Differential Impact of the Positive and Negative Image of Digital Games on University Students' Computational Thinking

Masanori Fukui
Iwate Prefectural University
152-52 Sugo, Takizawa, Iwate, 0200693 Japan
fmasanori@aol.com

Yudai Sano
Naruto University of Education
748, Nakajima, Takashima, Naruto, Tokushima, 7728502 Japan
22851039@naruto-u.ac.jp

Kazuki Okuno
Osaka Electro-Communication University
1130-70 Kiyotaki, Shijonawate, Osaka, 5750063 Japan
hw20a028@oecu.jp

Masakatsu Kuroda
Kobe Women's University
2-1 Higashisumaaoyama, Suma, Kobe, Hyogo, 6548585 Japan
m-kuroda@suma.kobe-wu.ac.jp

Eng Tek Ong
UCSI University
No.1, Jalan UCSI, UCSI Heights, Cheras Kuala Lumpur, 56000 Malaysia
OngET@ucsiuniversity.edu.my

Khar Thoe Ng
UCSI University
No.1, Jalan UCSI, UCSI Heights, Cheras Kuala Lumpur, 56000 Malaysia
postgradreview@gmail.com

Peter Chew
PCET Multimedia Education
9-G, Lorong Usahaniaga 3, Taman Usahaniaga, Bukit Mertajam, Pulau Pinang, 14000 Malaysia
peterchew999@hotmail.my

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INTRODUCTION

Research Background

The importance of the educational use of digital games is widely acknowledged, and the concomitant development of problem-solving skills is one of its most prominent features. The development of problem-solving skills through digital games is vital in the context of the future educational use of digital games, and research should be promoted to pave the way for their effective use.

Computational thinking is a thinking process for expressing problems in a way that computers can understand and is regarded as an essential 21st-century skill (Wing, 2006). To achieve this, it is crucial to develop subjects that enhance problem-solving skills using digital games, which may be related to the learners' actual engagement with digital games, skills, experiences, and images. According to Hattie (2008), learners' images and impressions of subject matter have a significant impact on learning enrichment. This may also be true for digital games.

In this study, we focused on the image of digital games held by learners and examined the relationship between this image and computational thinking.

METHODOLOGY

Survey Targets and Procedures

In September 2023, a web-based survey was conducted among 180 students (168 men and 12 women) from the Faculty of Information Science. After discarding 21 incomplete responses, the number of valid responses was 158 (146 men and 12 women), representing a valid response rate of 87.78%. The survey took approximately 15 minutes to complete. Participants with no digital game-playing time were excluded from this study.

Survey Items

We used the measurement scale of "the Image and Consciousness of Digital Game" developed by Fukui et al. (2022) to determine the kind of image they have of games and computational thinking. We also used Bando and Motozawa's (2021) Japanese version of Computational Thinking. This scale was translated from the scale for measuring problem-solving skills that had been developed by Korkmaz et al. (2017). Table 1 lists the items used to understand the game images. All computational thinking items were answered on a 5-point Likert scale ranging from "5: Strongly agree" to "1: Strongly disagree." Besides, all the images and consciousness of digital game items were answered from "5:Very applicable" to "1:Not applicable at all."

Analysis Procedure

After obtaining descriptive statistics for the image and consciousness of digital games and computational thinking, we divided the "Positive image of digital games" and "Negative image of digital games" up and down by the mean value, created four groups by the combination of each, and examined how computational thinking differed between the groups. Here, a positive image of digital games was calculated

using the mean values of factors II, III, and IV, and a negative image of digital games was calculated using the mean values of factors I, V, VI, and VII.

(Factor I. Personal and Social Bad Impressions)	(Factor III. skill improvement)
Games change many people's lives for the worse	Games make me smarter
People who play games are less sociable	Games improve my ability to think logically
People who play games all the time have bad personalities	Games help us understand the structure of various problems
Gaming is perceived as a dark hobby	Games are good for the brain because they involve a lot of use of hands and eyes.
Games are bad for education	Through games, we can acquire a variety of basic education.
Playing games is a waste of time	Through games, various abilities can be improved.
Playing games makes people stupid	Through games, we can learn mathematics.
Playing games interferes with concentration	Through games, students can learn what they learn in school.
Game-players have a bad image of people who play games.	Through games, students can acquire skills that can be used in other areas.
Playing games makes them commit crimes.	Games improve concentration.
Game-players lose interest in other things through playing games.	Games help us to think better.
Games are a pastime that lacks sociability.	Games can change many people's lives for the better.
Children should not be allowed to play games.	Games can strengthen our ability to make decisions.
Playing games is a waste of life.	Games improve physical functions, such as dynamic vision and instantaneous force.
People who play games are geeks.	Games increase interest in background mechanisms
Games are nothing but a money-making business for game companies.	(Factor IV. extensive communication)
Information provided by games cannot be trusted.	Making many friends through games
Games are complicated and difficult to understand	Connect with various people through games
Games make people lose their sense of money	Can communicate through games
Games make people withdraw from society and become NEETs.	I can communicate with friends at any time through games
(Factor II. Special experiences and positive impressions)	Through games, I can make more friends on the Internet.
Games provide experiences that cannot be experienced in daily life	Through games, I can make friends with common interests.
Games allow me to experience a world I do not know.	It is easy to make friends through games.
Games allow me to see the world differently from reality	Multinational exchange is possible through games.
Games allow us to do things that are impossible in reality	Games are useful as a communication tool
Games allow us to experience things that we cannot experience in everyday life.	(Factor V. Health Damage and Dependence Induced)
Games allow us to play difficult games that we cannot play in reality.	Playing games causes poor posture
Games are a tool that can be played at a distance.	Games have negative effects such as game brain and game addiction.
Games can be enjoyed in ways other than playing.	Once addicted to a game, it is hard to know when to stop playing.
Games can be enjoyed by one person or multiple people.	Playing games makes us more tired.
Games have intellectual elements such as strategy	Games have the same dependence as alcohol and cigarettes.
Games use a lot of knowledge of AI, physics, mathematics, etc.	When I play games, I become a competitive player.
Games are an engrossing medium.	Playing games makes my eyesight worse.
Games are well-crafted entertainment	(Factor VI. Negative ideological effects)
Games allow us to feel emotionally involved with the main characters.	Violent games affect personality and ideology
Games expand my world.	Gaming with cruel expressions has a negative impact on reality.
Games allow me to relax and unwind	Games inculcate prejudice and certain ideologies
Games have an epic storyline	(Factor VII. lack of physical activity)
Games allow me to lose track of time and have fun	Playing games prevents people from playing outside
	Playing games causes lack of exercise

Table 1: Measurement Scale of Image and Consciousness of Gaming (translated from Japanese)

RESULTS AND DISCUSSION

Results of Descriptive Statistics

The descriptive statistics for computational thinking and the image and consciousness of gaming are presented in Table 2.

	mean	*SD*
Creativity	3.54	0.59
Algorithmic thinking	2.90	0.89
Cooperativity	3.78	0.86
Critical thinking	2.96	0.79
Problem-solving	3.05	0.65
Personal and social bad impressions	2.42	0.64
Special experiences and positive impressions	4.52	0.49
Skill improvement	3.56	0.80
Extensive communication	4.15	0.88
Health damage and dependence Induced	3.62	0.68
Negative ideological effects	2.93	1.05
Lack of physical activity	3.61	1.12

(n = 158)

Table 2: Results of descriptive statistics

Results of Analysis of Variance and Post-Hoc Test

Analysis of variance (ANOVA) was subsequently used to evaluate the differences in each factor score of computational thinking, depending on the positive and negative images of the game. Tukey HSD test was used to compare the results of ANOVA for significant differences between groups. Here, the upper groups of positive and negative images of the game were set as Group 1 (denoted–U-U), Group 2 (U-L), Group 3 (L-U), and Group 4 (L-L). Table 3 summarizes the results.

		Group				F value	Group Comparison
		1	**2**	**3**	**4**		
Creativity	Mean	3.75	3.73	3.40	3.20	8.61**	1 > 3, 1 > 4, 2 > 3, 2 > 4
	SD	0.46	0.63	0.59	0.47		
Algorithmic thinking	Mean	3.11	2.89	2.83	2.72	1.24	
	SD	0.83	0.97	0.88	0.82		
Cooperativity	Mean	3.91	3.88	3.74	3.52	1.52	
	SD	0.95	0.72	0.84	0.95		
Critical thinking	Mean	3.21	3.10	2.83	2.64	4.19**	1 > 4, 2 > 4
	SD	0.70	0.78	0.82	0.73		
Problem-solving	Mean	3.07	3.15	2.91	3.07	1.04	
	SD	0.63	0.73	0.66	0.50		

**p < .01 (df = 3, 154)

Table 3: Results of ANOVA

Table 3 shows that there were significant differences between the groups in creativity and critical thinking: for creativity, Groups 1 and 2 had significantly higher means than Groups 3 and 4. For critical thinking, Groups 1 and 2 had significantly higher means than Group 4. In other words, creativity indicates that the group with a positive image of games may have higher creativity. Critical thinking indicates that groups with negative images of games may have lower scores in critical thinking. This could either

be a possibility that a negative perception of games affects critical thinking or that the group had a negative image of games due to low critical thinking skills. This behavior should be carefully examined in the future.

It follows that the habit of seeing things from various angles is acquired through repeated trial and error in the game, which contributes to the basic development of creativity and critical thinking. In addition, various experiences in games may contribute to the development of the basic ability to generate ideas that cannot be obtained in the real world.

CONCLUSION

To obtain basic findings for enhancing education by means of digital games, we focused on the image and consciousness of digital games held by learners and attempted to verify the relationship between this image and computational thinking. The results show that learners' perceptions of games may be related to their respective levels of creativity and critical thinking. It is necessary to conduct further surveys with various user groups to examine the results in more detail, to develop educational materials using digital games, and to examine the effects of such games in practice.

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