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Research Article

Examining the attitudes of middle school students towards robotic coding

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ABSTRACT

Coding is a language that enables communication through the utilization of information and communication technologies, and coding education is very important in providing individuals with 21st-century skills. Previous studies reported that coding education is not just about creating a program, but also that it can offer original solutions to the problems that students encounter. Coding education, which is included in the education of information and communication technologies, allows students to gain many skills. Coding education provides students with the skills of problem solving, creative thinking, analytical thinking, identifying the relationships between events or situations, noticing their own mistakes, and analyzing their consequences. Therefore, this study aims to investigate the attitudes of middle school students towards robotic coding. The study sample consists of 304 students enrolled at the middle school level of a private college in Kars-Türkiye. The data collection was performed by utilizing the attitude scale towards coding, which was developed by Yalcın, Kahraman and Yılmaz, and the validity and reliability of which were established. Since the obtained data exhibited a normal distribution, the independent sample t-test and ANOVA test were employed in the analysis. It was determined that male students' attitudes towards robotic coding were higher. In addition, it was determined that the attitudes of students showed significant differences by variables such as gender, age, classroom, daily internet use time, and daily smartphone use time. Given the results achieved, the present study is expected to guide future studies and can be used as a guide model in this context.

Keywords: Robotic coding; attitude; middle school level; attitudes scale; coding education

1. Introduction

From a general perspective, robotic coding education can be defined as the process of creating innovative products by using information from different engineering disciplines, such as mechanics, software, and electrical-electronic engineering. Considering this definition, it can be said that robotic coding education has a complex structure that includes many interdisciplinary information. Therefore, robotic coding education enables students to develop skills, including critical thinking, reasoning, problem solving, algorithmic thinking, and technological literacy. In the literature, the concept of "coding" or "programming" is defined as the process in which the basic structures of the programming language are logically brought

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together to ensure the connection between hardware and software [1]. In another definition, coding refers to the code sequence written to solve any problem using a programming language [2]. Based on the definitions made in the literature, it can be said that coding is the lines of code written to make technological devices perform certain operations.

In the 21st century, essential skills such as critical thinking, problem-solving, creativity, and digital literacy have become increasingly important. In this context, robotic coding equips students not only with technical abilities but also fosters the cognitive competencies demanded by this era [3]. Educational environments enriched with robotics activities enable learners to develop algorithmic thinking as well as social skills such as teamwork, communication, and self-regulation [4]. It has been emphasized that introducing robotics education at an early age increases students' interest in STEM fields and positively impacts their cognitive development [5]. Moreover, robotic applications are reported to enhance students' motivation and contribute to the development of positive attitudes toward learning [6]. Therefore, robotic coding is considered a critical area of learning for fostering 21st-century skills.

As technology continues to evolve rapidly, integrating robotics and programming into education has become essential for preparing students for future careers. Robotic coding not only supports STEM learning but also enhances computational thinking and real-world problem-solving abilities [7]. Students engaged in robotics projects tend to demonstrate higher levels of engagement, perseverance, and creativity compared to traditional learning approaches [8]. Furthermore, robotics education fosters interdisciplinary learning by connecting concepts from mathematics, science, and engineering with hands-on experiences [9]. Research also suggests that implementing robotics in classrooms helps reduce gender gaps in technology-related fields by increasing girls' interest and confidence in coding activities [10] . Thus, robotic coding plays a pivotal role in equipping learners with the adaptable, interdisciplinary, and innovative mindset required in the 21st century.

Robotic coding is increasingly recognized as a powerful educational tool for fostering essential 21st-century skills. In particular, it contributes significantly to the development of problem-solving, critical thinking, and learning motivation among students. Through robotics-based tasks, learners are encouraged to generate creative solutions, engage in real-world problem scenarios, and learn from failure, thus enhancing their problem-solving abilities [11].The process of coding, debugging, and logical reasoning activates core components of critical thinking, such as analytical processing, causal reasoning, and cognitive flexibility [12].Moreover, students' active involvement in designing and constructing their own robotic products fosters a sense of ownership and success, which in turn boosts their intrinsic motivation toward learning [13]. As such, robotic coding provides a holistic learning environment that strengthens not only technical competence but also self-efficacy, resilience, and positive learning attitudes.

For coding education to offer students the skills mentioned, they should receive this training from an early age. In this context, many countries have been updating their curriculum and including coding courses in their teaching processes to provide students with 21st-century skills [14-15-16]. Especially developed countries have included coding courses in their curriculum so that students can acquire coding skills starting from an early age [17]. It takes time to be successful in coding. Coding education, which is a complex and challenging process, requires patience and determination. Being successful in this process is associated with many variables [18-19]. Attitudes towards coding education are one of these variables. It is predicted that the positive or negative attitude towards coding may also affect the success in coding [20]. The concept of attitude has been associated with concepts such as habit, tendency and opinion [21], an affective characteristic that influences the learning of the individual during the learning process [22], the unity and consistency of a person's thoughts, feelings, and behaviors about an object [23], and (in some definitions) a mental state that occurs in the person's brain against a certain situation [24]. In summary, students' views and feelings towards coding, in other words, their attitudes, are an important dimension in this process. Knowing or revealing the attitudes of students towards coding is important in revealing their areas of interest. It can be stated that this can help them become aware of their professional orientation and make a significant contribution to the desired direction of the coding teaching process [25].

Adding coding education to the curriculum is an important step in providing students with the necessary skills. However, providing coding education alone is not enough to provide these skills. Besides, students also need to have a positive attitude towards coding education. It has been emphasized that whether students' attitudes towards coding are positive or negative will affect the success in teaching coding[20], and that even the success in teaching coding is directly related to attitude [26]. In this context, the factors affecting students' attitudes towards coding should be known. Therefore, this study aims to investigate middle school students' attitudes towards robotic coding. Given the results obtained, it is anticipated that this study will guide future studies and can be used as a guide model in this context.

Understanding middle school students' attitudes toward robotic coding is essential, as these formative years play a crucial role in shaping learners' future academic and career trajectories. Positive attitudes toward robotics are strongly associated with increased engagement, sustained interest in STEM fields, and the development of problem-solving and critical thinking skills [27]. Studies have shown that when students perceive robotic activities as enjoyable and meaningful, their motivation to learn coding increases significantly [28]. Moreover, fostering early positive attitudes can help reduce anxiety around programming and promote a growth mindset toward technological challenges [29]. Considering that attitude is a key predictor of learning outcomes in technology-enhanced education, cultivating enthusiasm and confidence in robotics among middle school students is vital for building a future-ready generation [30].

The number of studies examining the attitudes of middle school students towards coding is limited. The 5th, 6th, 7th, and 8th grade students were included in the sample in previous studies [31-32]. The information technologies and software course, where coding studies are carried out, is taught only in the 5th and 6th grades.

Studies conducted have shown that the attitudes of secondary school students towards robotic coding have been examined in terms of various variables and that activities in this area generally have positive effects on students. [33], developed an attitude scale that includes dimensions such as "curiosity", "interest", "expectation-value" and "self-confidence" and provided a systematic tool that can be used in the evaluation of robotic activities. [34], showed in their study in the Netherlands that robotics education positively affected the attitudes of female students towards STEM fields and reduced gender differences. [35], reported that significant increases were achieved in students' scientific curiosity and self-confidence levels with a short-term robotics workshop. In a virtual robotics-based study conducted by [36], it was observed that students' interest in coding and their awareness of artificial intelligence increased through the concept of reinforcement learning. [37], found that a mathematics-focused robotics curriculum developed with the C programming language positively affected both achievement and attitude. Finally, a meta-analysis study by [38], showed that robotics education generally improved K–12 students' computational thinking skills and attitudes toward STEM at a moderate level. When these studies are evaluated together, it can be said that robotics coding-based educational practices are effective in increasing the interest of middle school students, shaping their attitudes positively, and strengthening their learning motivation.

The Educational Robot Attitude Scale (ERAS), developed by [39], aimed to measure the attitudes of secondary school students towards educational robots, and the validity and reliability of the scale with a four-factor structure (participation, enjoyment, anxiety, and behavioral intention) has been proven (α = .90). In addition [40], developed a scale called AKAER to measure teachers' attitudes, knowledge, and application levels towards robotic technologies in education. This scale, consisting of a total of 49 items and five factors, was tested in a large sample and presented a very high internal consistency value (α = .929). These scale studies allow the systematic measurement of attitudes towards robotic coding and educational robots at both student and teacher levels.

1.1. The aim and sub-objectives of the study

This study aims to reveal the factors that affect the attitudes of middle school students towards coding. Thus, the following sub-objectives were established:

1. Is there a significant difference by gender?
2. Is there a significant difference by age?
3. Is there a significant difference by grade?
4. Is there a significant difference by daily internet use time?
5. Is there a significant difference by daily smartphone use time?
6. What is the general attitude of middle school students towards robotic coding?

2. Materials and methods

2.1. Research method

The scanning method, a quantitative research method, was employed in this study to investigate the variables influencing the attitudes of middle school students. This method aims to reveal some characteristics of a certain group. Scanning studies are those examining the interests, attitudes, skills, etc. of the participants included in a study regarding a subject or event [41]. In the context of this study, the attitudes of middle school students towards robotic coding were examined.

Although this study is limited to students in a private school in Kars, Türkiye, the course content examined is in accordance with the curriculum of the Ministry of National Education and is implemented in a similar manner in public schools. Therefore, the students' knowledge levels and experiences on the subject can be evaluated on a common ground to a large extent. In addition, although the opportunities of the relevant private school are somewhat more advanced compared to public schools, this difference is not at a level that will have a decisive effect on basic education practices. Therefore, it is thought that the findings obtained can offer meaningful inferences for public schools with similar demographic structures.

2.2. Universe and sample

The study universe consists of students at the middle school level in Kars province of Türkiye, and the sample consists of 304 students studying at the middle school level of a private college in Kars and selected from this universe using easily accessible case sampling. In this context, easily accessible sampling is a non-probability sampling technique in which samples are selected from the population only because they are convenient for the researcher [42]. The sample included 6th, 7th, and 8th grade students taking the Information Technologies and Software course, where robotic coding studies were taught.

2.3. Data collection tool

The attitude scale towards robotic coding developed by [43], was employed in the present study, upon the permission granted by the researchers. To examine the construct validity of the first 29-item version of the scale, Exploratory Factor Analysis (EFA) was conducted on data from 196 seventh-grade middle school students. The 22-item five-factor model was obtained as a result. The scoring of the 5-point Likert-type scale is as follows: completely agree = 5, agree = 4, partially agree = 3, disagree = 2, and not at all = 1. The scale consists of 5 dimensions: interest, motivation, desire for learning, self-efficacy, and anxiety. The Cronbach's α coefficient was calculated to be .91 in this study, indicating a high level of reliability [44].

In this study, the scale was used as the data collection tool. The scale was originally developed by [43], and has demonstrated strong reliability in previous research through high internal consistency coefficients. In the current study, the Cronbach's alpha coefficient for the scale was calculated as .91, indicating a high level of reliability [45]. A Cronbach's alpha value of .90 or above suggests that the items in the scale exhibit excellent internal consistency. Therefore, within the scope of this study, the scale was considered a valid and reliable measurement instrument. Moreover, this scale has previously been applied to similar samples and has yielded high reliability values. In this context, the use of the scale in the present study is also supported by the literature [46].

In the analysis of the data, Cronbach's Alpha reliability coefficient was calculated to evaluate the internal consistency of the scale. Mean and standard deviation values at the item level were presented as descriptive statistics. Confirmatory factor analysis (CFA) was performed to test the structural validity of the scale. CFA was performed using AMOS 24 software integrated with the SPSS program. Comparative Fit Index (CFI), Tucker-Lewis Index (TLI) and Root Mean Square Error of Approximation (RMSEA) indices were used in the evaluation of model fit. Fit indices were used to measure the fit of the model with the data; CFI and TLI values of 0.90 and above and RMSEA of 0.08 or below indicate a good fit [47]. The results obtained supported that the structural validity of the scale was appropriate.

2.4. Data collection process

The data collection was conducted in January in the academic year 2024-2025 (in the fall semester). The data collection tool aiming to obtain the descriptive characteristics of the students and their attitudes towards coding was administered face-to-face. Before the data collection process, the students were informed, and it was stated that participation was voluntary. The scale was applied in the students' free time or counseling classes without interrupting the teaching process, not exceeding one session (40 minutes). The data collection process lasted approximately 14 days. Of 324 forms obtained, 20 forms with missing data were excluded from the evaluation.

2.5. Analysis of data

The total scores were taken as the basis when analyzing the study data. In this context, the total scores obtained from the middle school students' attitude scale towards coding were calculated. The data distribution was examined in order to determine the analyses to be conducted in the study. The Skewness value of the scale was calculated to be -.054 and the Kurtosis value to be -.459. The values between -1 and +1 indicate a normal distribution [41]. Therefore, parametric tests were employed in the data analysis, as well as the arithmetic mean and standard deviation. Whether the attitudes of middle school students towards coding show significant differences by the relevant variables was tested employing the independent samples t-test and ANOVA test.

3. Results and discussion

The results achieved in this study are presented in this section. The order of the sub-questions of the study is taken as the basis for the presentation of the results.

Table 1. Descriptive characteristics of participants

Variables	Group	N	%
Gender	Female	154	53.2
	Male	150	46.8
Age	12 years	101	33.9
	13 years	103	34.5
	14 years	100	31.6
Classroom	6th	101	33.9
	7th	103	34.5
	8th	100	31.6
Daily Internet Use Time	≤1 h	34	12..5
	1-2 h	47	17.8
	3 h	94	29.5
	≥4 h	129	40.2
Daily Smartphone Use Time	≤1 h	36	11.0
	1-2 h	45	15.3
	3 h	101	33..3
	≥4 h	122	40.4
Total		**304**	**100**

As seen in Table 1, 154 middle school students are female (53.2%) and 150 middle school students are male (46.8%). It was determined that 101 students were 12 years old (33.9%), 103 students were 13 years old (34.5%), and the remaining 100 students were 14 years old (31.6%). The classes in which the students were educated were the same, parallel to this data.

Examining the daily internet usage of the students within the scope of other demographic data, it was determined that 34 students (12.5%) used it for 1 hour or less, 47 students (17.8%) used it for 1-2 hours, 94 students (29.5%) used it for 3 hours and 129 (40.2%) students used it for 4 hours or longer. Examining the frequency of students' smartphone use, it was determined that 36 students (11.0%) used it for 1 hour or less, 45 students (15.3%) used it for 1-2 hours, 101 students (33.3%) used it for 3 hours and 122 (40.4%) students used it for 4 hours or longer. Considering the relevant data, the frequency of students' both internet and smartphone usage draws attention. Similar to these results, [48]. reported that middle school students' frequency of both computer and internet use was 4 hours or longer.

Table 2. Robotic coding scale items mean and standard deviation values pilot application results

Items and Factors	*X*	SD
1. Developing robotic applications is enjoyable	3.48	1.42
2. I would like to develop new things regarding robotic applications	3.24	1.83
3. I like robotic applications	3.55	1.60
4. I would like to learn more about robotic coding applications	3.34	1.57
5. Developing robotic applications makes me happy	3.12	1.54

Items and Factors	***X***	**SD**
6. I believe that robotic coding applications are important for us	3.65	1.52
7. I can help my peers who have a problem with robotic coding applications	3.26	1.51
8. Robotic applications increase my interest in applied courses	3.52	1.64
9. I would like to apply what I learned about robotic applications outside of school as well	3.54	1.62
10. What I learned about robotic coding applications enhances my academic achievement	3.26	1.55
11. I would like to select a career path in robotic applications	3.44	1.63
12. Robotic coding applications make me think	3.32	1.47
13. I would like to constantly make robotic coding applications	3.39	1.76
14. I would like to have a robotic coding course	3.45	1.84
15. I would like to take a tutoring course in robotic coding	3.29	1.62
16. I would like robotic coding to be a separate course in the curriculum	3.31	1.41
17. I believe that I can generate new things using robotic applications	3.57	1.74
18. I believe that I can create a solution for the problems I faced when developing robotic applications	3.38	1.48
19. I can detect the problem I faced in the applications of robotic coding	3.25	1.55
20. I can solve the problem I encountered in the applications of robotic coding	3.36	1.76
21. I would not like to make robotic coding	3.47	.76
22. Robotic coding does not attract my interest	3.56	.87
Overall Mean	**3.40**	**1.53**

Table 2. (*Continued*)

The mean for 22 items was found to vary between 3.65 and 3.12. The score limits used in the interpretation are 1.00-1.79, 1.80-2.59, 2.60-3.39, 3.40-4.19, and 4.20-5.00 [49]. In this context, since the overall mean of all items for the relevant survey is 3.40, it can be stated that students' attitudes towards robotic coding are generally concentrated in the ***"I Agree"*** option. Items 21 and 22 are inverse items. The item with the highest mean on the scale was "***I believe that robotic coding applications are important for us".*** Given the results obtained from the scale, it was found that the students have high attitudes towards robotic coding.

Table 3. Independent groups t-test results on students' coding scores by gender

Gender	**N**	**X**	**Ss**	**Sd**	**t**	**p**
Male	154	172.34	42.722			
Female	150	160.11	38.992	508	3.045	**.002**

As presented in Table 3, the students' attitudes towards coding showed a significant difference by gender ($t(508)=3.045$, $p<.05$), with the difference being in favor of the male student group. In addition, the attitudes of both groups towards coding are positive. Similar to the present study [17], who examined the attitudes of middle school students towards robotic coding, also reported that male students have a higher level of attitude toward robotic coding. [50-53], also reported similar results. On the other hand, there are also studies that reported no significant difference by gender [16-32,54]. However, there also are studies reporting that female students have higher attitudes toward coding than male students do [55].

When evaluated on a country-specific basis, it can be said that various socio-cultural factors play a role in male students' higher attitudes towards robotic coding. First of all, gender roles and expectations lead to stereotypes that fields such as technology and engineering are more suitable for men [56]. This situation leads to families and teachers consciously or unconsciously directing male students more towards technology, while female students are not encouraged enough in these areas [57]. In addition, allowing boys to spend more time with digital tools from an early age increases their familiarity with technological skills, which is reflected positively in their attitudes [58]. Another factor that reinforces this perception is that the heroes and role models identified with technology in the media and popular culture are mostly men [59]. Therefore, it seems that this difference in attitude is based not only on individual interests but also on social guidance, inequality of opportunity and gender-based expectations [60].

Table 4. Independent groups anova results on students' coding scores by age

Sub Dimensions	Groups	N	x̄	Ss
Age	12 years	101	3.78	.89
	13 years	103	3.59	.93
	14 years	100	3.64	.84

The significant difference between students' robotic coding attitudes and their age variable was examined using the ANOVA test, and the results are shown in Table 4.1.

The finding that age and grade level did not significantly affect robotic coding attitudes in the study suggests that attitudes towards this field are shaped more by students' individual interests, experiences and environmental factors. Although cognitive development and contact time with technology increase with age, opportunities for exposure to innovative applications such as robotic coding may vary depending on the school environment, teacher competence and out-of-school support [58]. In addition, robotic coding education in many schools in Türkiye is limited to specific projects, clubs or out-of-class activities; this causes students at different grade levels to have similar experiences [60]. On the other hand, the fact that students' interests may shift to different areas with increasing age may not be a determinant on attitudes by affecting their motivation levels [60-61]. The implementation of the curriculum in a standard framework for all grades and the homogeneity of in-school practices may also limit differentiation based on age and grade level [59-62]. Therefore, it can be said that the main factors determining attitudes are the equality of opportunity offered to students, the frequency of application and the quality of interaction in the teaching process, rather than age or class level [56-61].

Table 4.1. Robotic coding attitudes anova test values by age variable

Source of Variance	Sum of Squares	sd	Average of squares	F	p	Significant Difference
Intragroup	1.10	2	.58	.69	.540	-
Intergroup	273.67	302	.84			
Total	264.68	304				

As seen in **Table 4.1**, the students' age does not affect their attitude towards robotic coding [F (304)=.540, p>.05]. In addition, it was determined that all three groups had positive attitudes towards coding. Data are similar because age groups and class variables are of the same type. Therefore, no re-tabulation was done.

Table 5. Independent groups anova results on students' coding scores by daily internet use time

Sub Dimensions	Groups	N	x̄	Ss
Daily Internet Use Time	≤1h	34	3.07	.65
	1-2 h	47	3.16	.71
	3 h	94	3.65	.87

Sub Dimensions	Groups	N	x̄	Ss
	≥4 h	129	3.81	.97

Table 5. (*Continued*)

The significant difference between students' robotic coding attitudes and their daily internet use time variable was examined using the ANOVA test and shown in Table 5.

Table 5.1. Robotic coding attitudes anova test values by daily internet use time

Source of Variance	Sum of Squares	sd	Average of squares	F	p	Significant Difference
Intragroup	120.5	3	40.16	.53	.0011	
Intergroup	302.9	301	8.45			
Total	424.4	304				

As seen in **Table 5.1**, the students' daily internet use time affects their attitude towards robotic coding [F (304)=.0011, p<.05], with the difference being in favor of student groups who use the internet for 4 hours or longer. In addition, it was determined that all three groups had positive attitudes towards coding. However, examining the middle school students' attitudes toward robotic coding, [63]. reported no difference by daily internet use levels of the students. ANOVA is a statistical technique employed in comparing the means of three or more groups to determine whether there are significant differences between them. It is used for categorical independent variables and a continuous dependent variable.

The increase in daily internet use can positively affect students' attitudes towards robotic coding and technology in general. The internet increases students' interest and awareness of technology by providing fast access to information and various educational materials. Especially in areas that require innovative and digital skills such as robotic coding, interactive content, online courses and communities provided over the internet increase students' motivation and support their learning processes. In addition, the widespread use of the internet allows students to meet and gain experience with technology at an earlier age, thus facilitating the development of positive attitudes towards technology. Similarly, international studies show that students who interact more with the internet and digital environments exhibit higher interest and positive attitudes towards technology and coding [64-65]. This situation reveals that internet use plays an important role in the development of students' digital skills.

Table 6. Independent groups anova results on students' coding scores by daily smartphone use time

Sub Dimensions	Groups	N	x̄	Ss
	≤1h	36	3.12	.61
Daily	1-2 h	45	3.21	.72
Smartphone	3 h	101	3.86	.89
Use Time	≥4 h	122	3.92	.96

The difference between students' robotic coding attitudes and their daily smartphone use time was investigated utilizing the ANOVA test, and the results are presented in Table 6.

Table 6.1. Robotic coding attitudes anova test values by daily smartphone use time

Source of Variance	Sum of Squares	sd	Average of squares	F	p	Significant Difference
Intragroup	85.2	3	28.4	.45	.0007	
Intergroup	256.6	301	8.31			
Total	350.9	304				

As seen in **Table 6.1**, the students' daily internet use time affects their attitude towards robotic coding [F (304)=.0007, p<.05], with the difference being in favor of student groups who use the internet for 4 hours or longer. In addition, it was determined that all three groups had positive attitudes towards coding.

The increase in the frequency of smartphone use has a positive effect on students' robotic coding and general technology attitudes. Smartphones provide students with access to information at any time, increasing their interaction with the digital world and feeding their interest in technology. Through these devices, students are introduced to coding applications, educational games, and various interactive platforms more frequently and effectively, thus strengthening their attitudes towards robotic coding. In addition, the social media and online communities offered by smartphones support students' learning processes by increasing their motivation towards technology. International studies also show that smartphone use plays an important role in digital skills and positive attitudes towards technology [66-67]. These findings emphasize that increased access to technology is a fundamental factor in attitude development.

4. Conclusion and recommendations

Robotic coding is the process of programming robots to perform specific tasks using various coding languages and platforms. It combines computer science, engineering, and problem-solving skills, allowing students and professionals to develop innovative automation solutions. Robotic coding is widely used in industries such as manufacturing, healthcare, and space exploration, as well as in education to enhance STEM learning. By learning robotic coding, individuals can improve their logical thinking, creativity, and technical skills, preparing them for the future of technology-driven industries.

Robotic coding helps students adapt to the needs of the 21st century by providing them with skills such as analytical thinking, problem-solving, and creativity. As an important part of STEM (Science, Technology, Engineering, and Mathematics) education, robotic coding allows students to reinforce theoretical knowledge with practical applications. It also prepares the students for careers in computer science and engineering by developing algorithmic thinking skills. Individuals who receive robotic coding training from an early age can be more successful in their future professions by gaining the innovation and technology production competencies required by the digital age. With Robotic Coding Workshops, students learn about technology very easily and quickly. Robotic coding lessons develop students' creative thinking skills and help them achieve extremely important gains such as collaboration, problem solving, and leadership.

Robotics coding education at the middle school level increases students' interest in technology by providing them with analytical thinking, problem-solving and creativity skills. This training helps develop basic skills in STEM fields, in addition to strengthening students' algorithmic thinking and logical reasoning abilities. In addition, through robotics coding activities, students gain 21st-century skills such as teamwork, communication, and project management. Having these skills at the middle school age supports students' future academic and professional success and can direct them towards technology-focused careers. In this context, students' attitudes towards robotic coding constitute an important factor that directly affects the efficiency of their learning processes in this field and their future career orientations. Students with a positive attitude develop their problem-solving, creativity, and analytical thinking skills, and they become more curious and motivated towards technology. Students who are interested in robotic coding actively participate in the learning process and make more efforts to overcome the challenges they encounter. In addition, students who approach this field positively can be more successful in STEM fields in the future by developing their skills in cooperation, teamwork, and critical thinking. Therefore, it is very important for educators and parents to encourage students to develop a positive attitude towards robotic coding. Therefore, this study examines middle school students' attitudes towards robotic coding. Given the results obtained, it is anticipated that this study will guide future studies and can be used as a guide model in this context.

Reviewing the literature, it can be seen that there are many definitions of the concept of attitude. As stated by [68], one of the most critical variables influencing individual learning during the learning process is affective entry characteristics. From this perspective, even if individuals forget the information they have learned about a subject, they retain their affective entry characteristics and/or attitudes toward that subject. Similarly [23], emphasized that attitudes are entirely personal and are formed as a result of a series of life experiences, although they may change suddenly after a single experience. An individual acquires knowledge about the attitude object first, then expresses this knowledge through affective responses, and ultimately transforms it into behavior. In short, an attitude is not an observable behavior itself but an action that prepares an individual to behave in a certain way. In this context, even though there are studies in Türkiye investigating students' attitudes toward computers and information technologies courses, the number of studies specifically focusing on middle school students' attitudes toward coding education is very limited.

In line with this information, the present study aims to examine middle school students' attitudes toward robotic coding. Given the results obtained, it is anticipated that the findings will serve as a guide for future studies and may be used as a reference model in this field. Remarkable results achieved in this study include students' usage intensity of both the internet and smartphones. Similarly [48], reported middle school students' daily computer and internet usage to be 4 hours or longer. The overall mean score of all items on the scale used for data collection in this study was 3.40, indicating that students' attitudes toward robotic coding were generally concentrated around the "Agree" response category. The item with the highest mean score on the scale was "I believe that robotic coding applications are important for us." Given the scale results, students were found to have high levels of positive attitudes toward robotic coding. There was a significant difference in students' attitudes toward coding by gender, favoring male students. In a similar study, it was found that male students had more positive attitudes toward coding in comparison to female students [48].

On the other hand, the variables of age and grade level did not significantly affect students' attitudes toward robotic coding. Moreover, all three grade groups exhibited positive attitudes toward coding. Similarly [32], also reported no significant differences in coding attitude scores across different grade levels. Their study also revealed that students' daily internet usage significantly influenced their attitudes toward robotic coding, with students who used the internet for four or more hours per day demonstrating more positive attitudes. Similarly [17], found that as students' computer and internet usage time increased, their attitudes toward coding also became more positive. Finally, the present study showed that daily smartphone usage also had a significant effect on students' attitudes toward robotic coding, again favoring the group of students who used these devices for 4 or more hours daily. Nevertheless, all three usage groups were found to have generally positive attitudes toward coding. Although the findings of the article show that smartphone and internet usage time positively affects attitudes towards robotic coding, it is an important limitation that it does not make a distinction as to whether this time is productive (learning-oriented) or passive (social media, entertainment). Because the literature emphasizes that the quality of screen time is a determinant in the development of attitudes and skills towards technology [65]. It is stated that productive digital activities support the cognitive development of students and strengthen their positive attitudes towards technology; on the other hand, passive use does not provide these effects or may have negative consequences [67]. In this context, considering the quality as well as the quantity of screen time in research and discussions is of critical importance in terms of evaluating the effectiveness of robotic coding training. In future studies, collecting data differentiated according to the types of digital activities of students and analyzing the effects of these different usage patterns on attitudes will provide more holistic and practical results.

In addition strengthening students' attitudes toward robotic coding directly contributes to the development of 21st-century skills such as collaboration, problem-solving, and creativity [69-70]. Gaining these skills at the middle school level provides significant support for students' future academic and professional success. However, since this study was conducted using a cross-sectional design, it does not offer the opportunity to observe changes in attitudes over time. While this is a natural limitation, future longitudinal studies [71-72], will allow for a more comprehensive understanding of developmental processes in this field.

Similar studies conducted in international contexts have highlighted the positive impact of robotics and coding education on students' attitudes, motivation, and cognitive development. For example [28], found that integrating robotics into secondary education significantly improved students' problem-solving and algorithmic thinking skills. [73], demonstrated that participation in robotics-based curricula enhanced primary and middle school students' engagement, collaboration, and positive attitudes toward STEM subjects. Another study by [74], emphasized that hands-on robotics activities increased students' confidence in using technology and strengthened their teamwork and critical thinking abilities. Furthermore [75], reported that middle school students who participated in robotics summer camps exhibited increased interest in pursuing STEM careers. These findings consistently support the argument that early exposure to robotics fosters both technical competencies and affective engagement, which are crucial for preparing students for technology-intensive futures.

Curriculum Development: In order to make robotics coding education more widespread and accessible at the middle school level, the curriculum should be updated, and course content should be adapted to the student level.

- *Applied Education and Project-Based Learning:* In order to increase students' interest, more space should be given to practical activities, competitions, and project-based learning approaches in addition to theoretical information.
- *Increasing the Competencies of Educators:* Teachers should be provided with training on robotics coding to ensure that they develop their knowledge and skills in this area.
- *Integration with STEM:* Robotics coding education should be made more integrated with STEM courses, and students should be encouraged to develop interdisciplinary thinking skills in the fields of science, technology, engineering, and mathematics.
- *Studies Examining Student Attitudes:* Long-term studies should be conducted to better understand the attitudes of middle school students towards robotics coding, and educational processes should be improved in line with these studies.
- *Accessibility and Infrastructure Development:* In order for all students to have access to robotics coding education, the necessary infrastructure (computer labs, robot kits, etc.) should be provided in schools, and special projects should be developed in disadvantaged regions.

- *Motivation-Increasing Reward and Incentive Systems:* Coding competitions, hackathons, and reward systems should be created to keep students' interest alive, and their success should be encouraged.
- *Increasing Parental Participation:* Informative seminars and events should be organized to raise awareness of robotics coding among families and to direct their children to this field.

To expand and enhance the effectiveness of robotics coding education at the middle school level, the curriculum should be updated and tailored to students' developmental levels. In addition to theoretical knowledge, greater emphasis should be placed on applied learning, project-based approaches, and competitions to foster student interest and motivation. Furthermore, comprehensive training and certification programs must be provided to increase educators' competencies in this field. Integrating robotics coding education with science, technology, engineering, and mathematics (STEM) subjects plays a crucial role in developing students' interdisciplinary thinking skills. Longitudinal studies examining students' attitudes are essential for the ongoing improvement of educational practices. In terms of accessibility, necessary infrastructure should be made available in all schools, with special projects implemented in disadvantaged regions. To sustain student engagement, motivation-enhancing mechanisms such as coding competitions, hackathons, and reward systems should be developed. Parental involvement should also be encouraged through informative seminars and activities to support students' learning at home. Additionally, complementary approaches including extracurricular programs, personalized learning opportunities, interdisciplinary projects, and initiatives promoting gender equity will make robotics coding education more inclusive and effective. Finally, integrating technology literacy and ethics education into the curriculum will ensure that students use technology responsibly and conscientiously.

These suggestions will positively affect the attitudes of middle school students towards robotics coding and contribute to raising more conscious and successful individuals in this field in the future. The fact that the study examined attitudes only at a single point in time can be considered a limitation in terms of revealing the changes in these attitudes over time and the effects of continuous exposure to robotic coding. However, this is a natural consequence of the cross-sectional design of the study and is important in terms of the findings reflecting the current situation at a certain period [71]. Conducting longitudinal studies to provide more in-depth information on the development and evolution of attitudes will allow for a better understanding of the dynamics of the field [72]. In addition, following this process in future studies will be a critical step in evaluating the effectiveness of robotic coding training over time and optimizing training strategies. Therefore, this suggestion of the author is a constructive approach that aims to contribute to the development of the field while being aware of the limitations of the study.

Curriculum improvements, teacher training, and parental involvement recommendations are critical to the success of innovative educational practices such as robotic coding. However, for these recommendations to be effective, concrete and measurable steps need to be determined. Governments should first clarify the standards for robotic coding and STEM education within the framework of national education policies and establish competency criteria in these areas. In addition, continuous professional development programs and certification processes should be organized to increase the pedagogical competence of teachers in these technological areas. Schools should adapt the curriculum in accordance with these standards, strengthen their physical infrastructure such as robotic coding laboratories and practice classes, and develop performance indicators to monitor success. Parental involvement can be increased through regular information meetings, workshops, and the provision of supportive materials at home. Measurable steps should include regular monitoring of student participation rates in robotics coding projects, levels of participation in teacher training, and implementation rates of curriculum content. In this way, policy recommendations can be transformed into practical and traceable actions, and permanent and positive changes can be achieved in education.

Author contributions

Conceptualization by Ezgi Pelin YILDIZ; methodology by Ezgi Pelin YILDIZ; software by Ezgi Pelin YILDIZ; validation by Ezgi Pelin YILDIZ; formal analysis by Ezgi Pelin YILDIZ; research by Ezgi Pelin YILDIZ; resources by Ezgi Pelin YILDIZ; data curation by Ezgi Pelin YILDIZ; writing - review & editing by Ezgi Pelin YILDIZ; visualization by Ezgi Pelin YILDIZ; supervision by Ezgi Pelin YILDIZ; project administration by Ezgi Pelin YILDIZ.

Ethical Permissions

In order to conduct the research, official permission was first obtained from the administration of the private school (college) where the study was carried out. Subsequently, parents of the students in the relevant classes were informed about the study, and their written consent was obtained. Student participation was entirely based on voluntary involvement, and no coercive measures were taken toward those who did not wish to participate. Ethical principles were observed throughout all stages of the research, and utmost care was taken to protect the participants' personal rights and confidentiality. The identities of the students were kept anonymous, and the collected data were used solely for scientific purposes.

Conflict of interest

The authors declare no conflict of interest

References

1. Yukselturk, E., Altıok, S., & Ucgul, M. (2017). Evaluation of a Scientific Activity Conducted for Web 2.0 Education: Participant Views. *Journal of Educational Technologies and Teacher Education, 6*(1), 1-8.
2. Arabacıoglu, T., Bulbul, H. I., & Filiz, A. (2007). A New Approach to Teaching Computer Programming. Proceedings Book of the IX. Academic Informatics Conference. Kutahya/Türkiye.
3. Ching, Y. H., Hsu, Y. C., & Baldwin, S. (2020). Developing computational thinking with educational technologies for young learners. *TechTrends, 64*(5), 669–681. https://doi.org/10.1007/s11528-020-00476-y
4. Angeli, C., & Valanides, N. (2020). Developing young children's computational thinking with educational robotics: A case study in the kindergarten. *Early Childhood Education Journal, 48*(6), 759–773. https://doi.org/10.1007/s10643-020-01064-8
5. Benitti, F. B. V., (2012). Exploring the educational potential of robotics in schools: A systematic review. *Computers & Education, 58*(3), 978–988. https://doi.org/10.1016/j.compedu.2011.10.006
6. Alimisis, D. (2013). Educational robotics: Open questions and new challenges. *Themes in Science and Technology Education, 6*(1), 63–71.
7. Bers, M. U., Flannery, L., Kazakoff, E. R., & Sullivan, A. (2014). Computational thinking and tinkering: Exploration of an early childhood robotics curriculum. *Computers & Education, 72,* 145–157. https://doi.org/10.1016/j.compedu.2013.10.020
8. Mubin, O., Stevens, C. J., Shahid, S., Al Mahmud, A., & Dong, J.-J. (2013). A review of the applicability of robots in education. *Technology for Education and Learning, 1,* 1–7. https://doi.org/10.2316/Journal.209.2013.1.209-0015
9. Eguchi, A. (2014). Robotics as a learning tool for educational transformation. Proceedings of the 4th International Workshop Teaching Robotics, Teaching with Robotics, 27–34.
10. Zawieska, K., Czarnowska, K., & Zawieska, D. (2020). Gender-inclusive robotics: Increasing engagement of girls in coding through collaborative educational robotics activities. *International Journal of STEM Education, 7*(1), 1–12. https://doi.org/10.1186/s40594-020-00231-3
11. Chalmers, C., Carter, M. L., & Cooper, T. (2020). Engaging students in STEM education through robotics: Exploring student perceptions of robotic learning activities. *Australasian Journal of Educational Technology, 36*(2), 1–15. https://doi.org/10.14742/ajet.5472

12. Román-González, M., Pérez-González, J. C., & Jiménez-Fernández, C. (2017). Which cognitive abilities underlie computational thinking? Criterion validity of the Computational Thinking Test. *Computers in Human Behavior, 72,* 678–691. https://doi.org/10.1016/j.chb.2016.08.047
13. Mouza, C., Yang, H., Pan, Y. C., Ozden, S. Y., & Pollock, L. (2016). Resetting educational technology coursework for pre-service teachers: A computational thinking approach to the development of technological pedagogical content knowledge (TPACK). *Australasian Journal of Educational Technology, 32*(5), 47–63. https://doi.org/10.14742/ajet.3508
14. Demir, A. G. Ö., & Seferoglu, S. S. (2017). New Concepts, Different Uses: A Review of Computational Thinking. *Educational Technology Readings, 41,* 468-483.
15. Lye, S. Y. & Koh, J. H. L. (2014). Review on Teaching and Learning of Computational Thinking Through Programming: What is next for K-12?.*Computers in Human Behavior, 41,* 51-61.
16. Yagcı, M. (2018). A Study on Computational Thinking and High School Students' Computational Thinking Skill Levels, *International Online Journal of Educational Sciences, 10*(2), 81-96.
17. Abdusselam, M. S. & Uzoglu, M. (2022). Investigating Secondary School Students' Attitudes Towards Coding According to Different Variables. *International Journal of Turkish Education Sciences, 2022*(18), 81-92. https://doi.org/10.46778/goputeb.1028285
18. Kaučič, B. & Asič, T. (2011, May). Improving Introductory Programming with Scratch? 34th International Convention MIPRO'da sunuldu, Hrvatska.
19. Numanoglu, M. & Keser, H. (2017). Robot Usage in Programming Education - Mbot Example. *Bartın University Faculty of Education Journal 6*(2), 497-515.
20. Baser, M. (2013). Attitude Towards Computer Programming Scale Development Study. *The Journal of Academic Social Science Studies, 6*(6), 199-215.
21. Nelson, J. (1939). Nelson's Blood: Attitudes and Actions of the Royal Navy. https://doi.org/10.1177/002200948101600305
22. Bloom, S. (1979). Human Qualities and Learning in School (Translated by: D. A. Ozcelik). Ankara: MEB Printing House.
23. Tavsancıl, E. (2002). *Measurement of Attitudes and Data Analysis with SPSS*. Ankara: Nobel Publishing House.
24. Larsen, K. S., & Le Roux, J. A. (2013). Study of Same-Sex Touching Attitudes: Scale Development and Personality predictors. *The Journal of Sex Research, 20*(3), 264–278.
25. Duatepe, A., & Cilesiz, S. (1999). Development of a Mathematics Attitude Scale. *Hacettepe University Faculty of Education Journal, 16*(16).
26. Fritz, R. (2008). Power of a Positive Attitude: Discovering the Key Success. [http://site.ebrary.com/lib/giresun/Doc?id=1027181andppg=8].
27. Toh, L. P. E., Causo, A., Tzuo, P. W., Chen, I. M., & Yeo, S. H. (2016). A review on the use of robots in education and young children. *Educational Technology & Society, 19*(2), 148–163.
28. Atmatzidou, S., & Demetriadis, S. (2016). Advancing students' computational thinking skills through educational robotics: A study on age and gender relevant differences. *Robotics and Autonomous Systems, 75,* 661–670. https://doi.org/10.1016/j.robot.2015.10.008
29. Sullivan, A., & Bers, M. U. (2019). Investigating the impact of a classroom-based robotics program on young children's computational thinking. *Journal of Educational Computing Research, 57*(5), 1407–1431. https://doi.org/10.1177/0735633118789308
30. Yuen, T. T., Adams, J. D., & Dobbs, J. (2013). Robotics camps: Enhancing interest in STEM among students and teachers. Proceedings of the 120th ASEE Annual Conference and Exposition, Atlanta, GA.
31. Abdusselam, M., S., & Uzoglu, M. (2020). Öğrencilerin kodlamaya yönelik tutumları: Bir ölçek geliştirme çalışması. *OPUS–Uluslararası Toplum Araştırmaları Dergisi, 16*(Eğitim ve Toplum Özel Sayısı). DOI: 10.26466/opus.749822
32. Akkus, A., & Bilgin, E. A. (2021). Examining The Attitudes of Secondary School Students Towards Coding. *Pearson Journal, 6*(12), 21–30. https://doi.org/10.46872/pj.262
33. Cross, J., Hamner, E., Zito, L., Nourbakhsh, I., & Bernstein, D. (2016, October). Development of an Assessment for Measuring Middle School Student Attitudes Towards Robotics Activities. In IEEE Frontiers in Education Conference (FIE) (pp. 1–9). https://doi.org/10.1109/FIE.2016.7757677
34. Van den Berg, A., & Visker, B. (2022). The effect of robotics education on gender differences in STEM attitudes among Dutch 7th and 8th grade students. *Education Sciences, 13*(2), 139. https://doi.org/10.3390/educsci13020139
35. De Costa, A. (2025, June 16). RoboBlimp: Enhancing middle school STEM through educational bioinspired blimps [Preprint]. arXiv. https://doi.org/10.48550/arXiv.2506.13844
36. Dietz, G., Chen, J. K., Beason, J., Tarrow, M., Hilliard, A., & Shapiro, R. B. (2022, July 18). ARtonomous: Introducing Middle School Students to Reinforcement Learning Through Virtual Robotics [Preprint]. arXiv. https://doi.org/10.48550/arXiv.2207.08974

37. Vollstedt, M., et al. (2022). Autonomous robotics math curriculum development using C coding language to increase student attitudes and learner outcomes. *International Journal of Robotics and Automation Technology.* https://www.zealpress.com/jms/index.php/ijrat/article/view/430
38. Zhang, Y., Luo, R., Zhu, Y., & Yin, Y. (2021). Educational robots improve K–12 students' computational thinking and STEM attitudes: Systematic review. *Journal of Educational Computing Research, 59*(3), 455–478. https://doi.org/10.1177/0735633121994071
39. Heerink, M., Kröse, B., Evers, V., & Wielinga, B. (2019). Development and Validation of an Educational Robot Attitude Scale (ERAS) for Secondary School Students. *Interactive Learning Environments, 27*(3), 377–388. https://doi.org/10.1080/10494820.2018.1474234
40. Gavrilas, L., & Kotsis, K. T. (2024). Development and validation of a survey instrument towards attitude, knowledge, and application of educational robotics (AKAER*). International Journal of Research & Method in Education, 48*(1), 44–66. https://doi.org/10.1080/1743727X.2024.2358780
41. Buyukozturk, S. (2020). *Handbook of Data Analysis For the Social Sciences*. Pegem Academy Ankara/Türkiye.
42. Creswell. J.W. & Creswell, J.D. (2017). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches.* 4th Edition, Sage, Newbury Park.
43. Yalcın, S., Kahraman, S., & Yılmaz, Z. A. (2020). Development and validation of Robotic Coding Attitude Scale. *International Journal of Education in Mathematics, Science and Technology, 8*(4), 342-352.
44. Creswell, J.W., & Tashakkori, A. (2007). Developing Publishable Mixed Methods Manuscripts. *Journal of Mixed Methods Research, 1,* 107-111.
45. George, D., & Mallery, P. (2003). *SPSS for Windows step by step: A simple guide and reference* (4th ed.). Allyn & Bacon.
46. Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education, 48*(6), 1273–1296. https://doi.org/10.1007/s11165-016-9602-2
47. Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*(1), 1-55. https://doi.org/10.1080/10705519909540118
48. Uyar, A., Oztürk, G., & Oztürk, Y. (2022). Attitudes of Secondary School Students Towards Coding. *Journal of Inonu University Institute of Educational Sciences, 9*(18), 1-11. https://doi.org/10.29129/inujgse.1166046 .
49. Buyukozturk, S. Cakmak, E. K., Akgun, O. E., Karadeniz & S., Demirel F. (2013). *Scientific Research Methods.* Ankara: Pegem Academy.
50. Askar, P., & Davenport, D. (2009). An Investigation of Factors Related to Self-Efficacy for Java Programming Among Engineering Students. *The Turkish Online Journal of Educational Technology, 8*(1).
51. Chang, S. L., Shieh, R. S., Liu, E. Z. F., & Yu, P. T. (2012). Factors Influencing Women's Attitudes Towards Computers in A Computer Literacy Training Program. *The Turkish Online Journal of Educational Technology, 11*(4), 177-187.
52. Stoilescu, D., & Egodawatte, G. (2010). Gender Differences in the Use of Computers, Programming, and Peer Interactions in Computer Science Classrooms. *Computer Science Education, 20*(4), 283-300.
53. Ozyurt, O., & Ozyurt, H. (2015). A Study to Determine the Attitudes of Computer Programming Students Towards Programming and Their Programming Self-Efficacy. *Theory and Practice in Education, 11*(1), 51-67.
54. Erol, O. & Kurt, A., A., (2017). The Effects of Teaching Programming With Scratch on Pre-Service Information Technology Teachers' Motivation and Achievement. *Computers in Human Behavior, 77*, 11-18.
55. Chiazzese, G., Fulantelli, G., Pipitone, V., & Taibi, D. (2018). Engaging Primary School Children in *Computational Thinking: Designing and Developing Videogames. Education in the Knowledge Society, 19*(2), 63-81.
56. Arslan, A. (2016). *Gender roles and education*. Ankara: Pegem Academy.
57. Yaman, F., & Yaman, S. (2014). Investigation of students' attitudes towards science and technology course according to gender variable. *Kastamonu Education Journal, 22*(3), 1195–1208.
58. Akgun, O. E. (2020). Investigation of middle school students' attitudes towards robotic coding activities in terms of some variables. *Gazi University Gazi Faculty of Education Journal, 40*(2), 957–978.
59. Gumus, S., & Atalmıs, E. H. (2019). STEM education and gender inequality in Türkiye: An evaluation of student attitudes and achievements. *Education and Science, 44*(199), 219–234. https://doi.org/10.15390/EB.2019.7997
60. Karakus, F., & Aksoy, Y. (2021). Examining STEM career interests of primary school students in terms of various variables. *Educational Technology Theory and Practice, 11*(1), 1–20. https://doi.org/10.33462/etku.830551
61. Master, A., Cheryan, S., & Meltzoff, A. N. (2016). Computing whether she belongs: Stereotypes undermine girls' interest and sense of belonging in computer science. *Journal of Educational Psychology, 108*(3), 424–437. https://doi.org/10.1037/edu0000061
62. Dasgupta, N., & Stout, J. G. (2014). Girls and women in science, technology, engineering, and mathematics: STEMing the tide and broadening participation in STEM careers. *Policy Insights from the Behavioral and Brain Sciences,* 1(1), 21–29. https://doi.org/10.1177/2372732214549471

63. Korucu, A. T., & Bicer, H. (2020). Investigation of Middle School Students' Attitudes Towards Robotic Coding According to Different Variables. *International Technology and Education Journal, 4*(1), 30-35.
64. Vekiri, I., & Chronaki, A. (2008). Gender issues in technology use: Perceived social support, computer self-efficacy and value beliefs, and computer use beyond school. *Computers & Education, 51*(3), 1392–1404. https://doi.org/10.1016/j.compedu.2008.05.003
65. Hsin, W.-J., Li, M.-C., & Tsai, C.-C. (2014). The influence of young children's use of technology on their learning: A review. *Journal of Educational Technology & Society, 17*(4), 85–99.
66. Selwyn, N. (2016). *Education and technology: Key issues and debates (2nd ed.).* Bloomsbury Academic.
67. Rideout, V. J., Foehr, U. G., & Roberts, D. F. (2010). Generation M2: Media in the lives of 8- to 18-year-olds. Henry J. Kaiser Family Foundation. https://kaiserfamilyfoundation.files.wordpress.com/2013/04/8010.pdf
68. Bloom, B., Englehart, M. Furst, E., Hill, W., & Krathwohl, D. (1956). Taxonomy of Educational Objectives: The Classification of Educational Goals. Handbook I: Cognitive Domain. New York, Toronto: Longmans, Green.
69. Resnick, M., & Silverman, B. (2005). Some reflections on designing construction kits for kids. In Proceedings of the 2005 conference on Interaction design and children (pp. 117–122). ACM.
70. Bers, M. (2012). *Designing Digital Experiences for Positive Youth Development: From Playpen to Playground.* Oxford University Press.
71. Creswell, J., W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches (4th ed.).* SAGE Publications.
72. Menard, S. (2002). *Longitudinal research* (2nd ed.). SAGE Publications.
73. Sullivan, A., & Bers, M. U. (2016). Girls, boys, and bots: Gender differences in young children's performance on robotics and programming tasks. *Journal of Information Technology Education: Innovations in Practice, 15,* 145-165. https://doi.org/10.28945/3547
74. Chambers, J., Carbonaro, M., & Murray, J. (2008). Learning to program through robotics: The effect of robotics activities on the confidence and attitudes of students. *International Journal of Technology and Design Education, 18*(2), 183–202. https://doi.org/10.1007/s10798-006-9009-1
75. Nugent, G., Barker, B., Grandgenett, N., & Adamchuk, V. (2010). The Impact of Robotics and Geospatial Technology Interventions on Youth STEM Learning and Attitudes. *Journal of Research on Technology in Education, 42*(4), 391–408. https://doi.org/10.1080/15391523.2010.10782562