The Relationship between Prior Gaming Experience and Consciousness of Computer Programming or Social Views on Information: An Empirical Study of High School Students in Japan

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ABSTRACT
The purpose of this research is to examine the relationship between prior gaming experience and consciousness of computer programming or social views on information. To evaluate this relationship, a questionnaire survey was conducted on high school students in Japan in 2016. As a result, the relationships between prior gaming experience and consciousness of computer programming or "Importance of understanding the mechanisms of computers" were shown. Besides, in the group playing the games usually, the average values of most items were significantly higher than those in the group which did not usually play the games. And there was also no significant difference between the higher group (over 2 hours a day) and the lower group (less than 2 hours a day). Based on the results, it was suggested that the use of game topics was effective for promoting consciousness of computer programming and social views on information in programming education.

Keywords
Prior gaming experience, Consciousness of computer programming, Social views on information, Empirical study, High school students

INTRODUCTION

The purpose of this research is to examine the relationship between prior gaming experience and consciousness of computer programming or social views on information by utilizing the data from the questionnaire survey towards high school students in Japan. In this section, the authors define several terms utilized in this research and explain about factors which might promote programming education based on the previous studies.

Importance of Programming Education

At the beginning, this paper defines "programming." Generally, most people think that programming is with coding or technical languages. So, it is considered difficult to master programming. In the educational system around the world, programming does not always require coding, and it is regarded as a skill to solve problems using computers (Ministry of Education, Culture, Sports, Science and Technology, 2015). Therefore, this research defines programming as "skills to solve problems using computers" and this paper proceed to discuss with an eye on this definition.

Currently, programming education is compulsory in various countries. For instance, in the UK, programming education is being implemented in the subject of "Computing" (Department for Education, 2013). In the US, Computer Science Teacher Association (CSTA) has published "CSTA K-12 Computer Science Standards," and programming education is being implemented based on CSTA's contents (CSTA, n.d.). Both in the UK and the US, it is expected to know and understand about computers and programming with "Computational Thinking" (Wing, 2006). In this context, it is considered that "in education, computational thinking is a set of problem-solving methods that involve expressing problems and their solutions in ways that a computer could execute (Wing, 2014)." Computational thinking is the ability/skill to solve problems using computers, and students are required to highlight this ability/skill for living in the changing society. In "the purpose of study of National Curriculum" in the UK, it is written as follows: "A high-quality computing education equips pupils to use computational thinking and creativity to understand and change the world. Computing has deep links with mathematics, science and design and technology, and provides insights into both natural and artificial systems. The core of computing is computer science, in which pupils are taught the principles of information and computation, how digital systems work and how to put this knowledge to use through programming. Building on this knowledge and understanding, pupils are equipped to use information technology to create programs, systems and a range of content. Computing also ensures that pupils become digitally literate – able to use, and express themselves and develop their ideas through, information and communication technology – at a level suitable for the future workplace and as active participants in a digital world." Thus, it is pointed out to be important to learn and develop computational thinking (Department for Education, 2013).

In programming education of each country, although there are several differences in the degree of using coding, there are many parts that are consistent with what Japanese government is aiming for. In fact, programming education is regarded as meaningful for promoting Science, Technology, Engineering, and Mathematics (STEM) education (Gonzalez and Kuenzi, 2012). Educating mathematical subjects to science and technology and understanding about existing information technologies are proposed and STEM education attracts attention as one of methods for efficiently acquiring these mathematical subjects. STEM education refers to education and learning in the fields of science, technology, engineering and mathematics.

Especially in Japan, it was decided to make programming compulsory at mandatory education in 2016, the new course of study guidelines was shown in 2018 and programming education will be implemented from 2020. At the high school level, programming education will be also further expanded in the near future (Ministry of Education, Culture, Sports, Science and Technology, 2018). Behind this background, Ministry of Education, Culture, Sports, Science and Technology is paying attention to the fact that our society is predicted to be greatly changed by technologies (e.g., artificial intelligence, IoT). It is expected that these changes by technologies will activate the activities of humans, support to discover new solutions related to various tasks, create new values and make the society convenient. Although the concrete contents of learning by students are not explained, it is pointed out that as our society is changing, what students are learning at school might become useless (Ministry of Education, Culture, Sports, Science and Technology, 2016; Ministry of Education, Culture, Sports, Science and Technology, 2018).

In the future, it is required not only to efficiently do a certain routine, but also to create new values through trial and error with computers. Creating new values is equally important for both junior high school and high school students, and it is meaningful to deepen their understanding about computers and programming (Ministry of Education, Culture, Sports, Science and Technology Elementary School Subcommittee, 2016; Ministry of Education, Culture, Sports, Science and Technology, 2018a).

Programming education at the compulsory education stage does not always require coding. It is important to learn about "Programming Thinking" and it is meaningful to put this thinking to work for jobs students choose after graduation. Programming thinking is that logical thinking about what kind of processing combination is necessary, how do they get better combination of some process, and how do they get better improving the process to get closer to the purpose in order to realize the student's own idea (Ministry of Education, Culture, Sports, Science and Technology Elementary School Subcommittee, 2016). Thus, programming thinking is related to problem-solving skills using computers.

Furthermore, at the high school level, it is expected to cultivate attitudes students have and cultivation of these attitudes might lead to the better life and society by making use of computers, scientific understanding about computers, and creative problem-solving skills with computers (Ministry of Education, Culture, Sports, Science and Technology, 2018a).

Thus, understanding about our society through utilization of computers and programming, the importance of creative activity, and understanding about various areas related to programming are important. In the high school education, using computer in systematic programming education from elementary school, with the goal of improving the qualities and abilities written in the summary of discussion while using coding etc. It is important to solve problems, to acquire the basis on the ability to use information creatively using computers. In other words, in programming education in Japan, it is required to promote "various consciousness of computer and programming" (hereinafter, "consciousness of computer programming"), "social views as background of programming" (hereinafter, "social views on information"), and it is important to consider how to train it. This research defined "social views on information" as student's consciousness about information society as the background of computer programming (Ministry of Education, Culture, Sports, Science and Technology Elementary School Subcommittee, 2016).

Gaming Experience and Programming Education

Previous studies researched about factors which have positive impact on the promotion of computer programming. Kuroda and Moriyama (2018) asked teachers working at elementary school about "programming education goals (qualities and abilities to train)" and "social views on information," and reports on the actual state of consciousness of teachers. Fukui et al. (2019) investigated the relationship between creative attitudes and interests for programming and clarified that students with higher creative attitudes had higher interests on programming. In addition to this aspect, it was pointed out that programming subjects enhanced "Analytical Problem Solving" and "Entrepreneurship." In this context, "Entrepreneurship" means the force to discover and observe new things. (Shigemasu et al., 1993). Other researches on the relationship between social views on information and creative attitudes are carried out (Fukui et al. 2018). In this way, various investigations have been conducted in the previous studies, but in order to enhance the programming education in Japan, it is necessary to conduct more investigations for students and teachers. Additionally, it is considered that it is necessary to develop subjects based on actual condition.

Although there are few studies about factors to highlight awareness about computer programming, several studies imply that programming is like a game. Practically, many programming activities with games and puzzles as subjects are introduced. Generally, game subjects are expected to increase their interests in programming (e.g., MIT Media Lab, 2019; Resnick, 2017). Although World Health Organization refers to the existence of "gaming disorder" (World Health Organization, 2018), and a negative image may be assumed in the game, there is a report that the degree of playing games has no negative effect on that of academic ability (Nakamuro, 2015). However, if students' prior gaming experiences are recognized to be related to various consciousness such as interest and usefulness of programming, it seems that at least the use of games in programming education is effective. DiSalvo and Bruckman (2008) studied the relevance between Video Games and Computer Science. As a result, they reported that there was a small relationship between gaming more frequently and the degree how students like Computer Science (DiSalvo and Bruckman, 2008; DiSalvo and Bruckman, 2009). In this way, there are several studies on the relevance of the game and computer related education, and it is necessary to consider how to utilize the game based on these findings. However, the research that has revealed the relevance of various consciousness about programming and social views on information, such as how prior gaming experience relates to interests of programming, is not present. Therefore, even in the development of the subject matter, it is not certain whether it is based on the student's actual condition.

If the relevance of the game experience and consciousness of computer programming or social views on information is shown, this relevance would suggest a possibility that the awareness about programming and social views on information is enhanced by using the game materials developed based on the actual situation. On the contrary, if there is no relevance, the game would should be utilized only for an easy-to-work subject and it would be necessary to consider lessons that combine non-game subjects. Also, if game experiences by students affect their relevance, it might be possible to propose that playing games is appropriate for activation of programming education.

Therefore, solving this problem may provide useful knowledge in further expanding programming education. Through the statistical analysis, this research tries to grasp the actual situation about the prior gaming experience, various consciousness of computer programming and the relevance of social views on information with the exploratory approaches by focusing on the attitudes of high school students in Japan.

OVERVIEW OF THE SURVEY AND METHODS

Survey Targets and Survey Procedure

To collect enough samples to analyze the relations this paper focused on, a total of 226 first-year students from 3 public high schools in H prefecture in Japan (92 boys and

134 girls) were targeted. They had not completed programming education in their high schools. The survey was conducted in the information class. After questionnaires were collected and aggregated appropriately, 169 effective responses were remained (64 boys and 105 girls). The response rate was 74.8%. Thus, these samples were utilized to analyze.

Measurement Scales

The measurement scale included (1) an item for grasping about how many hours each student is playing the game each day, (2) 5 items for evaluating the degree of consciousness of computer programming, and (3) 2 items for evaluating the degree of social views on information. Regarding consciousness of computer programming and social views on information, this paper measured items about (2) and (3) using a scale with the following possible responses: 4 = "Agree very much," 3 = "Agree slightly," 2 = "Do not agree much," and 1 = "Do not agree at all."

Prior gaming experience

As items to grasp the state of usual play of the game, students answered on how many hours they were playing the game each day (they wrote hours by numbers). It is impossible to track activities by high school students, so the optimal way to evaluate playing minutes was to ask them to answer the playing time. Thus, hours of playing games were self-reported data in this survey.

Consciousness of computer programming

In order to evaluate the degree of consciousness of computer programming by students, the following 5 items were prepared based on previous articles (Ministry of Education, Culture, Sports, Science and Technology, 2016; Fukui et al., 2018). Abbreviated versions of each item are shown in parentheses at the end of the sentence below.

(1) I'm interested in computer programming. (Interest in programming)
(2) Programming is very useful to me. (Usefulness of programming)
(3) I think that it is important to understand the contents of programming. (Importance of understanding the contents of programming)
(4) I think that the contents of programming are useful even for things other than programming. (Usefulness for applications other than programming)
(5) I think that it is meaningful to do programming. (Meaningfulness to do programming)

Social views on information

In order to evaluate the degree of social views on information by students, the following 2 items were prepared by citing the summary of discussion by Ministry of Education, Culture, Sports, Science and Technology (Ministry of Education, Culture, Sports, Science and Technology Elementary School Subcommittee, 2016), and other previous researches (Kuroda and Moriyama, 2018; Fukui et al., 2018). Abbreviated versions of each item were shown in parentheses at the end of the sentence below.

(1) I think that it is important to understand the mechanisms of computers. (Importance of understanding the mechanisms of computers)
(2) In the future, rather than using computers to improve work efficiency, I think that it will be more important to use computers for creative activities. (Importance of utilization of computers for creative activities)

Analysis Procedure

First, this paper shows the simple summary results about how many hours students are playing the games each day, each item on students' consciousness of computer programming (5 items) and social views on information (2 items). In order to evaluate the relevance between consciousness of computer programming and social views on information, Pearson product-moment correlation coefficient is calculated between each item. Pearson product-moment correlation coefficient test is also conducted to calculate p-value. In the next step, to confirm the positive relationship between prior gaming experience and consciousness of computer programming or social views on information, samples are classified into three different groups, "Higher group (over 2 hours a day)," "Lower group (less than 2 hours a day)" and "Not-playing group (don't play games)," based on hours of playing the game each day. Since the playing time of the game was 1.89 hours on average when looking at the students playing the game, that average time was rounded off to 2 hours. Therefore, over 2 hours a day was set as "Higher group," and less than 2 hours a day was set as "Lower group." After that, One-way ANOVA with prior gaming experience (3 groups) and consciousness of computer programming or social views on information is performed. In addition, this research also uses the multiple comparison between groups with Tukey-HSD. When considering about the practical conditions in the high school, teachers have to carry out most classes without distinction between boys and girls, so this research analyzes the relations without separating gender.

RESULTS

Descriptive Statistics and Correlations of Items

Prior gaming experience

From the results of this survey, there were 64 students playing games (37.9%) and 105 students who did not do them (62.1%). The playing time of the game was 1.89 hours on average (S.D. 1.59) when looking at the students playing the game and 1.03 hours on average (S.D. 1.51) as a whole. The longest playing time was 6 hours a day.

Consciousness of computer programming

Table 1 shows the simple summary results of each item about students' consciousness of computer programming. The average values of "Interest in programming" and "Importance of understanding the contents of programming" were lower than the midpoint of 2.50, and the average values of other items were higher than 2.50. And the mean value of "Usefulness of programming" was the highest among the items of consciousness of computer programming. Additionally, it was also shown that there was a large variation in "Interest in programming (S.D. 1.01)."

	Mean	S.D.
Interest in programming	2.24	1.01
Usefulness of programming	2.67	0.86
Importance of understanding the contents of programming	2.47	0.87
Usefulness for applications other than programming	2.50	0.83
Meaningfulness to do programming	2.53	0.87

(n=169)

Table 1: Descriptive statistics of consciousness of computer programming.

Social views on information

Table 2 shows a simple summary of the results of each item about social views on information. All the average values of social views on information were higher than the midpoint of 2.50. And the mean value of "Importance of understanding the mechanisms of computers" was the highest among the items of social views on information.

	Mean	S.D.
Importance of understanding the mechanisms of computers	2.98	0.77
Importance of utilization of computers for creative activities	2.69	0.79
		(n=169)

Table 2: Descriptive statistics of social views on information.

Correlation between consciousness of computer programming and social views on information

In order to evaluate the correlation between consciousness of computer programming and social views on information, Pearson product-moment correlation coefficients were calculated between each item. And Pearson product-moment correlation coefficient test was also conducted to calculate p-value. Table 3 shows Pearson product-moment correlation coefficients between consciousness of computer programming and social views on information.

As seen in Table 3, the relationships have positive correlations. These correlations between each item of consciousness of computer programming and each correlation were significant at 1% level. Especially, 17 relationships have higher correlation values above the value of 0.40.

	I	II	III	IV	V	VI	VII
I	—	0.56 **	0.60 **	0.61 **	0.56 **	0.40 **	0.25 **
II		—	0.77 **	0.74 **	0.63 **	0.43 **	0.30 **
III			—	0.77 **	0.60 **	0.42 **	0.32 **
IV				—	0.60 **	0.48 **	0.32 **
V					—	0.50 **	0.52 **
VI						—	0.49 **

Note: $^{**}p < .01$ (n=169)

I: Interest in programming
II: Usefulness of programming
III: Importance of understanding the contents of programming
IV: Usefulness for applications other than programming
V: Meaningfulness to do programming
VI: Importance of understanding the mechanisms of computers
VII: Importance of utilization of computers for creative activities

Table 3: Correlation between consciousness of computer programming and social views on information.

Based on these results, there were positive relations between each item of consciousness of computer programming and "Importance of understanding the mechanisms of computers" or "Importance of utilization of computers for creative activities." Therefore, on the whole, it was expected that there was a positive correlation between consciousness of computer programming and social views on information.

Relationships between prior gaming experience and consciousness of computer programming

In order to evaluate the relationship between prior gaming experience and consciousness of computer programming, three groups, “Higher group (over 2 hours a day),” “Lower group (less than 2 hours a day)” and “Not-playing group (don’t play games)” were set up based on hours of playing the game a day, and one-way ANOVA was performed with prior gaming experience and consciousness of computer programming. The multiple comparison among three different groups with Tukey-HSD was conducted. The results are shown in Table 4.

As seen in Table 4, the average values in the higher group were higher than the midpoint of 2.50, and those in the lower group were also higher than the midpoint of 2.50 except the one item, “Interest in programming.” And all the average values in the not-playing group were lower than the midpoint of 2.50. One-way ANOVA was performed with prior gaming experience and each items of consciousness of computer programming and as a result, about “Interest in programming” ($F_{(2,166)}$=8.15, p <.01), “Usefulness of programming” ($F_{(2,166)}$=6.10, p <.01), “Importance of understanding the contents of programming” ($F_{(2,166)}$=5.15, p <.01), “Usefulness for applications other than programming” ($F_{(2,166)}$=6.20, p <.01) and “Meaningfulness to do programming” ($F_{(2,166)}$=6.02, p <.01), the difference between the average values of each group were significant at 1% level. The average values of groups which playing games (Higher group and lower group) was higher than those of the group which not playing games (Not-playing group). As a result of multiple comparisons, the average values of both the higher group and the lower group was significantly higher than those of the not-playing group. However, the difference between the higher group and the lower group was not significant.

		Higher (n=38)	Lower (n=54)	Not-Playing (n=77)	F-value	Multiple Comparisons
Interest in	Mean	2.63	2.43	1.92	8.15	Higher > Not-Playing,
computer programming	S.D.	1.09	0.96	0.91	**	Lower > Not-Playing
Usefulness of programming	Mean	2.87	2.89	2.43	6.10	Higher > Not-Playing,
	S.D.	0.66	0.88	0.87	**	Lower > Not-Playing
Importance of understanding	Mean	2.61	2.70	2.25	5.15	Higher > Not-Playing,
the contents of programming	S.D.	0.84	0.90	0.81	**	Lower > Not-Playing
Usefulness for applications	Mean	2.74	2.67	2.26	6.20	Higher > Not-Playing,
other than programming	S.D.	0.75	0.84	0.80	**	Lower > Not-Playing
Meaningfulness to do programming	Mean	2.76	2.72	2.29	6.02	Higher > Not-Playing,
	S.D.	0.78	0.91	0.82	**	Lower > Not-Playing

Note: **p < .01 (df=2,166, n=169)

Table 4: Relationships between prior gaming experience and consciousness of computer programming.

Thus, relationships between prior gaming experience and all the items of consciousness of computer programming were shown. In addition, there was no significant difference between the higher group which playing the games over two hours a day and the lower group which playing the games less than 2 hours a day.

Relationships between prior gaming experience and social views on information

In order to evaluate the relationship between prior gaming experience and social views on information, one-way ANOVA with prior gaming experience and consciousness of computer programming was performed. Multiple comparison was also conducted between 3 groups with Tukey-HSD. Results are shown in Table 5.

As seen in Table 5, the average values of all items in each group were higher than the midpoint of 2.50. Next, one-way ANOVA with prior gaming experience and each items of social views on information was performed. As a result, in “Importance of understanding the mechanisms of computers” ($F_{(2,166)}$=6.93, p <.01), the difference between average values in each group was significant at 1% level, and the average values of groups playing games (Higher group and lower group) were higher than that of the group not playing games (Not-playing group). On the other hand, about “Importance of utilization of computers for creative activities” ($F_{(2,166)}$=2.31, *n.s.*), the difference between average values in each group were not significant. As the result of multiple comparisons in “Importance of understanding the mechanisms of computers,” the average value of the higher group was significantly higher than that of the not-playing group. Besides, the difference between the higher group and lower group and that between the lower group and the not-playing group were not significant in each item.

		Higher (n=38)	Lower (n=54)	Not-Playing (n=77)	F-value	Multiple Comparisons
Importance of understanding	Mean	3.34	2.98	2.79	6.93	Higher > Not-Playing
the mechanisms of computers	S.D.	0.62	0.78	0.76	**	
Importance of utilization of	Mean	2.79	2.82	2.55	2.31	—
computers for creative activities	S.D.	0.66	0.82	0.80	*n.s.*	

Note: ** p < .01 (*df*=2,166, n=169)

Table 5: Relationships between prior gaming experience and social views on information.

Thus, the relationship was recognized between prior gaming experience and “Importance of understanding the mechanisms of computers”. In addition, it was suggested that there was significant difference between the higher group which playing the games over two hours a day and the not-playing group which didn’t play the games usually. On the other hand, “Importance of utilization of computers for creative activities” was not significant so it was suggested that these items were not related to prior game experience by high school students.

DISCUSSION

The results can be mainly summarized into the following 5 points.

1. 64 students (37.9%) were playing games usually and 105 students (62.1%) were not doing them. The average time of playing games was 1.89 hours (S.D. 1.59, on only by the students playing the game) and 1.03 hours on average (S.D. 1.51, as a whole). The maximum value of playing time was 6 hours a day.

2. The overall average values of “Interest in programming” and “Importance of understanding the contents of programming” were lower than the midpoint of 2.50, and the average values of other items were higher than the midpoint, 2.50. The overall average values of social views on information were higher than the midpoint of 2.50.

3. All the relationships about the consciousness of computer programming and the social views on information had positive correlations, and these values showed significantly higher than the value of 0.40 in the most relationships.

4. In terms of “Interest in programming,” “Usefulness of programming,” “Importance of understanding the contents of programming,” “Usefulness for applications other than programming” and “Meaningfulness to do programming,”

the difference between average values were significant at 1% level, and the average values of higher group and lower-group was higher than those of the not-playing group. In addition, as the result of multiple comparisons, the average values of the higher group and the lower group were significantly higher than that of the not-playing group. However, the difference between the higher group and the lower group was not significant.

5. In terms of "Importance of understanding the mechanisms of computers," the difference between average values in each group were significant at 1% level, and the average values of both the higher group and the lower group was higher than that of the not-playing group. On the other hand, about "Importance of utilization of computers for creative activities," the difference between average values in each group were not significant at 5% level. In addition, as a result of multiple comparisons in "Importance of understanding the mechanisms of computers," the average value of the higher group was significantly higher than that of the not-playing group. And the difference between the higher group and the lower group and that between the lower group and the not-playing group were not significant.

As already pointed out, in programming as general education, it is important to develop programming thinking regardless of subjects and fields. At the same time, it is important to solve creative problems using computers and to promote various consciousness of computer programming and social views of information. Despite the presence or absence of the introduction of coding in the programming education, programming thinking is supposed to be effective.

It was considered that utilization of games might increase the interest in programming. Also, since there was no significant difference between the higher group and the lower group, even if student did not play games for such a long time, it could be expected that students who play games should highlight their consciousness of computer programming and "Importance of understanding the mechanisms of computers." Thus, there was a possibility that it was effective to enhance these ability/skills by playing the games for a short time or utilizing game subjects. At the introductory programming education, it can be expected to promote consciousness of computer programming by conducting classes on algorithms, making use of game subjects and lessons with games as a theme. Then, with new strategies, it is required to connect the programming education of coding with the education to promote consciousness of computer programming. On the other hand, "Importance of utilization of computers for creative activities" did not show any relevance to prior gaming experience. In "Importance of utilization of computers for creative activities," it was shown that it was meaningful to develop original themes and make strategies.

From the above, it might be effective to utilize game topics as a subject of programming. For the introductory programming education, it might be essential to highlight consciousness of computer programming and social views on information with topics of the game students usually play (e.g., puzzles).

SUMMARY AND FUTURE WORKS

This paper examined the relationship between prior gaming experience and consciousness of computer programming or social views on information. As a result, the following points are shown based on the analysis. First, all the relationships had positive/strong positive correlations.

Second, when focusing on "Interest in programming, "Usefulness of programming," "Importance of understanding the contents of programming," "Usefulness for applications other than programming" and "Meaningfulness to do programming," the differences between the average values of each group were significant at 1% level, and the average values of the higher group and the lower group was higher than those of the not-playing group. Based on the results of multiple comparisons, the average values of the higher group and the lower group was significantly higher than those of the not-playing group. However, the difference between the higher group and the lower group was not significant.

Third, when considering about "Importance of understanding the mechanisms of computers," the difference between average values in each group were significant at 1% level, and the average values of the higher group and the lower group was higher than that of the not- playing group. On the other hand, when looking at "Importance of utilization of computers for creative activities," the difference between average values in each group were not significant at 5% level. Besides, the results of multiple comparisons in "Importance of understanding the mechanisms of computers" showed the average value of the higher group was significantly higher than that of the not-playing group. And the difference between the higher group and the lower group and the difference between the lower group and the not-playing group were not significant.

The results of this research seem to be important for the promotion of future programming education. From the above, it was suggested that the use of game topics was effective for promoting most items about consciousness of computer programming and social views on information in programming education, while "Importance of utilization of computers for creative activities" were not related to the degree of playing the game. It is essential to consider about these two aspects and how to cultivate them.

However, there are several limitations to overcome in the future research. Firstly, we should consider whether it is required to reflect the difference by gender or not deeply. In this research, it was not conducted to compare the difference of the awareness towards programming with classification by gender. Generally, it is reported that men tend to be interested in robots. Actually, on average, girls and women are less involved with video games than boys and men (Hartmann and Klimmt, 2006). Therefore, in order to introduce lessons using games for cultivating the awareness towards programming or utilization of computers, it should be essential to prepare different themes that are interested by each gender. To clarify this difference by gender, it is essential to add several items related to concrete contents in the questionnaire survey and compare the awareness by men with that by women.

Secondly, it is necessary to grasp the type of games high school students play and to examine consciousness of computer programming as readiness based on the real situation. There are a variety of games, various genres and game machines. In addition, it is necessary to consider about the influence of various games such as digital or analog games, including rocking scissors, card games and massively multiplayer online role-playing games.

Thirdly, it is necessary to evaluate the relationship between prior gaming experience and other factors. For instance, playing the game is expected to cultivate and promote various abilities such as creativity, flexibility, critical thinking and so on. The insights about relationship between them might contribute to develop the new possibility to utilize the game for education.

Lastly, although this study used 4-point Likert-scale to design the questionnaire items, previous studies criticized the lack of validity of 4-point Likert-scale (e.g., Leung, 2011). It is essential to consider about the psychometric properties regarding Likert-scale in the future studies.

In keeping with limitations of this study, it is required to solve these problems and contribute to the development of programming education. We will try to solve them in the next step.

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BIBLIOGRAPHY

Computer Science Teacher Association (CSTA). n.d. "CSTA K-12 Computer Science Standards." 28 January. https://www.csteachers.org/page/standards.

Department for Education. 2013. "National curriculum in England: computing programmes of study." 28 January. https://www.gov.uk/government/publications/national-curriculum-in-england-computing-programmes-of-study/national-curriculum-in-england-computing-programmes-of-study.

DiSalvo, B.J., and Bruckman, A. 2004. "Exploring Video Game's Relationship to CS Interest." 28 January. https://pdfs.semanticscholar.org/d276/a014ea53d4b322ea4a2c67502466429e385a.pdf.

DiSalvo, B.J., and Bruckman, A. 2009. "Questioning video games' influence on CS interest." Proceedings of the *4th International Conference on Foundations of Digital Games*, 272-278.

Fukui, M., Kuroda, M., Moriyama, J. and Hirashima, T. 2018. "The Relationship between Students' Creative Attitudes and Consciousness of Computer Programming." *International Conference on Creativity and Innovation 2018 (ICCI2018)*, Osaka, Japan, 10-12, September. Japan Creativity Society (JCS).

Gonzalez, H.B. and Kuenzi, J.J. 2012. "Science, Technology, Engineering, and Mathematics (STEM) Education: A Primer." CRS Report for *Congress Prepared for Members and Committees of Congress.*

Hartmann, T. and Klimmt, C. 2006. "Gender and Computer Games: Exploring Females' Dislikes." *Journal of Computer-Mediated Communication*, 11, 910-931.

Kuroda, M. and Moriyama, J. 2018. "An Examination on Formation Factors of Teachers' Awareness on Meaning of Programming Education in Elementary School." *Journal of Educational Media Study*, 24(2), 43-54. (in Japanese)

Leung, S. O. 2011. "A Comparison of Psychometric Properties and Normality in 4-, 5-, 6-, and 11-Point Likert Scales." *Journal of Social Service Research*, 37(4), 412-421.

Ministry of Education, Culture, Sports, Science and Technology Elementary School Subcommittee. 2016. "Discussion about programming education at the stage of elementary school (Summary of discussion)." 28 January. (in Japanese) http://www.mext.go.jp/b_menu/shingi/chousa/shotou/122/attach/1372525.htm.

Ministry of Education, Culture, Sports, Science and Technology. 2015. "Survey Research Report on Programming Education in Other Countries." 28 January. (in Japanese) http://jouhouka.mext.go.jp/school/pdf/programming_syogaikoku_houkokusyo.pdf.

Ministry of Education, Culture, Sports, Science and Technology. 2018. "Elementary school programming education guide (2nd edition)." 28 January. (in Japanese) http://www.mext.go.jp/component/a_menu/education/micro_detail/__icsFiles/afieldfile/2018/11/06/1403162_02_1.pdf.

Ministry of Education, Culture, Sports, Science and Technology. 2018a. "The Courses of Study for High Schools (Information)." 28 January. (in Japanese) http://www.mext.go.jp/component/a_menu/education/micro_detail/__icsFiles/afieldfile/2019/03/28/1407073_11_1_1.pdf.

MIT Media Lab. 2019. "Scratch." 25 May. https://scratch.mit.edu.

Nakamuro, M. 2015. *Economics of academic ability*. Tokyo, Japan: Discover 21, 52-57.

Resnick, M. 2017. *Lifelong Kindergarten: Cultivating Creativity through Projects, Passion, Peers, and Play*, Cambridge, UK: The MIT Press.

Shigemasu, K., Yokoyama, A., Stern, S., and Komazaki, H. 1993. "Comparison of creative attitudes between American and Japanese students: A factor analytical study." *The Japanese Journal of Psychology*, 64(3), 181-190. (in Japanese)

Wing, J. M. 2006. "Computational Thinking." *Communications of the ACM*, 49(3), 33-35.

Wing, J. M. 2014. "Computational Thinking Benefits Society." 40th Anniversary Blog of Social Issues in Computing, 28 January. http://socialissues.cs.toronto.edu/index.html%3Fp=279.html.

World Health Organization. 2018. "Gaming disorder." 28 January. https://www.who.int/features/qa/gaming-disorder/en/.