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Children Preference Analysis of a Logic Game- "Lily's Closet"

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Abstract: Children autonomously play games. It is what Game-Based Learning is aiming for, that to create a learning process for children to acquire knowledge autonomously. This study is to discover the relations among children's age, preference, and learning performances in a digital game, Lily's closet. The researchers applied big data analysis and collect gaming behavior data from 6,924 children whose age range is 3-8 years old. The result shows that: a) Children's age is related to learning performance. The higher ranking shows higher learning effects. The relevance between ranking and age shows that the older children grow up, the better "logic concept" they can comprehend. b) However, the older they are, the more toys and environment they are approaching. That is why their willingness to repeat the same game is lower after growing up. As a result, we suggest that to assist learning, we should give children a different level of games according to their ages. The research hopes to resonate with readers and jointly explore the relationship between adaptive development and digital games.

Keywords: Digital games, game-based learning, big data analysis, autonomously play, adaptive development, learning performance

1. Introduction

"Games Generation," which is also called "G Generation," is a group of people who grow up by the sound and light stimulation of the game (Prensky, 2001; Gibson et al., 2007). Many studies showed children keep playing games is that games are interesting, exciting, and challenging in problem-solving (Gerkushenko & Gerkushenko, 2014; Dalton & Devitt, 2016). In-game scenarios, children "enjoy" the stimulus if they can feel they are capable of coping with challenges (Gerkushenko & Gerkushenko, 2014; Dalton & Devitt, 2016).

When we know that games are very important for young children, the development of logic concepts has always been an important milestone in the development of young children. We need to understand: 1. Children of different ages have different learning needs. Is there any trend in logic concepts learning in games? 2. Does one logic game have the same appeal to children of different ages? In response to the above problems, our research purpose is to discover the trend of children's digital play-based learning. Our study questions are as follows:

1. What is the relation between age and gaming frequency?
2. What is the relation between age and the learning effect?
3. What is the difference of children's playing behaviors and the learning effect between kids who are highly involved in the game and kids who are not?

2. Theoretical Structure

2.1 The significance of Digital Games to Children's Autonomous Learning

Digital Game-based Learning (DGBL) is a kind of gameplay that defines the learning outcomes and it involves the game rule design. The idea of GBL believes that if we can motivate children and

allow them to develop a learning awareness, children can automatically learn and obtain knowledge and information (Van Eck, 2006).

DGBL can improve children's attention and learning motivation, and children's learning effect is better in DGBL (Käser et al., 2013; Gerkushenko & Gerkushenko, 2014; Godwin et al., 2015; Mouws & Bleumers, 2015; Dalton & Devitt, 2016; Aunio & Mononen, 2018). However, the digital tool is a double-edged sword. If a digital game is not designed for learning purposes, and mediators like parents and teachers do not teach children how to use the digital product correctly, games may hurt children's cognitive development or cause wrong cognition (Lieberman et al., 2009). DGBL is an irreversible trend, therefore, to design a well-designed game that assists children's development, hobbies, and ability is an important task for future human beings.

This research creates a situation where children can play games autonomously. Research allows children to freely choose games in their own free time. Therefore, this research uses big data to observe the frequency of children's willingness to play games independently, and explores the relationship between different ages, genders, and learning effectiveness through research questions.

2.2 The Connection between Children's Logic Concepts Development and Game Design

The game in our research is about children's early logic concspts learning. Our study is based on Piaget's Cognitive-Developmental Theory. *Cognitive-Developmental Theory* explains how children develop their realization to the outer world, and the basic element of the development is called schema (Piaget, 1952; Hunting, 2010). Piaget conveyed that the establishment of cognition is an active process (Crain, 2014; Herczeg et al., 2019) based on prior knowledge (Bhattacharjee, 2015). Children meet cognition conflicts while interacting with the world and then build the new cognition through adaptation of the conflict by assimilation and accommodation (Piaget, 1962).

Our research participants are children in the Preoperational Stage between 3-8 years old. Children's cognitive thinking during the Preoperational Stage is fixed and concrete; they can read simple symbols but cannot think logically. While their cognition is developing to the next stage, the Concrete Operational Stage, they can do reasoning thinking according to the concrete stuff. Games are the way children learn new things (Piaget & Inhelder, 1969). There are various ways of gameplay, such as symbolic play or pretend play (Edna & Ronny, 2015), differentiate reality and fantasy (Woolley & Ghossainy, 2013), role-play, personification in the story, and perspective-taking (Yadi, 2020). Piaget considered that children would accommodate themselves in-game through transformation function, assimilate the new experience, and gain the knowledge. Children of different ages change their play contents and form along with the Different Stages of Cognitive Development, so as they constantly self-construct and develop in play (Piaget & Inhelder, 1969). Play material is a source of acquiring logic concepts for young children as well (Hunting, 2010; Piaget, 1962). Piaget (1962) stated that children construct logic concepts through hands-on play to explore and develop the realization of the object and logic relationship. Individuals involved in activities to acquire knowledge, then accumulate and build cognitive concepts step by step (Piaget, 1962). As a result, to children, the operation and repetition of games are important behaviors while learning logic concepts.

2.3 Meaning of "The Flow State" in Early Childhood

"Flow State" means a fully mental-involved activity. It is also called "being in the zone", which means players are in a mental state of fully immersed in a feeling of energized focus and enjoyment in the process of the activity (Csikszentmihalyi, 1998 & 2000; Cherry, 2018; Nakamura and Csikszentmihalyi, 2002). In other words, "Flow State" is characterized by complete absorption in what one does and a resulting loss in one's sense of space and time. Nakamura and Csikszentmihalyi (2002) identify six factors as experiencing the flow state:

- Intense and focused concentration on the present moment.
- Merging of action and awareness.
- A loss of reflective self-consciousness.
- A sense of personal control or agency over the situation or activity.
- A distortion of temporal experience, one's subjective experience of time is altered.
- Experience of the activity as intrinsically rewarding.

As a well-designed game can provide players' flow state (Csilszentmihalyi, 1998 & 2000; Cherry, 2018; Nakamura and Csikszentmihalyi, 2002), in this study, we employed DGBL to track the behavior of game players to see in which age group this game can stimulate their Flow State. Besides, we applied the Flow State Theory in the game design of the study that suggested challenges that match children's development. We observed children's reactions to the game and measured their attention level to find their preference for it (Csikszentmihalyi, 1998 & 2000; Cherry, 2018; Nakamura & Csikszentmihalyi, 2002).

If a game stimulates children's Flow State, they will spend more time and attention on such a game and be willing to choose it again and again (Csikszentmihalyi, 1998 & 2000; Cherry, 2018; Nakamura & Csikszentmihalyi, 2002). Therefore, to observe their Flow State, we observed the data of children's behavior and analyzed their tendency according to their frequency in the game, so that we could see if the Flow State is activated.

3. Method

3.1 Equipment and Game

The logic game in this study is "Lily's closet." (Figure 1)

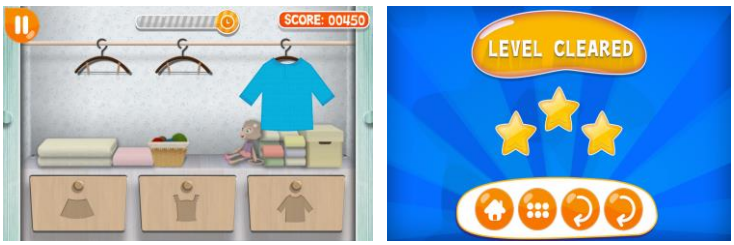

Figure 1. Screenshot of "Lily's Closet"

"Lily's closet" is a game about "identification and categorization" belonging to "logic" ability. In the game, users should touch and drag the right clothes shape to the matching closet. Once matched, users will score and the pad will give happy sound feedback. If the match is wrong, a hint will pop up with a warning sound. The game will give star levels after each session according to their gaming performance. Whenever players enter a game, the system starts to record automatically. The recorded content includes data such as entry time, game time, game level, stars scored (the lowest: 1; the highest: 3), user's age, etc.

The definition of the key data we mainly analyzed in this study as follows.

- "Game Time": means the length of gaming from entry to leaving the game. If the user taps into the game multiple times, the game time for each entry is recorded separately.
- "Frequency": means how many times the user logs into this game. No matter the length of the game time, every log-in is counted as "Frequency: 1."
- "Learning Effect" means the Stars that the user score. The lowest is 1 Star, and the highest is 3 Stars. This study hopes this game can improve children's logical ability of categorization/collation, and the learning effect will present as the star they scored.

3.2 Participants

Our research focused on children of 3-8 years old. We collected 6,924 children and 53,149 data. Then we divided five age groups (see Table 1). To compare the play frequency and their learning effect, we chose the top 100 children in each age group by their frequencies of the gaming data. Therefore, there are a total of 500 children who are the highest frequency among all in this game.

Table 1. *Number of Participants and Amount of Data*

Age Group(Year Old)	3-4	4-5	5-6	6-7	7-8	Total

Number of All Users	1929	1865	1557	1034	539	6924
Amount of All Data	17607	13984	10778	7300	3480	53194
Number of Highly Gaming Users	100	100	100	100	100	500
Amount of Data of Highly Gaming Users	5898	4622	4000	3387	2289	20195

4. Analysis Results

4.1 Frequency of DGBL in Different Age Groups

Average Frequency in Each Age Group shows in Table 2.

Table 2. *Average Frequency in Each Age Group*

Age Group(Year Old)	3-4	4-5	5-6	6-7	7-8	Total
All Users' Average Frequence	9.1	7.5	6.9	7.1	6.5	7.42
Highly Gaming Users' Average Frequence	59.0	46.2	40.0	33.9	22.9	40.4
Highly Gaming Users' Average Frequency ÷ All Users' Average Frequence	6.4	6.1	5.8	4.7	3.5	5.4

Unit: times

All children's average frequency is 6-9, while Highly Gaming Users' is 22-29. The difference between both is 3.5-5.4 times (Table 2). It represents that Lily's Closet can create high motivation in playing for children whose age range is 3-8 years old. They would want to play it over and over.

The Correlation Analysis between Age Group and Frequency shows in Table 3.

Table 3. *Correlation Analysis between Age Group and Frequency*

		Age Group	Game Time
Age Group	Pearson Correlation	1	-.314**
	Sig. (2-tailed)		.000
	Total Amount of Data of Highly Gaming User	20,195	20,195

**. Correlation is significant at the 0.01 level (2-tailed)

According to analysis (Table 3), the relation between age group and frequency has a significant difference as a negative correlation. Older children played fewer times than younger age.

4.2 Learning Effect of DGBL in Different Age Groups

This study recorded stars scored in each age group between 3-8 years old. We compared stars of Highly Gaming Users among each age group. Table 4 shows the average stars of all children and Highly Gaming Users. We analyzed the relationship among age groups and stars as Table 4 and 5 show.

Table 4. *Average Stars in Each Age Group*

Age Group(Year Old)	3-4	4-5	5-6	6-7	7-8
All Users' Average Stars	1.60	1.88	2.15	2.36	2.43
Highly Gaming Users' Average Stars	1.64	2.00	2.23	2.38	2.47

Table 5. *Correlation Analysis between Age Group and Stars*

		Age Group	Game Time
Age Group	Pearson Correlation	1	.375**
	Sig. (2-tailed)		.000
	Total Amount of Data of Highly Gaming User	20,195	20,195

**. Correlation is significant at the 0.01 level (2-tailed)

All children's average stars are 1.60~2.43, while Highly Gaming Users' are 1.64~2.47. Highly Gaming Users' average stars are all higher than all children's average. It represents that repeated gaming can help children to identify colors and shapes, and improve their categorization ability which is under a logic field. According to analysis, the relation between age group and stars has a significant difference as a positive correlation. Older children scored a higher rank of stars than a younger age.

5. Discussion

We would like to explore children's Digital Game-based Learning (DGBL) and their preference in this study. We discuss and answer the study questions as follows:

1. What is the relation between age and gaming frequency?

According to the analysis, the negative correlation between frequency and age group represents that Lily's Closet is more attractive to younger children, who have higher Flow State than older children. The factors that affect children's repetitive playing could be numerous, such as operating fluency of the game commands, comprehension of the rules, and challenging degree to them to evoke their motivation. If a game is too easy, children will end up not playing it because it cannot evoke a sense of challenge, though it may attract them first with sound and light effects. Children's logic ability is developed by the impact of social culture context, and they absorb the relative information through the living environment and contextual interaction (Piaget, 1962). Therefore, we convey that because older children own more life experience than younger children, it is less challenging for them to collate colors and shapes. As they can score three stars easily, they will not feel interested in it anymore.

2. What is the relation between age and the learning effect?

Children's age and their learning effect are significant relations. The analysis shows that the age group and average stars are positive correlations. It means that a game like Lily's Closet that classifies colors, shapes, and patterns, is attractive to children who are 3-4 years old. As they grow older, children's identification and classification abilities develop better, so that their stars and learning effects are higher.

3. What is the difference of children's playing behaviors and the learning effect between kids who are highly involved in the game and kids who are not?

All Highly Gaming Users scored higher stars than all children's average stars in any age group. We interpreted it as Highly Gaming Users' learning effect is better than average. According to the analysis, we suggested that playing Lily's Closet repeatedly can be a great practice for young children to improve their identification and categorization abilities. As Piaget (1962) mentioned, young children's cognitive process of constructing knowledge is through constant conflicts of concepts, adjustments, and then acceptance, so that they can form the cognition to the outer world. That is what so-called assimilation and accommodation process. The game rule of scoring in Lily's Closet is to touch and drag the clothes to the appointed closet. Once the wrong match happens, there will be a hint and red flashlight with a warning sound. Therefore, we consider that if children can repeatedly play DGBL games which improve cognition development, scored or not, the stimulus of the game can still help children to build their cognition right. The analysis data echoes our beliefs in this study.

Reflecting on the research results back to the theoretical framework, we found that:

1. The theory shows that digital games produce children's autonomous learning (Van Eck, 2006). Children are willing to play the game autonomously, and the children who are most willing to play autonomously for this game are 3-4 years old. The learning achievement of children with high autonomous play shows higher scores than the children with low autonomous play.

2. Logic games are constructed in cognitive schemes (Piaget, 1952; Hunting, 2010). This research shows that high-frequency gamers use this game to build cognitive schemes and improve their logical effectiveness.

3. Children enter the flow experience will continue to play the same game over and over again (Csilszentmihalyi, 1998 & 2000; Cherry, 2018; Nakamura and Csikszentmihalyi, 2002), which also reflect to our study that high-frequency players have the flow experience.

References

Aunio, P., & Mononen, R. (2018). The effects of educational computer game on low-performing children's early numeracy skills–an intervention study in a preschool setting. *European Journal of Special Needs Education*, 33(5), 677–691.

Bhattacharjee, J. (2015). Constructivist Approach to Learning – An Effective Approach of Teaching Learning. *International Research Journal of Interdisciplinary & Multidisciplinary Studies*, 1(6), 65-74.

Cherry, K. (2018). 'Flow' Can Help You Achieve Goals Understanding the Psychology of Flow.*Verywell Mind.*

Crain, W. (2014). *Theories of Development Concepts and Applications* (pp.123). UK: Pearson Education Limited.

Csikszentmihalyi, M. (1998). *Finding Flow: The Psychology of Engagement With Everyday Life* (pp.47). New York, NY: Basic Books.

Csikszentmihalyi, M. (2000). *Beyond Boredom and Anxiety: Experiencing Flow in Work and Play*. San Francisco: Jossey-Bass.

Dalton, G., & Devitt, A (2016). Gaeilge Gaming: Assessing how games can help children to learn Irish. *International Journal of Game-based Learning*, 6(4), 22–38.

Edna, O. & Ronny, G. (2015). Symbolic play and language development. *Infant Behavior and Development*, 38(1), 147-161.

Gerkushenko, S., & Gerkushenko, G. (2014). The Play Theory and Computer Games Using in Early Childhood Education. *International Journal of Game-based Learning*, 4(3), 47–60.

Gibson, D., Halverson, W., & Riedel, E. (2007). Games and simulations in online learning: Research and Development Frameworks (pp.175-188). USA: IGI Global.

Godwin, K., Lomas, D., Koedinger, K., & Fisher, A. (2015). Monster Mischief: Designing a Video Game to Assess Selective Sustained Attention. *International Journal of Gaming and Computer-Mediated Simulations*, 7(4), 18–39.

Herczeg, M., Winkler, T., & Ohlei, A. (2019). Ambient learning spaces for school education. *iCERi 2019 Proc*, 1, 5116-5125.

Hunting, R. (2010). Little people, big play, and big mathematical ideas. In Shaping the future of mathematics education: Proceedings of the 33rd annual conference of the Mathematics Education Research Group of Australasia (pp. 727-730).

Käser, T., Baschera, G. M., Kohn, J., Kucian, K., Richtmann, V., Grond, U., & von Aster, M. (2013). Design and evaluation of the computer-based training program calcularis for enhancing numerical cognition. *Frontiers in Psychology*, 4, 89.

Lieberman D. E., Bramble D. M., Raichlen D. A., & Shea J. J. (2009) Brains, Brawn, and the Evolution of Human Endurance Running Capabilities. In: Grine, F. E., Fleagle, J. G., Leakey, R.E. (Eds), *The First Humans – Origin and Early Evolution of the Genus Homo. Vertebrate Paleobiology and Paleoanthropology*. Dordrecht: Springer.

Mouws, K. & Bleumers, M. (2015). Co-Creating Games with children: a case study. *International Journal of Gaming and Computer-Mediated Simulations*, 7(3), 22–43.

Nakamura, J., & Csikszentmihalyi, M. (2002). The Concept of Flow. In C. Snyder, & S. Lopez (Eds.), *Handbook of Positive Psychology* (pp. 89-05). New York, NY: Oxford University Press.

Piaget, J. (1952). Autobiography. In E. G. Boring, H. S. Langfeld, H. Werner, & B. M. Yerkes(Eds.), *A history of psychology in autobiography* (pp.237-256). Worcester: Clark University Press.

Piaget, J. (1962). *Play, dreams and imitation in childhood*, Norton.

Piaget, J., & Inhelder, B. (1969). *The Psychology of the Child*, New York, NY: Basic Books.

Prensky, M. (2001). *Digital game-based learning*. New York, NY: McGraw-Hill.

Van Eck, R. (2006). Digital Game-based Learning: It's not just the digital natives who are restless. *Educase Review*, 41(2), 1-16.

Woolley, J. D., & Ghossainy, M. E. (2013). Revisiting the fantasy–reality distinction: Children as naïve skeptics. *Child Development*, 84(5), 1496-1510.

Yadi, Z. (2020, July). A Study of Preschool Children's Second Language Acquisition From the Perspective of Piaget's Theory of Cognitive Development Stages—A Comparison between Raz and Oxford Reading Tree. In *2020 5th International Conference on Humanities Science and Society Development* (pp. 657-665). Atlantis Press.