Japanese University Students' Learning Experiences and Attitudes Toward Computer Programming

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Abstract
In Japan, the development of human resources with programming skills has become an urgent issue. Meanwhile, the experience of learning programming varies from learner to learner. Interest in programing may differ depending on each learner's area of expertise. Thus, this study aimed to investigate learners' learning experiences and attitudes toward computer programming. A questionnaire using a five-point Likert scale was distributed to 117 Japanese university students from three classes: one in science and two in humanities. The findings suggest three main points: (1) A little more than 40% of students in humanities and two-thirds of the students in science did not have any programming experience—these numbers were higher than we expected. (2) Regarding students' awareness of programming skills use in their future careers, the average scores for all three classes reached 4 or higher, suggesting that both science and humanities students were fully aware of the importance of programming skills, although such responses were significantly higher among the science students. (3) Regarding interest in computer programming, the average score for both humanities classes was 3.1, whereas that for the science class was 4.5, which shows that interest in programming was significantly lower among humanities students. Furthermore, the results from the two humanities classes indicated that, of the students who indicated little or no interest in computer programming, 50% (humanities class 1) and approximately 70% (humanities class 2) had never learned programming. Liberal arts students' experience in learning programming may be affected by their interest in it.

Keywords: Programming Education, Programming Skills for Future Career Plans, Student Interest in Computer Programming, Information Technology Literacy

Introduction

Computer programming-based information technology (IT) has been firmly established in our lives. Various types of jobs will require human resources with programming skills soon. In Japan, the shortage of IT human resources is a major concern (Mizuho Information & Research Institute, Inc, 2019), and reinforcement measures are being implemented to raise the level of IT skills. As a part of the policy for promoting programming education (MEXT, 2018a), Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT) has deemed programming education mandatory in all curriculum guidelines (elementary school to high school) (MEXT 2017a, 2017b, 2018b). The Ministry of Internal Affairs and Communications (MIC) has also been working on a project to promote programming education among young people (MIC, 2016).

Despite these efforts, a survey (Fuse & Okabe, 2016) revealed that less than 20% of students received programming education before entering university. According to Fuse (2018), high schools were offering fewer programming classes than expected. Another survey (Obara, Tamada, & Matsuda, 2022) showed that many students entering university had high expectations regarding programming, as programming education has become a hot topic in society; however, after taking programming classes, they found that programming was not their forte, while they also had negative attitudes toward programming. Conducting a programming workshop for elementary school girls, Komura (2020) found that their interest in learning programming was directed more toward drawing illustrations and making movies rather than interactive programs that respond to user manipulation.

Different students may have different learning experiences, and interest in programing may differ depending on each learner's area of expertise. When learning programming, different individual learners may feel interested in different subject matters. To promote programming education, it is necessary to understand the current state of individual learners' experiences, interests, and needs for programming learning and to design curriculum for programming education based on such an understanding.

This study aimed to investigate learners' learning experiences and attitudes toward computer programming, thus exploring the current situation of learners, and identifying countermeasures for dealing with the problems that emerged in the survey. The researchers distributed a questionnaire study to 117 Japanese university students; the research questions were as follows:

1. Have students ever learned about computer programming before?
2. Do students perceive that they will require computer programming skills in their future careers? Are there any differences in how needs are perceived across faculties?
3. Are students interested in computer programming? Are there any differences in students' interest in such programming across faculties?
4. Is students' interest in computer programming related to their previous experiences with learning programming, developing logical thinking attitudes, using software, or any perceived demand for programming skills in their future careers? Are there any differences in this relationship across faculties?

In the following sections, this paper first provides the methods used to conduct the present study, delivers the study findings, and discusses these findings. Finally, the researchers present their conclusions and recommendations for further studies.

Methods

Participants

This study's participants comprised 117 first-year students from three classes—one in science and two in humanities—at a university in Japan. Table 1 reports the number of students and their majors. The students were informed about the study's purpose, and their informed participation consent was obtained. They were further informed that their data would remain confidential.

Class	Grade	Faculty	Number of Students
A	First year	Economics	39
B	First year	Global Human Sciences	39
C	First year	Engineering	39

Table 1: Number of participants and their majors

Data Collection and Analysis

The questionnaire shown in Table 2 was distributed to the participants to gather their subjective responses to items regarding their previous experiences with learning programming (Q1), their awareness of the importance of programming skills for future careers (Q2), and their interest in computer programming (Q3). They were also asked about their logical thinking (Q4 and Q5) and their experiences with software use (Q6). Participants had to choose their responses for Q1 from among the five options shown in Table 2. The participants' responses to Qs 2 to 6 were scored on a five-point Likert scale (1 point: "Strongly Disagree"; 2 points: "Moderately Disagree"; 3 points: "Neutral"; 4 points: "Moderately Agree"; and 5 points: "Strongly Agree").

Items Regarding Students' Perceptions of Programming Skills Requirements in Future Careers, Interest in Computer Programming, Logical Thinking, and IT Literacy
Q1. Have you ever learned about computer programming before?
1. I have learned programming in school classes (elementary through high school).
2. I have learned programming in an extracurricular club at school (not a school class).
3. I have learned programming at a private institute or cram school outside of school.
4. I have learned programming from parents, relatives, or acquaintances.
5. I have never learned programming before.
Q2. I will require programming skills after I get a job or in the future.
1. Strongly Disagree 2. Moderately Disagree 3. Neutral 4. Moderately Agree 5. Strongly Agree
Q3. I am interested in computer programming.
1. Strongly Disagree 2. Moderately Disagree 3. Neutral 4. Moderately Agree 5. Strongly Agree
Q4. I am good at thinking about things in order.
1. Strongly Disagree 2. Moderately Disagree 3. Neutral 4. Moderately Agree 5. Strongly Agree
Q5. I am good at thinking about things logically.
1. Strongly Disagree 2. Moderately Disagree 3. Neutral 4. Moderately Agree 5. Strongly Agree

Q6. I often use software applications (e.g., Microsoft Word, Excel, and PowerPoint).
1. Strongly Disagree 2. Moderately Disagree 3. Neutral 4. Moderately Agree 5. Strongly Agree

Table 2: Questionnaire items

Through a Kruskal-Wallis test and a Wilcoxon rank-sum test, we attempted to investigate whether there were any statistical differences among the ratings of the three classes or between the respective classes. Further, a correlational analysis was also used for investigating how the items were related to one another in the respective classes.

Results and Discussion

This study analyzed the results of the above-discussed questionnaire to answer its research questions regarding students' learning experiences and attitudes toward computer programming as well as the relationships between their interest in programming and the other questionnaire items. This section describes the overall questionnaire results and any data trends that were observed. The questionnaire response results are listed in Figures 1–6 along with the corresponding percentages of participant responses for individual items.

First, this study examined whether the participants had learned programming before. Figure 1 correlates to item Q1, which concerns students' previous experiences with learning programming. Figure 1 shows the corresponding percentages of the different participant responses to item Q1.

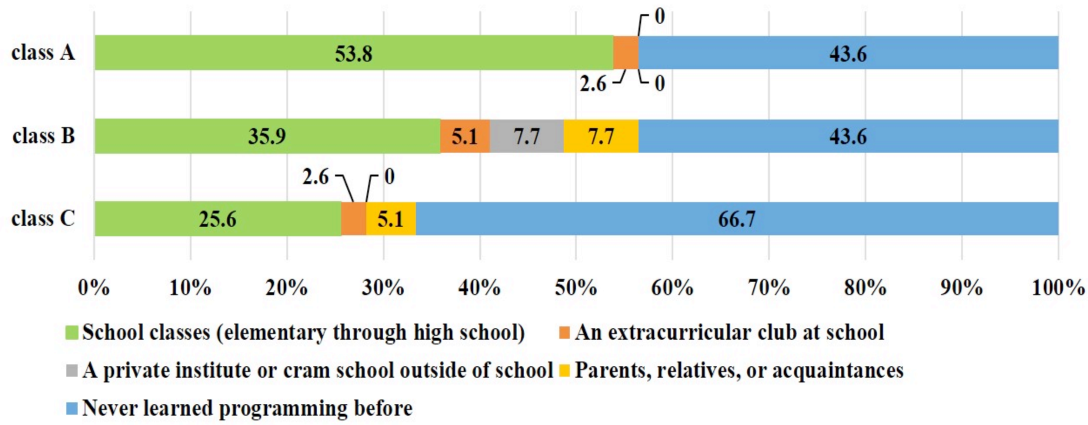

Figure 1: Corresponding percentages of participants' responses to item Q1.

According to the results for item Q1 (see Figure 1), 53.8% in class A (Economics), 35.9% in class B (Global Human Sciences), and 25.6% in class C (Engineering) chose "I have learned programming in school classes (elementary through high school)." The results suggested that participants' responses did not depend on whether they were in the science or humanities classes. It was observed that experiences with learning programming differed across individual students. Until programming education becomes more widespread in curricula from elementary school to high school, it should be promoted according to the programming learning experience of individual students.

Second, this study analyzed how the participants perceived a need for programming skills in their future careers. Figure 2 correlates to item Q2, which concerns students' perceived need for programming skills in their future careers. The percentages of participants who selected the different responses for Q2 are listed in Figure 2.

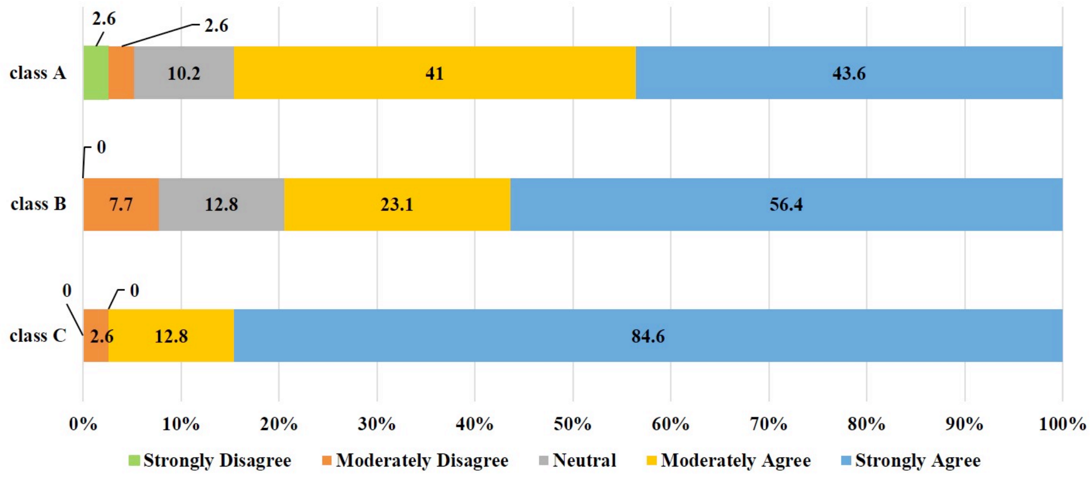

Figure 2: Percentages of participants' responses to item Q2.

According to the results for item Q2 (see Figure 2), 84.6% of the participants in class A (Economics) indicated their agreement—that is, they strongly and moderately agreed that they would require programming skills in their future careers. In class B (Global Human Sciences), 79.5% of the participants indicated their agreement with Q2. In both humanities classes, around 80% of participants indicated a positive agreement with Q2. Further, 97.4% of class C (Engineering) indicated their agreement with Q2. Regarding students' perceptions of the need for programming skills in their future careers, 80% to 90% in all classes provided positive responses.

Third, this study analyzed the nature of the participants' interest in computer programming. Figure 3 correlates to item Q3, which concerns students' interest in computer programming. The corresponding percentages of the participants' different responses to Q3 are listed in Figure 3.

According to the Q3 results (see Figure 3), 94.8% of participants in class C (Engineering) indicated their agreement with item Q3—that is, they strongly and moderately agreed that they were interested in computer programming. Meanwhile, 49% in class A (Economics) indicated their agreement with item Q3. Similarly, in class B (Global Human Sciences), 51% indicated their agreement. Around 50% of the participants in humanities were interested in computer programming. Regarding students' interest in computer programming and its relationship with their major, considerably more science students (rather than humanities students) responded positively to the item.

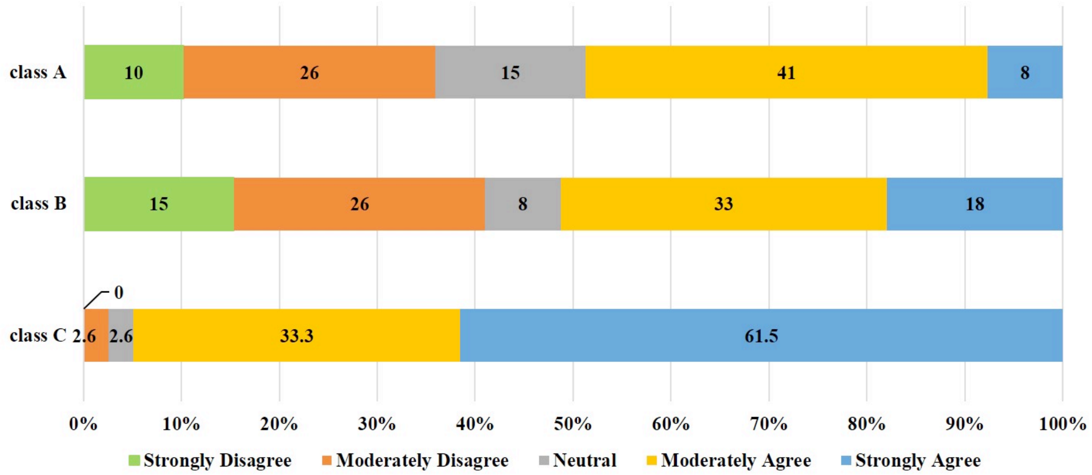

Figure 3: Percentages of participants' responses to item Q3.

Fourth, this study analyzed how the participants rated their own logical thinking attitudes. Figures 4 and 5 correlate to items Q4 and Q5 respectively, which concern students' logical thinking. The corresponding percentages of participants' different responses to Q4 and Q5 are listed in Figures 4 and 5, respectively.

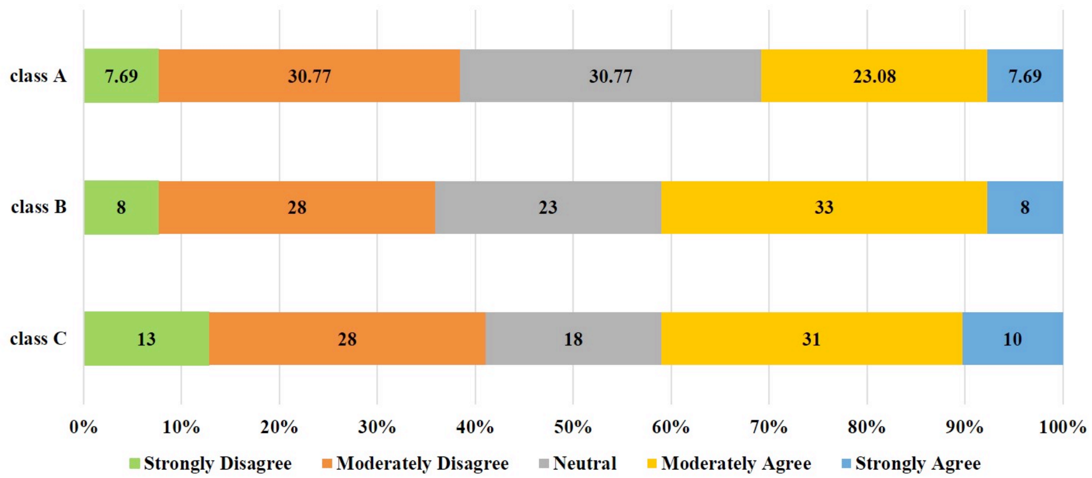

Figure 4: Percentages of participants' responses to item Q4.

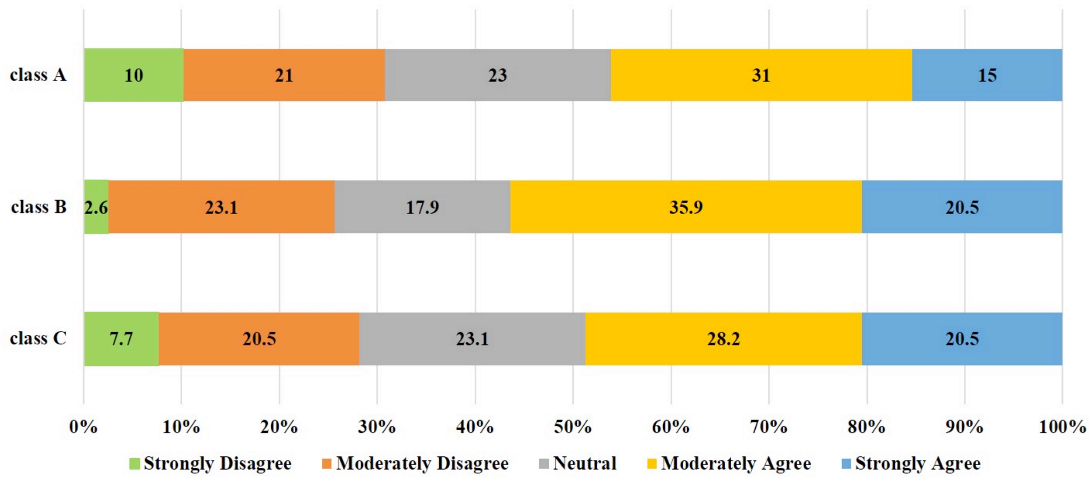

Figure 5: Percentages of participants' responses to item Q5.

According to the Q4 results (see Figure 4), 30.77% of the participants in class A (Economics) strongly and moderately agreed with Q4. In both class B (Global Human Sciences) and class C (Engineering), 41% of the participants indicated their agreement with item Q4.

According to the Q5 results (see Figure 5), 56.4% of the participants in class B (Global Human Sciences) strongly and moderately agreed with Q5. Slighter fewer participants (48.7%) in class C (Engineering) agreed with Q5, and even fewer participants (46%) in class A (Economics) indicated their agreement with Q5.

Regarding students' logical thinking attitudes, slightly fewer participants in class A (Economics) indicated positive responses for items Q4 and Q5.

Finally, this study analyzed how the participants rated their computer software experiences. Figures 6 depicts the percentages of responses to the items of Q6, which concerns students' computer software experiences. The corresponding percentages of participants' different responses to Q6 are listed in Figure 6.

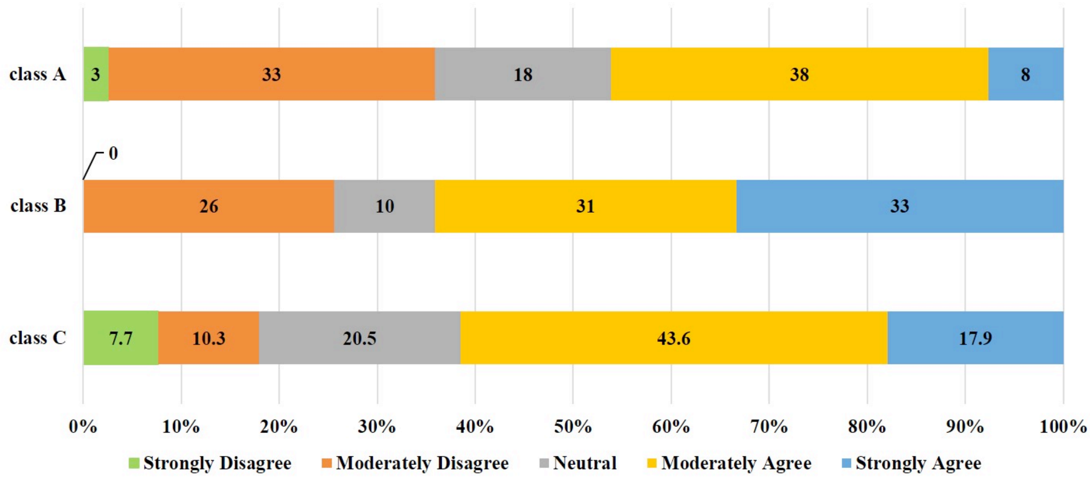

Figure 6: Percentages of participants' responses to item Q6.

According to the Q6 results (see Figure 6), 64% of the participants in class B (Global Human Sciences) and 61.5% in class C (Engineering) strongly and moderately agreed with Q6, while 46% in class A (Economics) indicated such agreement.

Regarding computer software experiences, the results suggest that fewer participants in class A (Economics) indicated positive responses for Q6 as well as Q4 and Q5.

Research question 1: Have students learned about computer programming before?

To address the first research question, this section analyzes whether and how the participants had learned programming before joining university. Figure 1 shows that 43.6% in class A (Economics) and class B (Global Human Sciences) and 66.7% in class C (Engineering) chose "I have never learned programming before." A little more than 40% of students in humanities and two-thirds of the students in science did not have any programming experience—these numbers were higher than we expected. Given the trend of promoting programming education nationwide, providing programing education to these university students, who have not yet learned programming, is an urgent issue.

Additionally, among students who learned programming outside of formal school classes, 2.6% in class A (Economics), 20.5% in class B (Global Human Sciences), and 7.7% in class C (Engineering) learned programming in an extracurricular club at school, at a private institute or cram school outside of school, or from their parents, relatives, or acquaintances. The number of private programming schools is increasing, and more students will be expected to study in these private programming schools. Based on these trends, students will be expected to have different learning experiences with regard to learning programming. The results thus suggest the need for designing curricula that consider the learning experiences of individual students.

Research question 2: Do students perceive that they will need computer programming skills in their future careers? Are there any differences in how such needs are perceived across faculties?

To address the second research question, this section analyzes whether and how the participants required programming skills in their future careers and how these needs were perceived across faculties. The average scores of their responses were calculated using a five-point Likert scale for each class to investigate overall student perceptions. The average scores were 4.2 for class A (Economics), 4.3 for class B (Global Human Sciences), and 4.8 for class C (Engineering). Given these high average scores, it can be surmised that many students across all classes perceived that they would require computer programming skills in their future careers.

Next, the Kruskal-Wallis test and the Wilcoxon rank-sum test were conducted using the Q2 data in order to determine whether the three classes differed from one another in a statistically significant manner at the 0.05 level. The results of the Kruskal-Wallis test revealed significant differences among the three classes ($p = 0.001$). Next, using a Wilcoxon rank-sum test, we attempted to investigate whether any statistical differences could be detected with regard to each class. The results revealed significant differences between class A (Economics) and class C (Engineering) ($p = 0.000$) and between class B (Global Human Sciences) and class C ($p = 0.005$), although no significant differences were found between class A and class B ($p = 0.510$).

These results ultimately suggest that the participants from all classes strongly perceived that they would require computer programming skills in their future careers, even though such responses were significantly higher among the science students. With regard to the science students, two-thirds of them did not have any programming experience from the results of research question 1. The lack of experience in learning programming may make them more aware of the need for programming in the future.

Research question 3: Are students interested in computer programming? Are there any differences in students' interest in such programming across faculties?

To address the third research question, this section analyzes whether and how the participants were interested in computer programming and whether there were any differences in their interest in programming across faculties. Regarding interest in computer programming, the average scores for the three classes were as follows: 3.1 both for class A (Economics) and class B (Global Human Sciences) and 4.5 for class C (Engineering). This showed that interest in programming was considerably lower among humanities students.

Next, the Kruskal-Wallis test and the Wilcoxon rank-sum test were conducted using Q3 data in order to determine whether the three classes differed from one another in a statistically significant manner at the 0.05 level.

Application of the Kruskal-Wallis test to the Q3 data revealed significant differences among the three classes ($p = 0.000$). Next, using a Wilcoxon rank-sum test, we attempted to investigate whether any statistical differences could be detected with regard to each class. The results revealed significant differences between class A (Economics) and class C (Engineering) ($p = 0.000$) and between class B (Global Human Sciences) and class C ($p = 0.000$), although no significant differences were found between class A and class B ($p = 0.848$).

These results reveal that the students were fully aware of the importance of programming skills, regardless of whether they studied in a science or humanities class. However, it should be noted that interest in computer programming was significantly lower among the humanities students. Given this finding, it is necessary to develop a computer programming curriculum that could effectively interest humanities students.

Research question 4: Is students' interest in computer programming related to their previous experiences with learning programming, developing logical thinking attitudes, using software, or perceiving a need for programming skills in their future careers? Are there any differences in this relationship across faculties?

Based on the results regarding the third research question, this study investigated what could facilitate or hinder programming learning. To explore the elements related to students' interest, this study investigated how students' interest in computer programming could be related to their previous experiences with learning programming, developing logical thinking attitudes, using computer software, or perceiving a need for programming skills in their future careers.

First, this study investigated how students' interest in computer programming was related to their previous experiences with learning programming. We assessed how many of those students in different classes who strongly and moderately disagreed with Q3 (i.e., their interest in computer programming) had never learned programming. We found that 14 students in class A (Economics), 16 students in class B (Global Human Sciences), and only one student in class C (Engineering) responded negatively to Q3. Among the students who responded negatively to Q3, 50% (seven students) of those in the Economics class and 69% (11 students) of those in the Global Human Sciences class had never studied programming. One student in the Engineering class, who had negative attitudes toward interest in programming learning, also had no experience with learning programming.

Regarding students' interest in computer programming and their previous experiences with learning programming, the results suggest that the presence or absence of experience with learning programming may have been related to interest in programming in the humanities classes. Regarding the Engineering class, we believe that the reliability of its relevant data will be a future issue since there was only one applicable respondent for the item.

Next, this study analyzed how students' interest in computer programming (Q3) was related to logical thinking attitudes (Q4 & Q5), computer software experiences (Q6), or their perceptions of the need for programming skills in their future careers (Q2). We calculated

Spearman's rank-order correlation coefficients between items Q3 and Q2, Q3 and Q4, Q3 and Q5, and Q3 and Q6 from the questionnaire (see Table 3).

	Class	Q2	Q3	Q4	Q5	Q6
Q2	A	–				
	B	–				
	C	–				
Q3	A	0.22	–			
	B	0.51*	–			
	C	0.47*	–			
Q4	A	0.31	0.10	–		
	B	0.23	0.25	–		
	C	-0.08	0.13	–		
Q5	A	0.07	0.18	0.57*	–	
	B	0.21	0.41*	0.60*	–	
	C	0.10	0.51*	0.70*	–	
Q6	A	-0.07	0.29	0.11	0.34*	–
	B	0.35*	0.34*	0.38*	0.31	–
	C	0.12	0.27	0.27	0.30	–

*$p < .05$.

Table 3: Correlations among questionnaire items

The results of the correlation coefficients between Q3 and Q2 in the three classes (see Table 3) demonstrated that, both in class B ($r_{Q3Q2} = 0.51$) and class C ($r_{Q3Q2} = 0.47$), a significantly positive relationship existed between students' interest in computer programming and their perception of the need for programming skills in their future careers. However, the correlation coefficient between Q3 and Q2 was not statistically significant for class A ($r_{Q3Q2} = 0.22$).

Regarding the perceived need for programming skills in future careers, a positive relationship was observed between students' interest in computer programming and their perception of the need for programming skills both in class B (Global Human Sciences) and class C (Engineering). The results suggest that the students' perception of the need for programming skills in their future careers could influence their interest in computer programming.

Further, this study also calculated the correlation coefficients between items Q3 and Q4, and Q3 and Q5 in order to examine how students' interest in computer programming was related to their logical thinking attitudes.

The results of the correlation coefficients between Q3 and Q4 in the three classes (see Table 3) (class A, $r_{Q3Q4} = 0.10$; class B, $r_{Q3Q4} = 0.25$; class C, $r_{Q3Q4} = 0.13$) demonstrated that no significant relationship existed between students' interest in computer programming and their logical thinking attitudes. Further, the results of the correlation coefficients between Q3 and Q5 revealed that a significantly positive relationship existed between students' interest in computer programming and their logical thinking attitudes both in class B ($r_{Q3Q5} = 0.41$) and class C ($r_{Q3Q5} = 0.51$). However, the correlation coefficient between Q3 and Q5 was not statistically significant for class A ($r_{Q3Q5} = 0.18$).

These findings regarding students' logical thinking attitudes revealed that, both in the Global Human Sciences class and the Engineering class, there was a positive relationship between students' interest in computer programming and their logical thinking attitudes as well as their perception of the need for programming skills in future careers. This suggests that students' logical thinking attitudes could influence their interest in computer programming.

Finally, this study also calculated the correlation coefficients between Q3 and Q6 to investigate how students' interest in computer programming was related to their computer software experiences.

The correlation coefficient results between Q3 and Q6 revealed a significantly weak positive relationship between students' interest in computer programming and their computer software experiences only in class B ($r_{Q3Q6} = 0.34$). However, the correlation coefficients between Q3 and Q6 were not statistically significant for both class A ($r_{Q3Q6} = 0.29$) and class C ($r_{Q3Q6} = 0.27$). Overall, regarding computer software experiences, this factor was found to have a weak positive relationship with students' interest in computer programming only in the Global Human Sciences class.

These results also suggest that students' computer software experiences could slightly influence their interest in computer programming.

Findings

Although this study should be improved further, its results revealed some critical findings regarding Japanese university students' learning experiences and attitudes toward computer programming. First, more than 40% of students in the humanities class and two-thirds of students in the science class did not have any previous experience with learning programming—these numbers were higher than we expected. Second, participants in all the classes strongly perceived that they would require computer programming skills in their future careers, although the science students who held this perception formed a significantly higher percentage of the respondents than the humanities students. As mentioned above, a larger percentage of the science students had no experience in learning programming than did liberal arts students. The lack of experience in learning programming may make them more aware of the need for programming in the future. Third, interest in computer programming was significantly lower among humanities students. Finally, among the students who indicated little or no interest in computer programming, 50% in the Economics class, and approximately 70% in the Global Human Sciences class had never studied programming. Among the humanities students, the presence or absence of experience with learning programming may have been related to interest in programming. Further, a positive relationship was observed between students' interest in computer programming and their logical thinking attitudes as well as their perception of the need for programming skills in future careers both in the Global Human Sciences class and the Engineering class. Although further investigations are necessary, students' logical thinking attitudes and their perception of the need for programming skills in future careers could influence their interest in computer programming. Furthermore, a weak positive relationship was observed between students' interest in computer programming and their computer software experiences only in the Global Human Sciences class. These results showed that students' computer software experiences could slightly influence their interest in computer programming.

To summarize the results, students were fully aware of the importance of programming skills for their future careers, regardless of their major fields of study. However, interest in computer programming seemed to be significantly lower among the humanities students.

The study results thus suggest that, when designing a curriculum and syllabus for programming classes, preparing materials that are relevant to students' post-graduation career paths based on their expertise may help stimulate those students' interest in programming. Furthermore, we suggest that a syllabus should be created with an awareness of fostering logic and that the curriculum must include classes that can familiarize students with software use before they can begin to learn programming.

Limitations and Recommendations

The present preliminary investigation study examined the experiences and attitudes of Japanese university students with regard to computer programming. First, the current survey must be promoted to a larger number of students. In particular, the number of learners experiencing programming learning is expected to increase due to the growth of private programming schools. It is thus important to continue conducting the survey over time. Second, individual students' interests in and attitudes toward learning programming will depend not only on their fields of expertise but also on their personal programming learning experiences and preferences. The relationship between interest in computer programming and other items of the current survey must be analyzed more deeply.

Conclusions

This study investigated Japanese university students' learning experiences and attitudes toward computer programming. A questionnaire using a five-point Likert scale was distributed to 117 Japanese university students in three classes; the results suggested three main findings. (1) Regarding their previous experiences with learning programming, a little more than 40% of students in humanities and two-thirds of the students in science did not have any programming experience—these numbers were higher than we expected. (2) Regarding the students' perception of the importance of programming skills in their future careers, the average scores for all three classes reached 4 or higher. The results ultimately suggested that both science and humanities students were fully aware of the importance of programming skills for their future careers, although science students' responses were more positive than those of humanities students. As mentioned above, a larger percentage of the science students had no experience in learning programming than did liberal arts students. The lack of experience in learning programming may make them more aware of the need for programming in the future. (3) Regarding interest in computer programming, the average score for both humanities classes reached 3.1, whereas that for the science class was 4.5; this showed that interest in programming was significantly lower among humanities students. Furthermore, the results of the two humanities classes indicated that, among students who had little or no interest in computer programming, 50% in the Economics class, and approximately 70% in the Global Human Sciences class had never learned programming.

Thus, for liberal arts students, their experience in learning programming may be related to their interest in it.

The current study had certain limitations. As a continuation of this study, the researchers would like to consider dividing learners into types with regard to their interest in learning programming by adding more survey items.

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