

# The Effect of Lego Wedo 2.0 Education on Academic Achievement and Attitudes and Computational Thinking Skills of Learners toward Science

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## Abstract

Today, the essential skills and characteristics of individuals change within the frame of changing needs. The acquisition of these skills to individuals is not sufficient with traditional education and difficulties are experienced in adapting to the age. While gaining 21<sup>st</sup> century skills, conducting interdisciplinary studies is becoming importance and increasing the efficiency. In this study, the effect of LEGO WeDo 2.0 robotics education on academic achievement, attitude and computational thinking skills of the learners toward science was examined. The study was conducted with 5<sup>th</sup> grade students (N=36) in a private school in Elazığ in the 2017-2018 school year. The study model was the "pretest-posttest control group design" of the experimental method. As data collection tool, "Science Course Academic Achievement Test", "Science Course Attitude Scale", and "Computational Thinking Scale" were used in the study. While the activities in the experimental group were carried out with LEGO WeDo 2.0 Robotic Education Set, the same activities in the control group were implemented using the traditional direct instruction technique as in the curriculum. The application was continued for eleven weeks and the obtained quantitative data were evaluated at the significance level of 0.05 with SPSS packaged software. It was seen as a result of the study that attitudes, academic achievements and computational thinking skills of the experimental group students, who received robotic-assisted science education, toward science course differed significantly compared to the students in the control group.

**Keywords:** robotics, science, technology, attitude, achievement, computational thinking

## 1. Introduction

Changes over time have revealed different needs in human life. Educational needs of communities have also changed with the change of the world from past to present. In order to adapt to this change, the system of education must constantly renew itself (Çayır, 2010).

Changing life conditions affect education as in every area of life. In order to keep up with the needs of the age, individuals are seen to need different applications in the education field too. The characteristics that 21<sup>st</sup> century individuals should have cannot be exactly met by ordinary, uniform, and traditional direct instruction. For questioning, investigating and criticizing individuals, changes are made in teaching activities and their effects are examined.

Following the changes in education, the educational use of robots has emerged and it was seen to be used in various disciplines. According to Nishimura (2006), the increasing use of robots in education has led to an increase in students' interest in science and technology. For the use of robots in education, interdisciplinary activities are seen to increase with the concept of STEM (Science, Technology, Engineering, Math). Today, it is seen that robots are used in more than one field such as medical, entertainment, military, industry, competitions and space research. Education has become one of the usage areas of robots recently. The emerging "Educational Robotics" field has become an integral part of the engineering and science education process in particular. There are two main approaches in the use of robots in education field, the first one is to teach subjects like robots and robots related artificial intelligence, design and control to the students in university level and the second one is to use robots as an instructional tool in the courses like mathematics, science, and technology at A-12 level (Malec, 2001). Educational robots are involved in the second

approach.

The idea of using robot in education emerged with the studies of Seymour Papert, the founder of Logo programming language (Papert, 1980). Logo programming language was developed with the studies conducted by Papert et al., to understand how children think and learn. Logo programming language is based on the theory of constructionism. Constructionism has changed the use of technology and educational transformations in education (Kafai and Resnick, 1996).

The goal in educational robot projects is to provide a robotic education program integrated with science and technology and to make learning more permanent and meaningful by integrating advanced technology into education with robots (Wood, 2003; Cited by Koç-Şenol, 2012). By doing group study with educational robots, students work by developing their creativity and analytical thinking skills in collaboration. The use of robots in education leads to an increase in the adaptation level in group studies, to be more eager to do research and to an increase in their technological knowledge level (Şabanoviç and Yannier, 2003; Cited by Koç-Şenol, 2012). With the educational robots, students of all ages can use simple robotic sets, design models and design and produce robots that perform animal movements (Miglino, Lung and Cardaci, 1999). Educational robots are also used to support STEM education (Üçgöl, 2013). Researches have shown that robotic activities have positive effects on STEM. When curriculum containing STEM was examined, it was seen that robotic activities developed skills like problems solving, questioning and critical thinking on students (Head Council of Education and Morality [TTKB], 2006a, 2006b, 2009). Costa and Fernandes (2004) stated that supporting Science and Technology courses with robotic activities increased the students' skills such as recognizing their abilities, problem solving, critical thinking, willingness to use technology, and learning by doing and experiencing.

While robotic assisted education started to be given in Turkey in 2000s, it was started to be used in 1990s in countries such as Canada, USA, Portugal, Japan, and Australia. According to this information, it can be asserted that robotics education is a new system that has just become common in Turkey. The United Nations Economic Commission (UNEC), Japan Robotics Association (JPA), and International Federation of Robotics (IFR) have stated that robots have been considerably involved in education and market area in recent years and they will continue to grow rapidly in the next 10 years (Barreto and Vavassori, 2012).

In the study, Baptista (2009) investigated the motivation levels of secondary school students for the physics course supported by the LEGO Mindstorms NXT robotic set. Various experiments were carried out by informing the students and teachers about LEGO Mindstorms NXT robotic set and program screen. When the results were examined, it was stated that the lessons with robotic activities provided motivation for students and they also learned the basic principles of science and engineering effectively.

Ribeiro (2006) prepared a master's thesis titled, "*Robot Carochinha: A Qualitative Study on Robotics Education in the Basic Education Cycle*". In the study, robots were designed and developed with students and programmed to dramatize the fairy tale history. As the basic result of the study, it was stated that robotics provided a high level of motivation and discipline on students.

When the national and international studies were examined in general, it was seen that the robot sets used were LEGO products, the studies were generally conducted by using experimental design, the pretest-posttest of the application were performed and the analyses were examined. The studies were mostly conducted with the students in the secondary school level and the variables such as academic achievement and motivation were examined. It was also determined that NXT and EV3 robot sets from LEGO robot sets were used. It was seen that the students' coding skills, attitude and motivation towards coding were examined. In this study, the change in academic achievement, attitude and computational thinking skill towards science course will be investigated which is believed to contribute to the field.

### 1.1 The Importance of the Study

In order to raise individuals with skills such as critical and creative thinking and problem solving suitable for the information age, the students should establish interdisciplinary connections with more than one field in science and technology course environment. The information acquired by students in the course should be a guide for the solution of problems that they may encounter in their daily lives.

Concrete learning environments that improve students' abstract thinking skills should be prepared. A learning environment, in which the student can gain experience by doing and experiencing, share his/her knowledge with his/her friends, and act in accordance with the collaborative learning environment within the group, should be provided.

The importance of STEM education, which is an interdisciplinary approach of Science, Technology, Engineering, and Mathematics to software, programming and production in the information society, is increasing day by day. The

Ministry of National Education (MNE) emphasized this importance in its STEM Report (2016) and stated that this interdisciplinary approach will be taken as a basis in Turkey. When the problems experienced in mathematics and science fields in Turkey have been examined, the importance of the STEM approach increases. In their report, Akgündüz et al., (2015) emphasized that STEM approach is a must for Turkey but it is not easy to provide this type of education.

In this study, in order to train individuals having skills suitable for the information age, a learning environment was prepared in which learners can use concrete objects and gain experience in the learning process, move freely in the environment, collaborate and obtain interdisciplinary gains. The purpose of this learning environment was to make learning permanent and meaningful with robotic applications integrated with technology.

### *1.2 Purpose of the Study*

The overall aim of this study was to determine the effect level of LEGO WeDo 2.0 robotic education on learners' academic achievement and attitude and computational thinking skills towards science course. In this respect, it was aimed to determine whether or not there were differences between learners' achievement, attitude and computational thinking skills in robotic-assisted education and traditional learning environment.

The sub-objectives determined within the above-mentioned general purpose were as follows:

- Is there any difference between the science academic achievements of the students participating in LEGO Wedo 2.0 robotics education (Experimental group) and the students studying in traditional learning environment (Control group)?
- Is there any difference between the attitudes of the students participating in LEGO Wedo 2.0 robotics education toward the science course?
- Is there any difference between the computational thinking skills of the students participating in LEGO Wedo 2.0 robotics education?

### *1.3 Assumptions of the Study*

The following assumptions were prepared in this study;

- The participants' responses to the Academic Achievement Test, Science Scale Attitude Scale and Computational Thinking Scale are their real thoughts and the participants are truthful when stating their opinions.
- Reliability and validity of data collection tools are suitable for the purpose of the study.
- The first academic achievement levels of the learners for science are sufficient in terms of equalization and unbiasedness while selecting the experimental and control groups.

### *1.4 Limitations of the Study*

The following limitations were pointed out in this study;

- This study is limited with 36 5th graders in a of a private school.
- This study is limited with 2018-2019 academic year.
- This study is limited with the subjects in the content of LEGO Education WeDo 2.0 Robotics set.
- This study is limited with the application duration of the sample group.

## **2. Method**

Within the scope of the study, it was aimed to determine whether or not Wedo 2.0 robotics education, which was the independent variable, had any effect on academic achievement, attitude and computational thinking skills which were the dependent variables. The study was a research in the experimental model. In the experimental models, "it is tried to be determine how systemic changes in the independent variable affect the dependent variable" (Karasar, 1994: 88).

Experimental and control groups were structured within the framework of the experimental research model. Two groups were formed as experimental and control groups. While determining the experimental and control groups, it was paid attention that the characteristics of the students to be included in the groups were similar. The groups and characteristics prepared in this way were as follows:

- Experimental Group: The group receiving WeDo 2.0 robotics education along with traditional learning environments,
- Control Group: The group receiving education in traditional educational environments.

The measurement tools were applied to the groups to measure their academic achievements before and after the study. In addition, attitude and computational thinking scales were distributed to the experimental group before and after the application and their levels were tried to be determined. Accordingly, the application was made in fall term of 2018-2019 academic year for 11 weeks in the form of Wedo 2.0 robotics education and traditional education. The general appearance of the study was designed according to “research model with pretest-posttest control group”.

### 2.1 Scope of the Study

- This study was conducted in a private school in Elazığ province during the fall semester of 2018-2019 academic year. The population of the study was composed of 36 5th graders in studying in 5/A and 5/B branches. When the curriculum of Wedo 2.0 robotics set and the curriculum of MNE were compared and analyzed, the student group at this level was chosen since the chapter and subject contents were suitable for 5th grade students.
- The models included in Wedo 2.0 robotic set were used in the study. The application was carried out by the researcher who is an information technologies and software teacher.
- The application period of the study was 11 weeks along with the application of pretest and posttest which are equal in both experimental and control groups.
- Since the Wedo 2.0 robotics education to be given within the scope of the study was limited to the number of educational sets, the groups were also limited by the number of sets. Before starting the application, a study plan was prepared for the works to be done during the study process and it was predicted that these works would be conducted in all groups in accordance with the determined plan.

### 2.2 Hypotheses

Within the framework of the determined sub-goals, the following hypotheses were tested.

#### Hypotheses for the First Sub-Goal

There were two groups in this study. These groups were the experimental group receiving Wedo 2.0 robotics education and the control group receiving education in traditional learning environment. Academic achievement scores were examined in both groups. The following hypotheses were developed within the framework of the first sub-purpose for these groups.

- There is no significant difference between the pretest and posttest scores of the experimental group receiving Wedo 2.0 robotics education.
- There is no significant difference between the pretest and posttest scores of the control group receiving education in traditional learning environment.
- There is no significant difference between the pretest scores of the experimental group receiving Wedo 2.0 robotics education and the control group receiving education in the traditional learning environment.
- There is no significant difference between the posttest scores of the experimental group receiving Wedo 2.0 robotics education and the control group receiving education in the traditional learning environment.

#### Hypothesis for the Second Sub- Goal

There is no significant difference between the attitude scale pretest-posttest scores of the experimental group receiving Wedo 2.0 robotics education.

#### Hypothesis for the Third Sub-Goal

There is no significant difference between the computational thinking skill scale pretest-posttest scores of the experimental group receiving Wedo 2.0 robotics education.

### 2.3 Population and Sample

This study was conducted in the fall semester of 2018-2019 academic year. The population of the study was composed of 36 students studying at 5th grade A and B branches of a private school in Elazığ province. The reasons behind why other grades were excluded from the study population were as follows:

- The content of the LEGO Wedo 2.0 Robotics set was compared with the curriculum of MNE and it was determined that the set contents were suitable for 5th grade in the curriculum of MNE.

The reasons behind why the study was conducted in the above school were given below:

- One of the main reasons for why the study was conducted at the specified school was that the researcher is currently working in this institution and in this respect, the researcher had the opportunity to form the experimental and control

groups easily.

•Another important reason was that the researcher has technologically competent robotics and coding laboratory facilities in this institution. The number of laptops in the laboratory gave each student the opportunity to work individually. In addition, since tablet-supported education is given in the school, the presence of own tablets of the students which are compatible with Wedo 2.0 robotics set software was among the reasons.

A total of 36 students (18 for each group) were selected for one experimental group and one control group in the sample of the study. In order to ensure objectivity in the formation of experimental and control groups, pretest scores were taken into consideration. Table 1 shows the arithmetic mean and standard deviation of the pretest-posttest scores of the groups.

**Table 1.** Arithmetic Mean and Standard Deviation of the Pretest Scores of the Groups

Groups	N	X	SD
Experimental	18	8.944	2.412
Control	18	8.333	2.646

When Table 1 was examined, there was no significant difference between the groups in terms of their pretest mean scores ( $p < .05$ ). It can be asserted that the groups had similar characteristics in terms of pretest scores.

#### 2.4 Data Collection Tools

Three types of measurement tools were used in the study to collect data. These tools were;

- The academic achievement scale used to measure the academic achievement of the students in the experimental and control groups toward the science course
- Science Attitude Scale of the students in the experimental group related to Wedo 2.0 robotics education
- Computational thinking scale of the students in the experimental group related to Wedo 2.0 robotics education

#### 2.5 Academic Achievement Test

Academic achievement test, which was used as a data collection instrument, was developed by researchers and the validity and reliability were analysed. It was found that item difficulty of the test ranged from 0.17 to 0.91. Having a wide range of item difficulties would suggest that there were easy and difficult items in the test. The average difficulty of the items in the test was found to be .66. Since the average difficulty value for the content knowledge is .50, it can be concluded that the achievement test is at a medium level of difficulty matching “desired average difficulty level” (Tekin, 2000). The reliability coefficient of the test was found to be 0.88 by using KR-20 formula. All these results suggest that the achievement test is reliable. Statistical analysis of the obtained data is presented in Table 2.

**Table 2.** Analysis Results of Achievement Test

Number	arithmetic mean (X)	standard deviation (Sd)	Average difficulty (P)	reliability KR-20
111	16,65	5,67	0,66	,889

#### 2.6 Science Course Attitude Scale

In this present study, an attitude scale which was constructed by Gürdal, A. Şahin, F. and Macaroğlu, E. aiming to examine students' attitudes in science courses in secondary schools in 1996 was used before and after the applications (Gürdal, 1997, p: 243). Science Course Attitude Scale, the reliability and validity of which was verified by Gürdal (1997), was used as the data collection tool. The Cronbach's alpha reliability coefficient of the scale was reported as 0.87 and the scale consisted of 23 positive and negative statements. While scoring the scale, reverse scoring pattern was used for negative statements, and then total score was calculated. The lowest possible score one can get is 23 and the highest possible score is 46; higher scores represent a positive attitude toward science courses.

#### 2.7 Computational Thinking Scales

“Computational Thinking Scales (CTS)”, designed by Korkmaz, Çakır and Özden (2016), was used as the data collection tool. The original scale was applied to 726 students enrolled in associate's degree and bachelor's degree programs in Amasya University, and the second application of the scale was carried out with 580 pedagogical formation students taking courses through distance education in Amasya University. The scale was then administered

to a group of 241 secondary school students to investigate whether the instruments used in the study were valid and reliable. In order to examine the psychometric properties of the scale, Cronbach's alpha values were calculated for each factor and confirmatory factor analysis was performed on the data.

The scale, developed by Korkmaz, Çakır and Özden (2016), was consisted of 29 items and 5 factors. A confirmatory factor analysis was performed to verify the factor structures of the scale, which was found to be consisted of 5 factors as a result of exploratory factor analysis. The results of confirmatory factor analysis showed that model had a good fit.

**Table 3.** Faktörlere Göre İç Tutarlılık Katsayıları ve Madde Sayıları

Factors	Number of items	Cronbach's Alpha
creativity	8	,843
Algorithmic thinking	6	,869
cooperativity	4	,865
Critical thinking	5	,784
Problem solving	6	,727
Total	29	,822

The independent sample t test values regarding the 22 items, factors and the total score on the scale vary between 3,818 and 23,287. The t-value for the whole scale was found to be -37,105. The level of each difference was found to be significant ( $p < 0,001$ ). Thus, it can be interpreted as indicative of very high item discrimination for the quality of the scale in general and each item. The Cronbach's alpha reliability coefficient of the scale consisted of 22 items and 5 factors was found to be 0.809. Additionally, the Cronbach's alpha values for factors ranged from 0,640 to 0,867. Cronbach's alpha values for creativity are slightly low. This value is expected to be 0.70 or above (Büyüköztürk, 2002).

### 2.8 Data Collection

Thirty-six pretest-posttest (academic achievement test, attitude scale, and computational thinking scale) were distributed to and collected from the students in the A and B branches of 5th grade before the study. At the end of the study, the same attitude scale, computational thinking scale, and academic achievement test were applied to the students by the researcher.

### 2.9 Data Analysis

Statistical operations were made in the data analysis section. The data obtained after the pretest and posttest were processed in computer-aided statistics packaged software. In the process of data related to the academic achievement of the subjects, dependent samples and independent samples t-test was applied in the cases where two variables existed. Percentage and frequency statistics were made in determining opinions about attitudes and computational thinking skills.

## 3. Results

This section involved the statistical results of the sub-goals and objectives for the problem status.

### 3.1 Results and Comments for the First Sub-Goal

The "achievement test" was applied twice to the experimental and control groups as pretest and posttest. In accordance with the hypotheses, statistical analyses were conducted with scores of the students. Results and comments about the hypotheses related to achievement test are given below.

**Hypothesis 1: There is no significant difference between the pretest and posttest scores of the experimental group.**

In order to investigate the effect of the experimental study on the achievement scores of the students in the experimental group, the achievement test was delivered to the students at the beginning and end of the application. Table 4 shows the results of the dependent samples t-test according to the mean scores.

**Table 4.** Results of Dependent Samples t-test related to Achievement Test Pretest-Posttest Scores of the Experimental Group

Experimental Group	X	N	Sd	Xdifference	t	sd	p
Pretest	8.9444	18	2.41252	-6.94444	-5.733	17	.000
Posttest	15.8889	18	3.92412				

When Table 2 was examined, it was determined that there was a significant difference between the achievement test pretest and posttest scores of the students in the experimental group ( $p < .05$ ). While pretest arithmetic mean of the experimental group was 8.9444, their posttest arithmetic mean was 15.8889. According to this result, a significant difference was observed between the pretest and posttest scores of the experimental group in favor of the posttest and the hypothesis 1 was rejected. This result indicated that robotics education was effective on the academic achievement of the students in science course.

**Hypothesis 2: There is no significant difference between the pretest and posttest scores of the control group.**

In order to investigate the effect of experimental study on the achievement scores of the students in the control group, the achievement test was delivered to the students at the beginning and end of the application. Table 3 shows the results of the dependent samples t-test made according to the mean scores.

**Table 5.** Results of Dependent Samples t-Test Related to the Achievement Test Pretest-Posttest Scores of the Control Group

Control Group	X	N	Std. Deviation	Xdifference	t	sd	p
Pretest	8.3333	18	2.97044	-2.88889	-7.638	17	.000
Posttest	11.2222	18	2.64699				

As seen in Table 5, it was determined that there was a significant difference between the pretest and posttest scores of the control group from the overall achievement test ( $p < .05$ ). While pretest arithmetic mean of the control group was 8.3333, their posttest arithmetic mean was 11.2222. According to this result, it was observed that there was a significant difference between the pretest and posttest scores of the control group in favor of the posttest and the hypothesis 2 was rejected.

**Hypothesis 3: There is no significant difference between the pretest scores of the experimental and control groups.**

Independent samples t-test was conducted to determine whether or not there was a significant difference between the pretest scores of the experimental and control groups. in Table 4 shows information related to this section.

**Table 6.** Results of Independent Samples t-test for the Achievement Test Pretest Scores of the Experimental and Control Groups

Groups	X	N	Std. Deviation	Xdifference	t	sd	p
Experimental group	8.9444	18	2.41252	.61111	.553	17	.588
Control group	8.3333	18	2.97044				

When Table 6 was examined, it was seen that there was a slight (0.61) score difference between the mean scores of the experimental and control groups. This result appeared as an insufficient result in making a significant difference. When the table was examined, the arithmetic mean scores of the experimental group ( $X = 8.94$ ) and control group ( $X = 8.33$ ) were very close to each other and no significant difference occurred at ( $t = 0.553$ ) and  $P < 0.05$  ( $P = .588$ ) levels. Based on this result, it was observed that there was a homogeneity between the experimental and control groups before the study and a similarity occurred in terms of academic achievement scores.

**Hypothesis 4: There is no significant difference between the posttest scores of the experimental and control groups.**

Independent samples t-test was conducted in order to determine whether or not there was a significant difference

between the posttest scores of the experimental and control groups. Table 5 shows information about this section.

**Table 7.** Results of Independent Samples t-test for the Achievement Test Posttest Scores of the Experimental and Control Groups

Groups	X	N	Std. Deviation	Xdifference	t	sd	p
Experimental	15.8889	18	3.92412	4.66667	4.012	17	.001
Control	11.2222	18	2.64699				

As seen in Table 7, there was a difference of 4.66 points in the arithmetic means of the experimental group ( $X=15.88$ ) and control group students ( $X=11.22$ ) for the academic achievement. Additionally, in terms of the presence of a statistical difference, a significant difference was determined at  $P<0.05$  ( $P=.001$ ) level ( $t=4.012$ ). This result was a sufficient result in making a significant difference.

### 3.2 Results and Comments on the Second Sub-Goal

In the results related to the second sub-goal, “attitude scale” was applied to the experimental group twice (pretest and posttest). The correlation between the attitudes of the experimental group was evaluated in terms of the differences between the pretest and posttest scores of the experimental group. At the beginning of the study, those in the experimental group were informed about the robotics education and attitude pretest was applied and attitude posttest was applied after the study was completed. In this way, it was determined whether or not there was a significant difference between the opinions of the students, who received robotics course, about their attitudes before and after the education. Necessary statistical procedures were carried out on the attitude pretest and posttest scores of the students in accordance with the related hypothesis. Results and comments about the attitude scale were given below.

**Hypothesis 1: There is no significant difference between the attitude scale pretest-posttest scores of the experimental group.**

Dependent samples t-test was applied in order to determine whether or not there was a significant difference between the pretest and posttest scores of the experimental group from the overall attitude scale. Table 6 shows the results of the dependent samples t-test.

**Table 8.** Results of Dependent Samples t-test Regarding the Attitude Test Pretest-Posttest Scores of the Experimental Group

Attitude	X	N	Std. Deviation	Xdifference	t	sd	p
Pretest	.4841	15	.06119	-.04348	-2.646	14	.019
Posttest	.5275	15	.03980				

As seen in Table 8, a significant difference was determined between the pretest and posttest attitude scores of the experimental group ( $p<0.05$ ) and the hypothesis 1 was rejected. As a result of this test, it can be asserted that the properties of robotics education to improve efficiency prepared the ground for positive changes in the attitudes of the students which caused the significant difference.

### 3.3 Results and Comments on the Third Sub-Goal

In the results related to the third sub-goal part, “computational thinking” was applied to the experimental group twice as pretest and posttest. The correlation between the computational thinking skills of the experimental group was evaluated in terms of the differences between the pretest and posttest scores of the experimental group. Those in the experimental group was informed about the robotic education and computational thinking pretest was applied at the beginning of the study and computational thinking posttests were applied after the completion of the study. In this way, it was determined whether or not there was a significant difference between the opinions of the students receiving robotics course, about the computational thinking skills before and after the education. The necessary statistical procedures were made on the computational thinking skill pretest and posttest scores of the students in accordance with the related hypothesis. Results and comments about computational thinking skills were given below.

**Hypothesis 1: There is no significant difference between the computational thinking skills pretest-posttest scores of the experimental group.**

Dependent samples t-test was applied to determine if there was a significant difference between the computational

thinking skills pretest and posttest scores of the experimental group. Table 7 shows the results of the dependent samples t-test.

**Table 9.** Results of Dependent Samples t-Test Related to Computational Thinking Pretest-Posttest Scores of the Experimental Group

Computational thinking	X	N	Std. Deviation	Xdifference	t	sd	p
Pretest	3.7348	18	.43129	.70960	6.755	17	.000
Posttest	3.0253	18	.34449				

As seen in Table 9, a significant difference at  $p < 0.05$  significance level was determined between the computational thinking skills pretest and posttest scores of the experimental group and the hypothesis 1 was rejected.

#### 4. Conclusion, Discussion, and Recommendations

##### 4.1 Conclusion and Discussion on Academic Achievement

With the academic achievement test developed by the researcher, the effect level of robotics education on the students' achievement in science course was examined. Science course contents and robotics coding education were given in accordance with LEGO WeDo 2.0 robotics set. When the data were examined as a result of the application, it was concluded that there was no significant difference between the pretest scores of the experimental and control groups. Likewise, when the posttest scores of the experimental and control groups were examined, a significant difference was found between the groups in favor of the experimental group. As a result of the study, it was revealed that the robotics education had a significant effect on science success. In their study conducted on the effect of robotics education on science course, Şenol and Büyük (2015) concluded that the students in the experimental group were more successful in scientific process skills test compared to the control group. They stated that although robotics education was not directly related to academic achievement, it was significantly related to scientific process skills and motivation. In a study, Şimşek (2018) investigated the effect of robot programming training on academic achievement and stated as a result of the analysis of the obtained data that there was no significant difference between the groups but the motivation and interest of the students increased. In the study conducted by Yolcu (2018) to investigate the effect of robot programming training on academic achievement, it was concluded that there was no significant difference between the groups.

##### 4.2 Conclusion and Discussion on Attitude toward Science Course

In order to measure the effect of robotics education on the students' attitudes towards science course, Gürdal (1997) used the science attitude scale. As a result of the analyses, it was found that there was a significant difference between the pretest-posttest scores of the experimental group who received robotics education. In his study supported with LEGO Mindstorms Ev3 Robot set named as "Mindstorms Robolab: Developing Science Concepts in Problem Based Learning Club", Cameron (2005) stated that there was an increase in the students' motivation and desire to join science and technology club. In a robotic-assisted study in physics teaching, Silva (2008) expressed that the students showed significant differences in terms of motivation and participation variables. In her study, Özdoğru (2013) investigated the effect of science education made by using LEGO Mindstorms NXT 2.0 robot set for Physical Events Learning Field of Primary School Science Education Program on the students' attitudes towards science course, academic achievements and scientific process skills and concluded that the students in the experimental group developed a positive attitude towards science course, their academic achievement increased and scientific process skills improved.

##### 4.3 Conclusion and Discussion on Computational Thinking Skill

Computational thinking skill is also among the 21st century skills. In order to measure the computational thinking skills of the students, "The Computer Thinking Skill Levels Scale" whose original name is "Computational Thinking Scales (CTS)" developed by Korkmaz, Çakır and Özden (2015) was used. As a result of the analysis, it was found that there was a significant difference between the computational thinking skills between the pretest and posttest scores of the experimental group. It is seen in the literature that the basic components of computational thinking have been investigated. In their study, Koç-Şenol (2012) investigated the effect of robotics-supported education on the students' motivation and scientific process skills towards science and technology course in "Force and Motion" chapter of the primary school 7th Grade Science and Technology course. As a result of the study, they expressed that there was an increase in the scientific process skills and motivation levels of the students who made robotics-assisted science

experiments. In her study, Çayır (2010) revealed that students' scientific process skills increased. Similarly, in his study, Sullivan (2008) investigated the effect of robotic activities on skills of secondary school students to understand scientific processes and systems and concluded that robotic activities had positive effects. In their studies, Kapa (1999), Lindh and Holgersson (2007), Atmatzidou, Markelis and Demetriadi (2008), Barak, Zadok (2009), Turner and Hill (2006) showed that the problem solving skills of the students in the experimental group improved more. Unlike the obtained results, in their study, Ma, Lai, Prejean, Ford and Williams (2007) stated that robotic activities did not cause any change in the scientific process skills of secondary school students.

## 5. Recommendations

In this section, recommendations for educators and researchers regarding the results and conclusions obtained in the study are included.

- The effects of robotics-supported education can be examined for different disciplines.
- Just like the academic achievement test developed for science course in the context of the study, tests can be developed for other courses such as mathematics etc.
- Various robotic sets (EV3, Arduino etc.) can be integrated into the courses according to student levels.
- This study, carried out in experimental design, can be supported by qualitative data.
- Similar studies can be conducted with different student age groups and different size of samples
- In classroom environments enriched with robot sets, students can be monitored and the effects of training can be examined.
- Students' emotions, thoughts and skills can be investigated in terms of different variables such as motivation and creative thinking towards STEM courses.
- Similar studies can be conducted at teacher and parent levels apart from student level.

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