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INVESTIGATION OF MOTHERS' AND FATHERS' CONCERNS ABOUT PROGRAMMING EDUCATION IN ELEMENTARY SCHOOL

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Abstract. *Parents play a very important role in elementary school education, and their attitudes toward education have a considerable influence on their children's attitudes. However, if parents do not have enough information about computer programming, they cannot get involved in their children's education positively. Some studies suggest that a promising way to ensure parents' involvement is through their participation in workshops with their children. To investigate the impact of the participation of parents in workshops on their concerns about programming education in elementary schools, parent-child workshops were organized by the author. This paper presents the result of the survey and a comparison between the responses of mothers and fathers. The results indicated that the mothers' expectations from computer programming education, in the context of gaining general skills, were raised after the workshops. In respect to anxiety regarding computer programming education and attitudes and confidence in supporting children at home, the experience of the workshop was rather effective for mothers and fathers.*
Keywords: Programming education, Elementary school, Parents' concerns, Computational thinking, Programming workshop

1. **Introduction.** Significant efforts have been made to introduce computational thinking into elementary and secondary (also known as K-12) education [1,2]. The term "computational thinking" was first used by Papert [3] and later popularized by Wing [4], who defined it as follows: "Computational thinking involves solving problems, designing systems, and understanding human behavior by drawing on concepts that are fundamental to computer science" (p.33). Wing further stated that computational thinking is a fundamental universal skill and should be added to every child's repertoire of analytical abilities. The article caught the attention of education researchers and educators and led to several studies on computational thinking for K-12. In the UK, "computing" was added as a new subject into primary and secondary school curricula. The primary school teacher's guide to computing stresses the importance of computational thinking.

As computational thinking gains popularity, programming education is also receiving recognition as a method to teach computational thinking. Lye and Koh [5] state that "programming 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 Ministry of Education, Culture, Sports, Science, and Technology's Central Council for Education submitted a report on the introduction of programming education in elementary schools. Another council report said that programming education in elementary schools should not aim to teach students how to code, but rather foster students' programming thinking (translated by author). Programming thinking is considered a concept similar to computational thinking and is also considered a part of computational thinking. However, knowledge of the aims of programming education

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has not spread sufficiently among the public. Misconceptions and anxieties concerning programming education seem to have begun spreading among parents. Parents play a very important role in elementary education, and their attitudes toward education have considerable influence on children's attitudes. Researchers have investigated parent-child collaborations in robotics education [6,7] and in learning programming [8,9]. Parents' misconceptions and anxieties related to programming education could serve as obstacles in their involvement with their children's learning. Research indicates the usefulness of parent-child workshops in improving parents' concerns about programming education, instilling confidence in them, and informing their role in their children's informal education [7].

2. **Related Work.** As aforementioned, parents' attitudes toward education have a considerable influence on children's attitudes. Hart [9] conducted a computer-science-based workshop targeting fourth, fifth, and sixth graders (mostly female) and their parents. An attitudinal survey was administered in the first and last session of the workshop. Results indicated perceptions of general computer use, the potential for a career as a computer scientist, and positive reactions to perceived differences in ability based on gender during the last session. In general, feedback from participating parents was positive.

Lin and Liu [8] observed three parent-child pairs in a computer camp that used the M-SWLogo programming environment. It was found that parent-child collaborations during programming naturally fell into a special form of "pair programming" and that children wrote programs in a more systematic and disciplined manner. It was also reported that programs written by participants were relatively more compact, well-structured, and error-free. Thus, parents' involvement in education significantly impacted children's attitudes and outcomes.

However, some parents displayed a lack of confidence in being involved in their children's education, especially concerning new technology. Feng et al. [10] investigated parents' perception of edutainment products using programmable bricks. They found that while parents felt that programmable bricks were useful for children, they were not confident in using the bricks themselves to teach their children. Feng et al. thus recommended customized courses for both parents and children as a means to improve parents' confidence in teaching children in the future. Participation in educational workshops could be a promising way to improve parents' attitudes and confidence.

According to Roque et al. [7], social support from parents can be essential in engaging children toward creative opportunities with respect to computing; however, parents with limited computing background are often unsure of how to contribute. Through case analyses of three parent-children groups, Roque et al. demonstrated how parents' participation in design-based activities with children enabled and supported their roles in such programs. While some studies exist on the impact of parents' participation in parent-child workshops on the attitudes of children, they are insufficient due to limited participation. Moreover, very few studies have focused on changes in parents' concerns.

This study investigates the influence of participation in programming workshops for children and parents and observes changes in parents' concerns and perceptions about programming education in elementary schools. The main focus is on differences in perceptions between mothers and fathers.

3. **Method.** The survey was conducted in a programming workshop for children and parents. Three types of programming workshops took place in August 2018 and March 2019. Participants were recruited via brochures distributed in 18 local elementary schools in Kanagawa, which is close to Tokyo. Participants were required to be child-parent/guardian pairs. Workshops were held 34 times in 15 days. Each pair together attended one workshop that lasted two hours and was assigned an instructor (author) and an assistant

(university student). Workshops began with short lectures on computer programming followed by workshop activities. A total of 232 groups participated.

Questionnaires contained the following sections: 1) demographics of participants and their children (only in the pre-workshop questionnaire), 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 (only in the pre-workshop questionnaire). This study focuses specifically on sections 4 through 7. There were other questions that sought responses from children; however, those responses are excluded from this study.

Table 1 presents questions regarding expectations and anxieties. With regards to expectations, parents unfamiliar with computer programming felt that outcomes of programming education were merely related to computers and expected children to become familiar with computers or acquire skills or knowledge related to computers. However, as aforementioned, "programming is more than just coding" [5]. Considering Resnick [11] and Yamamoto et al. [12], twenty-three items were created (Table 1) that were categorized into five categories, namely, P: programming-related (item 17), C: computer-related skills and ICT knowledge (items 1, 2, 5, 6, 13, 14, 15, 16, and 18), J: future-job-related (items 4 and 7), S: related to other subjects (items 19 and 21), and G: general skills (items 3, 8, 9, 10, 11, 12, 20, 22 and 23).

Participants voluntarily completed two questionnaires, one before and one after the workshop. In total, 182 valid responses were obtained, of which 110 were from mothers and 69 from fathers of elementary school students; 3 sets of parents did not provide any responses. Therefore, 179 responses constituted analysis targets in this study. Average age was 41.7 for mothers and 43.3 for fathers.

4. **Results and Discussion.**

4.1. **Parents' expectations for programming education.**

Respondent parents were asked to choose from "I don't expect it at all", "I don't expect it much", "I cannot say", "I somewhat expect it", or "I fully expect it" for items related to expectations. Each response was converted to a score on a Likert-type scale ranging from 1 to 5, and average values were calculated for mothers and fathers (Figure 1). Overall, mothers were found to have higher expectations than fathers. On the other hand, fathers seemed to have higher expectations regarding gaining general skills (items 3, 8, 11, and 20). Mann-Whitney U test results indicated statistically significant differences between mothers and fathers ($p < 0.05$) for items 2, 3, 5, 6, 14, 15, 16, and 18 ($p = 0.001$, $p = 0.036$, $p = 0.012$, $p = 0.016$, $p = 0.008$, $p < 0.001$, $p < 0.001$, and $p < 0.001$), demonstrating that mothers had higher expectations than fathers when it came to their children gaining skills and knowledge related to computers and ICT as a result of programming education. Fathers had higher expectations with regards to gaining general skills – especially thinking logically – than mothers.

Figure 2 presents results for expectations before and after workshops for mothers and fathers in the left and right representations respectively. Overall, a rise in mothers' expectations was observed after the workshops. Wilcoxon signed-rank test results indicated statistically significant differences before and after ($p < 0.05$) for items 6, 7, 8, 9, 10, 11, 12, 13, 17, 19, 20, 21, 22, and 23 ($p = 0.017$, $p = 0.003$, $p = 0.002$, $p = 0.002$, $p < 0.001$, $p = 0.001$, $p < 0.001$, $p = 0.030$, $p = 0.045$, $p = 0.017$, $p = 0.039$, $p = 0.017$, $p < 0.001$, and $p = 0.022$). In particular, expectations on gaining general skills were raised. It is likely that experiences cooperating with or helping children in workshops caused changes in mothers' expectations. With regards to fathers' expectations, results

TABLE 1. Questions and items concerning parents' expectations and anxieties

Expectations (Do you expect the following outcomes as a result of introducing programming education?)
(1) Children will become skilled at using computers.
(2) Children will like using computers.
(3) Children will learn to think logically.
(4) It will help with work in the future.
(5) Children will learn how to use information and communications technology (ICT).
(6) Children will learn ICT skills.
(7) It will foster personnel with advanced ICT skills.
(8) Children will acquire problem-solving skills.
(9) Children will learn to be creative.
(10) Children will learn how to express themselves.
(11) Children will acquire problem-identification skills.
(12) Children will be able to communicate better.
(13) Children will be inclined to use computers.
(14) Children will be able to use a computer to write compositions.
(15) Children will be able to use a computer to draw pictures.
(16) Children will understand how a computer works.
(17) Children will be able to write computer programs.
(18) Children will learn how to use the Internet.
(19) Children will understand arithmetic and science.
(20) Children will think about steps one must follow when performing a task.
(21) Children will be better able to study other subjects.
(22) Children will be better able to tell their thoughts.
(23) Children will be better able to work with others.
Anxieties (Are you anxious about the following items concerning programming education in elementary schools?)
(1) There are not enough teachers to provide instruction.
(2) The aim of programming education is unclear.
(3) Programming could adversely affect students' study of other subjects.
(4) The content taught differs depending on the school and teacher.
(5) Children's workload will increase.
(6) I wonder whether my child can keep up.
(7) I wonder if I can provide guidance at home.
(8) Perhaps there are inequalities in the degrees of comprehension.
(9) The content of programming education is generally unclear.
(10) I wonder if teachers can take care of the whole class.

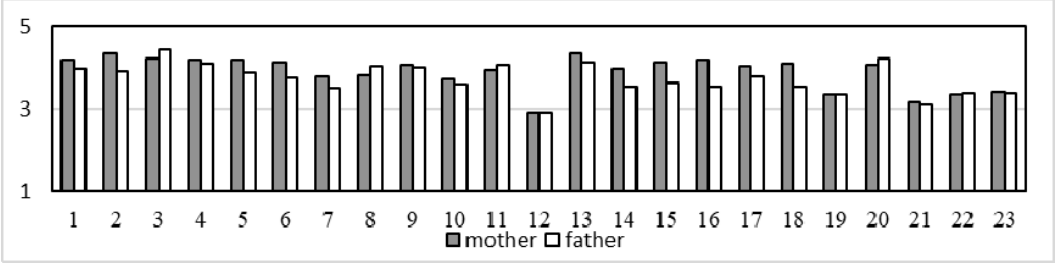

FIGURE 1. Average values of parents' expectations for programming education

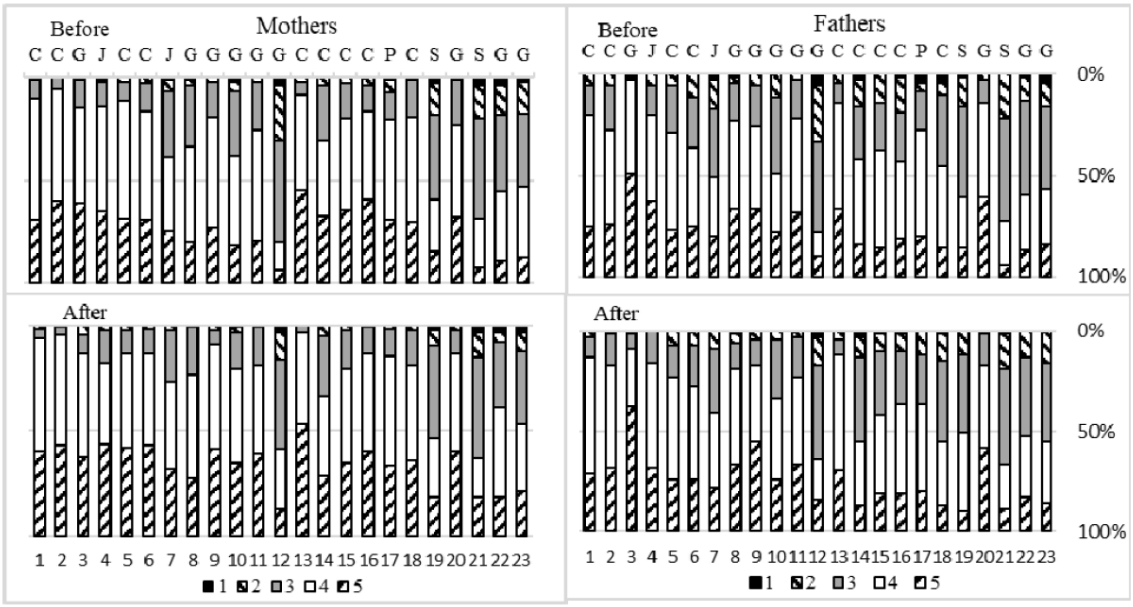

FIGURE 2. Parents' expectations for programming education before and after workshops

of Wilcoxon signed-rank test indicated statistically significant differences only for items 2, 9, 10, and 12 ($p = 0.023$, $p = 0.011$, $p = 0.005$, and $p < 0.001$), suggesting that workshop experiences were not so effective in addressing fathers' concerns.

4.2. **Parents' anxieties regarding programming education.** Participants were asked to choose from response items "I am not anxious at all", "I am not so anxious", "I cannot say", "I am somewhat anxious", and "I am very anxious" in relation to anxieties. Each response was converted to a score on a Likert-type scale ranging from 1 to 5, and average values were calculated for mothers and fathers (Figure 3). Results of the Mann-Whitney U test indicated statistically significant differences between mothers and fathers only for item 7 ($p < 0.001$); mothers worried if they could support children at home more than fathers did.

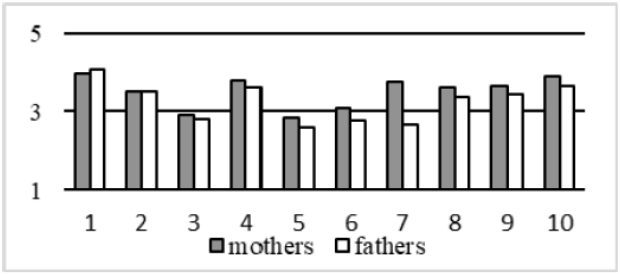

FIGURE 3. Average values of parents' anxieties regarding programming education

Figure 4 shows results concerning anxieties before and after workshops for mothers and fathers in the left and right representations respectively. With respect to results from mothers, the Wilcoxon signed-rank test indicates statistically significant differences before and after workshops ($p < 0.05$) for items 2, 6, 7, 8, 9, and 10 ($p = 0.022$, $p = 0.005$, $p < 0.001$, $p = 0.046$, $p < 0.001$, and $p = 0.001$). Anxieties regarding supporting children at home had eased. With fathers, results of the Wilcoxon signed-rank test indicated statistically significant differences before and after workshops ($p < 0.05$) for items 2, 3, 9, and 10 ($p = 0.002$, $p = 0.005$, $p = 0.009$, and $p = 0.015$), suggesting that workshop experiences proved to be effective for both mothers and fathers.

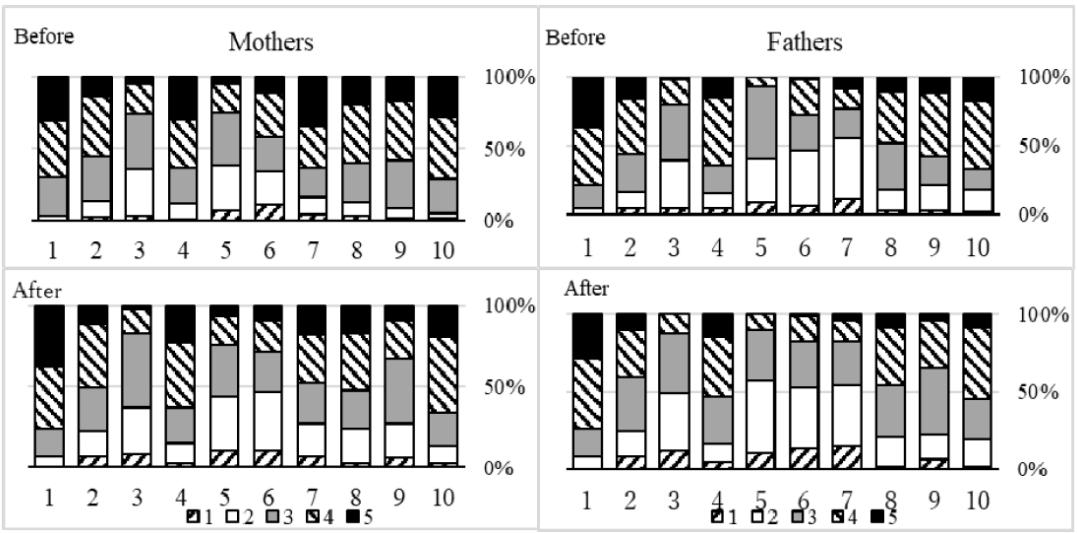

FIGURE 4. Parents' anxieties about programming education before and after workshops

4.3. **Parents' attitudes and confidence in supporting children at home.** Tables 2 and 3 present questions and results respectively concerning supporting children at home. Wilcoxon signed-rank test results indicate statistically significant differences before and after the workshops on items regarding necessity in mothers as well as attitudes and confidence levels in both mothers and fathers. Both attitudes and confidence levels supporting children at home improved as a result of workshop participation.

TABLE 2. Items concerning supporting children at home

Item 1) Do you think supplementary instruction outside of school will be necessary for programming education?	
1. Fully agree	3. Don't really think so
2. Somewhat agree	4. Disagree
Item 2) Do you think you will be involved in supplementary instruction for programming education at home?	
1. Will be involved	4. Will not be very involved
2. Will be actively involved to a certain extent	5. Will not be involved at all
3. Will be involved if necessary	
Item 3) If you will be involved in supplementary instruction at home, how much confidence do you have in your involvement?	
1. I'm very confident	3. I'm not very confident
2. I'm somewhat confident	4. I'm not confident at all

4.4. **Experiences of computer usage.** In all, 34.7% of participating fathers responded that they currently or in the past held computer-related jobs, as opposed to 8.2% of mothers. Moreover, 7.2% of the fathers responded that they rarely or never used computers for work, in contrast to 39.1% of mothers. Concerning self-evaluations of computer use, 72.5% of the fathers responded "Quite skilled" or "Capable" and 27.5% responded "Not very skilled" or "Not skilled at all", whereas only 33.6% of the mothers responded "Quite skilled" or "Capable" and 66.4% responded "Not very skilled" or "Not skilled at all". It is probable that different levels of experience in computer usage affect these differences between mothers and fathers in their expectations and the anxiety about supporting their children at home. Most fathers used computers regularly at work, so they knew that computer programming skills were not solely be related to computers. On the other hand,

TABLE 3. Results for items concerning supporting children at home

Item 1)		1	2	3	4		
		freq.(%)	freq.(%)	freq.(%)	freq.(%)		
Mothers	Before	13(11.8)	45(40.9)	49(44.5)	3(2.7)		$p = 0.001$**
	After	16(14.5)	64(58.2)	28(25.5)	2(1.8)		
Fathers	Before	6(8.7)	24(34.8)	38(55.1)	1(1.4)		$p = 0.59$
	After	9(13.0)	28(40.6)	32(46.4)	0(0.0)		
Item 2)		1	2	3	4	5	
		freq.(%)	freq.(%)	freq.(%)	freq.(%)	freq.(%)	
Mothers	Before	7(6.4)	21(19.1)	67(60.9)	12(10.9)	3(2.7)	$p < 0.001$**
	After	14(12.7)	29(26.4)	61(55.5)	4(3.6)	2(1.8)	
Fathers	Before	10(14.5)	15(21.7)	40(58.0)	4(5.8)	0(0.0)	$p = 0.001$**
	After	14(20.3)	21(30.4)	31(44.9)	3(4.3)	0(0.0)	
Item 3)		1	2	3	4		
		freq.(%)	freq.(%)	freq.(%)	freq.(%)		
Mothers	Before	2(1.8)	16(14.5)	52(47.3)	40(36.4)		$p < 0.001$**
	After	3(2.7)	30(27.3)	57(51.8)	20(18.2)		
Fathers	Before	6(8.7)	37(53.6)	21(30.4)	5(7.2)		$p < 0.001$**
	After	9(13.0)	43(62.3)	15(21.7)	2(2.9)		

Note: $^{**}p < 0.01$

mothers were not so familiar with computer programming before the workshops, and thus could not visualize the programming processes and did not expect general skills as outcomes. Moreover, mothers' lack of experience seemed to cause their anxiety.

5. **Conclusions.** Participation in the programming workshops seemed to especially promote mothers' understanding of computer programming, boost expectations, and decrease anxieties about the introduction of programming education into elementary schools. This study suggests that different levels of experience in computer usage affect attitudinal differences between mothers' and fathers' as well as expectations and anxieties about supporting children at home. However, there is the possibility that differences in number of responses received from mothers and fathers impacted results. Further investigation in this regard is required.

This study examined changes in parents' concerns and perceptions immediately after the workshop. It is essential that the changes lead to actual parental involvement in children's programming education. A follow-up survey on subsequent parental involvement at home with workshop participants will be conducted.

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