

# Examination of Remote Support by University Students for Programming-Related Lessons in Elementary Schools

Tomohiro Yamamoto <sup>\*</sup>, Tatsuya Horita <sup>†</sup>

## Abstract

In Japan, programming education was introduced into the elementary curriculum from FY2020 onward. We analyzed a case in which university students became remote support teachers for 10 programming classes in four elementary schools by the use of a Web conference system. The results show that teaching-related self-confidence increases when university students provide remote support. Additionally, facilitating the exchange of cooperative guidance between university students and teachers is important, along with the positive evaluations of student's work, thus providing guidelines for improving university students' remote support.

*Keywords:* Programming education, Information education, Distance education, School support, Web conference

## 1 Introduction

Japanese schools tend to organize their curriculums based on national guidelines. The latest version of these guidelines introduced programming education at the elementary school level. In addition, programming tools can now be incorporated into elementary school mathematics and science classes [1].

However, the information and communication technology (ICT) field and its educational use are currently insufficient; it is therefore necessary to improve the skills of programming teachers that. According to the survey results of Kuroda and Moriyama [2], teachers feel they lack sufficient knowledge about and understanding of programming education, meaning teacher training is necessary. However, it is not easy for schools to secure training time, which makes it important to increase the efforts to improve skills while also receiving support for ongoing classes.

As a result, there are several studies on this issue. For instance, Krauss and Prottsman proposed specific teaching methods and teaching materials for computing [3]. Sentance and Csizmadia showed that the curriculum plays an important role in teachers' attempts to develop programming education and also suggested it is important for teachers and university students to learn

---

<sup>\*</sup> Graduate School of Education, Kagoshima University, Kagoshima, Japan

<sup>†</sup> Graduate School of Information Sciences, Tohoku University, Miyagi, Japan









However, as the university students required a considerable amount of time to check on all elementary-level students, the classroom teachers taught along with the university students and also helped the elementary-level students. Therefore, it is necessary to grasp the overall progress of the elementary-level students and cooperate with the teacher in charge. Figure 1 shows the classroom situation through the instructor-classroom channel. In Figure 1, a university student explains how to use a programming tool to all students within the classroom of an elementary school.

Table 6 shows the contents when creating a programming work using micro:bit. Since it is created with a visual programming tool, it is created by combining blocks, not code. These are programming games that children in the lower grades can play. (1) Displaying and blinking the mark is a simple matter. (1) is a repetitive program that uses about three blocks. (2) The stopwatch game is a program that measures the elapsed time by pressing a button. (2) is a conditional branch when the button is pressed, and is a program that uses about 6 blocks with time as a variable. (3) Measure the angle (4) Rock-paper-scissors game is a program that uses an acceleration sensor. (5) The compass is a program that uses a directional sensor. The programs from (3) to (5) are advanced programs using sensors. Based on the variables obtained from the sensor, we used about 7 blocks in a program that branches according to conditions.



Figure 1: State of the instructor-classroom channel

Table 6: Contents of works using micro:bit

Contents of works	Specific production content
(1) Mark display and blinking	Specific production content Mark display blinking Save the program Data transfer
(2) Stopwatch game	Measure elapsed time Press the button the first time to start measuring the time, and press the button the second time to display the measured time. Save the program, Data transfer

(3) Measure the angle	Works using accelerometers Shows the tilt of the micro:bit Save the program, Data transfer
(4) Rock-paper-scissors game	Measurement of the angle around you Works using accelerometers When shaken, one of Goo, Choki, and Par is displayed. Save the program, Data transfer
(5) Compass (compass)	Works using magnetic sensors Show orientation Save the program, Data transfer

The content of the program to be produced is the content that the university students researched and considered in advance. Before remote support, we consulted with each other and examined it. As a programming method, we have made it possible to learn the concepts of conditional branching and variables. For example, a conditional branch is provided when a button is pressed. In addition, the variables obtained from the sensor are displayed. Table 7 shows the contents considered from the implementation records and class videos of university students in the connection form of Form ① “Instructor-Classroom”.

Table 7: Contents considered from the implementation records and class videos

[From the implementation record of university students]

- I was able to explain in an easy-to-understand manner by explaining using screen sharing.
- I felt that remote support could close the gap between regions.
- I was able to give advice on the basic contents of programming operations.
- Because the time was short, there were some scenes that were difficult to convey.
- Voice was disturbed due to communication conditions, so I was conscious of speaking clearly.

[From the recording of the lesson video]

- There were many cases where the homeroom teacher gave guidance between desks.
- It was seen that the homeroom teacher re-transmitted the explanation of the university students.
- It was seen that university students proceeded while confirming, such as asking for a raised hand.

### 3.3 Instructor-learner support

Stages 2 and 3 (instructor–learner): The university students and the groups of elementary-level students connected to each other one-on-one, the former providing individual support. In Stage 2, the university students answered questions and explained how to program by screen sharing. Depending on the content of the question, some were able to provide responses after searching the Internet or manual.

In Stage2, university students answered questions from elementary school students through a web conference. Table 8 shows some of the questions from elementary school students and the answers from university students.

In response to a question from an elementary school student, a university student explained using the screen sharing function of a web conference. The university students explained the contents that could not be displayed on the screen, such as the connection of the USB cable, while contacting the teacher in charge.

In Stage 3, the university students evaluated the elementary-level students' work positively. Since the university students saw the work for the first time, there were some instances where the corrected responses could not be provided immediately. Figure 2 shows a class using the instructor–learner channel. Multiple university students responded to each group, with one university student answering questions from four students.

Table 8: the questions from elementary school students and the answers from university students

Questions from elementary school students	University student answers
The created program does not work. Why?	Share the screen and explain. Check the parts that do not work and explain how to work.
Please tell me where to put the block out.	Share the screen and explain. I will explain how to put out blocks.
I want to create a more difficult game. Please tell me how to do it.	Share the screen and explain. I will explain the difficult method while carefully instructing it.
I want to create another program, but what should I do with the program I created immediately before?	Share the screen and explain. We will explain how to save the program created immediately before and how to create it after deleting it.
I would like to use other blocks, but what kind of blocks are there?	Share the screen and explain. We will explain repeating blocks and variable blocks that you can create new blocks by yourself.
The program is not transferred. Why?	Understand the situation and encourage them to try another connection code.
Why does the mark change when shaken?	Point to the part where the accelerometer is located and bring it closer to the front of the camera. The acceleration sensor will be explained.
Why is the micro:bit on the left moving?	Explained that the program can be confirmed and recreated by performing a simulation before transferring the data.





Figure 2: State of the instructor-learner channel

Table 9: Descriptive survey items for the university students

---

[From the implementation record of university students]

- I was able to convey not only advice but also impressions of the work.
- I was able to share the screen and answer the students' questions well.
- I couldn't answer the simple questions of the students well, probably because I lacked programming knowledge and skills.
- At first glance, it was not possible to identify what was wrong with the student's work (program).
- It was necessary to think about where to teach while giving instructions and what to make students think.

---

[From the recording of the lesson video]

- University students were seen complimenting the work and its process.
  - By having the students raise their hands, it was observed that the university students were proceeding while checking their understanding and progress.
  - It seemed that it took time for university students to point out the corrections.
- 

## 4 Analysis Results

### 4.1 Results of the attitude survey for the university students

We analyzed the results of the attitude surveys administered to the university students in May 2019 and February 2020. The percentage of positive responses was analyzed using the  $\chi^2$  test. Table 10 shows the results. For the five items, the results were as follows. For confidence, a significant difference was observed ( $\chi^2(1) = 4.54, p < 0.05$ ). However, there were no major changes in the four items of knowledge/skills, effective method, difficulty, usefulness did not show significant differences.

Table 10: Descriptive survey items for the university students

	2019.5	2020.2
(1) [Confidence]	11.1% (1/9)	66.7% (7/9)
(2) [Knowledge/Skills]	33.3% (3/9)	77.8% (7/9)
(3) [Effective method]	88.9% (8/9)	88.9% (8/9)
(4) [Difficulty]	88.9% (8/9)	88.9% (8/9)
(5) [Usefulness]	100.0% (9/9)	100.0% (9/9)

#### 4.2 Analysis results for description contents

The contents that the university students and teachers produced after the practice were classified into six items: (1) instructional methods, (2) curriculum, (3) equipment and environment, (4) programming skills, (5) elementary-level students' understanding, and (6) distance teaching skills. For example, a description such as "selection of words according to the development stage and speech style according to the development stage" was judged to belong to the instructional methods category; descriptions such as "curriculum ideas and positioning of annual guidance plans" were judged to belong to the curriculum category; descriptions such as "maintenance of equipment and communication lines" were judged to belong to the equipment and environment category; descriptions such as "knowledge and skills of programming tools used" were judged to belong to programming instruction; descriptions such as "communication, grasping the actual situation" were judged to belong to elementary-level students' understanding; and descriptions such as the "ability to explain using the screen sharing function" were judged to belong to the distance teaching skills category. Table 11 summarizes the tools, skills, and processes necessary for remotely teaching programming to elementary-level students and the issues that should be addressed. Table 12 summarizes useful content for university students. According to Tables 11 and 12, both the instructional method and curriculum were frequently referred to.

Table 11: Classification of necessary items and issues to be addressed

	Classroom teachers	University students	Total
(1) Instructional methods	16	7	23
(2) Curriculum	16	4	20
(3) Equipment and environment	7	5	12
(4) Programming instruction	3	4	7
(5) Elementary-level students' understanding	3	3	6
(6) Distance teaching skills	2	3	5

Table 12: Classification of content useful for university students

	Classroom teachers	University students	Total
(1) Instructional methods	9	3	12
(2) Curriculum	6	4	10
(3) Programming instruction	2	3	5
(4) Distance teaching skills	2	3	5

## 4.2 Analytical results regarding practical information use

A total of 38 elementary-level students responded to a questionnaire survey on the practical use of information. Using a *t*-test, we compared the average of the answers before and after support being received from the university students. Table 13 shows the analysis results. For the presentation using ICT, the post-practice result was significantly higher (at the 1% significance level) than that for the pre-practice. Additionally, for creating tables and graphs and presentation material, the post-practice results were significantly higher (at the 5% significance level) than for the pre-practice. There were no significant differences between character input and information retrieval.

Table 13: Analytical results regarding practical information use

Item	Before support	After support	<i>t</i> , <i>p</i>
(1) Character input	2.77 (0.91)	3.03 (0.91)	<i>t</i> =1.19 <i>n.s.</i>
(2) Information search	3.03 (0.82)	3.29 (0.77)	<i>t</i> =1.40 <i>n.s.</i>
(3) Creating tables and graphs	1.89 (0.96)	2.50 (1.06)	<i>t</i> =2.59 <i>p</i> <0.05
(4) Presentation material creation	2.26 (0.98)	2.74 (0.95)	<i>t</i> =2.12 <i>p</i> <0.05
(5) Presentation using ICT	2.43 (0.95)	3.03 (0.88)	<i>t</i> =2.79 <i>p</i> <0.01

*t*: *t*-test value; *p*: significance; *n.s.*: not significant

## 5 Discussion

Analysis of the attitude survey administered to university students showed that they improved their confidence with regard to programming education. In addition, the university students' records showed responses such as "I felt that remote support can bridge the gap between regions" or "I was able to provide advice about the basic content of programming operations." Therefore, university students' confidence increased.

However, the implementation records also showed communication problems. There were responses such as "Some situations were difficult to convey due to the short time available" or "Communication was disrupted, but I proceeded and continued to speak clearly." Communication posed problems when multiple students and individuals or groups were connected.

In addition, the recorded videos showed that many teachers were active in the classroom, some of them repeating the university student's explanation when needed. These problems are often seen in non-face-to-face remote classes, as it is not easy to grasp the progress of the classroom and of the learning process, thus requiring improvement. In response to this, the university students continued to verify the understanding of the classroom, for example by asking for a show of hands. It is necessary to collaboratively devise remote explanations and instructions with the teacher in the classroom. When we interviewed three faculty members who participated, they answered that remote support for university students was very effective.

In our study, the university students not only provided remote guidance for the entire classroom but also supported groups of learners individually. The video recording of the lessons showed that the university students praised the work of learners, which led to a positive evaluation of the programming they worked on.

However, there were also cases where the university students could not provide clear advice to the elementary-level students or answer their questions due to a lack of programming knowledge and skills that did not allow them to identify problems at the first glance. As such, in some cases, it took some time for the university students to point out errors and offer corrections. These facts show that some issues should be solved so that individual support can be provided to the elementary-level students. In particular, it is necessary for university students to grasp the level of the elementary-level students and also consider what advice they can offer in advance.

An analysis of the content written by the university students and teachers after the practice showed that most content was related to the instructional methods and curriculum. This shows that the university students and teachers required the same teaching skills during the remote programming lessons as those required for face-to-face lessons. Therefore, it is important for university students in teacher training programs to improve their teaching skills and enhance their curriculum learning.

In the survey for the elementary-level students, we analyzed the changes in consciousness with regard to information use. The items that improved included those related to expressiveness, such as presentation and material creation. The study results suggest that enriching the programming education-related classroom practice through remote support may improve the elementary-level students' expressiveness.

In this study, we implemented two forms of remote support, instructor–classroom and instructor–learner, and analyzed their contents. The learner–learner channel was not implemented. Moore [11] categorizes the interactions in distance education into the following categories: learners and learning content, learners and professors, and learners and learners. That is, in some cases, learners may work together to complete a programming task. It is conceivable that university students could provide support for situations where learners share programming work remotely and provide advice to each other. As such, future research should clarify how university students can support the remote interactions between learners.

During the period from March to May 2020, Japanese elementary schools were closed due to measures against the new coronavirus infection, and elementary school students began to live at home. In order to support home learning, university students have made it possible to remotely support home learning for elementary school students. In the future, it will be necessary to consider supporting programming learning by university students as home study when not attending school.

In order to enhance remote support by university students, it is conceivable to enhance the classes dealing with elementary school programming education at teacher training universities and improve the teaching skills of university students who support remotely. Maruyama et al. [13] (2019) reported that they tried STEM education classes for university students at a teacher training university and that the university students who took the classes increased their confidence in STEM education. In addition, in order to set courses at many teacher training universities in Japan, it is necessary to set the criteria for computational thinking (NETS-T) [14] set by

the International Society for Technology in Education (ISTE) in Japan.

## **6 Conclusions**

In this study, some university students remotely supported a programming class by using a Web conference system. The study results showed that teaching-related self-confidence increased when the university students participated in remote support. The implementation records and interviews preserved over the course of the research showed that elementary school teachers could solve elementary-level students programming anxiety while conducting lessons.

In addition, in order to enhance remote support, it is necessary for university students to not only teach programming skills to elementary-level students but also enhance university students' positive evaluations of elementary-level students' works. In particular, this study showed that it is necessary to devise teaching methods and curriculums, such as explanations, instructions, and the questions of university students, rather than simply understand programming and remote system tools. A remote university student is required to cooperate with the teacher in the classroom and devise remote explanations and instructions.

As previously mentioned, in the future, we will examine how to develop remote support for connecting learners with learners.

## **References**

- [1] Ministry of Education, Culture, Sports, Science and Technology, "National guideline for elementary school study guide," [https://www.mext.go.jp/content/1413522\\_001.pdf](https://www.mext.go.jp/content/1413522_001.pdf), 2017. (accessed 2020.3.1)
- [2] M. Kuroda and J. Moriyama, "The relationship between teachers' awareness of issues and training needs for implementing programming education at the elementary school stage," *Transactions of the Japan Society for Educational Technology*, vol. 41 (Suppl), 2017, pp. 169-172.
- [3] J. Krauss and K. Prottzman, "Computational thinking and coding for every student: The teacher's getting-started guide 1st," CORWIN, Thousand Oaks, California, 2017.
- [4] S. Sentence and A. Csizmadia, "Computing in the curriculum: Challenges and strategies from a teacher's perspective," *Education and Information Technologies*, vol. 22, 2017, pp. 469-495.
- [5] CSTA, "Progression of Computer Science Teachers Association (CSTA) K-12 Computer Science Standards, Revised 2017," <https://www.csteachers.org/page/standards>, 2017. (accessed 2020.3.1)
- [6] Ministry of Education, Culture, Sports, Science and Technology, "Guide on Programming Education for Elementary Schools (Third Edition)," [https://www.mext.go.jp/content/20200218-mxt\\_jogai02-100003171\\_002.pdf](https://www.mext.go.jp/content/20200218-mxt_jogai02-100003171_002.pdf), 2020. (accessed 2020.3.1)

- [7] M. Kanazuka, T. Yamamoto, and T. Motomura, "Proposal of learning process for acquiring programming skills Programming instruction for elementary school students by university students," *Educational Information Research*, vol. 24 (4), 2009, pp. 37-43.
- [8] T. Yamamoto and Y. Yamauchi, "Proposal for programming learning with a special subject morality in primary education," *Educational Information Research*, Vol. 34 (1), 2018, pp. 17-25.
- [9] Y. Uchida, "Distance education system utilization guidebook, 1st edition," [https://www.mext.go.jp/content/1404424\\_1\\_1.pdf](https://www.mext.go.jp/content/1404424_1_1.pdf), 2019. (accessed 2020.3.1)
- [10] Uchida Yoko "Survey and research report on the results of the project entrusted by the Ministry of Education, Culture, Sports, Science and Technology of 2016, A demonstration project for maintaining and improving the quality of education by utilizing ICT in a declining population society," [https://www.mext.go.jp/a\\_menu/shotou/zyouhou/1364592.htm](https://www.mext.go.jp/a_menu/shotou/zyouhou/1364592.htm), 2017. (accessed 2020.3.1)
- [11] Ministry of Education, Culture, Sports, Science and Technology, "Regarding the results of the information utilization ability survey," [https://www.mext.go.jp/a\\_menu/shotou/zyouhou/1356188.htm](https://www.mext.go.jp/a_menu/shotou/zyouhou/1356188.htm), 2015. (accessed 2020.3.1)
- [12] M. G. Moore, "Three types of interaction," *American Journal of Distance Education*, vol. 3 (2), 1989, pp. 1-6.
- [13] M. Maruyama, T. Nagahama, T. Kitagawa, N. Setozaki, Y. Morita, "Practical Study on STEM Education for School Teacher Training Course Students," *JSSE Research Report*, Vol. 34 (3), 2019, pp. 303-308.
- [14] The International Society for Technology in Education "ISTE STANDARDS FOR Educators," <https://www.iste.org/standards>, 2018. (accessed 2020.3.1)