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Investigation of the relationships between the attitudes of secondary school students towards robotic activities and the levels of self-regulation, metacognitive awareness

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Abstract

This study examines secondary school students' attitudes towards robotics, self-regulation skills, and meta-cognition awareness. The research was conducted in the correlational research model, one of the general survey models. The research sample comprised 68 secondary school students who attended a robotic course for two terms. The research data were collected using online data collection tools consisting of two parts. The first part is demographic questions, and the second contains attitudes towards robotics, self-regulation skills, and meta-cognition awareness Scale items. Descriptive statistics, ANOVA, T-Test, and Pearson Correlation analyses were used to analyze the data. While there was no significant difference between students' attitudes towards robotic activities, self-regulation skills, and metacognitive skills according to their education level of mother and father, a statistically significant difference was found between self-regulation skills and grade level. The self-regulation scores of fifth and sixth grade students are significantly higher than those of seventh grade students. Finally, a high positive correlation was found between students' attitudes towards robotic activities and their self-regulation and metacognitive skills.

1. Introduction

Robotics courses and events have become very popular rapidly in recent years. Investments in robotics are growing to produce high-tech products. Undoubtedly, education investments for children, who are the future of societies, come first among these investments. In this direction, it is seen that various robotics courses have become widespread in schools. Robotic courses are given in schools, especially in secondary and high schools. There are also various private robotic workshops, and parents and children are highly engaged and interested in those workshops.

Several robot construction kits have been developed over the years specifically for educational robotic courses (Amanatiadis et al., 2020). Various companies produce kits for educational robotics studies, and some courses use cost-effective microcontrollers such as Arduino and open-source applications. In these courses, students work individually or as a group, design, and actively participate.

Students have to be active in their learning process and be responsible for their own learning (Jørgensen, 2000; Fonteijn, 2015; Önür, & Kozikoğlu, 2019; Albano & Sabena, 2020). Identifying and developing

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students' self-regulation skills, which are accepted as self-management processes, support them in transforming their mental skills into academic skills (Dinsmore, Alexander, & Loughlin, 2008). Students with self-regulation competence are self-confident individuals who systematically handle information, are aware of their abilities, take action to reach information when needed, and perhaps most importantly, discover new ways to overcome their difficulties.

The term metacognition is used to express the processes that can be considered as cognitions about cognition or information about learning and knowing in general and enable the individual to notice, monitor, control, and regulate their cognitive processes (Pintrich, 2002). Metacognition monitors and regulates cognitive processes such as learning, problem solving, comprehension, and reasoning. Thus, it enables the individual to display his/her most compelling performance by strategically using his/her knowledge.

Attitudes are a widely researched topic in psychology and educational sciences. Multiple scales have been developed to measure students' attitudes towards various subjects, especially mathematics and science, and teachers' attitudes towards technology, their profession, and self-regulated learning (Akın, 2012). Positive attitudes are always desirable. Research on measuring attitudes and determining the factors or mediating variables affecting attitudes has been frequently conducted in educational sciences.

Robotics is based on constructivist learning theory. Research, especially in the last decade, has shown that robotics promotes thinking and problem-solving skills, foster creativity and teamwork, and support collaboration and computational thinking (Evripidou et al., 2020). In all of these experimental studies, students were randomly selected. Considering the Robotics content and the course taught, a constructivist learning environment is tried to be created, and students work in groups and produce concrete solutions. Students often need metacognition and self-regulation skills during their work.

OECD Future of Education and Skills 2030 project report (2019) emphasized strictly cognitive, meta-cognitive skills, and learning self-regulation in interrelated three different types of skills (OECD, 2019).

In the literature, Şişman and Küçük recently developed a scale to determine student attitudes towards robotics. Currently, it has become possible to measure students' attitudes in out-of-school robotics studies conducted in schools. However, it is essential to find the variables that correlate with attitudes or affect them positively or negatively.

It is thought that there may be a relationship between students' attitudes towards robots and their metacognition and self-regulation levels. In this study, fundamentally, to reveal the variables that may be related to students' attitudes towards robotics, its relationship with metacognition and self-regulation, which are the elements of self-regulated learning, was analyzed. The study, conducted with 68 students who attended robotics courses for two semesters, was designed in a relational scanning model in quantitative design. Whether there is a significant difference between secondary school students' attitudes towards robotic activities, self-regulation, and metacognition levels and according to their gender, grade level, parental education level, and also whether there is a relationship between attitudes toward robotic activities, self-regulation skills, and metacognition skills has been analyzed.

2. Literature

2.1. Robotics

Papert (1993), the pioneer of educational robotics, considered that problem-solving is the critical point of human intelligence, knowledge is only a part of understanding, and accurate understanding occurs as a result of practice and experience. Papert understands constructivism as "learning by doing" (Papert & Harel, 1991). Papert (1993) claimed that robotics activities had remarkable potential to improve classroom teaching. There was limited empirical evidence to prove the impact of robotics on the k-12 curriculum in the early stages of robotics (Williams et al., 2007). Educators started to generate ideas and develop activities and researchers to incorporate robotics into teaching various subjects, especially math, science, and engineering. Benitti (2012) reviewed the literature on the use of robotics in schools and indicated that studies focused on improving learning.

An essential part of robot learning and building and programming robots is controlling them in-game. Robot control is integral to constructivism and robotics technology (Alimisis & Kynigos, 2009). Briefly, Robotics refers to the process of realizing the effect of coding on objects (Karataş, 2021). In Robotics activities, students involve designing and coding a robot and perform specifically defined tasks.

Today, the use of robotic coding software and physical and virtual robot coding environments in robotic coding teaching is relatively high. Makeblock Kits, Lego Mindstorms Kits, Robotis, MakeBlock, and 3Doodler are examples used in robotic courses. Some robotic coding languages are mBlock, Mindstorm NXT-G, Bricx Command Center, MS Touch Develop, Microsoft Small Basic, and ROBOT C (Numanoğlu & Keser, 2017).

In robotic coding activities, students develop a physical product and have the opportunity to see concretely the actions they code to do this. In robot development, students willingly learn the scientific method, coding logic, and engineering design processes while simultaneously improving their creativity with problem-solving, collaborative working, and mathematical thinking skills (Fidan & Yalçın, 2012). Ucgul and Çağıltay (2014) describe critical factors for designing and developing educational robotics activities. They claim that combining educational robots with entertaining activities in game-like content contributes to a more effective learning environment.

Educational robotics has become a crucial pedagogic tool for K–12 STEM education. Robotics usage has exploded in the past two decades, especially after the MINDSTORMS was developed by the Massachusetts Institute of Technology (MIT) Media Lab (Anwar et al., 2019)

2.2. Self-regulation

Self-regulation is a multi-component, iterative, self-directed process that targets cognition, emotions, actions, and environmental characteristics for one's purposes (Cascallar, Boekaerts, & Costigan, 2006).

Learning is not seen as an implicit event that occurs as a reaction to teaching, but as an activity learners do for themselves in their future. As a result, self-regulation is considered a process in which learners' mental skills transform into academic achievement (Zimmerman, 2002). In addition, an essential factor of self-regulated development is self-efficacy, and the aim is to train students with self-efficacy (Vohs, & Baumeister, 2016)

It has been seen in studies that have been going on for many years that self-regulation skills are effective on students' self-efficacy (Zimmerman, Bonner & Kovach, 1996), academic achievement (Boekaerts, Pintrich, & Zeidner, 2000, Zimmerman & Shunck, 2001), and motivation (Pintrich, 2000; Hall & Goetz, 2013, Zimmerman & Schunk, 2011).

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Self-regulation is using the control mechanism over internal and external factors, which prevents the individual from drawing his own way by restructuring his behavior. Therefore, it is the individual's ability to limit his behaviors with his goals and contextual dynamics to exhibit constructive and effective behavior patterns by differentiating them (Pintrich, 2000). It is generally accepted that self-regulation consists of three dimensions: cognition, emotion, and behavior, which generally overlap and affect each other (Ainley & Patrick, 2006). Self-regulation is defined differently based on different psychological theories since it is a competency that includes mental, behavioral, and motivational (Pintrich, 2003) basic features and self-control and emotion regulation processes.

Bronson (2000) examined evolving perspectives on self-regulation by selected psychoanalytic, behavioral, social learning, social cognitive, Vygotskian, Piagetian, Neo-Piagetian, and informational processing theorists. Although self-regulation evolved from various perspectives, the prominent one in the literature is based on the social cognitive theory, founded by Albert Bandura (1989), and the other is the socio-cultural approach that emphasizes the social environment in which the individual lives and defines learning as a social phenomenon (Ağır & Ağır, 2021).

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2.3. Metacognition

Metacognition mentions to high-level thinking that contains dynamic control over the cognitive processes involved in learning. Metacognition is one of the critical aspects of successful learning, and it is crucial to studying metacognitive activity and determining how students could be taught to apply their cognitive resources through metacognitive control.

The term "metacognition" is associated with John Flavell (1979), who proposed that metacognition has two parts: metacognitive knowledge and metacognitive experiences. Flavell briefly divides metacognitive knowledge into the knowledge of person variables, task variables, and strategy variables (Flavell, et al., 1981). Schraw and Moshman modeled metacognition in two main parts; knowledge of cognition and regulation of cognition. The knowledge of cognition consists of descriptive, methodological, and conditional knowledge; the regulation of cognition consists of behaviors that ensure the control and use of information in cognition (Schraw & Moshman, 1695).

Metacognitive knowledge is stored knowledge of a person's own cognitive states and others' cognitive states. Metacognitive knowledge also refers to an understanding of how different factors may interact to influence our own thinking (Larkin, 2009). Metacognition plays an essential role in fundamentally all cognitive tasks, from daily behaviors and solving problems to proficient performance in the disciplines (Winne, & Azevedo, 2014).

Some studies focused on the relationship between metacognition and achievement and found that students with high cognitive awareness also have high academic success (Ward, & Butler, 2019; Demetriou, Kazali, Kazi, & Spanoudis, 2020; Özçakmak, Köroglu, Korkmaz, & Bolat, 2021)

The concept of metacognition has been used to explore student achievement in some fields, especially math, science, and literature, and skills such as creativity, and self-efficacy in schoolchildren (Norman et al., 2019)

Self-regulation and self-regulated learning are two aspects that are being discussed, and metacognition is explained by the complex set of abilities people employ to control their behaviors and learn to reach the required aims (Negretti, 2012). When the relationship between metacognitive awareness and learning is taken into consideration, many researchers found that metacognitive awareness positively affects the learning process (Azevedo, Greene, & Moos, 2007; Young & Fry, 2008; Sawhney & Bansal, 2015; Özsoy, 2015; Boğar, 2018; Abdelrahman, 2020)

Among the scales developed to measure the level of metacognition, the most commonly used one is the Metacognitive Awareness Inventory (MAI) (Schraw & Dennison, 1994). This scale has two main parts: metacognitive knowledge and metacognitive regulation. Adopting the perspective of this scaling technique, Sperling, Howard, Miller, and Murphy (2002) developed Jr MAI, which has two versions measuring the metacognitive skills of secondary school students. Karakelle and Saraç (2007) adapted this scale to Turkish for primary and secondary school students.

2.4. Self-regulated learning

Self-regulated learning began to flourish in the early 1980s. Over the years, many studies have been conducted, and it has become increasingly important. Different definitions and models have emerged. Zimmerman defines (1989) self-regulated learning as the process whereby students' thoughts, feelings, and behaviors are produced spontaneously by the learner towards achieving their learning goals. A self-regulated person is motivated to successfully perform a task, set realistic objectives, use effective strategies to accomplish the task, and be self-monitoring to measure effectiveness and adjust or regulate strategy use when necessary (Zimmerman, 1989). Self-regulated learners are more meta-cognitively, motivationally, and behaviorally active, participating in their own learning process (Kramarski & Gutman, 2006; Zimmerman & Schunk, 2013).

Pintrich and De Groot (1990) emphasized that self-regulated learning was learning to develop self-efficacy and argued that students with such competence are more successful in self-regulated learning environments. According to him, motivation is the essential component of self-regulated learning, and Self-efficacy beliefs related to motivation need to be formed to develop self-regulated and self-regulated learning.

Self-regulation models reached a consensus that self-regulation is a multi-component, iterative, self-directed process that targets one's cognition, emotions, actions, and environmental characteristics in line with one's own goals (Cascallar et al., 2006). Thus, self-regulated learning needs to be distinguished from externally regulated learning. The most salient feature of this type of learning is that the individual controls his/her own learning process.

Self-regulated learning is combined three pillars of learning under the broad umbrella term: cognition, metacognition, and motivation (Kaplan, 2008). Metacognition is monitoring and controlling what is in thinking; self-regulation is monitoring and controlling how one interacts with a learning environment, and self-regulated learning is applying metacognition and self-regulation to own learning goals.

Although the importance of self-regulated learning has emerged in social field research such as psychology, and education, it has come to the agenda again with the recent Covid 19 pandemic. With the pandemic, formal education was interrupted at all education levels and continued with distance education methods. Studies conducted during the pandemic period revealed that the main problems in education were not only technological inadequacies, inadequacies of teachers in giving online lessons (Kavuk & Demirtas, 2021), but also the inadequacy of students' self-regulation skills (Ağır & Ağır, 2021; Dede et al., 2021).

2.5. Aim of the Study

This research examines students' attitudes towards robotics, self-regulation skills, and metacognition awareness. The following questions will be investigated.

Q1. What are the total scores of attitudes towards robotics, self-regulation skills, and meta-cognition awareness of the students in this research?

Q2. Do secondary school students' attitudes towards robotics applications, self-regulating skills, and metacognition awareness show statistically significant differences regarding gender, grade, education level of mother, and education level of father?

Q3. Is there a significant relationship between attitudes towards robotics and self-regulation levels and meta-cognition awareness of the secondary school students who participated in the robotic course for two terms?

3. Methodology

3.1. Research Model/Design

Correlational research and causal comparison models were used in the study. The correlational model analyzes possible relationships between two or more variables without intervention or manipulation (Şener et al., 2008). One of the strengths of this model is that it allows us to predict possible outcomes based on the relationships obtained. In this research model, the co-change of variables is emphasized and analyzed rather than the cause-effect relationship. The findings obtained by applying the correlational research method can only give an idea about the possible cause-and-effect relationships. This study applied a correlational research design to examine the relationship between middle school students' attitudes towards robotics and students' self-regulation and metacognition levels.

The causal comparison design aims to compare two or more groups that are the subject of research and are thought to be different. In this approach, there is no guidance or manipulation by the researcher, and the results obtained are independent of the researcher. The researcher has no direct influence on the selection of comparison groups (Şener et al., 2008). In this study, based on the causal research model, middle school students' attitudes towards robotics, self-regulation, and metacognition levels were analyzed by comparing them according to the variables of gender, grade, education level of the mother, and education level of the father.

3.2. Data Collecting Tools

The research data was collected online via Google Forms in 2021. The data collection tool has two sections, the first section includes the student's demographic variables, and the second section includes the items of the "robotics attitudes scale, self-regulated learning questionnaire, and metacognition awareness inventory."

The student's demographic variables form included the student's gender, class, education level of mother, and education level of father. Parents' level of education is categorized as primary school, secondary school, high school, high school, university, master's degree, or doctorate according to the level of education in the Turkish education system (the illiterate option was also offered, but none of the students chose it).

"Robotics attitude scale" (RAS) (Şişman & Küçük, 2018) was used to determine students' attitudes towards robotics attitudes. It consists of 24 items and has four dimensions; learning desire, confidence, computational thinking, and teamwork skills. The scale items in the five-point Likert form are scored one to five. The highest score in RAS is 120, and the lowest score is 24. The Cronbach Alpha for the original scale is 0.93, and it was found as .91 in this study.

The "Self-regulated learning questionnaire" (SRLQ) developed by Öz and Şen, (2018) determines the students' self-regulation skills. It is a five-factor structure consisting of 39 items. These factors include "studying method, self-evaluation, receiving support, time management, planning, and seeking information." The highest score that can be obtained from RAS is 195, and the lowest score is 39. The Cronbach Alpha value of the scale is .94. In this study, it was found as .96

"Metacognitive Awareness Inventory for Children B Form" (Sperling, Howard, Miller, & Murphy, 2002), adapted by was Karakelle and Saraç (2007) used to determine the student's metacognitive awareness. The scale was a self-report inventory to measure students' metacognitive skills in grades three to nine. The original scale was two dimensions, but the Turkish adapted version has no sub dimension, measuring only children's metacognitive awareness level. The highest score that can be obtained from MAI is 90, and the lowest score is 18. The Cronbach Alpha value of the scale is .80. In this study, it was found as .90

3.3. Study Group

The data were collected from 77 secondary school students in the 5th, 6th, and 7th grades who participated for first time and same robotics course two terms in Istanbul, Turkey, in the 2020-2021 academic year. Google Forms was used for data collection. Nine students' records were canceled because they did not answer all the survey questions. Sixty-eight students' data were analyzed.

3.4. Course description

Robotics courses were held for 150 minutes weekly during students' out-of-school time. 5th, 6th and 7th grade students participated in this course voluntarily for the first time. The same curriculum and robotics tools were utilized in these three groups. Each course had a total of twelve students in two groups of six. Each group attended the courses one day a week, 150 minutes, for two semesters (one academic year). Robotis dream II School toolkit was used, and the content for the activities came from.

Students performed different robot design and programming tasks each week. In the first weeks, robots with only mechanical features (no programming required) were made to get them used to the physical parts. Mechanical design and programming tasks were assigned as goals in the following weeks. The subjects were requested to perform the following tasks:

- Design and programming of a four-legged walking robot on a linear path,
- Design and programming of a robot that recognizes objects by light reflection (distance sensor),
- Design and programming of a robot that claps as loud as the sound coming from the external environment by taking advantage of the sound propagation feature,
- Design and programming of a wheeled robot that follows different routes according to different color lines with the help of a color detection sensor,
- Design and programming of autonomous and semi-autonomous object-carrying robots,
- Design and programming of a mini sumo robot that tries to push each other off the track thanks to the different algorithms and designs it contains,

Concepts such as algorithms, variables, condition structures, loops, and debugging were presented to the students in a sequential structure under the instructor's guidance. The instructor has been preparing these courses in the same school for ten years and has been instructing them himself.

3.5. Data Analysis

In the study, the data obtained from 68 students were analyzed using the SPSS 24.0 software. The frequency and percentage distribution of the research participants' demographic characteristics were calculated.

The descriptive statistics method was used in the first research problem, and the findings were presented in a table. Kurtosis and Skewness values are calculated to find the normality of the score of the scales and determine which parametric/nonparametric test would be used in the second problem of the research. T-test and one-way variance analysis (ANOVA) was used for normally distributed data. Pearson Correlation analysis was conducted to obtain the third problem.

If the result of Kurtosis and Skewness is between -1.5 and +1.5, it is considered a normal distribution (Tabachnick & Fidell, 2013). The skewness and kurtosis scores of the scales were calculated between -1.5 and +1.5, and parametric tests were used. (Table 1)

Table 1. Skewness and kurtosis score of the scales

RAS	Skewness	-0,904
	Kurtosis	0,350
SRLQ	Skewness	-0,883
	Kurtosis	-0,060
MAI	Skewness	-0,857
	Kurtosis	-0,197

3.6. Findings and Discussions

Male students comprised 63.2% of the students, and female students were 36.8% of the students in this research. The frequency and percent of the other variable are given in Table 2.

Table 2. The Frequency Analysis of the Demographic Characteristics of the Students

	Gender	*f*	%
Gender	Male	43	63.2
	Female	25	36.8
Grade	5th Grade	21	30.9
	6th Grade	26	38.2
	7th Grade	21	30.9
Education_Level of_Mother	Primary School	11	16.2
	Secondary School	9	13.2
	High School	21	30.9
	University	24	35.3
	MSc or PhD	3	4.4
Education_Level of_Father	Primary School	7	10.3
	Secondary School	10	14.7
	High School	21	30.9
	University	23	33.8
	MSc or PhD	7	10.3
	Total	68	100.0

Q1. What are the total scores of attitudes towards robotics, self-regulation skills, and meta-cognition awareness of the students in this research?

RAS scores of the students are quite high, and some students had a maximum score on the scale. Similarly, the mean of MAI is very high, some students had maximum scale scores, and finally, SRLQ scores are also high (Table3). Students participating in robotics courses not only have attitudes towards robotics, but also students' self-regulation skills and metacognition levels are quite high.

Table 3. Descriptive findings of the scores of the scales

Scales	N	Minimum	Maximum	Mean	Std. Deviation
RAS	68	76	120	106,60	10,72
SRLQ	68	88	194	154,82	28,53
MAI	68	54	90	78,88	9,46

Q2. Do secondary school students' attitudes towards robotics applications, self-regulating skills, and metacognition awareness show statistically significant differences regarding gender, grade, education level of mother, and education level of father?

To find a significant difference in the averages of the total scores of the RAS, SRLQ, and MAI compared to the gender variable T-test was applied (Table 4). Within the scope of the independent sample t-test results, there is no statistically significant difference in terms of the gender variable of RAS (t=-1.66, p>0.05). In contrast, SRLQ scores regarding gender variable are statistically significant (t=-3.38, p=0.001).

The average scores of female students are higher than those of male students (*M*=147.28, *SD*=30.33) (Table 4).

Total scores of the MAI compared to the gender variable are statistically significant (*t*=-3.47, p=0.001). The average scores of female students for MAI (*M*=83.08, *SD*=5.24) are higher than the average scores of male students (*M*=76.44, *SD*=10.51) (Table 4).

Table 4. T-Test Results of RAS. SRLQ. and MAI Regarding Gender Variable

Scales	Gender	N	$\bar{X}$	sd	df	t	p
RAS	Male	43	104.98	11.41	66	-1.66	0.10
	Female	25	109.40	8.94			
SRLQ	Male	43	147.28	30.33	65.15	-3.38	0.001
	Female	25	167.80	19.62			
MAI	Male	43	76.44	10.51	64.864	-3.47	0.001
	Female	25	83,08	5,24			

p<0.05

One-way analysis of variance was used to control whether a significant difference in the average RAS, SRLQ, and MAI scores of the students forming the sample group according to the grade variable. Only a significant difference was found in the student's total scores of SRLQ regarding grade variable *F* (2,65) = 0.97, p=0.01. In contrast no significant difference found the student total scores of RAS regarding to grade variable *F* (2,65) = 0.97, p=0.01, and student total scores of MAI regarding to grade variable *F* (2,65) = 2.70, p=0.08. (Table 5).

Table 5. ANOVA Results of Students' RAS, SRLQ, and MAI Total Scores Regarding Grade Variable

		Sum of Squares	df	Mean Square	F	Sig.
RAS	Between Groups	222.556	2	111.28	0.97	0.39
	Within Groups	7469.723	65	114.92		
	Total	7692.279	67			
SRLQ	Between Groups	7256.307	2	3628.15	4.99	0.01
	Within Groups	47273.575	65	727.29		
	Total	54529.882	67			
MAI	Between Groups	459.301	2	229.65	2.70	0.08
	Within Groups	5531.758	65	85.10		
	Total	5991.059	67			

p<0.05

As a result of Scheffé's Post-Hoc analysis performed after variance analysis to determine the significant difference between the grades, a significant difference was found between the 5th and 7th grade students. SRLQ scores of 5th grade students (M = 161.19, SD = 27.80) significantly greater then 7th grade students' scores (M = 139.38, SD = 30.05). In addition, there was a significant difference between the 6th-grade and 7th grade students. SRLQ scores of 6th grade students (M = 162,15, SD = 23.45) significantly greater then 7th grades students' scores (M = 139.38, SD = 30.05) (Table 6).

Table 6. Scheffé Post-Hoc Results

	Grade		Mean Difference (I-J)	Std. Error	Sig.
SRLQ	5th Grade	6th Grade	-0.963	7.91	0.99
		7th Grade	21.81*	8.32	0.04
	6th Grade	5th Grade	0.96	7.91	0.99
		7th Grade	22.77*	7.91	0.02
	7th Grade	5th Grade	-21.81*	8.32	0.04
		6th Grade	-22.773*	7.91	0.02

p<0.05

One-way analysis of variance (ANOVA) was conducted to determine whether there was a significant difference in the average RAS, SRLQ, and MAI scores of the students forming the sample group according to the education level of father and the education level of the mother. No significant difference was found between the student scores of the scales RAS (F= 0.76 ; p>.05). SRLQ (F= 0.91; p>.05). and MAI (F= 0.92; p>.05) regarding the education level of the mother variable (See Table 7). Similarly no significant difference was found between the student scores of the scales RAS (F= 0.74 ; p>.05). SRLQ (F= 0.46 ; p>.05). and MAI (F= 1.33 ; p>.05) regarding the education level of the father variable (See Table 8).

Table 7 Results of Variance Analysis of RAS, SRLQ, and MAI Scores Regarding Education Level of Mother

Education Level of Mother		Sum of Squares	df	Mean Square	F	Sig.
RAS	Between Groups	354.302	4	88.56	0.76	0.555
	Within Groups	7337.978	63	116.48		
	Total	7692.279	67			
SRLQ	Between Groups	2982.528	4	745.63	0.91	0.463
	Within Groups	51547.354	63	818.21		
	Total	54529.882	67			
MAI	Between Groups	329.746	4	82.44	0.92	0.460
	Within Groups	5661.313	63	89.86		
	Total	5991.059	67			

p<0.05

Table 8. Results of Variance Analysis of RAS. SRLQ. and MAI Scores Regarding Education Level of Father

Education Level of Father		Sum of Squares	df	Mean Square	F	Sig.
RAS	Between Groups	346.318	4	86.58	0.74	0.567
	Within Groups	7345.962	63	116.60		
	Total	7692.279	67			
SRLQ	Between Groups	1536.083	4	384.02	0.46	0.767
	Within Groups	52993.800	63	841.17		
	Total	54529.882	67			
MAI	Between Groups	466.539	4	116.64	1.33	0.269
	Within Groups	5524.520	63	87.69		
	Total	5991.059	67			

p<0.05

Q3. Is there a significant relationship between attitudes towards robotics, self-regulation skills, and meta-cognition awareness of the secondary school students who attended a robotic course for two terms?

Pearson’s correlation test was performed to find the relation between attitudes towards Robotics of the students and students’ self-regulation skills, metacognition awareness of students. Students’ attitude towards Robotics is strongly positively correlated, to students’ self-regulation skills (r=.75) and metacognition awareness of students (r= .71).

Table 9. Correlation results between RAS and SRLQ, MAI

		SRLQ	MAI
RAS	Pearson Correlation	.75**	.71**
	Sig. (2-tailed)	0.000	0.000
	N	68	68

$p<0.05$

4. Conclusion and Suggestions

One of the study's limitations is the number of students participating and the fact that the students are middle school students. Different kits and different curricula are used in robotics courses. Therefore, this study is limited to the course process described and the robotics kit used. It is advised to conduct future studies with more students. Another suggestion is that a similar study can be conducted with students at different education levels.

This study determined that the total scores of students’ attitudes towards robotics, self-regulation skills, and metacognition awareness are quite high. Even though participation in robotics courses is voluntary and not every student can participate, it seems noteworthy that students' self-regulation skills and metacognitive awareness scores are also exceptionally high. Karademir et al. (2018), found that secondary school students' self-regulation skills are above the intermediate level. Students who participated in this robotics course were held out of school time, paying a fee because they were interested in it. Therefore, it can be assumed that the current self-regulation and metacognition levels of students who want to work in a new and different subject, such as robotics, which requires knowledge from fields such as programming, mathematics, and science, are intermediate and above. Participating in this course for an academic year may have improved students' self-regulation and metacognition levels.

This study found that attitudes towards robotics showed no significant difference according to the gender variable. Some studies in the literature support this result of the research that attitude towards robotics has no difference regarding gender (Cheng, Huang, & Huang, 2013; Atmatzidou & Demetriadis, 2016; Reich-Stiebert & Eyssel, 2016; Master, Cheryan, Moscatelli, & Meltzoff, 2017). Peleg and Baram-Tsabari (2017) have found that female students exhibit more negative attitudes towards robotics than male students. Some research results support the research in the opposite direction; the male students had higher levels of attitudes than the female students (Milto, Rogers & Portsmore, 2002; Kucuk & Sisman, 2020). Boys were more motivated toward technology than girls in the findings of Master et al. (2017). Sullian (2019) claimed that female students are underrepresented in competitions. Recent studies have reported different results on the effect of gender on robotics. Therefore, it would not be correct to generalize the findings. Today, the effect of gender in educational research is often criticized. In this context, future studies can be conducted to determine the influencing factors in studies that differ according to gender instead of generalizing the research results. For example, whether the students participating in the study were in a big city or a small town, the characteristics of the kits used the teacher's qualifications and the curriculum.

According to the data obtained from the research, self-regulation skills show a statistically significant difference according to the gender variable, and female students score significantly higher than male students. Some studies conducted with secondary school students support this finding (Karademir et al., 2018; Dede et al., 2021) examined the self-regulation skills of secondary school students and found that female students' scores were significantly higher than male students. As in this study, studies conducted for many years have shown that female students have higher self-regulation levels than male students (Meece,

& Painter, 2012). According to the data obtained from the research, metacognition awareness level shows a statistically significant gender difference, and female students’ scores are higher than male students. There are some studies support this finding (Akçam, 2012; Kurtuluş and Öztürk, 2017; Karademir, Deveci & Çaylı, 2018). The way boys and girls are raised, and the expectations of society may have led to this difference. In Turkish society, girls are expected and encouraged to be orderly, attentive, and harmonious. On the other hand, boys' disorganization and sometimes belligerence can be tolerated by saying, "it is a boy." Since cultural change takes a long time, it may be considered normal that these gender differences still continue to exist.

It was determined in the study that the self-regulation skills of both 5th and 6th grades students were significantly higher than 7th-grade students, respectively. Remarkably, the self-regulation skills of 7th-grade students are lower than 5th and 6th-grade students. The study of Dede et al. (2021) conducted with secondary school students during the Covid-19 period found no difference in students' self-regulation skills according to grade level. On the contrary, Karademir et al. (2018) found that self-regulation skill scores were higher in favor of lower grades at the grade level.

No significant difference was found in metacognitive awareness of students regarding grade, but Kurtuluş and Öztürk (2017) found a significant difference between students’ metacognitive awareness in the fifth and sixth grades, seventh grades, and 8th-grade; in each case, fifth grade students' scores were higher than the upper grades. In addition, found a significant difference between the sixth and eighth grade students, and sixth grade students' metacognitive awareness scores were significantly higher. Contrarly Akçam (2012) found 6th and 7th-grade students' metacognition awareness scores higher than the others.

It was found that the research students’ attitudes towards robotics, self-regulation level, and meta-cognition awareness did not show a statistically significant difference according to the education level of mother and education level of father. In the literature, no study found a relationship or difference between students’ attitudes towards robotics and parents' education level. In this study group with different education levels, it is seen that the parent education level does not make a difference in the level of the student's metacognition and self-regulation. Research by Uykan and Akkaynak supports the finding of this study, but contrarily Dinçer and Sümer (2022) find a significant difference between preservice classroom teachers’ metacognition levels. Sarıgöz (2019) found that only education level of mother impacts the metacognition of the students who participated in PISA 2012.

Remarkable findings of this study, students’ attitude towards robotics is highly positively correlated to self-regulation level and metacognition awareness of students. Measuring attitudes towards robotics and examining the factors affecting attitudes have started recently. Therefore, there are no directly related research results in the literature.

The other finding of this study is that students' self-regulation level is strongly positively correlated to students’ metacognition awareness. Abassi and Dergahi (2014), Taghizadeh et al. (2016), and Çetin (2017) conducted research with university students and found a positive correlation between the self-regulation of students and metacognition awareness. Contrarily, in the study of Adıgüzel and Orhan (2017) with university students, no relationship was found between student self-regulation and metacognitive awareness.

The influence of self-regulation is widely studied in many different disciplines, from educational sciences to psychology, from physical education to preschool education, using qualitative and quantitative research methods (Kazu & Simge, 2021). In some of the experimental studies, the impacts or relationships of self-regulation on students' traits such as self-efficacy, attitudes, behaviors, and beliefs were researched (Theobald, 2021; Allee-Herndon, & Roberts, 2019). In some studies, the variables influencing self-regulation were researched (Zeidner et al., 2000). Similarly, in the experimental studies of metacognition, a wide variety of studies have been conducted on students' success in their courses, problem-solving skills, and collaborative working skills, mainly in mathematics and science, which metacognition affects (Lai, 2011; Kontostavlou, & Drigas, 2021). Some studies examined variables affecting metacognition (Ellis et al., 2012; Rhodes, 2019).

In robotics activities, students work as a group using ready-made kits to achieve a specific goal, and although an instructor guides them, they take the initiative in their learning and production process. This process requires them to have self-regulation skills. In programming activities, they actively engage in computational thinking, requiring metacognitive skills. Therefore, in a properly designed robotics course, there would be expected to be a relationship between students' self-regulation and metacognition levels during the course and their attitudes towards robotics. The results of this study support this idea. As students' self-regulation and metacognition levels increase, their attitudes towards robotics also increase in a highly positive direction. To the present day, robotics courses have not been included in the curriculum as a specific course but rather as an activity that students voluntarily participate in during the out-of-school time. Many studies have revealed that robotics courses positively affect students' success in courses, especially in mathematics and science, and improve their problem-solving and working together habits. However, it is seen that if students' self-regulation and metacognition levels are low, their attitudes towards robotics also decrease. Students' self-regulation and metacognition skills may negatively affect their attitudes towards robotics; they may have difficulties and even be unsuccessful, especially when it is continued as a school course for a year or even in the following years. As a result, it is evident that robotics improves many skills of students and contributes positively to their lessons. However, since the attitudes of students who have no or meager qualifications required by the robotics processes may be negative, it is thought that this result should be considered.

Few studies on robotics courses and activities have been focused cognitive skills or the impact of cognitive skills. In this context, this study is preliminary research. Some suggestions may shed light on future studies on the subject. The studies conducted with students who do not participate or are unable to participate in robotics courses and activities should examine whether it contributes to students' self-regulation levels, skills, and metacognitive awareness. In particular, the effects of the robotics courses attended by academically unsuccessful students should be researched on self-regulation level and skills, metacognition awareness, academic achievement, and self-efficacy. In future studies, it is recommended to determine the factors that affect or are related to student attitudes towards robotics. The research on large samples could reveal the potential of robotics and detailed results. Finally, various detailed findings may be obtained in future studies using the qualitative or mixed methods

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