An Experimental Study in Determining Basic Robotic Coding Skills of Pre-School Students with Intellectual Disabilities

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Abstract—Today, it can be said that coding has become a key competence for students and people working in many different fields in the business world. It is assumed that those who seek and develop new ways to learn-teach coding will be one step ahead. The educational use of coding started with the use of the Logo programming language in the 60s.This concept has started to revive in recent years with visual programming languages such as "Alice, its code, code.org and Scratch". These visual programming structures enable young learners to write applications without having to learn the complex code structures of traditional programming languages. In this study to develop an experimental study to determine the basic robotic coding skills of preschool students with intellectual disabilities. The sample of the study consists of a total of 20 students with studying in pre-school education institutions in a city in Türkiye. The ages of the students are between 5 years old. Semi-experimental design, one of the experimental research designs, was used in the research. In this context, 1 experimental and 1 control group was formed with the random assignment method. The materials used in both the experimental and control groups were determined as the pre-school robotic coding set U-bot starter package.5 weeks were determined as the teaching process and a total of 12 activities that served the purpose were applied to the students. During the applications, the data of the students were collected with the help of the observation form, coding skill test and after the application, they were collected through focus group interviews. As a result, at the end of the 5-week period, it was observed that there were positive significant changes in the two dependent variables (academic achievement andlearning rate) that were used as a basis for measuring the learning skills of both the experimental group and the control group students.

Keywords—robotic coding skills, U-bot starter package, pre-school children with mental retardation, kindergarten students

1 Introduction

The educational use of the concept of coding dates back to the 60s.When the literature is examined, there are four different orientations to coding education. These orientations consist of visual programming, programming with robotics, text-based programming and computer-free computer science, which is based on teaching coding concepts without using technological devices such as computers (Bower & Folkner 2015).

The concept of coding first started with the Logo programming language (Calao et al. 2015), and in recent years, it has started to become popular again through visual programming languages such as Alice, Code.org, and Scratch. These structures used by students consist of virtual structures based on producing their own games, animation, story and many other creativity in environments supported by visual programming languages (Taylor et al. 2010). The main purpose of using these environments is coding. It is based on the acquisition of other skills that are desired to be developed, rather than being taught. It is seen that after the application on these environments, the motivation of the children is increased by producing their own products (Resnick, 2013).

It is aimed to gain basic coding skills in the courses that are compulsory for 5th and 6th grade students and optionally taught to 7th and 8th grade students under the name of "Information Technologies and Software" in public schools in Türkiye. In addition to public schools, programming education has started to be given at pre-school levels in many private education institutions in the current system. For this purpose, it is aimed to train individuals who use information technologies effectively and efficiently (Uslu, Mumcu & Egin, 2018).

In today's world, where the importance given to coding education is becoming more widespread day by day, ensuring that it is more effective and meeting the needs through the trainings to be given is based on the acquisition of these skills starting from a young age.

2 Conceptual framework

When the literature on robotic coding education in the pre-school period is examined;

Altun (2018), investigated the effect of algorithm and coding education integration into the preschool curriculum on students' problem solving skills. The study group of the research conducted in the mixed pattern model consisted of 30 students in the age group of five attending a private kindergarten. In the research, 4 weeks of algorithm training and then 4 weeks of OSMO Coding training was given under the name of basic coding training."Problem Solving Skills Scale" was applied to all students before and after the application as a pre-test and post-test. As a result, at the end of the 4-week period, it was observed that there were significant positive changes in the development of problem solving skills of both the experimental and control group students.

Tagci (2019), investigated the effect of coding education on primary school students in her study. In the 2017-2018 academic year, 26 primary school students studying in a province of Türkiye were given 6-week training and an application was made regarding

this education. As a result, when the coding education skill test data were analyzed, it was seen that there was a statistically significant difference between the pre-test and post-test and the scores of the students in the coding skill test increased.

Curaoglu (2019), investigated the effect of algorithm and coding education integration into the secondary school curriculum on students' problem solving skills. The participants of the study consist of 26 volunteer students studying in a secondary school in a province in Turkey. The method of the research is based on mixed design. In the research, "Robotic Preliminary Questionnaire", "Robotic Satisfaction Test", "Problem Solving Inventory for Children" and "Activity Perception Scale" were used, observation and focus group interviews were conducted. According to the analysis of the collected data, it was seen that the five-week robotic coding training made a significant and positive contribution to the problem solving skill levels of the students.

2.1 Purpose and sub-objectives of the research

The general aim of the research is to develop an experimental study to determine the basic robotic coding skills of preschool students with intellectual disabilities. Within the framework of this general purpose, answers will be sought for the following sub-objectives:

- Is there a significant difference between the pre-test scores and the post-test scores for the academic achievement of the students who received algorithm and basic coding training?
- Is there a significant difference between the pre-test scores and the post-test scores for the learning rate of the students who received algorithm and basic coding training?
- What are the views of the students who receive algorithm and coding education about the learning process?

2.2 The importance of the research and its contribution to the literature

Today, children's acquaintance with technology has fallen at a very early age. It has been seen that it is recommended to give coding education in the pre-school period, which can transform the students' familiarity with technology into a positive one and improve their problem solving and critical thinking skills (Mittermeier, 2013; Kert &Uğras, 2009; Saygıner &Tuzun, 2017; Altun et al., 2021).

When the literature was searched, it was seen that the studies on coding education in the pre-school period were quite limited and they were generally studied with primary school and university students. It is thought that this research will contribute to the literature due to the scarcity of studies conducted in the preschool period in our country and will be a guide in terms of algorithm and coding education to be given in the pre-school period.

Counts. It is assumed that students have previous experience of using tablets.

Limitations. This study is limited to five age group special education students attending a private kindergarten in Adapazarı district of Sakarya province in Türkiye.

3 Method

In the research mixed design, in which qualitative and quantitative data were obtained, was used in order to determine the effect of algorithm and coding education to be given to five-year-old special education students attending pre-school education on learning skills. Johnson and Turner (2003) describe the mixed method as the collection of multiple data using different strategies, methods and approaches. True-experimental design, one of the experimental research designs, was used in the research. These are the patterns in which the subjects in the randomly created sample are randomly assigned to the groups (Creswell & Creswell, 2017). In this context, 1 experimental and 1 control group was formed with the random assignment method.

3.1 Study groups

The research was carried out with special education students in the age group of five attending a private kindergarten in the Adapazarı district of Sakarya in Türkiye province in the 2021-2022 academic year. The distribution of these students is given in Table 1.

Table 1. Study Group Distribution

Group	Male	Female	Method	Total
Experimental group	4	6	Algorithm+U bot	10
Control group	3	7	U bot training	10
	7	13		20

3.2 Data collection

Within the scope of the research, qualitative and quantitative data collection tools were used together. As a qualitative data collection tool, an observation form prepared by the researcher and focus group interview technique were used to monitor the learning process. Within the scope of the research, a total of two groups of special students attending kindergarten were studied. The first group received 4 weeks of algorithm training followed by 4 weeks of U-Bot Coding training, and the second group received 4 weeks of U-Bot Coding training without algorithm training.

3.3 Data collection tools

During the applications, the data of the students were collected with the help of the observation form, coding skill test and after the application, they were collected through focus group interviews.

Coding skill test. The main purpose of using skill tests in the study process is to determine the learning situations before and after the application and to determine to what extent they have achieved the skills they want to gain. For this purpose, a skill test was prepared by taking expert opinion. The prepared skill test consisted of 9 sub-

questions; types of questions such as short answer, true - false, matching, multiple choice were used. The skill test was administered to special students under the supervision of their teachers. Before the skill test data were analyzed, the test items were examined and a question pool was created. During this examination, total scores were obtained by giving 1 point for each correct answer and 0 for each incorrect answer and blank answer.

After obtaining the total scores, the total scores were ordered from the highest score to the lowest in order to determine the item discrimination index and item difficulty index on the skill test. Starting from the highest score in the ranking, 27% upper and lower groups were determined according to the lowest score. After determining the upper and lower groups, the item discrimination index and difficulty index were calculated. The coding skills pre-test and post-test results of the experimental and control groups are given in the Tables 2 and 3.

Table 2. Control Group Coding Skills Pre-test Results

		Pre-Test Activity Numbers												
	Student Coding:	1	2	3	4	5	6	7	8	9	10	11	12	**Total**
1	**X1**	+	+	-	-	-	-	-	-	-	-	-	-	**10**
2	**X2**	+	+	-	-	-	-	-	-	-	-	-	-	**10**
3	**Y1**	-	+	+	+	-	-	-	-	-	-	-	-	**15**
4	**X3**	+	+	+	+	-	-	-	-	-	-	-	-	**20**
5	**Y2**	+	+	-	-	-	-	-	-	-	-	-	-	**10**
6	**Y3**	+	-	+	+	-	-	-	-	-	-	-	-	**15**
7	**Y4**	+	+	+	+	-	-	-	-	-	-	-	-	**20**
8	**Y5**	+	-	+	+	-	-	-	-	-	-	-	-	**15**
9	**X4**	+	-	+	-	-	-	-	-	-	-	-	-	**10**
10	**Y6**	+	+	+	+	-	-	-	-	-	-	-	-	**20**

Table 3. Control Group Coding Skills Post-test Results

		Post-Test Activity Numbers												
	Student Coding:	1	2	3	4	5	6	7	8	9	10	11	12	**Total**
1	**X1**	+	+	-	-	-	-	-	-	-	-	-	-	**35**
2	**X2**	+	+	-	-	-	-	-	-	-	-	-	-	**40**
3	**Y1**	-	+	+	+	-	-	-	-	-	-	-	-	**30**
4	**X3**	+	+	+	+	-	-	-	-	-	-	-	-	**15**
5	**Y2**	+	+	-	-	-	-	-	-	-	-	-	-	**40**
6	**Y3**	+	-	+	+	-	-	-	-	-	-	-	-	**35**
7	**Y4**	+	+	+	+	-	-	-	-	-	-	-	-	**40**
8	**Y5**	+	-	+	+	-	-	-	-	-	-	-	-	**35**
9	**X4**	+	-	+	-	-	-	-	-	-	-	-	-	**25**
10	**Y6**	+	+	+	+	-	-	-	-	-	-	-	-	**40**

According to Table 2 and Table 3, the names of the students were kept hidden and only nicknames were given. Female students began to be coded with the nickname Y, male students with the nickname X. During the learning-teaching process, 12 activities were presented to the students in 5 weeks and the questions for these activities in the skill test were developed by the researchers. The score for completing each activity is determined as 5 points. The points that students will get from 12 activities are determined as a maximum of 60 and a minimum of 5 points. When the pre-test and post-test results of the control group were compared; results showed that the post-test scores of the control group students who received U-bot coding training had a positive and significant effect.

According to Table 4 and Table 5, the names of the students were kept hidden and only nicknames were given. Female students began to be coded with the nickname Y, male students with the nickname X. During the learning-teaching process, 12 activities were presented to the students in 5 weeks and the questions for these activities in the skill test were developed by the researchers. The score for completing each activity is determined as 5 points. The points that students will get from 12 activities are determined as a maximum of 60 and a minimum of 5 points. When the pre-test and post-test results of the experimantal group were compared; results showed that the post-test scores of the control group students who received Algorithm+U bot coding training had a positive and significant effect.

Table 4. Experimental Group Coding Skills Pre-test Results

		Pre-Test Activity Numbers												
	Student Coding:	1	2	3	4	5	6	7	8	9	10	11	12	**Total**
1	**Y7**	+	+	-	-	-	-	-	-	-	-	-	-	**30**
2	**Y8**	+	+	-	-	-	-	-	-	-	-	-	-	**30**
3	**Y9**	-	+	+	+	-	-	-	-	-	-	-	-	**30**
4	**Y10**	+	+	+	+	-	-	-	-	-	-	-	-	**25**
5	**Y11**	+	+	-	-	-	-	-	-	-	-	-	-	**25**
6	**X5**	+	-	+	+	-	-	-	-	-	-	-	-	**30**
7	**X6**	+	+	+	+	-	-	-	-	-	-	-	-	**25**
8	**Y12**	+	-	+	+	-	-	-	-	-	-	-	-	**30**
9	**X7**	+	-	+	-	-	-	-	-	-	-	-	-	**25**
10	**Y13**	+	+	+	+	-	-	-	-	-	-	-	-	**25**

Table 5. Experimental Group Coding Skills Post-test Results

		Post-Test Activity Numbers												
	Student Coding:	1	2	3	4	5	6	7	8	9	10	11	12	**Total**
1	**Y7**	+	+	-	-	-	-	-	-	-	-	-	-	**50**
2	**Y8**	+	+	-	-	-	-	-	-	-	-	-	-	**50**
3	**Y9**	-	+	+	+	-	-	-	-	-	-	-	-	**40**
4	**Y10**	+	+	+	+	-	-	-	-	-	-	-	-	**40**
5	**Y11**	+	+	-	-	-	-	-	-	-	-	-	-	**55**
6	**X5**	+	-	+	+	-	-	-	-	-	-	-	-	**55**
7	**X6**	+	+	+	+	-	-	-	-	-	-	-	-	**50**
8	**Y12**	+	-	+	+	-	-	-	-	-	-	-	-	**55**
9	**X7**	+	-	+	-	-	-	-	-	-	-	-	-	**60**
10	**Y13**	+	+	+	+	-	-	-	-	-	-	-	-	**60**

3.4 Media and materials used in the experimental group

Fig. 1. U-Bot Preschool Robot Coding Kit - Starter Pack

Learning Goals:

1. Straight two steps

2. L two steps

4. Straight 2-3-2 step opposite

5. Straight 2-2-2 step target

3. 3-3 steps single target

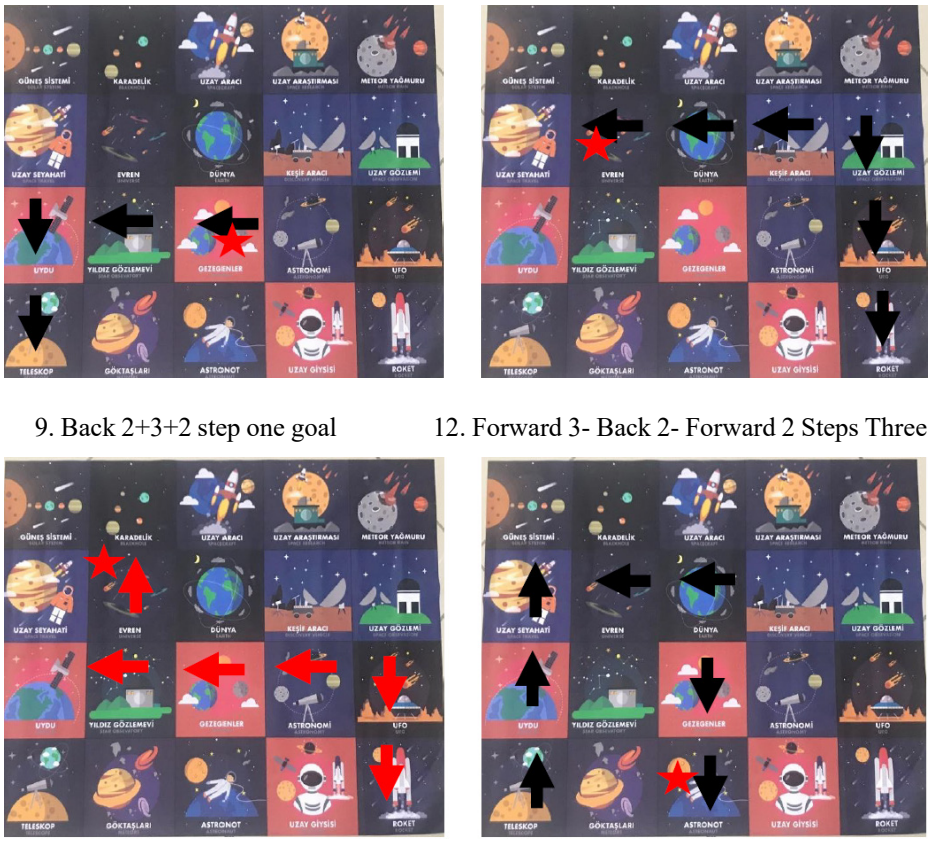
6. Straight 2-3-1 Step 3 target

7. Back 3 steps single target

10. Forward 2 Back 3 steps two goals

8. Back L 2+2 step single target

11. Back 3 forward 3 steps two goals



9. Back 2+3+2 step one goal

12. Forward 3- Back 2- Forward 2 Steps Three

Fig. 2. U-Bot Learning Target- Starter Pack

3.5 Comparison of pre-test post-test academic achievement and learning_rate scores of experimental groups and control group students

According to the Wilcoxon signed-rank test, the z values are -6.628, -6.781 and -6.780, and the significance level is below the critical value of .05. In this context, a significant difference was found between the pre-test and post-test scores of the experimental and control group students; this difference is in favor of posttest scores. In order to calculate the effect size of the difference, using the Wilcoxon signed-rank test effect size formula;

- For Experimental Group r = Z / √N (r= --6.628 / √180) r = -0.51
- For Control Group = Z / √N (r= --6.780 / √180) r = -0.51

Table 6. Pre-Test Post-Test Academic Achievement and Learning Rate Scores of Experimental Groups and Control Group Students

Groups	Pre-test Post-test	N	Rank Average	Df	z	p	Significant difference
Experimental	Negative Rank Postive Rank Indifferent	1 58 1	33.50 29.94	33.50 1736.50	6.628	.000	There is a significant difference between groups
Control	Negative Rank Postive Rank Indifferent	0 59 1	.00 30.00	.00 1770.00	6.780	.000	There is a significant difference between groups

Since this calculated effect size is greater than 0.5; it has been revealed that there is a significant difference between the pre-test and post-test scores of the experimental groups and the control group. This difference shows positive significance towards them in the post-test.

3.6 Learning process steps

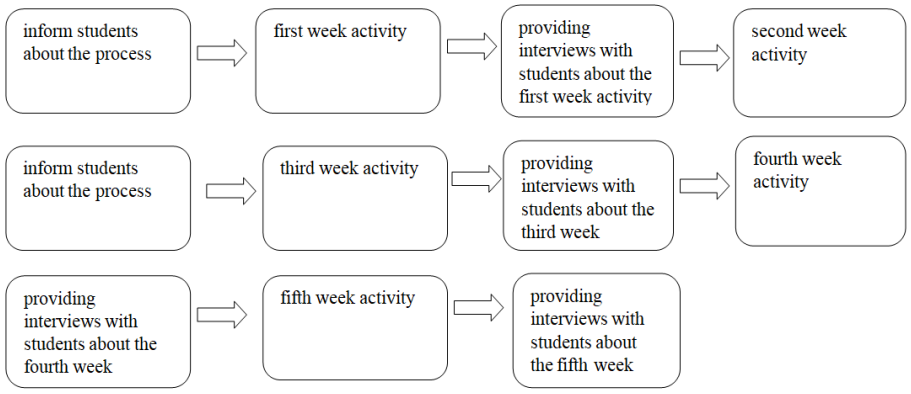


Fig. 3. The learning-teaching process steps followed for 5 weeks

Observation form and focus group interview. During the applications, the observations of the students were collected with the help of the observation form and after the application, the data were collected through focus group interviews. Qualitative data were collected through the observation form developed by the researcher and the audio recordings made during the focus group interviews after the application.

An observation form consisting of the steps of the coding education was developed by the researcher. The following stages were carried out in the preparation of the observation forms:

a) The scope of the observation forms was determined by scanning the literature.
b) The prepared observation forms were submitted to expert opinion for content validity. The observation forms were reviewed by the thesis advisor, a faculty member

from the preschool department, two experts in the field of educational technology, 2 special education teachers, and a specialist psychological counselor, and they were rearranged by making changes in line with their opinions.

c) Observation forms were applied to 5 special students.
d) After the preliminary application, necessary arrangements were made in the observation forms and the forms were given their final form.

Focus group discussions did not exceed 15 minutes. Between 6 and 8 students participated in each focus meeting. At the beginning of the interview, a few questions were prepared by the researchers to get the students' opinions and thoughts on the U-Bot application. These questions are:

- What comes to mind when you think of U-Bot?
- What can you do using U-Bot?
- What did you gain by using U-Bot?
- Would you like to use U-Bot in lessons?
- What comes to mind when you think of coding?

3.7 Findings obtained from focus group interview analysis

When the answers given by the students to the questions prepared for the focus group interview are examined;

- The students stated that they compared the u-bot to a ladybug and that they realized learning with the commands given by it.
- Although the students do not know how to read and write, they stated that they can easily learn the logic of coding with the U-bot.
- The students stated that the U-boot made them think, thanks to this they hovered and hopped on space and solar systems.
- "Would you like to use U bot in lessons?" all students gave an enthusiastic "yes" answer to the question. It is thought that the use of applications that attract the attention of students, facilitate their learning, and appeal to more sense organs in the teaching process make students more willing.
- When asked what comes to mind when you think of coding, students often said "robot".

4 Result, discussion & suggestions

In this study to develop an experimental study to determine the basic robotic coding skills of preschool students with intellectual disabilities. The sample of the study consists of a total of 20 students with studying in pre-school education institutions in a city in Türkiye. The ages of the students are between 5 years old. Semi-experimental design, one of the experimental research designs, was used in the research. In this context, 1 experimental and 1 control group was formed with the random assignment method. The materials used in both the experimental and control groups were determined as the pre-

school robotic coding set U-bot starter package.5 weeks were determined as the teaching process and a total of 12 activities that served the purpose were applied to the students. During the applications, the data of the students were collected with the help of the observation form, coding skill test and after the application, they were collected through focus group interviews.

The main purpose of using skill tests in the study process is to determine the learning situations before and after the application and to determine to what extent they have achieved the skills they want to gain. The prepared skill test consisted of 9 sub-questions; types of questions such as short answer, true - false, matching, multiple choice were used. During the learning-teaching process, 12 activities were presented to the students in 5 weeks and the questions for these activities in the skill test were developed by the researchers. The score for completing each activity is determined as 5 points. When the pre-test and post-test results of the control group were compared; results showed that the post-test scores of the control group students who received U-bot coding training had a positive and significant effect. When the pre-test and post-test results of the experimantal group were compared; results showed that the post-test scores of the control group students who received Algorithm+U bot coding training had a positive and significant effect. Pre-test and post-test results were analyzed with Wilcoxon significance test and positive and significant results of post-test results were revealed.

During the applications, the observations of the students were collected with the help of the observation form and after the application, the data were collected through focus group interviews. Focus group discussions did not exceed 15 minutes. Between 6 and 8 students participated in each focus meeting. At the beginning of the interview, a few questions were prepared by the researchers to get the students' opinions and thoughts on the U-Bot application. When the answers given by the students to the questions prepared for the focus group interview are examined; the students stated that they compared the u-bot to a ladybug and that they realized learning with the commands given by it. Although the students do not know how to read and write, they stated that they can easily learn the logic of coding with the U-bot.

When similar studies in the literature are examined; Konyaoglu (2019) tried to determine the opinions of secondary school students on robotic coding activities and designed a five-week, single-group experimental research in this context. The method of the research is based on mixed design. In the mixed design, qualitative and quantitative data were collected simultaneously and analyzed separately. In the research, "Robotic Preliminary Questionnaire", "Robotic Satisfaction Test", "Problem Solving Inventory for Children" and "Activity Perception Scale" were used, observation and focus group interviews were conducted. As a result, it is among the results of the research that the students participating in the research were very satisfied with the activities, their preliminary thoughts towards robotics were positive, and they enjoyed the activities and had fun.

The following suggestions can be given to educators who are interested in the subject;

- U-Bot robots were used in this study. Similar studies can be done with different educational robots.

- The duration of this learning is limited to a period of 5 weeks, two hours per week. In future studies, more activities can be organized by increasing the duration of the learning.
- Scientific studies investigating the effects of robotic coding education on students' creative thinking and collaborative studying skills will contribute to the field.

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