An Investigation of the Relationship between Science Course Attitudes and Robotics Attitudes

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ABSTRACT

The current study aimed to investigate the relationship between middle school students' science course attitudes and robotics attitudes. To this end, the correlational survey model was used. The study group of the current study is comprised of 220 students attending middle schools in the 2019-2020 school year. In the study, the "Science Course Attitude Scale" was used to measure the students' science course attitudes and the "Robotics Attitude Scale" was used to measure their robotics attitudes. In the study, the relationship between the robotics attitude dataset consisted of the learning desire, self-confidence, computational thinking and teamwork variables and the science course attitude dataset consisted of the daily life and learning new knowledge, difficulty in practice, problem solving, motivation and anxiety variables was analyzed with the canonical correlation analysis. As a result of the study, a significant correlation was found between the science course attitudes and the robotics attitudes and the covariance shared between the datasets was found to be 38.4%. The relationship between these two variables was discussed and various suggestions were made.

Keywords: *Science course, robotics attitude, middle school students, canonical correlation analysis*

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INTRODUCTION

In today's age of science and technology, the basic philosophy of developing science education is to train science literate individuals who are researching, questioning, problem solving, creative, and having higher order thinking skills. Attitudes towards science have an important place in achieving science literacy because students' science literacy can only be achieved by their interest in science subjects and their positive attitudes (Kozcu Cakir, Senler & Gocmen Taskin, 2007; Yasar & Anagun, 2008). Students with positive attitudes come to the lessons on time, participate in the activities in the class with pleasure, are willing to investigate, question, generate ideas and offer solutions to various problems. In addition, positive attitudes towards science course are effective in students' learning science subjects better (Dogru & Kiyici, 2005), their academic success and their orientation to the fields of science in their future lives (Altinok, 2004).

Attitudes represent a complex system of cognition, emotion, and action tendencies, affecting students' continuing interests and tendencies in forming positive and constructive responses to science and related issues (Bybee & McCrae, 2011). Students' attitudes towards science develop at early ages, and certain attitudes about which subjects they like, or dislike are settled by the age of 11-12. This plays an important role in students' effective and permanent learning in science subjects (Altinok & Acikgoz, 2006). Because students think that science classes are complex as they include abstract concepts and thus they have difficulty understanding (Inaltekin, Ozyurt, & Akcay, 2012). This contributes to the development of negative attitudes towards science course in students. However, there are many reasons that affect students' attitudes towards science, such as gender, age, number of students in class, teacher, school and friend circle and socio-economic and educational level of the family (Gunduz & Kale, 2019). In the studies on science attitudes in the literature, it is stated that the teaching models and methods used in the lessons play an active role on students' science attitudes (Celik & Cavas, 2012; Doymus, Simsek, & Bayrakceken, 2004). Lecturing with traditional methods and techniques in learning environments and traditional teaching materials are insufficient to attract the interest and attention of generation z students who are used to technology (Kaya & Aydin, 2011, Somyurek, 2014). In this context, rich learning environments using student-centred techniques, methods and materials should be created in order to make attitudes positive that can be acquired through learning (Kurbanoglu & Takunyaci, 2012).

Recently, technology-supported teaching based on constructivist learning approach has been carried out in science classrooms for students to more easily make sense of science subjects and concepts and to develop positive attitudes towards science (Dagdalan & Tas, 2017; Demirbas, Topsakal, & Ozkan, 2019; Duman & Avci, 2016; Orhan & Durak Men, 2018; Ozenc & Ozmen, 2014; Sirakaya & Alsancak Sirakaya, 2018; Timur & Ozdemir, 2018; Tufekci & Benzer, 2018). When these studies are examined, it is seen that technology-supported teaching in science education makes learning more effective and enjoyable by enabling students to be engaged in interactive applications, concretize abstract concepts, carry out some dangerous experiments in the classroom, record and repeat activities and by allowing immediate feedback, and teaching with multimedia techniques such as painting, video, sound, animation. In addition, technology-supported teaching increases students' attention, interest and attitude towards the subject, as it allows students to perform interactive activities by doing and experiencing, to discover new information and offers different activities suitable for their age, learning speed and style (Kennewel, 2006; Shenton & Pagett, 2007). With this kind of teaching, learning environments are enriched, they become more enjoyable for the student, and more meaningful learning is accomplished as students are active in the process (Akpinar, Aktamis, & Ergin, 2005). In this regard, it is reported in the literature that smart boards (Ozenc & Ozmen, 2014; Sakiz, Ozden, Aksu, & Simsek, 2014; Tercan, 2012; Tiryaki, 2014; Tufekci & Benzer, 2018), virtual laboratory applications (Duman & Avci, 2016), web-based teaching (Balci, 2018; Can, 2008; Orhan & Durak Men, 2018; Ozgen, 2017; Tuysuz & Aydin, 2007), augmented reality applications (Sirakaya & Alsancak Sirakaya, 2018; Timur & Ozdemir, 2018; Yetisir, 2019; Yildirim, 2018), computer-assisted mind maps (Akinoglu & Yasar, 2007; Aydin, 2009; Gomleksiz & Fidan, 2013), simulations (Chen & Howard, 2010; Dagdalan & Tas, 2017), 3D applications (Demirbas, Topsakal, & Ozkan, 2019), social media-enhanced applications (Akgunduz, 2013), QR code applications (Yilmaz, 2019) and robotics coding applications (Kozcu Cakir & Guven, 2019; Okkesim, 2014; Ozdogru, 2013) are used to improve students' attitudes towards science. In the literature, it is particularly emphasized that robotics applications are effective in increasing students' desire to learn and making learning fun (Eguchi, 2010; Highfield, 2010; Mioduser & Levy, 2010; Pina & Ciriza, 2016; Wei, Hung, Lee, & Chen, 2011).

Robotics applications in science education enable students to gain many skills such as problem solving, finding practical solutions to problems, critical thinking, realizing their own abilities, learning by doing and experiencing, increasing level of using technology and being more willing to use technology (Costa & Fernandes, 2005). With such applications, abstract concepts are concretized, meaningful learning is accomplished, new knowledge is discovered and skills such as building, designing, debugging, checking, coding are acquired (Costa & Fernandes, 2005; Witherspoon, Schunn, Higashi, & Shoop, 2018). Furthermore, the fact that robotics applications in learning environments enable students to participate in meaningful learning by providing opportunities for active participation and mental activities positively affects students' affective characteristics such as interest, motivation and attitude (Khanlari & Kiaie, 2015; Scaradozzi, Sorbi, Pedale, Valzano, & Vergine, 2015) because students' taking an active role in lessons while learning and being aware of their learning make the process more enjoyable (Alimisis, 2013; Bruciati, 2004). As a result, while students accomplish meaningful learning, they may also develop positive attitudes towards science course.

In this connection, Papert (1971) states that students learn best when they actively participate in the process and design and create meaningful products.

Robotics refers to functional tools that can be programmed to do a job. Robots can perceive the environment with the help of sensors and various responses are created by interpreting the obtained data as programmed by the microcontroller or processor. In particular, the use of robots that can be programmed with block-based codes is becoming widespread in education. These types of educational robots enable students to work with concrete objects and deal with real life problems. Moreover, robotics applications offer students rich learning environments with fun activities to get to know the world of technology. In educational robotics applications, students work with engineering materials such as gears, motors and sensors, perform coding using their own imaginations and thinking algorithmically, collect data by interacting with their environment and create unique projects in the light of these data. In this connection, the use of various tools such as robots that can perform coding, smart objects, do-it-yourself kits and sets, virtual robot coding platforms and robot programming languages have become widespread in science learning environments. Cubelets, Edison, Finch Robot, mBot, Mindstorms EV3, Macro bit, Ozobot, Parallax Boebot, Rubbo, Scribber, Tinylab and VEX Robotics can be given as examples of such educational robotics sets that can be used in educational environments (Guven & Kozcu Cakir, 2020). As a result, given that education and instruction become more meaningful and permanent in an environment where students have fun in science lessons, it is thought that student attitudes towards such robotics applications and attitudes towards science course are important factors. In this regard, Cavas et al. (2012) also stated that there is a positive relationship between robotics activities and training science literate individuals. In this context, the purpose of the current study is to examine the relationship between science course attitudes and robotics attitudes.

RESEARCH METHOD

The current study employed the correlational survey model, one of the designs of survey model. The survey model is used to describe a past or present event or situation (Islamoglu, 2003). A type of survey model, correlational survey design aims to determine the existence and/or degree of covariance between two or more variables (Fraenkel & Wallen, 2006).

Participants

The study employed the convenient sampling method, one of purposive sampling methods, in the selection of the sampling. The study group consists of 220 students attending middle schools in the 2019-2020 school year. Of the participating students, 140 (63.6%) are females and 79 (35.9%) are males. The distribution of the students across the grade levels are as follows: 34 fifth grade students (15.5%), 67 sixth grade students (30.5%), 60 seventh grade students (27.3%), 58 eighth grade students (26.4%). Stevens (2012) states that in canonical correlation analysis, the reliability of the findings can be achieved with the number of participants 20 times higher than the total number of variables in each set. When the scales used in the current study are examined in this regard, it is seen that in the *Robotics Attitude Scale*, there are 4 variables called learning desire, self-confidence, computational thinking and teamwork, in the *Science Course Attitude Scale*, there are 5 variables called daily life and learning new knowledge, difficulty in practice, problem solving, motivation and anxiety; thus, there are a total of 9 variables. Thus, at least 180 participants (9x20=180) were decided to be included in the study for the reliability of the data. Thus, the size of the sample in the current study can be said to be adequate for the reliability of the findings.

Data Collection Tool

Robotics Attitude Scale: Robotics attitude scale [RAS] was developed by Cross, Hamner, Zito, Nourbakhshh and Bernstein (2016) in order to determine the attitudes of middle school students towards robotics activities, and it was adapted to Turkish by conducting validity and reliability studies by Sisman and Kucuk (2018). The scale consisted of 24 items has 4 sub-scales and is in the form of a five-point Likert scale. The sub-scales are named as learning desire (12 items), self-confidence (6 items), computational thinking (3 items) and teamwork (3 items). The general Cronbach's Alpha reliability coefficient of the scale was found to be .93 in the original study while it was calculated to be .94 in the current study. Sample items and Cronbach's Alpha reliability coefficients of the sub-scales of the scale are given in Table 1.

Table 1. *Reliability coefficients of Robotics Attitude Scale sub-scales with sample items*

Sub-scale	Cronbach's Alpha (Original Scale)	Cronbach's Alpha (This Scale)	Sub-Item
Learning Desire (LD)	0.92	0.93	I am interested in discovering things about robots.
Self-confidence (SC)	0.86	0.91	I can write a computer program.
Computational Thinking (CT)	0.82	0.81	I like solving complex problems.
Teamwork (TW)	0.73	0.62	I can communicate my ideas to my team.

Science Course Attitude Scale: The "*Science Course Attitude Scale*" [SCAS] used in the current study was developed by Sener and Tas (2016). The scale consisted of 21 items has 5 sub-scales and is in the form of a five-point Likert scale. The sub-scales are named as daily life and learning new knowledge (8 items), difficulty in practice (3 items), problem solving (3 items), motivation (4 items) and anxiety (3 items). The general Cronbach's Alpha reliability coefficient of the scale was found to be .87 in the original study while it was calculated to be .92 in the current study. Sample items and Cronbach's Alpha reliability coefficients of the sub-scales of the scale are given in Table 2.

Table 2. *Reliability coefficients of the SCAS sub-scales with sample items*

Sub-scales	Cronbach's Alpha (Original Scale)	Cronbach's Alpha (This Scale)	Sub-Item
Daily Life and Learning New Knowledge (DL)	0.82	0.88	I am interested in following up-to-date subjects in science.
Difficulty in Practice (DP)	0.61	0.82	I have difficulty in understanding experiments conducted in science classes.
Problem Solving (PS)	0.74	0.73	It is enjoyable to solve problems related to science subjects.
Motivation (M)	0.67	0.85	I get bored while doing homework given in the science course.
Anxiety (A)	0.52	0.80	I am afraid of doing experiments in science classes.

Data Analysis

The relationship between the middle school students' robotics attitudes and science course attitudes was analyzed by using the canonical correlation analysis. Canonical correlation examines the linear relationship between an X variable group (X1, X2,… Xp) and a Y variable group (Y1, Y2, Y3,… ..Yn). However, the X and Y variable groups must be 2 and more than 2 in themselves. The reason for preferring canonical correlation analysis instead of multiple regression in the current study is that while the relationship between a single variable (Y) and two or more variables (X1, X2, ... Xp) is examined in multiple regression analysis (Cohen, 1968), canonical correlation allows simultaneous analysis of the connections between multiple Y variables and multiple X variables and includes structural equation models (Bordens & Abbott, 2011; Knapp, 1978). The most important feature of canonical analysis is that since the relationship between two data sets can be revealed in a single analysis, it allows to keep Type I error to a minimum that may interfere with the measurement process (Sherry & Henson, 2005).

When the dataset variables used in the current study are examined, it is seen that there are 4 variables called learning desire, self-confidence, computational thinking and teamwork in the robotics attitudes dimension and that there are 5 variables called daily life and learning new knowledge, difficulty in practice, problem solving, motivation and anxiety in the science course attitudes dimension; thus, there are a total of 9 variables. The datasets formed here are called set 1 and set 2 and the relationship between the two datasets is tried to be determined without assigning them as dependent and independent variables (Stevens, 2012).

Before the canonical correlation analysis was done, it was examined whether the data showed a normal distribution. Skewness and Kurtosis values were examined for normality test. It was observed that the Kurtosis value varied between -0.525 and +1.005, and the Skewness value varied between -0.922 and +0.020. According to Tabachnick and Fidell (2007), Skewness and Kurtosis values being between -1.5 and +1.5 indicates that the data are distributed normally. Canonical correlation analysis was performed at 0.05 significance level and with syntax writing in SPSS 22 program. The general scheme of canonical correlation analysis is shown in Figure 1.

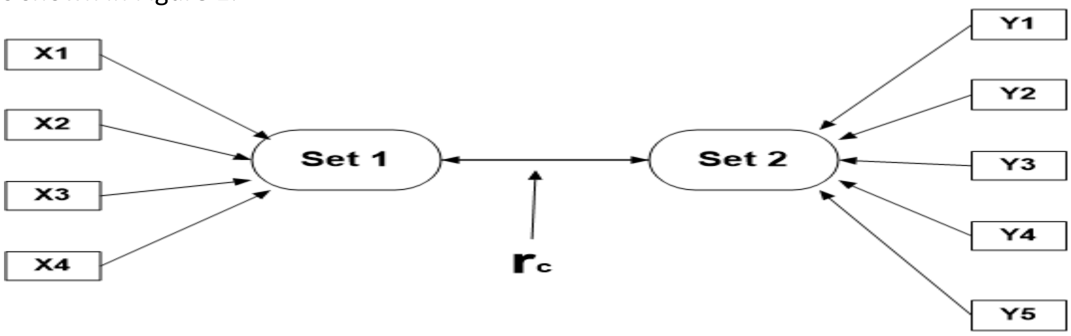

Figure1. *Illustration of the first function in a canonical correlation analysis with four predictors and five criterion variables. The canonical correlation is the simple Pearson r between the two synthetic variables, which were linearly combined from the observed variables.*

FINDINGS

The descriptive values of the relationship between the robotics attitudes of the middle school students participating in the study and their attitudes towards the science course and the correlation values of the sub-dimensions with each other are given in Table 3.

Table 3. *Relationships between robotics attitudes and science course attitudes*

Variables	Mean	SD	1	2	3	4	5	6	7	8	9
LD (1)	45.46	9.72	1								
SC (2)	17.34	5.83	.58	1							
CT (3)	11.88	2.55	.38	.40	1						
TW (4)	12.56	2.16	.37	.37	.52	1					
DL (5)	34.27	5.09	.39	.35	.46	.50	1				
DP (6)	11.17	3.09	.07	.12	.33	.23	.25	1			
PS (7)	12.69	2.31	.23	.23	.40	.32	.59	.54	1		
M (8)	17.05	3.25	.07	.11	.21	.24	.50	.56	.57	1	
A (9)	12.81	2.59	.06	.15	.26	.21	.32	.58	.59	.69	1

LD: Learning desire; SC: Self-confidence; CT: Computational Thinking; TW: Teamwork; DL: Daily life and learning new knowledge; DP: Difficulty in practice; PS: Problem solving; M: Motivation; A: Anxiety.

When the correlation values between the variables given in Table 3 are examined, it is seen that the correlations between the variables of learning desire, self-confidence, computational thinking and teamwork in the first variable set vary between .37 and .58 and it is seen that the correlations between the variables of daily life and learning new knowledge, difficulty in practice, problem solving, motivation and anxiety in the second variable set vary between .25 and .69. Correlation coefficients between the first dataset and the second dataset were found to be varying between .06 and .50.

In the canonical correlation analysis process, primarily the multivariate significance test, which indicates whether the canonical model is statistically significant, was examined. These significance tests consist of four different tests: Pillais, Hotellings, Wilks and Roys. By converting each of these tests to the F test, the significance of the canonical model resulting from the analysis can be tested. The fact that the theoretical basis of each of these four tests is different causes the F value calculated for each test to be different. However, interpretations are generally made based on the Wilks ƛ test, as it is more applicable in research (Stevens, 2012).

Table 4. *Multivariate test of significance*

	Value	Approx F	Hypoth df	Eror df	Sig. of F
Pillais	.46493	5.62907	20	856	.000
Hotellings	.71443	7.48369	20	838	.000
Wilks	.56574	6.56538	20	700	.000
Roys	.38832		20		

(S = 4, M = 0, N = 104 1/2)

When Table 4 is examined, it is seen that the canonical model obtained from the current study is statistically significant [Wilks's λ = .56574, F(20, 700) = 6.565, $p < .001$]. However, the significance of these tests does not provide information about the strength of the relationship obtained. In canonical correlation analysis, it is important to evaluate the effect size besides the significance of the model. To do so, the Wilks λ value, which is called the reverse effect size, is used. Since the Wilks λ value denotes the unexplained variance between canonical variables in the model obtained as a result of the analysis, the "1-λ" value gives the amount of covariance shared by the canonical variables and is interpreted like the r2 value in the regression analysis. In this case, for the Wilks' λ value obtained, the "1-λ" value was calculated to be 0.4343. Accordingly, it can be said that the covariance shared between the middle school students' robotics attitudes and science course attitudes datasets is 43.43%. After determining whether the canonical model is statistically significant or not, the significance of each canonical function in the model should be examined separately. Here, while the significance of the canonical model obtained from the canonical correlation is tested, the cumulative values of the canonical functions are used. In a canonical model in which cumulative values are statistically significant, some of the canonical functions are significant, while the relationship between variables may be very low in others. Therefore, when interpreting the results of canonical correlation analysis, the significance of each canonical function should be evaluated separately together with the canonical model. Eigenvalues and canonical correlation values of canonical functions are examined to decide which canonical functions are significant. In the study, four canonical functions were obtained as a result of the canonical correlation analysis applied to examine the relationship between robotics attitudes and science course attitudes datasets. The eigenvalues and canonical correlation values of these functions are shown in Table 5.

Table 5. *Canonical correlation analysis results between robotics attitudes and science course attitudes*

Roods	Eigenvalue	%	Cum %	r_c	r_c^2
1	.635	88.86	88.86	.62	.384
2	.051	7.15	96.01	.22	.048
3	.021	2.96	98.97	.14	.020
4	.007	1.02	100	.09	.008

According to the values shown in Table 5, the canonical correlation value for the first row canonical function was determined to be .62. Accordingly, in the first canonical function, robotics attitudes and science course attitudes datasets share a variance of 38.4%. In the second canonical correlation, the canonical correlation value, which is not considered in the first canonical function, is calculated and which reveals the maximum relationship between two canonical variables. It was determined that the canonical correlation value calculated for the second canonical function is .22 and in this function, the robotics attitudes and science course attitudes datasets share a variance of 4.8%. After removing the common variance shared by the datasets in the first two canonical functions, it is seen that the canonical correlation value of the third canonical function is .14 and the covariance shared by the datasets for the third canonical function is 2%. Finally, after removing the covariance shared by the datasets in the first three canonical functions, it was determined that the canonical correlation value of the fourth canonical function is .09, and the covariance shared by the datasets for the fourth canonical function was found to be 0.8%. Examining the significance of each canonical function determined as a result of the analysis separately sheds light on which of the functions emerging as a result of the canonical correlation analysis should be interpreted. In relation to which canonical functions determined as a result of the analysis should be interpreted, Tabachnick and Fidell (2007) argue that only those that are statistically significant would be appropriate to interpret. According to Sherry and Henson (2005), the canonical value calculated for each function should be squared and the sum of the obtained values should be compared with the "1-λ" value. If the "1-λ" value is equal to or greater than the value obtained in the comparison made here, that amount of function should be interpreted. The results of the dimension reduction analysis made for the relationship between the middle school students' robotics attitudes and science course attitudes datasets are given in Table 6.

Table 6. *Dimension reduction analysis*

Roods	Wilks L.	F	Hypothesis df	Error df	r_c	r_c^2	Sig. of F
1 to 4	.566	6.565	20	700.76	.62	.384	.000*
2 to 4	.925	1.401	12	561.19	.22	.048	.161
3 to 4	.972	1.009	6	426.00	.14	.020	.419
4 to 4	.993	.782	2	214.00	.09	.008	.459

When Table 6 is examined, it is seen that the canonical correlation coefficient calculated between the robotics attitudes and science course attitudes datasets for the first canonical model (function 1 to 4) regarding Wilks's λ values and chi-square values of the four canonical functions obtained as a result of the analysis is statistically significant [Wilks's λ=.57, F(20, 700.76)=6.565, p<.001]. Here, the correlation value of the first canonical function was found to be .62. Accordingly, the covariance shared between datasets is 38.4%. For the second canonical function (function 2 to 4) remaining after the removal of the first canonical function, which has the highest correlation between canonical variables, it was determined that the relationship between the datasets was not statistically significant [Wilks's λ=.925, F(12, 561.19)=1.401, p>.05]. According to the Wilks's λ value of this relationship, which consists of cumulative values of the second, third and fourth canonical functions, the covariance shared between the datasets is 7.6%. For the third canonical function (functions 3 to 4) remaining after the removal of the second canonical function, it was found that the relationship between the datasets was not statistically significant [Wilks's λ=.972, F(6, 426.00)=1.009, p>.05]. According to the Wilks's λ value of this relationship, which consists of the cumulative values of the third and fourth functions, the covariance shared between datasets is 2.8%. There is no statistically significant relationship between the datasets for the fourth canonical function (function 4 to 4) remaining after the removal of the third canonical function [Wilks's λ=.993, F(2, 214.00)=.782, p>.05]. In this function, where the relationship between canonical variables is the weakest, the datasets share a covariance of only 0.8%.

The standardized coefficients and structural coefficients of the first canonical function between canonical variables were examined to determine its contribution to the relationship between the variables of learning desire (LD), self-confidence (SC), computational thinking (CT) and teamwork (TW) in the robotics attitudes dataset and the variables of daily life and learning new knowledge (DL), difficulty in practice (DP), problem solving (PS), motivation (M) and anxiety (A) in the science course attitudes dataset. These coefficients are presented in Table 7.

In the findings, standardized coefficients belonging to canonical functions are shown with "Coef" and structural coefficients with "rs". In Table 7, while learning desire (LD), self-confidence (SC), computational thinking (CT) and teamwork (TW) variables are specified with the robotics attitudes dataset, the covariance that these variables share with the science course attitudes dataset is shown with "rc2". In addition, by summing rc2 values in the first canonical function belonging to the LD, SC, CT and TW variables in the robotics attitudes dataset and to the DL, DP, PS, M and A variables in the science course attitudes dataset in the table, how much covariance shared by these variables with the dataset they are in can be determined in the canonical model. The value of .45 was taken as the criterion in determining whether the variance that the variables shared with the dataset they were in was significant. Accordingly, it can be said that the contribution of variables with rs values of .45 and above to the dataset they are in is significant (Sherry & Henson, 2005). In addition, in order for the variables in each dataset to be a part of the canonical model, the correlations must be greater than .30 (Tabachnick & Fidell, 2007).

Table 7. *Canonical solution for robotics attitudes and science course attitudes for functions 1*

	Function 1		
Variables	**Coef.**	r_s	r_s^2(%)
LD	-0.222	-0.64	.41
SC	-0.093	-0.59	.35
CT	-0.512	-0.86	.74
TW	-0.441	-0.82	.67
r_c^2		**38.4**	
DL	-0.962	-0.93	.86
DP	-0.349	-0.47	.22
PS	-0.076	-0.67	.45
M	0.432	-0.39	.15
A	-0.147	-0.41	.17

Structure coefficients (rs) greater than |.45| are underlined. Coef = standardized canonical function coefficient; rs = structure coefficient; = squared structure coefficient

When Table 7 is examined, it is seen that the contribution of the LD, SC, CT and TW variables to the robotics attitudes dataset in the first canonical function is over .45. Similarly, in the first canonical function, it is seen that the contribution of the DL, DP and PS variables to the science course attitudes dataset is above .45. However, it was determined that the structural coefficients of the M and A variables are below .45.

In the canonical functions obtained from canonical correlation analysis, the direction of the relationship between these variables can be determined according to the positive or negative status of the variables (having a structural coefficient of .45 or more) that contribute significantly to the dataset. In the first canonical function, where the structural coefficients of LD, SC, CT and TW variables are significant, when the sign of the variables is examined, it is seen to be negative. Accordingly, it can be said that there is a same directional relationship between the LD, SC, CT and TW variables. In the first canonical function, when the variables in the science course attitudes dataset are examined, it is seen that the signs of the DL, DP and PS variables are negative and there is a relationship in the same direction between them. Moreover, according to Table 7, it can be said that there is a positive relationship between the LD, SC, CT and TW variables and the DL, DP and PS variables. According to this result, with the increase in the robotics attitudes scores of the students in the dimensions of learning desire (LD), self-confidence (SC), computational thinking (CT) and teamwork (TW), their scores in the science course attitudes dimensions of daily life and learning new knowledge (DL), difficulty in practice (DP) and problem solving (PS) also increase. According to Table 7, rc2 value for the first canonical function was calculated to be 38.4. This value reveals that the covariance shared between robotics attitudes and science course attitudes datasets in the first canonical function is 38.4%. In addition, the structural coefficients of the first canonical function and the canonical correlation coefficients between the datasets for this function are given in Figure 2.

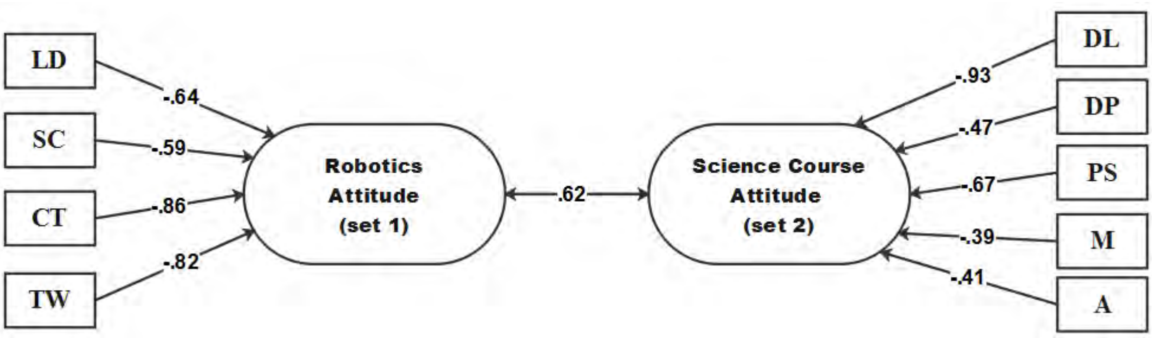

Figure 2. *Canonical correlation results*

As a result, in line with the data obtained from middle school students, it was determined that the covariance shared between robotics attitudes and science course attitudes datasets is 38.4%. In this connection, based on the findings obtained from the canonical correlation analysis, the relationship between robotics attitudes and science course attitudes is given in Figure 3.

Figure 3. *Covariance shared between two datasets (38.4%)*

DISCUSSION AND CONCLUSION

The current study was carried out in order to reveal the relationship between the middle school students' science course attitudes and robotics attitudes.

Correlation analysis was performed to determine the relationship between the sub-dimensions of the scales and four results were obtained. As a first result, it was determined that the robotics attitudes scale sub-dimension of learning desire has a positive medium correlation with the science course attitudes scale sub-dimensions of daily life and learning new knowledge, and problem solving. According to this result, the students' desire to learn more about, research and explore robotics applications and learn about how they work is correlated with their pleasure and excitement to learn new information about science, their thinking that they can use the information in their daily life and that problem solving about science topics is fun. When the literature is reviewed, it is seen that middle school students exhibit positive attitudes towards robotics applications (Kasalak, 2017; Kozcu Cakir & Guven, 2019; Okkesim, 2014; Ozdogru, 2013). In these studies, it is stated that middle school students very much want robotics applications to be performed in science classes, that they find such applications fun and that they learn the subjects better. In this regard, Kozcu Cakir and Guven (2019) stated that such technological applications are liked by middle school students, that they are engaged in such activities with pleasure and that they want science lessons to be taught with robotics applications. In addition, the researchers stated that the students associated science concepts with daily life by means of robotics applications. Chou (2018) states that there is a relationship between robotics applications and problem-solving skills of middle school students. In this respect, it can be said that robotics applications and attitudes towards such applications are an important factor in students' learning new information in science lessons, in associating what they have learned with daily life and in their willingness to solve various problems.

As a second result, it was determined that the self-confidence sub-dimension in the robotics attitudes scale has a positive medium correlation with the daily life and learning new knowledge sub-dimensions in the science course attitudes scale. According to this result, it is seen that the self-confidence of middle school students in coding about robotics applications, establishing robotic mechanisms and designing robots is correlated with their willingness to learn new information about science, to follow current issues and to explain what is happening around them. In this regard, Okkesim (2014) reported that students stated that they could make robots after engaged in robotics applications, although there were many mechanical parts. Ozdogru (2013), on the other hand, stated that students were very happy thinking that they were able to establish mechanisms for the visually impaired with robotics applications and that they did something useful. Similarly, Kasalak (2017) stated that students' robotics applications had a great effect on their development, that they believed that they would have the skills necessary to develop such mechanisms in the future, and that these applications would facilitate their learning science subjects. In this respect, it can be said that students' self-efficacy towards robotics applications is important in their following new information about science, being willing to research, discover and learn.

As a third result, it was determined that the computational thinking sub-dimension in the robotics attitudes scale has a positive medium correlation with the daily life and learning new knowledge, difficulty in practice, and problem solving sub-dimensions in the science course attitudes scale. According to this result, it is seen that the logical and algorithmic thinking of middle school students related to computational thinking is in a relationship with their learning and adaptation of concepts related to science subjects and their willingness to solve complex problems. When the literature is reviewed, it is seen that robotics applications improve students' computational thinking skills (Atmatzidou & Demetriadis, 2016; Gonzalez, Gonzalez, & Fernandez, 2016; Karaahmetoglu, 2019). In these studies, it is stated that such skills have increased with robotics applications where block-based coding is performed. In this regard, Kozcu Cakir and Guven (2019) stated that technological applications such as robotics can improve middle school students' computational thinking and problem-solving skills. In addition, Sengupta, Kinnebrew, Basu, Biswas, and Clark (2013) emphasize that computational thinking has an important relationship with learning scientific knowledge in the field of science. Accordingly, it can be said that computational thinking influences learning science concepts, adapting them to daily life and problem solving. It is seen that robotics applications should be implemented for the development of computational thinking.

As a result, it was determined that the sub-dimension of teamwork in the robotics attitude scale has a positive high (large) correlation with the sub-dimensions of daily life and learning new knowledge in the science course attitude scale and a positive middle correlation with the sub-dimension of problem solving. According to this result, it can be argued that middle school students' working as a group is in a relationship with taking pleasure in learning new information about science subjects, feeling excited, thinking that they can use the information in daily life and that problem solving related to science subjects is fun. In this connection, in the study conducted by Okkesim (2014), middle school students wanted to do the activities performed in robotics applications with a group or with a friend, and thus the activities were more fun, they thought that such applications became easier when done together and that they learned science subjects better. Similarly, Gaudiello, Zibetti, and Carrignon (2010) stated that robotics applications performed with teamwork improved problem-solving skills and more meaningful learning occurred. Atmatzidou, Markelis, and Demetriadi (2008) stated that group work in robotics applications prevented students from losing their motivation and desire and made learning easier. In this respect, it can be said that performing robotics applications through teamwork is an important factor in students' learning new information in science lessons, associating what they learned with daily life and being willing to solve various problems.

As a result of the canonical correlation analysis carried out in the current study, four canonical functions related to the relationship between the students' robotics attitudes and science course attitudes were obtained. In the canonical model consisting of cumulative values of canonical functions obtained from this analysis, the covariance shared by the robotics attitudes and science course attitudes datasets was calculated to be 38.4%. This result shows that there is a relationship between the middle school students' science course attitudes and robotics attitudes. Relevant studies indicate that robotics applications of students in science classes positively affect their attitudes towards science course (Fokides, Papadakis & Kourtis-Kozoullis, 2017; Kozcu Cakir & Guven, 2019; Okkesim, 2014; Ozdogru, 2013; You & Kapila, 2017). In this context, students' experiences in science classes with robotics applications and being guided to design something with these experiences, explaining the relevant concept in detail, associating it with daily life, working in teams and making meaningful learning may have affected their attitudes towards science course because the implementation of such applications in science classes enables students to participate actively and to learn meaningfully by offering mental activities, and positively affects their affective characteristics such as interest, motivation and attitude (Khanlari & Kiaie, 2015; Scaradozzi et al., 2015). Moreover, students' taking an active role in lessons and being aware of their learning make them experience an enjoyable process (Alimisis, 2013; Bruciati, 2004). This can improve students' positive attitudes towards science by allowing them to accomplish meaningful learning.

Suggestions

In light of the findings of the current study, it is recommended to implement robotics applications in order to improve middle school students' attitudes towards science course. Robotics applications in these lessons should be associated with science concepts and with daily life, and it is recommended to create a fun environment by using teamwork. In addition, it is recommended to investigate the factors that affect students' attitudes towards science course and robotics. In addition, qualitative studies can be conducted to examine the relationships obtained in this study in depth. In this context, it may be suggested to conduct new research to examine the relationship between science course attitudes and robotics attitudes by using different data collection techniques such as interview and observation.

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