learning and situated learning theory

Social learning theory explains that people can learn by observing others, their behaviors, and the results of the observed behaviors. situated learning theory is also based on the assumption that learning occurs through social interaction. Lave claims that learning is situated [9]. This means learning is inseparable from the activity, five Theories for Gamification in Learning and Education context, and culture [9]. According to situated learning theory, knowledge is socially constructed and closely associated with contexts. Learning that lacks authentic contexts makes its application to the real world more difficult [10].

2.4 Metacognition Skills

Metacognition as part of educational psychology was discussed in many points of views. Therefore, there were many which stressed their focus of discussion. Livingston highlight that metacognition is higher order thinking in learning [11]; Serra & Metcalfe defined metacognition as a critical analysis

of thought, knowledge, and cognition about cognition phenomena [12]; Reeve & Brown expressed that metacognition is an individual ability to understand and manipulate their own cognitive processes [13]; Flavell (1976) metacognition refers to the monitoring, regulation and orchestration of cognitive process and products [14]; and Ahmed Oguz Akturk and Ismail Sahin metacognition is about individuals' having information about their cognitive structure and being able to organize it [15]. Those definitions generate keywords, i.e., higher order thinking, critical analysis of thought, cognition about cognitive phenomena, self-monitoring, self-regulation, and manipulating their own cognitive processes, organizing the cognitive structure.

Metacognition is a big picture about learning. Metacognition explains in detail how someone learns and how to solve the problems correctly. There are three famous models that discourse metacognition concepts, i.e., Flavell's model [16], Brown's model [17], and Schraw's model [18]. Flavell's model explains metacognition through four components, namely, 1) cognitive knowledge; 2) metacognitive experience; 3) goals or tasks; and 4) actions or strategies [16]. Brown's model describes the concept of metacognition through two broad categories; that is knowledge of cognition, and regulation of cognition [17]. Next Schraw's model is presented to further elaborate on Brown's model. Schraw's model explains the knowledge of cognition through three components, namely, 1) declarative knowledge; 2) procedural knowledge, and 3) conditional knowledge [18]. In addition, Schraw's model also explains the regulation of cognition in three basic components, those components are planning, monitoring, and evaluation [19].

3. RESEARCH PROCEDURE

This work comprises a design and development research that is driven by the theoretical aspects. The procedure designed to complete this project is partially a combination of the research procedures presented by Tracey and Richey [20], and Lee and Jang [21]. Table 1 described which are the main procedure consists of five steps.

Table 1. Synthesized Procedures for Designing game for education to improve metacognitive skills [20][21]

Steps	Details of synthesized Procedure
Data source definition	Determine the theoretical foundations of the conceptual model
Data Collection	Review the relevant literature within the theoretical foundation
Data Analysis	Identify and re-conceptualize variables / activities from the literature to derive model component
Model Ideation	Make logical networks based on the relationships between variables or activities
Model Representation	Graphically represent the relationship in a conceptual model

4. RESULT AND DISCUSSION

Step a, b and c (Data Source Definition, Data Collection, and Data Analysis)

Results of step a, b and c have been shown from fundamental concepts that provide information of gamification, elements of game, theories for gaming in education and learning, and definition of metacognition as shown in the previous section.

Step d and e (Model Ideation and Model Representation)

In this section we explain how models ideate from analysis of literature data and make the logical network among variables and activities. Based on a logical network of among variables to predict the metacognitive skills as a result, a graphical model was drawn.

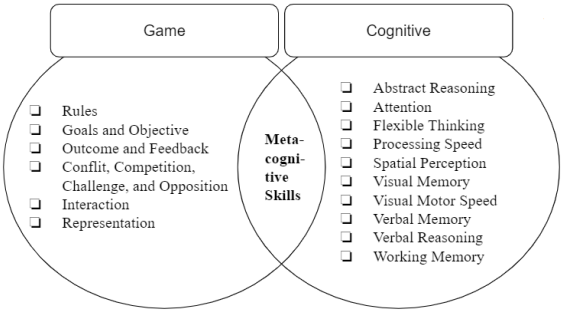

Figure 3. Metacognitive between game and cognitive

Figure 3 explains that the game has several components and is going to trigger cognitive. Game has rules, goals and objectives, outcome and feedback that cause elements of conflict, competition, challenge, opposition, interaction and representation to other players or NPC. Before the elements happen, each player is going to be cognitive first, taking order of visual memory, verbal memory, working memory, visual motor speed, attention, processing speed, abstract reasoning, verbal reasoning, spatial perception, and flexible thinking. Spatial perception would happen because not all players have the same thought or perception, that's going to trigger elements of the game such as conflict, challenge, interaction and after discussion or some events, that's going to be flexible thinking happens to every player.

Which Gaming can trigger player their cognitive, building it to do planning or what next to do for clearing the games, which occur Metacognitive on each players that playing the game.

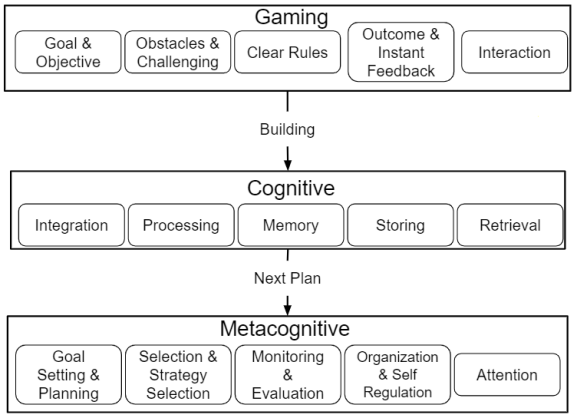

Figure 4. Gaming Build Cognitive and Next Plan Metacognitive

Figure 4 explains that metacognitive is above cognitive. Metacognitive is occur through the process of cognitive. Cognitive needs memory to memorize events, processing what's happening on events, storing, retrieval and integration to occur plan out of planning. Metacognitive would help players to clear any stages, until they reach to the end, or they found one stuck on stages. After getting stuck, another thought would come, another changing storing.

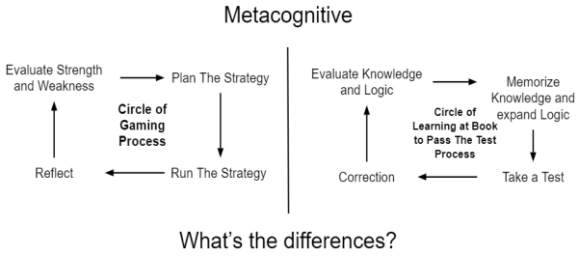

Figure 5. Circle of Gaming and Learning

Figure 5 explains the circle of gaming process and learning have the same pattern, the difference is a design that provides content.

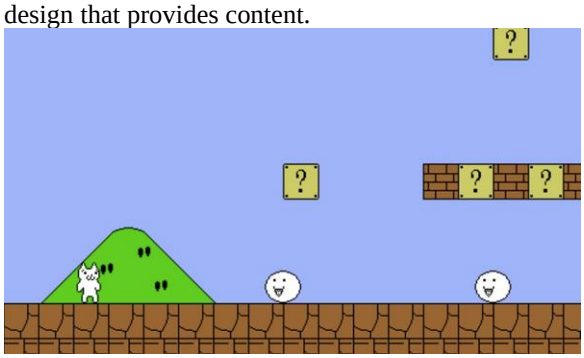

Figure 6. Cat Mario (for example) [22]

Figure 6 is just an interface of the game Cat Mario (for example). Clearing stages of the game Cat Mario is nearly impossible if the player does not memorize the pattern of trap and speed of hand to move the character. First, evaluate the strength and weakness of the cat, the character of the game. How much range can a cat jump? or how much faster to run? With knowing stats of the cat aka knowing strength and weakness, so the player can plan a strategy. Cat Mario's strategy is simple, just dodge the trap and move to the right side of the world. After the player runs the strategy, what happens? Player would be caught by a trap and the character died so the player needs to retry again from their checkpoints. But the difference now is the player recognizes the place and pattern of the trap. So, after retrying, clear the first trap, and then get caught again at the second trap, the character dies again, and the player needs to retry again from their checkpoints, and the player needs to pass the first trap again. And then the player gets caught by third trap, fourth, fifth, until they clear the stage. Even after the player recognizes another new trap's place and pattern, the player could fall to the known trap if the player forgets it because memorizing so many traps.

To think that how that hard game like Cat Mario would trigger the people to play it or knowing to discuss it? Well from platform YouTube checking at 23rd April 2022, combining most views of 10 YouTube videos, has approximately 146.3 million views [23]. That's 26.3 million more views than all videos of math teaching content from Australian youtuber math teacher Eddie Woo that has 4,832 videos with a total views 120 million views [24].

So, learning the effort of clearing stages of Cat Mario would encourage students to memorize knowledge and pattern of question so they could clear the question and learn new stuff through metacognitive skills that are obtained by their gaming experiences.

5. CONCLUSION

Each element of the game works mechanically which corresponds with the learning process, namely cognition and metacognition process. Cognition process between game element and metacognition skill cultivation. Metacognition skill will be generated by encompassing cognition activities with the game environment.

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