ISSN (Print) : 0974-6846
Indian Journal of Science and Technology, Vol 9(24), DOI: 10.17485/ijst/2016/v9i24/96104, June 2016 ISSN (Online) : 0974-5645

The Effect of Robot Programming Education on Attitudes towards Robots

Seong-won Kim and Youngjun Lee*

Department of Computer Education, Korea National University of Education, Korea;
sos284809@gmail.com, yjlee@knue.ac.kr

Abstract

Background/Objectives: How robot programming education affects the attitude of pre-service teachers toward robots was analyzed, along with how pre-service teachers appreciate robot programming classes. **Methods/Statistical Analysis:** In this research, the Negative Attitude toward Robots Scale of Nomura et al. was used as a test tool. Research subjects were divided into an experimental group taking robot programming education and a control group taking ordinary classes. Both groups took a test to indicate their attitudes toward robots before and after the experiment; the experimental group also took a test asking their appreciation of robot programming education. Each group's test results were analyzed using paired t-tests and independent t-tests. The attitude toward robot programming education was analyzed through frequency analysis. **Findings:** Before the experiment, the groups' results did not show statistically significant differences; however, after the experiment, they did. Comparing pre- and post-testing of each group, the control group showed no significant difference; however, the experimental group showed significant difference. This implied that robot programming education affected pre-service teachers' attitudes toward robots, especially in a positive way. When asked their attitude toward robots, pre-service teachers answered that programming education promoted more interest in robots because they could make and realized with their own hand; however, the design and the assembly of robot would be negative. Pre-existing research had only studied attitudes toward robots and compared them by countries or investigated effect elements. This research focused on not only the attitude of pre-service teachers toward robots but also elements that could improve those attitudes. In follow-up studies, researchers could attempt to solve the imbalance of research subjects and add the group taking programming classes. **Application/Improvements:** The result of this study could be used for the development of robot education programs and basic material for the training of teachers.

Keywords: Attitude toward Robots, Robot Programming, Robotic Education, Robot, Programming

1. Introduction

"The Future of Jobs", a report from the World Economic Forum, predicted that there would be a fourth industrial revolution owing to the evolution of information and communication technology in the form of artificial intelligence and robots. It also stated that existing jobs would disappear and new jobs would be created based on computer science and robots. The application of robot technology in diverse fields has accelerated. In the education field, robots have been introduced in class because of their benefits. Robots can motivate students to participate in class and provide them with opportunities for reflection as well as an interactive, heuristic, and collaborative learning environment[1-11]. Therefore, the number of studies on the application of robots in class has rapidly increased[12,13]. However, teachers' negative attitudes toward robots, the costs and time needed to manage robots, and the teachers' lack of expertise on robots have prevented robots from being applied in class[14]. Research is needed to introduce robots to schools, which would have diverse educational effects.

The negative attitude of teachers toward robots is a serious concern. Teachers' attitude is one of the important factors influencing teaching affect and teaching self-concept[15]. As in the case of computers, the attitude toward robots has a significant effect on robot education[16]. Nomura et al. recognized the importance of the attitude

* Author for correspondence

toward robots and developed various tools to measure it[17]. Moreover, many studies have analyzed the factors that affect the attitude toward robots[17-22].

In Korea, few studies have been conducted on the attitude toward robots. Lee recognized the necessity of tools to measure attitudes toward robots and developed a questionnaire to analyze elementary, middle school, and high school students' attitudes toward robots[23,24]. Baek and Keum implemented after-school programs on robot education and studied the effects of these programs on the attitude toward robots[25]. Shin and Kim investigated pre-service teachers' attitude toward robots and analyzed its correlation between attitudes toward robots and other factors[26]. They also found that Korean teachers have more negative attitudes toward robots compared with their counterparts in other countries. Kim and Lee discovered that Korean elementary school teachers have more negative attitudes toward robots than pre-service teachers' do[27].

The literature review shows that the number of studies on teachers' and pre-service teachers' attitudes toward robots is insufficient. Existing research on this topic is limited to the correlation of selected variables with the attitude toward robots; research on the change in attitudes toward robots is rare. Robot programming education has been proven effective in positively changing the attitude toward computer[28].

So, this research will intensively study the influence of robot programming education on pre-service teachers' attitudes toward robots. It will also investigate pre-service teachers' perceptions of robot programming education. By doing so, it can contribute to the future of robot programming education and research on attitudes toward robots.

2. Research Method

2.1 Research Procedure

This study used the following steps to examine how robot programming education affects pre-service teachers' attitudes toward robots: First, a literature review on attitudes toward robots was done. Second, a test tool for measuring attitudes toward robots was selected. Third, a robot programming education program that can influence pre-service teachers' attitudes toward robots was developed and verified by experts. Fourth, a pre-test was conducted on a control group and an experimental group to measure their attitudes toward robots. Fifth, the experimental group was exposed to robot programming education while the control group was not. Finally, after the program was completed, the control group and the experimental group took a post-test, and data on the pre-service teachers' attitudes toward robots were collected and analyzed.

2.2 Research Subjects

The research subjects were 40 pre-service teachers who were working at a university of education in South Korea. The sample consisted of 23 male students (57%) and 17 female students (43%). In this study, the experimental treatment was conducted as part of the university curriculum. Therefore, sample group were divided according to the selected experimental group and the control group. The majority (65%) of the control group were men, while more than half (57%) of the experimental group were women. There were only a few seniors (7%); the students were mostly juniors (35%), sophomores (33%), and freshmen (25%). The experimental group was composed of sophomores (36%) and juniors (64%). The control group consisted primarily of freshmen (38%) and sophomores (31%); juniors and seniors made up 19% and 12% of the control group, respectively.

The majority of pre-service teachers were majoring in computer education (65%). Other majors included technology (17%), earth science (10%), primary education (3%), home economics (3%), and pedagogy (3%). In the control group, computer education (46%) was also the dominant major, followed by technology (17%), earth science (10%), primary education (4%), home economics (4%), and pedagogy (4%). In the experimental group, all the participants were computer education majors, since the robot programming class is for pre-service teachers majoring in computer education. The literature has shown that attitudes toward robots vary according to the type of contact with robots: direct or mediated[26]. Experience in using robots in class is also a significant factor affecting attitudes toward robots[23]. In the present study, the majority (63%) of participants had experience in controlling robots. In the experimental group, the gap between the percentage with and without experience (43%) is smaller than that of the control group. Only about a third (35%) of the participants had experienced using robots in an actual class. In the experimental group, the percentage of those with experience is equal to those without experience (50%). In the control group, the percentage with experience is lower (27%) than the percentage without experience. Finally, 95% of the total students have had at least a mediated experience with robots shown in Table 1.

2.3 Research Design

In this study, a robot programming course for pre-service teachers had been done. Pre-service teachers' attitudes toward robots were measured by a pre- and post-test. The teachers were also asked about their opinions on robot programming education through a questionnaire.

The pre-service teachers in the experimental group took the robot programming course. The pre- and post-test were used to analyze how the teachers' negative attitudes toward robots changed. The experimental group took the post-test on attitudes toward robots and answered the questionnaire on attitudes toward robot programming education is shown in Figure 1.

Experimental group (n=14)	O_1	X	O_1	O_2
Control group (n=26)	O_1		O_1	

O_1 : Negative Attitude towards Robots Scale
X : Programs of Robot programming education
O_2 : Questionnaire on robot programming education

Figure 1. Research design.

2.4 Research Instruments

The research instruments consist of the Negative Attitude toward Robots Scale (NARS) and a questionnaire on robot programming education.

Table 1. Detailed information of research subjects Number of studies (%)

				Gender			
		Male			Female		Total
Con.		6(43)			8(57)		14(100)
Exp.		17(65)			9(35)		26(100)
Total		23(57)			17(43)		40(100)
				Grade			
	Freshman	Sophomore		Junior		Senior	Total
Con.	0(0)	5(36)		9(64)		0(0)	14(100)
Exp.	10(38)	8(31)		5(19)		3(12)	26(100)
Total	10(25)	13(33)		14(35)		3(7)	40(100)
				Major			
	Computer	Technology	Earth Science	Primary Education	Home Economics	Pedagogy	Total
Con.	14(100)	0(0)	0(0)	0(0)	0(0)	0(0)	14(100)
Exp.	12(46)	7(27)	4(15)	1(4)	1(4)	1(4)	26(100)
Total	26(65)	7(17)	4(10)	1(3)	1(3)	1(3)	40(100)
				Have you controlled robots?			
		Yes			No		Total
Con.		8(57)			6(43)		14(100)
Exp.		17(65)			9(35)		26(100)
Total		25(63)			15(37)		40(100)
				Have you utilize robots for your class?			
		yes			no		total
Con.		7(50)			7(50)		14(100)
Exp.		7(27)			19(73)		26(100)
Total		14(35)			26(65)		40(100)
				Do you have any mediated experience with robots?			
		yes			no		total
Con.		13(93)			1(7)		14(100)
Exp.		25(96)			1(4)		26(100)
Total		38(95)			2(5)		40(100)

Table 2. Negative attitude towards robots scale

Sub-domain	Questionnaire items	Numbers
Negative attitude toward situations of interaction with robots	I would feel uneasy if I was given a job where I had to use robots The word "robot" means nothing to me I would feel nervous operating a robot in front of other people I would hate the idea that robots or artificial intelligences were making judgments about things I would feel very nervous just standing in front of a robot I would feel paranoid talking with a robot	6
Negative attitude toward social influence of robots	I would feel uneasy if robots really had emotions Something bad might happen if robots developed into living beings i feel that if I depend on robots too much, something bad might happen I am concerned that robots would be a bad influence on children I feel that in the future society will be dominated by robots	5
Negative attitude toward emotions in interaction with robots	I would feel relaxed talking with robots* If robots had emotions, I would be able to make friends with them* I feel comforted being with robots that have emotions*	3
Total		14

* reversed item

2.4.1 NARS

The NARS, which was developed by Nomura et al. measures negative attitudes and emotions toward robots[17]. In the current study, it was used to assess pre-service teachers' attitudes toward robots. The NARS consists of 14 questions, each using a five-point Likert scale. Three of the questions were reverse coded. The test tool includes three sub-areas: interaction with robots, social influence of robots and emotional bond with robots is shown in Table 2. The Cronbach's α of NARS is .791. This means that the NARS has acceptable internal consistency. The NARS was developed in English, so a translated Korean version was used in this study[26].

2.4.2 Questionnaire on Robot Programming Education

A questionnaire on robot programming education was administered to the pre-service teachers to examine their individual opinions on robot programming education. The questionnaire consisted of seven questions that covered what the participants liked and disliked about the class, a comparison of activities related to robots, a comparison of robot programming education and a general computer science class, and the preferred teaching method for robot activities are shown in Table 3.

2.5 Treatment

Fourteen pre-service teachers in a university of education in South Korea attended robot programming classes from September 3 to December 10, 2015. Each class was four hours long. The class was called "Information Technology Seminar II" and was for juniors and seniors majoring in computer education.

In week 1, the pre-service teachers were provided with a general outline of the robot class, a brief introduction

Table 3. Questionnaire on robot programming education

Questionnaire items	Number
What did you like in robot programming education?	1
What did you dislike in robot programming education?	1
Describe what you liked and disliked about robot programming education from 2nd week to 6th week.	1
Describe what you like and dislike about robot wrestling comparing with the other activities.	1
Describe what you liked and disliked about name writing robot, Stack/Cue robot and cube solving robot comparing with the others.	1
Describe what you liked and desliked about robot programming comparing with existing computer science class.	1
Describe the way you like when doing robot programming activities: team or individual?	1
total	7

of LEGO Mindstorms EV3 robots and their components, and an explanation of block-based programming.

In week 2, the functions of the motors and sensors of the EV3 robots were explained to the pre-service teachers. The teachers participated in activities where they assembled and activated a basic model. Previous research has shown that Korean students' and teachers' attitudes toward robots are negative[23,26,27]. Moreover, the type of contact with robots, whether direct or mediated, did not have an influence on attitudes but affected the interest in robots[26]. In the present study, half of the pre-service teachers who took the robot programming course had no experience with robots. Less than half of the pre-service teachers had experienced using robots in class. When robot-related activities and block programming were done at the same time, it was possible for the pre-service teachers to have negative attitudes toward robots; thus, on the second day, the assembly and manipulation of robots was the goal of the class.

From week 3 to week 6, the pre-service teachers were asked to deal with actual problems using EV3 and programming language. In week 3, using ultrasonic sensors, they were assigned to make robots that moved in a certain way. In week 4, using gyro sensors, they were asked to make robots that could move in a certain angle and in a certain shape. In addition, using medium motors, the robots moved an object to a specific location. In week 5, using color sensors, the teachers were told to make robots that do different things depending on the color and its brightness. Using touch sensors, the teachers made robots that could control their speed. They also made the robots perform line tracing. In week 6, using all the sensors and motors that were used from week 3 to week 5, the pre-service teachers were asked to make robots that could escape from a maze and deliver some objects. Lee (2013) stated that diverse problem-solving activities are needed to positively change attitudes toward robots[23]. Therefore, in the activities from week 3 to week 6, sensors and motors were explained in detail, and the pre-service teachers were exposed to situations where they had to cope with actual problems. The instructor helped them when they experienced difficulties in individual problem solving. From week 8 to week 11, due to the educational practice program, the treatments could not proceed. Thus, in week 7, assignments were given. From week 8 to week 11, the pre-service teachers were supposed to solve the assignments. From week 12 to week 15, they had to present the results of the assignments. In week 12, they were asked to think about how they could apply what they had learned about robots to computer education. They were also asked to design and present a one class that robot utilized. In week 13, the pre-service teachers made EV3 robots and engaged them in robot wrestling. In the robot wrestling activity, each team's robot was supposed to push its counterpart out of a circle of a certain size. In week 14, the pre-service teachers were asked to make name-writing robots, robots that can implement the principles of the queue and stack, and cube-solving robots. The teachers were told to present these robots to the rest of the class. Name-writing robots can write their names when commanded to do so. Robots that can implement the principles of the queue and stack were designed using EV3 without any regulations on their form. Cube-solving robots can solve the 3×3 hexahedron, which has six different colors on each of its sides. In week 15, the pre-service teachers presented the designs and algorithms of the robots they made during the last two weeks. From week 2 to week 7, they made robots individually; beginning in week 8, teams of three students solved the assignments.

2.6 Data Analysis

The collected data were analyzed in various ways. First, paired t-tests were used to examine the change between the pre- and post-test of the control group and experimental group. In the pre- and post-test, independent t-tests were used to ensure the homogeneity of the two groups. Finally, results from the questionnaire on robot programming education were coded, categorized, and then analyzed using frequency distributions. The validity of the categorized data was verified by experts. SPSS version 21 was used for the statistical analysis.

3. Result and Discussion

3.1 NARS pre-test results

The NARS pre-test results for the experimental group (M = 37.29, SD = 5.55) and the control group (M = 38.85, SD = 5.66) did not show any statistically significant difference, $t(38) = .837$, $p = .408$. In terms of the attitudes toward interaction with robots, the experimental group (M = 14.29, SD = 4.73) and the control group (M = 14.89, SD = 3.15) did not show a statistically significant difference, $t(38) = .479$, $p = .634$. Similar results were found for attitudes toward the social influence of robots

Table 4. The results of nars in pre-test

		Group	N	M	SD	t	p
Total		con.	14	38.85	5.66	.837	.408
		exp.	26	37.29	5.55		
Sub-Areas	negative attitude toward interaction with robots	con.	14	14.89	3.15	.479	.634
		exp.	26	14.29	4.73		
	negative attitude toward social influence of robots	con.	14	15.69	4.01	1.184	.244
		exp.	26	14.29	2.59		
	negative attitude toward emotion in interaction with robots	con.	14	8.27	1.91	-.685	.498
		exp.	26	8.71	2.05		

and emotional interaction with robots. Thus, the control group and experimental group are homogeneous in their attitudes toward robots despite their different majors and grade levels are shown in Table 4.

3.2 NARS Post-Test Results

The post-test results show that the pre-service teachers' negative attitudes toward robots significantly changed after receiving robot programming education, t(38) = 2.667, p = .011. Compared with the control group (M = 38.23, SD = 6.61), the experimental group had a less negative attitude toward robots (M = 33.00, SD = 4.30). For the question on interaction with robots, the experimental group (M = 11.00, SD = 2.83) had a significantly less negative attitude toward interaction with robots than the control group (M = 14.39, SD = 3.10), t(38) = 3.393, p = .002. Compared with the control group (M = 11.00, SD = 3.57), the experimental group (M = 15.12, SD = 3.85) also had a significantly less negative attitude toward the social influence of robots, t(38) = 3.304, p = .002. Finally, with regard to the attitude toward interaction with robots, the experimental group (M = 8.73, SD = 1.99) registered a higher score than the control group (M = 11.00, SD = 3.04), and the difference was statistically significant, t(38) = -2.851, p = .007. Questions on the interaction with robots were reverse coded, so this result indicates that the experimental group showed more positive attitudes toward emotional interaction with robots than the control group did. These post-test results indicate that the control groups' and the experimental group's attitudes toward robots changed in all three sub-areas are shown in Table 5.

3.3 Comparison of Pre- and Post-Test Results of the Control Group

To determine the source of the change in attitudes toward robots in the post-test, the results of the pre- and post-test for the control group were compared. The negative attitude toward robots did not change significantly between the pre-test (M = 38.85, SD = 5.66) and post-test (M = 38.23, SD = 6.61), t(25) = .403, p = .690. In terms of the sub-areas, attitudes toward interaction with robots did not show a statistically significant difference between the pre-test (M = 14.89, SD = 3.15) and post-test (M = 14.36, SD = 3.10), t(25) = .697, p = .492. Likewise, there was no significant difference between the attitudes toward the social influence of robots in the pre-test (M = 15.12, SD = 3.85) and post-test (M = 15.69, SD = 4.01), t(25) = .687, p = .498. A similar result was found for the attitude toward emotional interaction with robots, t(25) = -1.726, p = .097. Therefore, in all sub-areas, no significant differences in the negative attitudes toward robots were found between the pre- and post-test. In conclusion, significant changes did not occur in the control group is shown in Table 6.

Table 5. The results of nars in post-test

		Group	N	M	SD	t	P
Total		con.	14	38.23	6.61	2.667	.011*
		exp.	26	33.00	4.30		
Sub-Areas	negative attitude toward interaction with robots	con.	14	14.39	3.10	3.393	.002**
		exp.	26	11.00	2.83		
	negative attitude toward social influence of robots	con.	14	15.12	3.85	3.304	.002**
		exp.	26	11.00	3.57		
	negative attitude toward emotion in interaction with robots	con.	14	8.73	1.99	-2.851	.007**
		exp.	26	11.00	3.04		

*p<.05, **p<.01

Table 6. The results of comparison of pre- and post-test of the control group

		Group	N	M	SD	t	p
Total		Pre	26	38.85	5.66	.403	.690
		Post		38.23	6.61		
Sub-Areas	negative attitude toward interaction with robots	Pre	26	14.89	3.15	.697	.492
		Post		14.39	3.10		
	negative attitude toward social influence of robots	Pre	26	15.69	4.01	.687	.498
		Post		15.12	3.85		
	negative attitude toward emotion in interaction with robots	Pre	26	8.27	1.91	-1.726	.097
		Post		8.73	1.99		

3.4 Comparison of Pre- and Post-Test Results of the Experimental Group

The experimental group's negative attitude toward robots showed a statistically significant difference between the pre-test (M = 37.29, SD = 5.55) and post-test (M = 33.00, SD = 4.30), t(13) = 2.626, p = .021. The negative attitude toward robots lessened after robot programming education. The attitudes in each sub-area also registered significant changes. The attitude toward interaction with robots differed significantly between the pre-test and post-test, t(13) = 2.530, p = .025. The score in the post-test (M = 11.00, SD = 2.83) was lower than that of the pre-test (M = 14.29, SD = 4.73). With regard to the attitude toward the social influence of robots, the post-test score (M = 11.00, SD = 3.57) showed a clear drop from the pre-test score (M = 14.29, SD = 2.59), and the gap was statistically significant, t(13) = 4.101, p = .001. Finally, for the attitude toward emotional interaction with robots, the post-test score (M = 11.00, SD = 3.04) was significantly higher than the pre-test score (M = 8.71, SD = 2.05), t(13) = -2.853, p = .014. Since the questions on the last sub-area were reverse coded, this result shows that the negative attitude declined from the pre-test to the post-test. Therefore, in every sub-area, robot programming education changed the experimental group's negative attitudes toward robots. Thus, the statistical difference in the post-test came from the change in the experimental group, not the control group is shown in Table 7.

Lee, Song and Lee stated that robot programming education has a clear influence not only on the attitude toward computers but also on the attitude toward robots[28]. Shin and Kim reported that direct or mediated contact with robots had no influence on the attitude toward robots but had an effect on the attitude toward robots[26]. Baek and Keum and Lee claimed that it was possible to change the attitude toward robots through various activities with robots; the results of the current study prove this claim, as the pre-service teachers' negative attitudes toward robots changed significantly after robot programming education[23,25].

Compared with teachers in other countries, Korean teachers showed highly negative attitudes toward robots[26,27]. The present study acknowledges that robot programming education is one of the most effective tools to positively change the negative attitude toward robots. However, Bartneck et al. stated that the attitude toward robots depends on culture, gender, and other factors; thus, it is necessary to conduct further research considering these factors[29].

3.5 Investigation on Teachers' Attitudes toward Robot Programming Education

In this study, a questionnaire on opinions about robot programming education was administered to pre-service

Table 7. The results of comparison of pre- and post-test of the experimental group

		Group	N	*M*	*SD*	*t*	*p*
Total		Pre	26	37.29	5.55	2.626	.021*
		Post		33.00	4.30		
Sub-Areas	negative attitude toward interaction with robots	Pre	26	14.29	4.73	2.530	.025*
		Post		11.00	2.83		
	negative attitude toward social influence of robots	Pre	26	14.29	2.59	4.101	.001**
		Post		11.00	3.57		
	negative attitude toward emotion in interaction with robots	Pre	26	8.71	2.05	-2.853	.014*
		Post		11.00	3.04		

*p<.05, **p<.01

teachers to investigate their understanding of robot programming education. First, when asked about their most preferred part of robot programming education, half (50%) of the teachers answered that the best part was being able to assemble and operate robots on their own, 42.9% of the teachers answered that robot programming education is fun, and 28.6% answered that it was good to deal with actual problems. Additionally, 7.1% answered that they could gain confidence in programming, another 7.1% answered that it was good to form a team to handle the assignments, and 7.1% answered that it was easy to understand the contents of robot programming education. These results show that robot programming education is effective in increasing the students' interest[30].

Second, when asked which part of robot programming education they disliked, the most common answer was the difficulty in controlling the robots (64.3%), followed by the excessive number of assignments (42.9%), the difficulty in assembling and designing robots (28.6%), and the inappropriate class environment (14.6%). These answers suggest that in robot programming education, many pre-service teachers experience difficulties with the robot itself. Most of the pre-service teachers pointed out that the assembly, design, and control of the robot are the major difficulties. Korean teachers have more negative attitudes toward robots than Japanese or American teachers[21], perhaps because they have not been exposed often to robots[29]. Therefore, to lessen the teachers' negative attitudes toward robots, they must perform more activities related to robots.

Third, the participants were asked about the strengths and weaknesses of the problem-solving activities with robots from week 2 to week. Most (92.9%) of the respondents pointed out that it was much easier to understand the contents of the class when they were using robots to deal with problems than when they were only controlling the robots. About one in seven (14.3%) answered that they had formed a bond with the robots, 14.3% said their interest in programming had increased, and another 14.3% answered that their interest in robots had grown. With regard to the weaknesses, 14.3% of the respondents mentioned the excessive number of assignments.

Fourth, when asked about robot wrestling, all the respondents (100%) answered that it was the most interesting part of the entire class. The majority (64.3%) of teachers said it was fun to design robots on their own for robot wrestling. A small percentage (7.1%) said it was good to compete with peers, another 7.1% said it was good to apply what they had learned, and 7.1% answered that it was nice to be able to share their opinions. None of them mentioned any weakness of robot wrestling. Hence, the results indicate that robot wrestling was the most effective part of robot programming education for pre-service teachers.

Fifth, when asked about the activity involving name-writing robots, stack-and-queue robots, and cube-solving robots, 42.9% of the respondents answered that the activity itself was fun, 14.3% said it enabled them to feel some sense of accomplishment, and another 14.3% answered that it was good to make robots. When asked about the weakness of the activity, all the respondents (100%) mentioned the difficulty of the activity, unlike in the case of robot wrestling. Therefore, programs suitable to the level of the respondents should be developed.

Sixth, when asked to compare robot programming education and general computer science class, 71.4% of the respondents said that their interest and sense of accomplishment in robot programming education was much bigger than in general computer science class because they could use robots. Nearly three in 10 (28.6%) answered that robot programming education was good since they could practice, 21.4% answered that the interactive environment was good, and 14.3% pointed out that it was good because it was a student-focused class. The respondents also mentioned different weaknesses of robot programming education: 14.3% pointed out the difficulty of assembling and disassembling robots, 14.3% mentioned the malfunctioning of robots, and another 14.3% answered that it was hard to perform the experiment due to the external environment. Lastly, 7.1% of the respondents answered that the theories were too complicated to understand because the students were focused on using the robots. These results suggest that the educational power of robots is impressive; however, the technicality of robots causes some inconvenience in robot education.

Finally, the respondents were asked about their preferred format for robot programming education. Most of the students preferred team-based classes because they could understand assembly problems and share individual opinions, which they could not do in individual problem solving. In addition, for problem-solving activities using robots, 21.4% of the respondents preferred the individual format to the team-based format. However, they preferred the team-based format for activities that involve assembling, designing, and programming robots, such as robot wrestling. On the other hand, 14.3% of the respondents answered that they preferred only the individual format. These results indicate that the team-based format is effective in robot programming activities are shown in Table 8.

Table 8. The results of Investigation on teachers' attitudes toward robot programming education

Questions	Response	Number
Which part did you like on robot programming education?	Making, Control	7(50.0)
	Interest	6(42.9)
	Problem solving	4(28.6)
	Confidence	1(7.1)
	Team based activities	1(7.1)
	Easy to understand	1(7.1)
Which part did not you like in robot rogramming education?	Difficulty in control	9(64.3)
	Amount of assignment	6(42.9)
	Diffiulty in design and control	4(28.6)
	Environment	2(14.3)
Tell us the strength and weakenss of robot programming education from the 2nd week to 6th week.	**Likeness**	
	Help to understand	13(92.9)
	Bond with robots	2(14.3)
	Interest in programming	2(14.3)
	Interest in robots	2(14.3)
	Weakness	
	Too much amount of assignment	2(14.3)
Comparing robot ssireum with the other activities, which part did you like most and dislike?	**Likeness**	
	Interest	14(100.0)
	Design and assembly on my own	9(64.3)
	Competition	1(7.1)
	Being able to apply what is learned	1(7.1)
	diverse ideas	1(7.1)
	Weakness	
	None	14(100.0)
Tell us what you like and dislike about name writing robots, stack and cue robot and cube solving robots comparing with the other activities.	**Likeness**	
	Fun	6(42.9)
	Understanding	2(14.3)
	Sense of accomplishment	2(14.3)
	Making	2(14.3)
	Dislikenss	
	Difficulty	14(100.0)
Tell us what you like and dislike about robot programming education comparing with the general computer science classes.	**Likeness**	
	Interest, absorption and sense of accomplishment	10(71.4)
	Practive	4(28.6)
	Interaction	3(21.4)
	Understanding	2(14.3)
	Students are more focused	2(14.3)
	Dislikenss	
	Difficult to assemble and dissemble	2(14.3)
	Malfunction of robots	2(14.3)
	Influence by external environment	2(14.3)
	Difficult to understand theoretical pat	1(7.1)
Which format do you prefer, individual or team based?	Team	9(64.3)
	Individual	2(14.3)
	Mixed	3(21.4)

4. Conclusions

In this study, the influence of robot programming education on pre-service teachers' attitudes toward robots was analyzed. The teachers were divided into two groups: the control group and the experimental group. They took the pre-test and post-test on their attitudes toward robots. The experimental group received robot programming education so that the change in attitudes toward robots of both the control group and the experimental group could be determined. The conclusions of this study are as follows:

First, robot programming education had a certain influence on pre-service teachers' attitudes toward robots. The pre-test proved that the control group and experimental group are homogeneous. However, the experimental group's negative attitudes became significantly more positive in the post-test. The control group did not show any difference between the pre- and post-test. Moreover, in every sub-area, statistically significant differences were found. Thus, robot programming education lessened the pre-service teachers' negative attitudes toward robots.

Second, the teachers said that robot programming education was good because it allowed them to make and control robots on their own and increased their interest in the class. In response to questions on what they liked about robot programming education, questions on robot wrestling, questions on the strengths of classes that use robots compared with the usual classes, and questions on name-writing robots, stack-and-queue robots, and cube-solving robots, the pre-service teachers answered that it was good to make and control robots on their own and that the activity per se was interesting.

Third, difficulty with the robot itself was a major problem in robot programming education. Except for project-related elements, many pre-service teachers had difficulty in controlling, assembling, and disassembling robots in robot programming education.

This study analyzed the effect of robot programming education on pre-service teachers' attitudes toward robots. The results of this study could be used as a basis for analyzing the factors that influence attitudes toward robots. The study results could also be used to help develop a theory and model of teaching and learning about robots and to create an educational program to change teachers' and pre-service teachers' attitudes toward robots.

Previous research has shown that Korean teachers and pre-service teachers have negative attitudes toward robots. This could be an obstacle to robot education in school. Thus, it is necessary to change negative attitudes with robot programming education in the pre-service teacher training course and in teacher training programs.

This study covered only a limited number of pre-service teachers majoring in computer education. Therefore, the results of this study cannot be generalized. The sample must be expanded to include more pre-service teachers or to include pre-service teachers majoring in other subjects. Additionally, for both teachers and pre-service teachers, research is needed on how to develop and apply robot programming education for elementary, middle school, and high school students.

Another limitation of this study is that robot programming education was only used as part of the curriculum for a major course. Thus, special cases like practice teaching were excluded, and there were certain limits in estimation and courses. To analyze the influence of robot programming education on the attitude toward robots, research without these limits must be conducted.

Finally, this study did not determine whether the control of robots or the process of programming using robots is a main factor influencing the attitudes toward robots. Hence, additional research that includes respondents who have taken programming classes is needed. Although previous research has indicated that interaction with humanoid robots helps form an image of robots, the effect of interaction with educational robots on the attitudes toward robots has not yet been investigated. Thus, additional research should be done to analyze the influence of interaction with robots on the attitude toward robots, considering correlations among diverse factors such as gender and advanced experience.

5. Acknowledgement

This work was supported by the National Research F\ oundation of Korea (NRF) grant funded by the Korea government (MSIP) (No. 2013R1A2A2A03068459).

6. References

1. Barnes D. Teaching introductory Java through LEGO MINDSTORMS models. ACM SIGCSE bulletin. Proceedings of the 33rd SIGCSE Technical Symposium on Computer Science Education; United States, 2002. p. 147-51.

2. Blank D. Robots make computer science personal. Communications of the ACM. 2006 Dec; 49(12):25-7.
3. Yu B, Lee W, Kim J. Consideration for the acquisition of the concept of object in the robot programming. Indian Journal of Science and Technology. 2015 Oct; 8(26):1-6.
4. Park I, Kim D, Oh J, Jang Y, Lim K. Learning effects of pedagogical robots with programming in elementary school environments in Korea. Indian Journal of Science and Technology. 2015 Oct; 8(26):7-11.
5. Chen H, Wigand R, Nilan M. Exploring web users' optimal flow experiences. Information Technology and People. 2000 Dec; 13(4):263-77.
6. Hussain S, Lindh J, Shukur G. The effect of LEGO training on pupils' school performance in mathematics, problem solving ability and attitude: Swedish data. Journal of Educational Technology and Society. 2006 Jul; 9(3):182-94.
7. Lee E, Lee Y. The effects of robot programming on pre-service computer science teacher training. Proceedings of Society for Information Technology and Teacher Education International Conference; United States. 2008. p. 3826-31.
8. Onishi Y, Tominaga H, Hayashi T, Yamasaki T. Exercise analysis and lesson plan with robot behavior in LEGO programming contest for problem solving learning. Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications; United States. 2006. p. 1943-51.
9. Tzafestas C, Palaiologou N, Alifragis M. Virtual and remote robotic laboratory: comparative experimental evaluation. IEEE Transactionson Education. 2006 Aug; 49(3):360-9.
10. Subramanian K, Kumaravel AM, Jennifer P. Effectiveness in teaching' introductory programming' for the students of engineering and technology: The need of hour. Indian Journal of Science and Technology. 2015 Nov; 8(31):1-5.
11. Jang Y, Lee W, Kim J. Assessing the usefulness of object-based programming education using arduino. Indian Journal of Science and Technology. 2015 Jan; 8(1):1-8.
12. Choi J, Seo Y, Lee Y. Analysis of the status of the robot education researches. Proceedings of the Korean Society of Computer Information Conference; Korea. 2011. p. 397-400.
13. Kim C. An analysis of domestic research trend and educational effects in relation to robot education. Journal of the Korean Association of Information Education. 2012 Jun; 16 (2):233-43.
14. Park G. A review of current status and directon of education of robot and educational materials in elementary schools. Journal of Korean Practical Arts Education. 2011 Sep; 24(3):323-43.
15. Freeman D. Teacher training, development, and decision making: A model of teaching and related strategies for language teacher education. Tesol Quarterly. 1989 Mar; 23(1): 27-45.
16. Correlates of computer anxiety in college students. 2016. Available from: http://repository.upenn.edu/dissertations/AAI8208027
17. Nomura T, Suzuki T, Kanda T, Kato K. Measurement of anxiety toward robots. In Robot and Human Interactive Communication. The 15th IEEE International Symposium; Italy. 2006. 372-7.
18. Bartneck C, Nomura T, Kanda T, Suzuki T, Kato K. Cultural differences in attitudes towards robots. Proceedings of Symposium on Robot Companions; United Kingdom. 2005. p. 1-4.
19. Nomura T, Kanda T, Suzuki T. Experimental investigation into influence of negative attitudes toward robots on human–robot interaction. Ai and Society. 2006 Feb; 20(2):138-50.
20. Nomura T, Suzuki T, Kanda T, Kato K. Altered attitudes of people toward robots: Investigation through the Negative Attitudes toward Robots Scale. Proceedings of AAAI-06 Workshop on Human Implications of Human-Robot Interaction; United States. 2006. p. 29-35.
21. Nomura T, Kanda T, Suzuki T, Han J, Shin N, Burke J, Kato K. Implications on humanoid robots in pedagogical applications from cross-cultural analysis between Japan, Korea and the USA. The 16th IEEE International Symposium on Robot and Human Interactive Communication; Korea. 2007. p. 1052-7.
22. Nomura T, Kanda T, Suzuki T, Kato K. Prediction of human behavior in human--robot interaction using psychological scales for anxiety and negative attitudes toward robots. IEEE Transactions on Robotics. 2008 Apr; 24(2):442-51.
23. Lee C. elementary students' attitude towards robot in Korea. Journal of Korean Practical Arts Education. 2013 Jun; 26(2):83-96.
24. Lee C. Korean students' attitude scale towards robot. Journal of Korean Practical Arts Education. 2013 May; 19(2):151-68.
25. Baek S, Keum J. The effects of after school robot program on the attitudes toward robot and technological thinking disposition of children. Journal of Korean Practical Arts Education. 2014 May; 20(2):183-201.
26. Shin Na, Kim S. Korean students' attitudes towards robots: Two survey studies. Journal of Korea Robotics Society. 2009 Feb; 4(1):10-6.
27. Kim S, Lee Y. A survey on elementary school teachers' attitude toward robot. Proceedings of E-Learn: World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education; United States. 2015. p. 1802-7.
28. Lee J, Song J, Lee T. An effect of the programming learning using robot on attitude toward computer learning and computer in practical arts education. Journal of Korean Practical Arts Education. 2009 Aug; 15(3):89-108.
29. Bartneck C, Suzuki T, Kanda T, Nomura T. The influence of people's culture and prior experiences with Aibo on their attitude towards robots. Ai & Society. 2007 Nov; 21(1-2):217-30.
30. Sapounidis T, Demetriadis S, Stamelos I. Evaluating children performance with graphical and tangible robot programming tools. Personal and Ubiquitous Computing. 2015 Jan; 19(1):225-37.