IADIS International Journal on Computer Science and Information Systems
Vol. 14, No. 1, pp. 1-16
ISSN: 1646-3692

THE IMPACT OF WORKSHOP ACTIVITIES ON PARENTS' CONCERNS ABOUT COMPUTER PROGRAMMING EDUCATION IN ELEMENTARY SCHOOL

Yukiko Maruyama
Tokai University. Kanagawa, Japan

ABSTRACT

Parents play an influential role in the lives of children studying in elementary school, and their attitudes toward education have a considerable influence on children's attitudes. In the context of computer programming education, parents' ignorance could affect their children's education and attitudes towards education adversely. A promising way to support parents is through informal workshops with their children, in which the former are exposed to the subjects and skills that the children will be learning. This study examined the impact of different types of workshop activities on parents' concerns regarding various aspects of their children's programming education. Three types of workshops were organized, each characterized by a particular activity; including a wooden robot with coding blocks, a robotics toy with visual programming language, and visual language. Data were collected from parents before and after their participation in these workshops. The results from the analysis of the data revealed that the impact of the three activities on the parents varied, with all three activities and workshops having a positive impact on the attitudes and confidence levels of parents in supporting their children at home with technology-related education in addition to enhancing their understanding of programming education.

KEYWORDS

Programming Education, Elementary School, Parents' Concerns, Computational Thinking, Programming Workshop

1. INTRODUCTION

There have been widespread attempts to introduce computational thinking in elementary and secondary or K-12 education (Barr and Stephenson 2011, Grover and Pea 2013). The term "computational thinking" was first used by Papert (1993) and popularized by Wing (2006). According to Wing, "'Computational thinking' involves solving problems, designing systems, and understanding human behavior, by drawing on concepts that are fundamental to computer science" (p. 33). She also stated that computational thinking is a fundamental skill for all and that it should be an analytical ability that every child has. The article caught the attention of many education researchers and educators, and several research studies related to computational thinking in K-12 have since been carried out. In the United Kingdom, "computing," was introduced as a subject in primary and secondary schools. In the primary teachers' guide for this subject, the importance of computational thinking is repeatedly stated.

As computational thinking increasingly draws attention, computer programming education is also receiving importance as one of the ways of teaching computational thinking. Lye and Koh (2014) state that "[p]rogramming is more than just coding; for, it exposes students to computational thinking which involves problem-solving using computer science concepts, and is useful in their daily lives" (p. 51). In Japan, the Central Council for Education in the Ministry of Education, Culture, Sports, Science, and Technology submitted a report that mentions the introduction of programming education in elementary schools. The Council, in another report, noted that the aim of programming education in elementary schools should not be to teach students how to code but rather to foster students' programming thinking (translated by the author). Programming thinking is considered to be a concept similar to and a part of computational thinking.

Parents play a very important role in elementary education, and their attitudes toward education have a considerable influence on those of their children. Although some researchers have investigated parent-child collaboration in robotics education (Cuellar et al. 2013, Roque et al. 2016) and in learning programming (Lin and Liu 2012, Hart 2010), the general public does not have adequate awareness of the aim of programming education as yet. Misconceptions and anxieties concerning programming education seem to have begun spreading among parents. A generation of parents whose children are studying in elementary schools did not learn computer programming as a part of formal school education and are not familiar with it. Parents' misconceptions and anxieties related to programming education could become obstacles to their involvement in children's learning. They probably neither have the confidence to support their child or children at home nor can imagine the kind of role they can play in informal programming education. It is necessary to encourage parents' involvement in programming education. Research suggests the usefulness of parent-child workshops in improving parents' concerns about programming education, instilling confidence in them, and informing them about their role in the informal education of their children (Roque et al. 2016, Maruyama 2017). However, the impact of different types of workshop activities on parents' concerns has not been examined adequately. Grebelsky-Lichtman (2014) suggested that parents' actions in parent-child cooperation were influenced by task difficulty. This paper reports the results of an investigation into the impact of participation in a programming workshop for children and parents on parents' concerns about programming education in elementary schools with a comparison of the differences in the workshop activities.

2. BACKGROUND AND PURPOSE

2.1 Research on Parents' Role in Education involving New Technology

Hart (2010) carried out a computer science-based workshop that targeted fourth through sixth graders, mainly female students, and their parents. Participants took part in an attitudinal survey during the first and last sessions of the workshop. The results of this survey revealed their perceptions of general computer use and the potential for a career as a computer scientist., It was also found that the perceived differences in the ability based on gender turned positive during the last session. Moreover, much of the feedback from parents was positive.

Lin and Liu (2012) observed three parent-child pairs in a computer camp using MSWLogo. They found that parent-child collaboration during programming naturally fell into a special form of "pair programming" and that children wrote programs in a more systematic and disciplined manner. Moreover, they reported that the programs produced by these participants were relatively more compact, well-structured, and error-free.

Cuellar et al. (2013) conducted a robotics education workshop in which parents and children interacted by experimenting with concepts of robotics and developing problem-solving skills. They expected students to become more interested in technology and their parents to encourage them toward engineering and science majors. Over the course of the workshop, they observed enhanced teamwork and interaction between the parents and children as well as a positive attitude towards the initiative.

Thus, parents' involvement in education significantly impacts children's attitudes and outcomes. However, some parents have low confidence in their involvement in education, especially regarding new technology.

Feng et al. (2011) regard parents as important influencers in children's decision to attend a robotics course and the use of educational robots among children. Therefore, they investigated parents' perception of edutainment products, including programmable bricks. They sent questionnaires to 55 parents and received 26 valid questionnaires. The questionnaire included questions on the usefulness of programmable bricks and the respondent's confidence in teaching programmable bricks. The results revealed that parents thought that programmable bricks were useful for their children but that they were not confident in using them to teach their children. Taking this into account, Feng et al. alluded to customized courses for both parents and children as a means of improving parents' confidence in teaching children.

Lin et al. (2012) investigated parents' perceptions regarding educational robots. The results of responses to the self-administered questionnaires from 29 parents indicated that parents had a positive attitude toward educational robots and considered learning about educational robots that are beneficial for their children. Additionally, they found that parents have little confidence in using educational robots to teach or to play with their children. The study recommended that it was crucial to train or teach parents about educational robots.

These studies indicate that participation in educational workshops could be a promising way of improving parents' attitudes and confidence.

Roque et al. (2016) state that social support from parents could be essential to engage children in creative opportunities regarding computing; however, parents whose background in computing is limited are often unsure of the roles they can play. To develop such parents' support, they suggest offering them a chance to gain first-hand experience in creative computing. They examined the experiences of parents' participation in a community-based program where families design and invent together using creative technologies. Through case analyses of three parent-children groups, they illustrated how parents' participation in design-based activities with their children enabled and supported the roles that they played in the program. As the research method was case study, the sample size was small. However, it is necessary to study this aspect using a larger sample.

In a study by the author (Maruyama 2019), the effects of participation in parent-child workshops on parents' concerns about programming education in elementary school were investigated. Three types of computer programming workshops were organized. Elementary school children were invited to participate in the workshops with their parents. A survey using questionnaires was carried out before and after the workshops. The results from 66 valid responses revealed that the experience of participating in workshops promotes parents' understanding of programming so that they are able to visualize the contents of programming education. Moreover, parents' attitudes toward and confidence in supporting their children at home improved as a result of the workshops. However, the number of responses was not adequate to analyze these aspects for each workshop type. As a result, the impact of the different types of workshop activities on parents' concerns could not be examined.

This paper reports the results of further investigation into parents' concerns. For this study, additional workshops were organized. Data from additional workshops were merged into the data from the workshops organized in the previous study (Maruyama 2019), and the impact of the different types of workshop activities on parents' concerns was examined.

3. PROGRAMMING WORKSHOPS

This study's survey was executed through programming workshops for children and their parents. Three types of programming workshops took place in August 2018 (Maruyama 2018) and March 2019. Participants were recruited via brochures distributed through 18 local elementary schools in Kanagawa, which is near Tokyo. The children were required to attend the workshops with their parents or guardians. Three types of workshops were held 34 times in total over a period of 15 days. Each parent-child pair took part in one of these. Each workshop lasted for two hours each with a break between the first and second halves. Each workshop was moderated by an instructor (author) and an assistant (university student). At the beginning of each workshop, a short lecture on computer programming was presented after which the workshop activities took place. A total of 232 groups (83 in Aug 2018 and 149 in March 2019) were part in the workshop.

3.1 Workshop Type 1

The first type of workshop targeted first and second grade students and their parents. A total of 66 groups (16 in August 2018 and 50 in March 2019) took part in these workshops.

3.1.1 Learning Tool: Cubetto

Cubetto (Primo Toys https://www.primotoys.com/) is an educational and screenless coding toy for children aged 3-6 years. Users can make a program with coding blocks by placing them into a control board. By pushing a button on the board, the cubetto moves, following the code on a map that has 6 x 6 cells. Four types of coding blocks were used in the workshop (Table 1). Each group used one set of cubetto in the workshop.

Figure 1. Cubbeto, cording blocks and a control board (left), a map (right)

Table 1. Types and number of blocks used in the workshop

Type	Roles	Number
Forward	Take a cell forward	6
Right	Turn to the right on the cell	4
Left	Turn to the left on the cell	4
Function	Replacement for a set of blocks placed in right side on the board [Fig. 1(left))]	2

3.1.2 Workshop Activity Scenario

In the first half of the workshop, all blocks, except the function, were used. At first, participants were asked to check the roles of blocks by placing them individually in a control board. Subsequently, they performed some coding tasks that allowed the cubetto to move from one cell to another. As the workshop progressed, the paths of the cubetto became longer and more complicated. The participants were required to find multiple paths for some tasks.

The function block was introduced at the beginning of the second half of the workshop. Participants were required to find the role of the function block by using the hints provided by the instructor.

Throughout the workshops, in all groups, the coding was mainly done by the children, while the parents advised them. It seemed that some tasks were somewhat difficult for the children; they solved these using the trial and error method. Conversely, the tasks were easy for the parents, so they gave hints positively. In almost all groups, parents gave some extra tasks to their children during their spare time in the workshops.

3.2 Workshop Type 2

Workshop 2, which was the second type of workshop, targeted children studying in third, fourth, fifth and sixth grades. A total of 105 groups (37 in August 2018 and 68 in March 2019) took part in these workshops.

3.2.1 Learning Tool: BB-8 and - SpheroEdu

BB-8™ App-Enabled Droid™ (Sphero https://www.sphero.com/) is a robotics toy that can be operated by application programs running on tablets and smart phones. SpheroEdu (https://edu.sphero.com/) has been developed for STEAM education with computer programming. By using SpheroEdu, the user can make codes to control robotics toys. SpheroEdu has a visual programming interface, so user can make codes by building blocks on the screens. In the workshop, each group used one robot and one tablet.

Figure 2. BB-8(left), interface of SpheroEdu for coding with blocks (center) and sample code (right)

3.2.2 Workshop Activity Scenario

At beginning of the workshop, participants learned some basic coding operations, such as displaying programming blocks on the screen, building blocks, deleting blocks, and connecting with the robot. In the first half of the workshop, participants did coding tasks that control the robot with the roll blocks [second block in Fig. 2 (right)]. At the beginning of the task, the participants were provided with instructions for the roll blocks, which let the robot run in certain directions. The roll blocks have three parameters: heading, speed, and duration. The robots were not very precise. Therefore, the tasks required finely adjusting the parameters for controlling the robot as desired by the participants

At the beginning of the second half, some blocks for controlling the sounds and lights of the robots were introduced. Subsequently, the dance task was assigned; this task required the participants to envision a scenario that would be a combination of a series of movements, sounds, and lights, and to write a code for the scenario. The participant were informed that they were required to demonstrate their tasks individually at the end of the workshop. All participants except one made the demonstrations.

Throughout the workshops, in all groups, children operated the tablet and did the coding, while their parents advised them. Participants were allowed to try using blocks that had not been introduced by the instructor.

3.3 Workshop Type 3

Workshop 3, which was the third type of workshop. targeted children studying in first through sixth grades. A total of 61 groups (30 in August 2018 and 31 in March 2019) took part in these workshops.

3.3.1 Learning Tool: Scratch

Scratch (The Lifelong Kindergarten Group at the MIT Media Lab https://scratch.mit.edu/) is visual programming language developed by The Lifelong Kindergarten Group at the MIT Media

Lab. It is provided free of charge. Scratch is popular in computer programming workshops for children in Japan. In the workshop, parents and children used a computer and wrote codes by themselves.

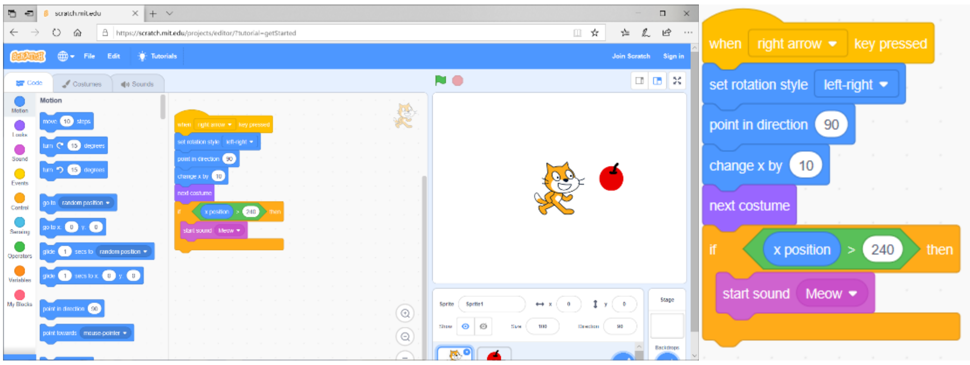

Figure 3. Interface of Scratch (left) and sample code (right)

3.3.2 Workshop Activity Scenario

At the beginning of the workshop, participants learned some basic coding operations, such as displaying programming blocks on the screen, building blocks, deleting blocks, and running codes. In the first half of the workshop, blocks categorized into Motion, Looks, Sound, Event, Control, and Operators were introduced. The instructor demonstrated the operations on the monitors placed between the children and their parents. The participants coded by following the instructions.

In the second half, participants developed a game in which players control a character named Scratch cat, using operating keys, to catch apples. The game codes required scripts for controlling the movements of the Scratch cat and the apples, as well as a script to determine the judgment of collisions between the Scratch cat and the apples. Participants coded by following the procedure described in the handout and the instructor's instructions.

In the workshop, while coding, some parents supported their children in coding by themselves. Participants followed instructions throughout the workshop. Therefore, there was less flexibility for the participants in comparison with the other two types of workshops.

4. INVESTIGATION

4.1 Research Method

Data were collected using two types of questionnaires: one was administered to the respondents before the workshop and another after the workshop. The questionnaire included the following sections: 1) demographics of participants and their children, 2) participants' interests in programming education, 3) attitudes toward programming education in elementary schools, 4) expectations of introducing programming education to elementary schools, 5) anxieties regarding the introduction of programming education, 6) attitudes toward and confidence in supporting children's programming education at home, and 7) participants' experiences in computer usage. Sections 1, 2, and 7 were only a part of the questionnaire administered before the workshop. There were other questions that sought responses from the children, but the results of those responses have not been included in this paper.

4.1.1 Expectations from the Introduction of Programming Education in Elementary Schools

Parents who are not familiar with computer programming believe that the outcomes of programming education are merely related to computers and expect that their children will at most gain familiarity with computers or acquire skills or knowledge related to computers.

On the other hand, Resnick (2011), who is known as the central researcher in a research group developing Scratch, described that as members of the Scratch community become more fluent with digital media, they develop an important array of “fluency skills,” in particular, thinking creatively, reasoning systematically, and working collaboratively. He also stated, “These skills are essential for full participation and success in today’s workplace, not only for computer programmers but for marketing managers, journalists, graphics designers, and most other occupations.” Yamamoto et al. (2016) examined the educational significance of programming education in elementary secondary education by reviewing existing research. As a result, they suggested that the educational significance and learning effect of programming education include acquisition of skills such as inquiring skills, algorithmic and logical thinking skills, comprehension skills, communication skills, collaborative skills, and informational perspectives and ways of thinking. Considering the above, 23 items were created (Table 9). These items are categorized into 5 categories, including P: related programming (item 17), C: related computer and knowledge of computer and ICT (item 1, 2, 5, 6, 13, 14, 15, 16 and 18), J: related future job (item 4 and 7), S: related other subjects (item 19 and 21), and G: general skills (item 3, 8, 9, 10, 11, 12, 20, 22 and 23).

4.1.2 Anxieties Regarding the Introduction of Programming Education

With regard to anxieties, two research studies related to English education in elementary school (Morita 2011, Makino 2008) were referenced while creating the items (Table 10). There were two reasons for selecting these studies. One, there are only a few research studies related to elementary school programming education that focus on parents' concerns. Two, English education will be introduced in the curriculum of elementary schools in Japan as a subject from 2020. As compared to programming education, English education in elementary school appears to receive more attention from researchers; therefore, there are several insightful studies on this topic. A useful insight into research on programming education was gained from these studies.

Morita’s study (2011) aimed to establish a learning environment for English education at home. He stated that it was necessary to know parents' concerns regarding English education in order to establish an appropriate environment. Therefore, they studiously considered items to incorporate in the questionnaire in order to investigate parents' concerns, and chose items regarding parents' anxieties about English education.

Makino (2008) carried out a survey on parents' concerns about English education in elementary school. The results of the survey showed that parents were anxious about the contents and policies of education and about teachers.

4.2 Respondents

The parents and guardians who participated in the three types of workshops were administered two questionnaires at the reception and were asked to complete one of them before and the other after the workshop; this was voluntary. Of the 182 valid responses obtained, 110 were from mothers, 69 were from fathers, and 1 was from a grandfather; 2 did not specify their relation with the children. The average age of respondents was 42.5 years (42.0: workshop 1, 43.1: workshop 2, 42.0: workshop 3). The age of the respondents and the school years of their children are presented in tables 2 and 3, respectively.

Table 2. Age of participants

Age	Frequency		
	Workshop 1	Workshop 2	Workshop 3
39 and younger	16	18	13
40-44	22	33	20
45-49	8	19	13
50 and older	4	7	1

Table 3. School year of participants' children

School year	Frequency		
	Workshop 1	Workshop 2	Workshop 3
1	29	0	6
2	22	0	7
3	0	26	7
4	0	24	14
5	0	20	0
6	0	11	7

5. RESULTS AND DISCUSSION

For merging the two data sets from the workshops held in August 2018 and March 2019, the Mann-Whitney test was performed for all variables related to the items included in the pre-workshop and post-workshop questionnaires to confirm if there were differences in the timing of implementation. The results of the test indicated statistically significant differences for the variable related to item 3 in attitudes toward computer education (Table 8) and variables related to items 5, 6, 19, 21, and 23 in expectations of programming education (Table 9). Therefore, those items were eliminated from further analysis.

5.1 Experiences of Computer Use and Interest in and Attitudes toward Computer Education

As presented in tables 4 and 5, approximately two-thirds of the respondents were found to use computers at work or in their daily lives. While they were familiar with computers, half of the total number of participants evaluated themselves as being either "not very skilled" or "not skilled at all." Some of the participants were relatively modest.

Figure 4 presents the results on interest in programming education (Table 7). As can be seen in the graphs for items 1 and 3 in all three workshops, a majority of the respondents are interested in programming education and welcome the introduction of programming education in elementary school. However, with regard to items 2 and 4, the graphs reveal that the respondents are not familiar with the contents of programming education, especially in workshop 1. This suggests that they do not have enough information about programming education.

Table 4. Experience of using computers at work

Responses	Frequency (%)		
	Workshop 1	Workshop 2	Workshop 3
I have a computer-related job	8 (15.7)	10 (12.2)	9 (18.4)
I had a computer-related job	2 (3.9)	4 (4.9)	0 (0)
I use a computer for work	22 (43.1)	30 (36.6)	28 (57.1)
I used a computer for work	6 (11.8)	12 (14.6)	3 (6.1)
I seldom use a computer for work	7 (13.7)	14 (17.1)	0 (0)
I never use a computer for work	6 (11.8)	12 (14.6)	4 (8.2)

Table 5. Experience of using computers in daily life

Responses	Frequency (%)		
	Workshop 1	Workshop 2	Workshop 3
I use one often	20 (39.2)	26 (31.7)	24 (49)
I use one sometimes	16 (31.4)	36 (43.9)	16 (32.7)
I seldom use one	11 (21.6)	16 (19.5)	8 (16.3)
I never use one	4 (7.8)	4 (4.9)	1 (2)

Table 6. Self-evaluation of using computers

Responses	Frequency (%)		
	Workshop 1	Workshop 2	Workshop 3
Quite skilled	3 (5.9)	12 (14.6)	6 (12.2)
Capable	22 (43.1)	27 (32.9)	19 (38.8)
Not very skilled	18 (35.3)	31 (37.8)	18 (36.7)
Not skilled at all	8 (15.7)	12 (14.6)	6 (12.2)

Table 7. Questions concerning parents' interests in programming education

(1) Are you interested in programming education in elementary school?
(2) Do you know what the new course of study (teaching guidelines issued by the Ministry of Education, Culture, Sports, Science and Technology) for elementary schools stipulates regarding programming education?
(3) Are you in favor of or opposed to programming education in elementary school?
(4) Do you know what children currently learn in computers in elementary school?

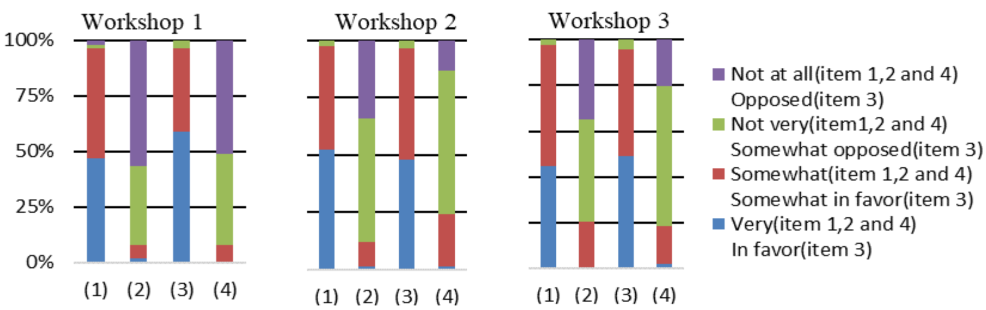

Figure 4. Responses to questions concerning interests

With regard to attitudes, respondents were asked to choose "I fully think so," "I somewhat think so," "I cannot say," "I do not think so," or "I do not think so at all" as a response for items related to attitudes (Table 8). Each response was converted to a score on a Likert-type scale ranging from 1 to 5. To explore the differences in attitudes before and after the workshop, the Wilcoxon signed-rank test was performed for each workshop. The results of the test indicated statistically significant differences for item 1 in all workshops. There were statistically significant differences for items 2 and 4 in workshop 1. This suggests that a lack of adequate information affected their attitudes and that participation in workshop 1 promoted their understanding of programming.

With regard to workshop 3, there were statistically significant differences for items 2 and 4. This implies that although parents thought that "Elementary school is too early to learn programming," they also believed "Programming should be part of the elementary school curriculum." This result points to a contradiction, which calls for further investigation.

Table 8. Result of the Wilcoxon signed-rank test for attitudes toward programming education

Item	*p*-value		
	Workshop1	Workshop2	Workshop3
(1) Everyone needs to know how to program.	$< .001^{**}$	$< .001^{**}$	$.001^{**}$
(2) Programming should be taught in elementary school.	$.025^{*}$	.061	.127
(3) Programming will be required in future societies, so it should be taught in elementary school.	-	-	-
(4) Elementary school is too early to learn programming.	.813	.709	$.013^{*}$
(5) Programming should be part of the elementary school curriculum.	$< .001^{**}$	.238	$.006^{**}$
(6) Programming will affect students' other studies, so it should not be taught in elementary school.	.403	.106	.869

5.2 Expectations and Anxieties about Programming Education

Figure 5 presents the results of pre-workshop expectations for each workshop. Respondents were asked to choose "I fully expect it," "I somewhat expect it," "I cannot say," "I don't expect it so much," or "I don't expect it at all" as a response for items related to expectations (Table 9). Each response was converted to a score on a Likert-type scale ranging from 1 to 5. The graphs are in descending order of rate of respondents who chose response 1 or 2 (i.e., in order of expectation). Each letter on the labels on the horizontal axis stands for the categories mentioned in section 4.1.1. With regard to workshop 1, some general skills were ranked higher. On the other hand, some computer-related items were ranked higher in workshops 2 and 3. "Think logically" was ranked high in all the workshops. Some other general skills related to communication, such as "express themselves," "to communicate," and "to communicate their thought" were ranked low in all the workshops.

To explore the differences in expectations before and after the workshop, the Wilcoxon signed-rank test was performed for each workshop. Results of the test (Table 9) indicate statistically significant differences for items 2, 7, 9, 10, 11, 12, 13, 20, and 22 in workshop 1, for items 7, 9, 10, 12, 14, and 22 in workshop 2, and for items 10, 12 and 22 in workshop 3. This suggests that the experiences of the workshops were most effective for the participants in workshop 1 and the least effective for those in workshop 3. As mentioned in section 5.1, the participants in workshop 1, in particular, were not familiar with the contents of programming education prior to the workshop. It is likely that their experiences in the workshops enhanced their understanding of programming thus resulting in their higher expectations after the workshops. General skills related to communication (item 10, 12 and 22), which were ranked low before the workshops, were ranked higher in all the workshops. A likely reason for this could be that prior to the workshops, the parents had the idea that programming was a task to be done individually. The activities in which they cooperated with or helped their children in the workshops could have transformed their expectations.

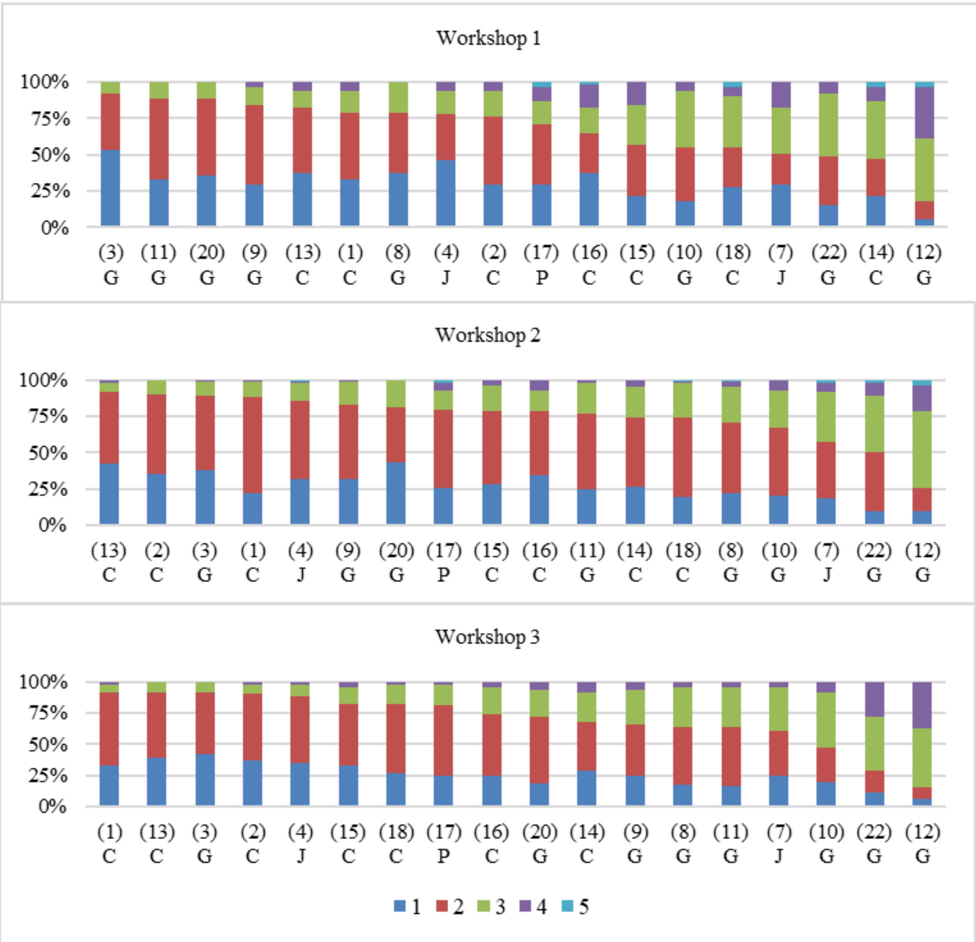

Figure 5. Responses to questions concerning expectations before workshop

With regard to workshop 1, the expectations of gaining general skills were high, in particular. As mentioned in section 3.2.1, children often solved tasks using the trial and error method in workshop 1. It is conceivable that parents' observation of such behavior in their children lead to higher expectations of parents related to "problem-identification," and "think about the steps in performing task."

With regard to workshop 2, the expectation for "Children will learn to be creative" became higher. On the other hand, the expectation for "Children will be able to use a computer to write compositions" became lower. This suggests that by doing the dance task and creating a scenario, parents recognized that programming was not just cording or using computer.

In workshop 3, as mentioned in section 3.3.2, participants followed instructions throughout the workshop. Therefore, there was less flexibility for the participants. It is likely that the impact of workshop 3 on expectations in general skills was less as compared with the other workshops.

Table 9. Results of the Wilcoxon signed-rank test for expectations

Item	Category	*p*-value		
		Workshop1	Workshop2	Workshop3
(1) Children will become skilled at using computers.	C	.314	.070	.129
(2) Children will like using computers.	C	.014*	.201	.888
(3) Children will learn to think logically.	G	.134	.590	.213
(4) It will help with work in the future.	J	.056	.876	.449
(5) Children will learn how to use information and communications technology (ICT).	C	-	-	-
(6) Children will learn ICT skills.	C	-	-	-
(7) It will foster personnel with advanced ICT skills.	J	.019*	.002**	.590
(8) Children will learn problem-solving skills.	G	.097	.077	.127
(9) Children will learn to be creative.	G	< .001**	.009**	.394
(10) Children will learn how to express themselves.	G	.002**	< .001**	.021*
(11) Children will acquire problem identification skills.	G	.028*	.112	.337
(12) Children will be able to communicate better.	G	< .001**	.008*	.002**
(13) Children will be inclined to use computers.	C	.019*	.594	.796
(14) Children will be able to use a computer to write compositions.	C	.768	.021*	1.000
(15) Children will be able to use a computer to draw pictures.	C	.303	.442	.835
(16) Children will understand how a computer works.	C	.060	.485	.356
(17) Children will be able to write computer programs.	P	.371	.175	.707
(18) Children will learn how to use the Internet.	C	1.000	.867	.468
(19) Children will understand arithmetic and science.	S	-	-	-
(20) Children will think about the steps one must follow when performing a task.	G	.035*	.739	.129
(21) Children will be better able to study other subjects.	S	-	-	-
(22) Children will be better able to communicate their thoughts.	G	.011*	.011*	.019*
(23) Children will be better able to work with others.	G	-	-	-

Respondents were asked to choose "I am very anxious," "I am somewhat anxious," "I cannot say," "I am not so anxious," or "I am not anxious at all" as a response for items related to anxieties (Table 10). Each response was converted into a score on a Likert-type scale ranging from 1 to 5. Results of the test (Table 10) indicate statistically significant differences for items 2, 7, and 9 in workshop 1, items 4, 6, 7, 8, 9, and 10 in workshop 2, and items 2, 6, 7, 9, and 10 in workshop 3. This suggests that the experience of participating in the workshop was effective for participants in workshops 2 and 3. On the other hand, the experience in workshop 1 was not very effective. However, the parents were able to rid themselves of the anxieties regarding the aim and contents of programming education (items 2 and 9) following their participation in workshops 1 and 3. These results suggest that the experiences in the workshops promoted parents' understanding of programming.

Table 10. Results of the Wilcoxon signed-rank test for attitudes toward programming anxieties

Item	*p*-value		
	Workshop1	Workshop2	Workshop3
(1) There are not enough teachers to provide instruction.	.872	.061	.065
(2) The aim of programming education is not clear.	.001**	.207	.034*
(3) Perhaps programming will adversely affect the study of other subjects.	.072	.093	.088
(4) The content taught differs depending on the school and teacher.	.568	.022*	.655
(5) Children's workload will increase.	.397	.466	.33
(6) I wonder whether my child can keep up.	.213	.009**	.033*
(7) I wonder whether I can provide guidance at home.	.041*	.008**	.005**
(8) Perhaps there are inequalities in the degrees of comprehension.	.705	.018*	.585
(9) Contents of programming education are not clear.	< .001**	< .001*	.008**
(10) I wonder whether the teacher can take care of the entire class.	.13	.007**	.003**

5.3 Attitudes Toward and Confidence in supporting Children at Home

As presented in Table 11, the effects of participation in the workshops can be observed in changes in attitudes toward and confidence in supporting children's programming education at home in all the workshops. Concerning the necessity of supplementary instruction, there was a statistically significant difference only in workshop 2. It can be said that in general, participation in the workshops improved parents' concerns related to supporting their children at home.

6. CONCLUSION

This study examined the impact of a range of workshop activities on parents of school children with regard to their concerns about programming education in elementary school. Three types of workshops were organized, each characterized by a type of activity: a wooden robot with coding blocks, a robotics toy with visual programming language, and visual language.

The results revealed that the workshops enhanced parents' understanding of programming, particularly workshop 1. With regard to expectations, the experience of participating in the workshops was most effective for those who participated in workshop 1. Children often solved tasks using the trial and error method in workshop 1. It is conceivable that parents' observation of such behavior in their children lead to higher expectations of parents related to general skills

With regard to anxieties, the results suggest that the experience of the workshop was most effective for those who participated in workshops 2 and 3. Workshop 1 was found to promote parents' understanding of programming. Participation in these workshops in general improved the attitudes and confidence levels of parents to support their children at home.

However, a contradicting result was indicated in the attitudes toward programming education. There is scope for further study of these phenomena using research methods such as interview and observation, followed by detailed analysis.

Table 11. Results of the Wilcoxon signed-rank test for questions concerning support at home

Item	*p*-value		
	Workshop1	Workshop2	Workshop3
(1) Do you think supplementary instruction outside of school will be necessary for programming education?	.056	.003**	.102
(2) Do you think you will be involved in supplementary instruction for programming education at home?	.01**	.003**	.005**
(3) If you will be involved in supplementary instruction at home, how much confidence do you have in your involvement?	< .001**	< .001**	.012**

ACKNOWLEDGEMENT

This work was supported by JSPS KAKENHI Grant Number JP18K02832.

REFERENCES

Barr, V., and Stephenson, C., 2011. Bringing computational thinking to K-12: What is involved and what is the role of the computer science education community? *Acm Inroads*, Vol. 2, No. 1, pp. 48-54.

Cuellar, F., Penaloza, C. and Kato, G., 2013, August. Robotics education initiative for parent-children interaction. *In RO-MAN*, 2013 IEEE (pp. 364-365). IEEE.

Feng, H.C., Lin, C.H. and Liu, E.Z.F., 2011. Parents' perceptions of educational programmable bricks for kids. *British Journal of Educational Technology*, 42(2), pp.E30-E33.

Grebelsky-Lichtman, T., 2014. Parental patterns of cooperation in parent–child interactions: The relationship between nonverbal and verbal communication. *Human Communication Research*, 40(1), pp.1-29.

Grover, S., and Pea, R., 2013. Computational thinking in K–12: A review of the state of the field. *Educational Researcher*, Vol. 42, No. 1, pp. 38-43.

Hart, M. L., 2010, Making contact with the forgotten K-12 influence: Are you smarter than YOUR 5th grader? *Proceedings of the 41st ACM technical symposium on Computer science education*, Wisconsin, USA, pp. 254-258.

Lin, C.H., Liu, E.Z.F. and Huang, Y.Y., 2012. Exploring parents' perceptions towards educational robots: Gender and socio-economic differences. *British Journal of Educational Technology*, 43(1).

Lin, J. M.-C., and Liu, S.-F., 2012. An investigation into parent-child collaboration in learning computer programming. *Educational Technology & Society*, Vol.15, No.1, pp162–173.

Lye, S. Y., and Koh, J. H. L., 2014, Review on teaching and learning of computational thinking through programming: What is next for K-12? *Computers in Human Behavior*, Vol. 41, pp. 51-61.

Makino, M., 2008. Parental perception of English activities at elementary schools – focusing on expectation and involvement-, *Research Institute for Communication, Kansai University of International Studies, Studies on Communication*, 6, 61-73 (in Japanese).

Morita, A., 2011. Data analysis of parents' involvement in primary school English language education, *Waseda review of Education*, 25, 1, 163 – 172 (in Japanese).

Maruyama, Y., 2018, An investigation into the effects of programming workshop experiences on parents' concerns about programming education in elementary school, *Proceedings of the 2019 International Conference on Education and Technology*, Hong Kong, pp55-64.

Papert, S., 1993. *Mindstorms: Children, Computers, and Powerful Ideas*, 2nd ed, Basic Books, New York.

Resnick, M., 2012, Mother's day, warrior cats, and digital fluency: Stories from the Scratch online community, *Proceedings of the Constructionism 2012 conference*, Athens, Greece, pp1-7.

Roque, R., Lin, K. and Liuzzi, R., 2016. "I'm Not Just a Mom": Parents Developing Multiple Roles in Creative Computing. Singapore: *International Society of the Learning Sciences*.

Wing, J.M. 2006. Computational Thinking, *Communications of the ACM*, Vol. 49, No. 3, pp. 33-35.

Yamamot, T., Hongou, T., Motomura, T., and Nagai, K., 2016, Consideration of educatinal significance of programming education in elementary secondary education, *Kyouiku Joho Kenkyu [Study on Educational Information (translated by author)]*, 32, 2, pp3-11 (in Japanese).