Relationships between Japanese University Students' Interest in Computer Programming, Their Logical Thinking, and IT Literacy

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Abstract

Increasing emphasis is being placed on strengthening personal ability for computer programming. However, students have different levels of readiness and consciousness to learn programming. When promoting computer education, it is imperative that the curriculum be designed, considering students' backgrounds and awareness of computer programming. This study examines the relationships between Japanese university students' interest in computer programming, logical thinking, and IT literacy. A questionnaire study with 118 Japanese university students suggests the following findings on the students in humanities. (1) More than 60% of the liberal arts students are interested in computer programming, which is more students than we expected; (2) it is important for students in humanities to focus on designing a program that motivates them; (3) their computer software experiences may slightly influence interest in computer programming. Although further investigations are needed, the preliminary indicators from this study suggest that the curriculum flow, in which general information literacy classes are introduced before computer programming classes, is expected to reduce liberal arts students' psychological resistance to programming and promote their readiness and consciousness toward it. Furthermore, we hope to investigate the relationships between students' interest in computer programming and their future career plans by targeting the students in humanities.

Keywords: Programming Education, Student Interest in Computer Programming, Logical Thinking, IT Literacy

Introduction

Increasing emphasis is being placed on strengthening personal ability for computer programming. Japan’s Ministry of Education, Culture, Sports, Science and Technology (MEXT) (MEXT, 2018) explicitly mentioned fostering information literacy, including the ability to think logically as a way of programming in elementary and secondary education. Computer programming became a mandatory subject in Japan’s elementary schools in 2020 (MEXT, 2020). The National Center for University Entrance Examinations (2021) also announced that the subject “information” was planned to be introduced into the Common Test for University Admissions in 2025, and exam sample questions were published and explained (Mizuno, 2021). These measures aim to train a new generation by equipping them with advanced information and technology skills.

On the other hand, students have different levels of readiness and consciousness to learn programming. Particularly, university students did not go through such a mandate, and they have varied experience and knowledge regarding computer programming. It should be considered how to adapt instructions for different populations. In order to plan and implement effective instructions, it is critical to have a better understanding of students.

To meet this challenge, this study examines the relationships between Japanese university students’ interest in computer programming, logical thinking, and IT literacy. We conducted a questionnaire study with 118 Japanese university students to investigate the following research questions:

1. How is students’ interest in computer programming? Is there any difference depending on the faculty?
2. Is students’ interest in computer programming related to their logical thinking attitudes? Is there any difference depending on the faculty?
3. Is students’ interest in computer programming related to their personal computer experiences? Is there any difference depending on the faculty?

Below, we first describe related studies, then provide the methods of the present study, deliver its results, and discuss its findings. Finally, we present our conclusions and recommendations for further studies.

Related Studies

Nowadays, fostering human resources based on information technology is globally demanded regardless of whether the student is in a humanities course or science (MEXT, 2018). In response to these demands, the development of teaching plans and training materials for computer programming is being promoted (MEXT, 2019). Efforts related to computer programming education are being promoted at elementary schools nationwide, and various practical reports are being made. For example, programming activities for mathematics and English classes are introduced in a case report (Shimabuku, 2021). Programming activities using a one-board microcomputer were proposed in science classes (Kato, Matsuda, Ueno, & Hamada, 2019). Programming education in elementary school is conducted within various existing subjects. In junior high school education, students learn programming for measurement, control, and interactive content, and in senior high school education, they learn programming, including algorithms (Kanemune, 2019). At the junior high school level, Noguchi and Ogura (2020) investigated the systematic curriculum for programming education, taking science as an example. Shinkai & Sumitani (2008) developed the learning support system for introductory programming courses and they succeeded in a preliminary evaluation experiment for technical college students.

On the teacher's side, many elementary school teachers are expected to be worried about teaching programming. To deal with this problem, training programs for teachers who are unfamiliar with programming education are being proposed. For example, a training program is proposed in which training sessions are conducted multiple times in a short time considering the actual working conditions of the respective schools (Kawasumi, Ito, Kuroha, & Kobayashi, 2019). In the research case by Yasukage & Shinch (2018), elementary school teachers gained confidence in practice and contributed to promoting programming education through the teacher training course. On the student's side, Kobayashi and Nakagawa (2019) revealed the changes in the consciousness of students on "thinking and expression" in programming education at the elementary school level through three categorized educational practices. Another research reported on the educational practices in elementary school mathematics classes using a block-based visual programming language called "Scratch" and non-computer programming (Kuroha, Ito, Kawasumi, & Kobayashi, 2021). The results indicated that learning content has become more established than in conventional educational practice and that students' motivation and interest in programming have increased.

Given the varying levels of readiness and consciousness as well as the experience and knowledge regarding computer programming, we considered it important to design the curriculum taking into account students' backgrounds and awareness of computer programming. From this point of view, we explore the relationships between Japanese university students' interest in computer programming, logical thinking, and IT literacy.

Methods

Participants

This study's participants consisted of 118 first-year students in three classes at a university in Japan (i.e., 40 in Economics class, 39 in Global Human Sciences class, and 39 in Engineering class). Table 1 shows the number of students and their respective majors. These students completed a questionnaire, the questions of which are displayed in Table 2.

Data Collection and Analysis

A questionnaire was administered to gather subjective responses from students about their interest in computer programming, logical thinking, and IT literacy. Table 2 shows the questionnaire items. Responses were scored on a five-point Likert Scale (i.e., 1 point for Strongly Disagree, 2 points for Moderately Disagree, 3 points for Neutral, 4 points for Moderately Agree, and 5 points for Strongly Agree). Through a Wilcoxon rank-sum test and a correlational analysis, we attempted to investigate how the variables were distributed and related to one another.

Table 1: Number and Major Field of Participants

Class	Grade	Major Field	Number of Students
A	1^{st} year	Economics	40
B	1^{st} year	Global Human Sciences	39
C	1^{st} year	Engineering	39

Table 2: Questionnaire Items

Regarding Students' Interest in Computer Programming, Logical Thinking, and IT Literacy
Q1. I am good at thinking things in order.
Q2. I am good at thinking things logically.
Q3. I often use Microsoft Office applications, such as Word, Excel, and PowerPoint.
Q4. I am interested in computer programming.

Results and Discussion

We investigated research questions on students' interest in computer programming, and the relationships between their interest in programming and other items. Here we analyzed the whole tendency of the questionnaire results. The results of the questionnaire responses are listed in Figure 1 to Figure 4. The percentage of participants who chose the five options in the respective questions is shown in these figures. Q1 in Figure 1 and Q2 in Figure 2 concern students' logical thinking, Q3 in Figure 3 concerns their computer software experiences, and Q4 in Figure 4 concerns their interests in computer programming.

First, we will look at how the participants showed agreement with Q1 and Q2, that is, their logical thinking attitudes. According to the results of Q1 in Figure 1, a total of 60% of the participants in class A showed agreement (i.e., "I am good at thinking things in order."). In class B, a total of 56.4% agreed with Q1. In both classes, around 60% showed agreement with Q1. Meanwhile, a total of 76.9% in class C showed agreement with Q1. From the results of Q2 in Figure 2, a total of 55% of the participants in class A agreed (i.e., "I am good at thinking things logically."). In class B, a total of 56.4% agreed with Q2. In both classes, a little less than 60% showed agreement with Q2. Meanwhile, a total of 74.3% in class C agreed with Q2. Regarding student logical thinking attitude, more participants in science (class C) than those in humanities (class A and B) show positive responses, as expected to some extent.

Next, we will look at how the participants showed agreement with Q3, that is, their computer software experiences. According to the results of Q3 in Figure 3, a total of 37.5% of the participants in class A showed agreement (i.e., "I often use Microsoft Office applications, such as Word, Excel, and PowerPoint."). In class C, a total of 41% agreed with Q3. In both classes, around 40% showed agreement with Q3. Meanwhile, a total of 64.1% in class B agreed with Q3. Regarding computer software experiences, it did not matter if the participants were in science or humanities. Regarding Q4, we will discuss this in the following section.

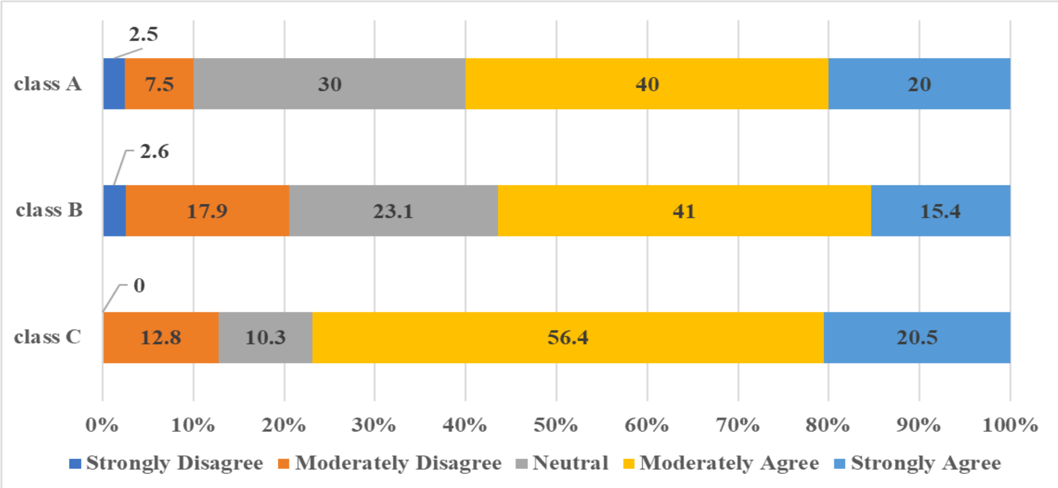

Figure 1: The Percentage of Participants Who Chose the Respective Options in Q1.

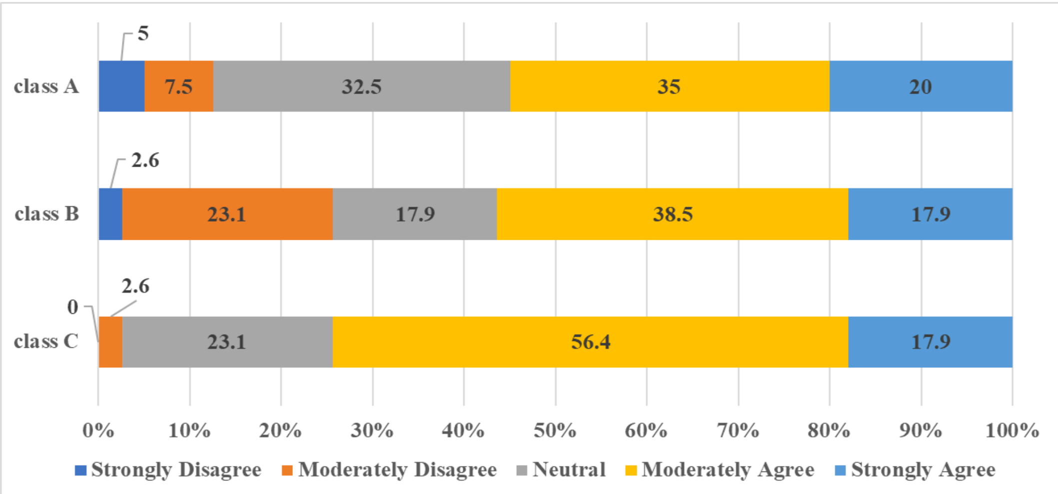

Figure 2: The Percentage of Participants Who Chose the Respective Options in Q2.

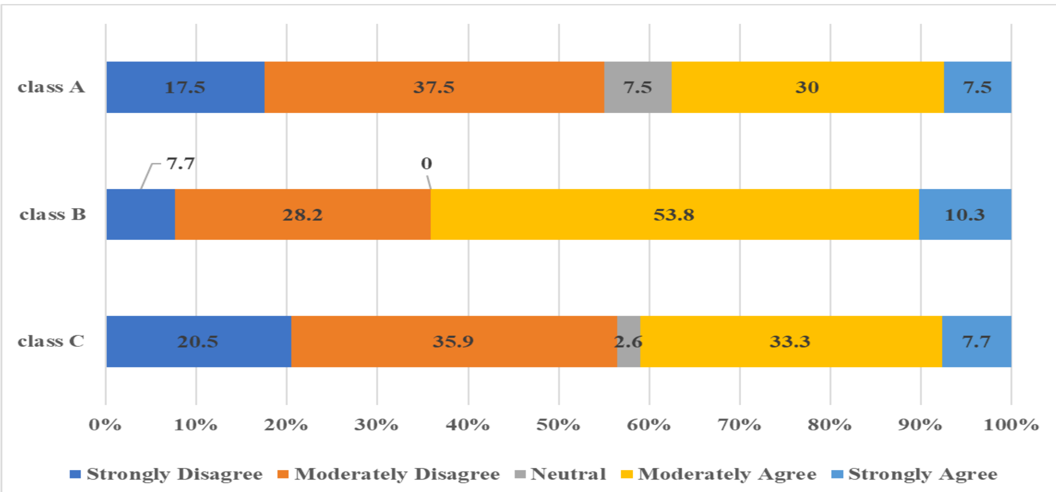

Figure 3: The Percentage of Participants Who Chose the Respective Options in Q3.

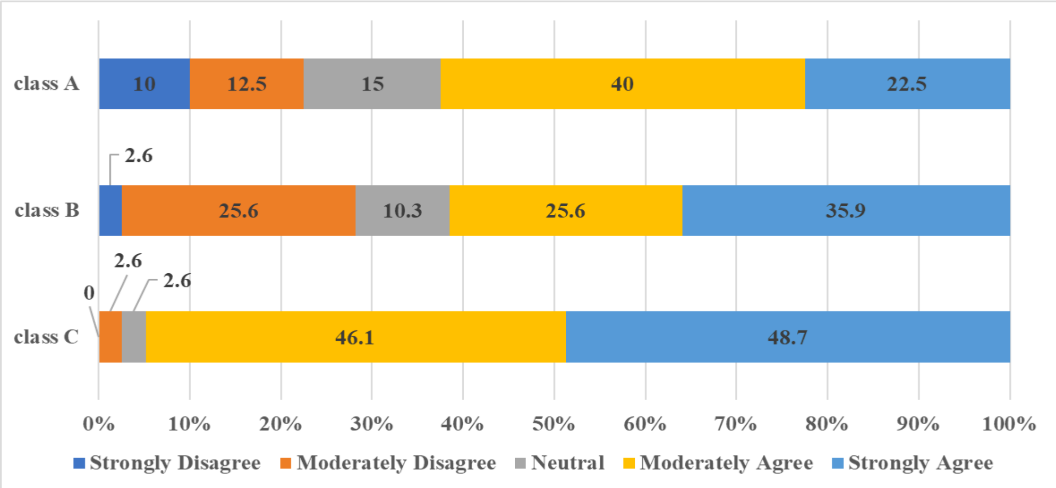

Figure 4: The Percentage of Participants Who Chose the Respective Options in Q4.

RQ1: How is students' interest in computer programming? Is there any difference depending on the faculty?

Concerning RQ1, we will analyze how the participants showed agreement with Q4, that is, their interests in computer programming. Here we used Wilcoxon rank-sum test on the data of Q4 to analyze whether two classes are different from one another in a statistically significant manner at the 0.05 level.

We first calculated the average scores of the responses by a five-point Likert Scale for the respective classes to investigate student perceptions overall. The average scores for the three classes were 3.5 (class A), 3.7 (class B), and 4.4 (class C). The average score of class C was higher than those of class A and class B. From the results of Figure 4, a total of 94.8% of the participants in class C showed agreement with Q4 (i.e., "I am interested in computer programming.").

Then by using the Wilcoxon rank-sum test on the data of Q4, we analyzed whether the following two classes, class A and class B, class A and class C, and class B and class C, are statistically different. The results indicated that class A and class C ($p=0.0006$) and class B and class C ($p=0.0158$) are statistically different, while class A and class B ($p=0.5319$) are not.

These results suggest that participants in science have significantly higher interests in computer programming compared to those in humanities.

At the same time, from the results of Q4 in Figure 4, a total of 62.5% of the participants in class A showed agreement. Also, in class B, a total of 61.5% agreed with Q4. In both classes, more than 60% of the participants showed agreement with Q4. The results indicate that more students than we expected have interests in computer programming. These results suggest the importance of designing a program that motivates liberal arts students when considering a program for computer programming.

RQ2: Is students' interest in computer programming related to their logical thinking attitudes? Is there any difference depending on the faculty?

We investigated how students' interest in computer programming was related to their logical thinking attitudes. To analyze the data related to RQ2, we calculated Spearman's rank-order correlation coefficients between Q1 and Q4, also Q2 and Q4 from the questionnaire. *Correlation represents statistical significance at the 0.05 level.

Table 3: Correlations among Questionnaire Items.

	Class	Q1	Q2	Q3	Q4
Q1	**A**	—			
	B	—			
	C	—			
Q2	**A**	**0.56***	—		
	B	**0.68***	—		
	C	**0.52***	—		
Q3	**A**	**-0.13**	**-0.11**	—	
	B	**0.29**	**0.27**	—	
	C	**0.26**	**0.05**	—	
Q4	**A**	**0.22**	**0.23**	**0.37***	—
	B	**0.20**	**0.03**	**0.07**	—
	C	**0.26**	**0.35***	**0.19**	—

* $p<.05$

The results of the correlation coefficients between Q1 and Q4 in the three classes indicated in Table 3 (class A: r_{Q1Q4}=0.22, class B: r_{Q1Q4}=0.20, class C: r_{Q1Q4}=0.26) show that no significant relationship exists between students' interest in computer programming and their logical thinking attitudes. Meanwhile, the correlation coefficient results between Q2 and Q4 only in class C in Table 3 (r_{Q2Q4}=0.35) show a significantly weak positive relationship between students' interest in computer programming and their logical thinking attitudes. However, the correlation coefficients between Q2 and Q4, both in class A (r_{Q2Q4}=0.23) and class B (r_{Q2Q4}=0.03), are not statistically significant.

Regarding student logical thinking attitude, there is a weak relationship between interest in computer programming and logical thinking ability only in the Engineering class. The results suggest that students' logical thinking may slightly influence interest in computer programming.

RQ3: Is students' interest in computer programming related to their personal computer experiences? Is there any difference depending on the faculty?

We also investigated how students' interest in computer programming was related to their computer software experiences by calculating Spearman's rank-order correlation coefficients between Q3 and Q4.

The results of the correlation coefficient between Q3 and Q4 only in class A in Table 3 (r_{Q3Q4}=0.37) show a significantly weak positive relationship between students' interest in computer programming and their computer software experiences. However, the correlation coefficients between Q3 and Q4, both in class B (r_{Q3Q4}=0.07) and class C (r_{Q3Q4}=0.19), are not statistically significant. Regarding computer software experiences, there is a weak relationship between interest in computer programming and computer software experiences only in the Economics class. The results also suggest that students' computer software experiences may slightly influence interest in computer programming.

From these suggestions, it is important to design a curriculum in which students take general information literacy education before learning computer programming. This curriculum flow is expected for students to become more interested in computer programming.

Findings

As for considering students' backgrounds and awareness of computer programming, it is still a work in progress. However, the preliminary indicators from this study suggest important findings on the students in humanities. From the questionnaire results, more than 60% of the students in humanities have an interest in computer programming. Regarding students' interest in computer programming and their logical thinking attitudes, the results also show that no significant relationship exists among students in humanities. These results suggest the importance of focusing on designing a program that motivates liberal arts students rather than sticking to whether they have logical thinking abilities. Furthermore, regarding computer software experiences, the results show a weak relationship between interest in computer programming and computer software experiences in the Economics class. It is suggested that students' computer software experiences may slightly influence interest in computer programming. From these suggestions, if general information literacy classes are introduced before students learn computer programming, this curriculum flow is expected to reduce liberal arts students' psychological resistance to programming and promote their readiness and consciousness toward it.

Limitations and Recommendations

The current study has certain limitations. It was conducted with only three classes, a small group of students. More studies are needed to target a larger number of students. Also, logical thinking ability is subjectively evaluated by the students themselves in this study. Objective evaluation is needed to measure logical thinking ability. Furthermore, the preliminary indicators from this study suggest that students' fields of study and future career plans must be considered when designing and implementing computer education. We hope to investigate the relationships between students' interest in computer programming and their future career plans.

Conclusion

In order to promote computer education, the curriculum must be designed considering students' backgrounds and awareness of computer programming. This study examines the relationships between Japanese university students' interest in computer programming, logical thinking, and IT literacy.

The results of our preliminary study suggest the following findings on the students in humanities. (1) More than 60% of the liberal arts students are interested in computer programming, which shows that more students than we expected have an interest; (2) it is important to focus on designing a program that motivates them; (3) their computer software experiences may slightly influence interest in computer programming. The curriculum flow, in which general information literacy classes are introduced before computer programming classes, is expected to reduce their psychological resistance to programming and promote their readiness and consciousness toward programming.

As a continuation of this study, we could examine these relationships by targeting the students in humanities. The preliminary indicators from this study suggest that students' fields of study and future career plans must be considered when designing and implementing computer education. We hope to investigate the relationships between students' interest in computer programming and their future career plans.

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