The Contribution of Robotics Coding Education to Students' Higher-Order Thinking and Language Development: A Literature Review

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Absract: Robotics and coding education aims to teach students the basic principles of robots and coding language to enable students to establish close relationships with technology and become independent individuals. Through robotics and coding education, students find opportunities to develop problem solving, computational thinking, creative thinking and language skills. Accordingly, the purpose of this study is to investigate and examine the effects of robotics and coding education on students' higher-order thinking skills, including creative thinking skills, critical thinking skills, problem solving skills, and computational thinking and language skills. The main focus of the research is closely related to the extent to which students are can advance their potential in these areas in the process of robotics and coding education. In addition, considering students with different developmental levels, the current research reviewed studies on nongifted and gifted students. When the results of the research were examined, it was found that robotics and coding education was a great source of motivation for nongifted and gifted students, the disadvantages related to gender in education were eliminated, and with this motivation, students showed great progress in high-level thinking skills and language skills. This study aims to contribute to educators, researchers and families by examining the performances of typically developing and gifted students in robotics and coding education. As a result of the analyzed research, some suggestions were made.

Keywords: Robotic coding, gifted children, higher-order thinking, language skills, creativity

1. INTRODUCTION

With the increase in knowledge in a rapidly changing world, developments have occurred in many disciplines. Among these fields, technology is the most striking field. Thanks to technology, the production process has accelerated and production has reached a more efficient level in terms of quality and time. The advantages provided by technology are used in many fields such as industrial production and software technology. With the increasing need for personnel arising from the rapid development of technology, technology has started to appear in educational environments in different ways (Çetin, et al., 2004; Şenel & Gençoğlu, 2003). The introduction of technology into educational environments has gained a different dimension with robotic coding and the development of certain skills in students has become one of the main objectives (Piedade et al., 2020).

Robotics and coding education adopt a student-centered approach (Uzun & Uz, 2018). The student-centered approach is based on the differentiation of content, process, product and environment in teaching according to students' interest, learning style and readiness level (Gül, 2014; Zoraloğlu & Şahin, 2022). Robotics and coding education aim to increase students' motivation in line with their interests and thus to improve their attitude towards the course and their ability to learn effectively. Robotic coding education considers students' learning styles. It creates a suitable ground for students' visual learning by using visual blocks, auditory learning while listening to commands and explanations from the robot, tactile/kinesthetic learning with robot design after programming, and social learning styles through teamwork (Bike, 2020; Coşkunserçe, 2021; Günüç, 2017). The level of readiness is important in terms of continuing education with students with different potentials or different levels of intelligence, and these students can be examined in two different categories: those who perform at an advanced level as gifted students, while those at an average level can be examined in two different categories as nongifted. As a matter of fact,

among the main problems in teaching environments, it is emphasized that students with different levels of readiness should receive education in the same environment (Akkaş &Tortop, 2015). Robotics and coding trainings serve a great function in adapting teaching to appeal to students with different levels of readiness (Bölükbaşı & Arı, 2019). Students' interest, learning style and readiness levels become possible with robotics and coding education. All these actions actually require the differentiation of content, process, product and environment with robotic coding. Content differentiation related to robotic coding education is considered as learning the language of robotics and using this language for problem solving (Şanal & Erdem, 2017). Process differentiation is the development of students' high-level thinking skills and academic areas (Pakman, 2018). Product differentiation is that students produce new products with ideas that are useful and suitable for their purpose at the end of the process with robotic coding (Aksu, 2019). Within the framework of all these actions, it can be said that the differentiation of the educational environment and robotics education are intertwined. Considering the differentiation of content, process, product and environment, robotic coding trainings pave the way for students to learn through interaction, as well as increasing student motivation and level of understanding. In addition, the fact that students who learn by doing and living gain concrete experiences and become social learners contributes to the development of new products (Yurttaş, 2021). Thus, as a result of the robotics and coding education process, some changes occur in student roles. To put it more clearly, students are transformed into independent individuals who find, try to solve and solve problems, and come up with new ideas, rather than being someone who receives and memorizes information from the teacher. Therefore, it is very important for students to acquire a number of new skills in this process and to develop their meta-thinking skills (Güleryüz, 2019). Higher-order thinking represents the complex process that individuals exhibit during a problem and consists of skills, problem solving, critical thinking, computational thinking and creative thinking. In addition, higher-order thinking skills are closely related to language skills. The reasons for this include the necessity of language skills and effective communication skills for students to analyze complex problems, think critically and produce creative solutions (Söylemez, 2018). According to Polat and Ulutaş (2023), it was stated that there were improvements in language skills as a result of students interacting with coding commands during robotics and coding trainings.

In this context, the aim of this study is to draw attention to the studies on the development of higher-order thinking skills and language development in typically developing and gifted students through robotics and coding education and to identify instructional factors for the development of these skills and propose some solutions. Therefore, the current research is analyzed under the following main headings:

- Robotic coding and problem solving skills
- Robotic coding and critical thinking skills
- Robotic coding and computational thinking skills
- Robotic coding and creativity
- Robotic coding and language development

2. ROBOTİC CODİNG AND PROBLEM SOLVİNG SKİLLS

Human beings have been encountering certain problems in all areas of life since their existence and have been making certain efforts to solve these problems (Gelbal, 1991). When the definition of a problem is considered, problem is an unknown situation that is handled in different ways in line with the accumulation of past experiences and the uniqueness of individuals and that must be solved when it encounters obstacles (Martorella, 1978). According to Özüpek (2023), a problem is defined as a stimulus that arouses the individual's interest in cognitive actions such as understanding and interpreting the world in which they live. For this reason, the problems addressed in educational environments should have an effective structure. Karaduman (2017) emphasizes that problems should have a structure that leads to multiple results as opposed to a single result, and that problem solving should be planned and support higher-order thinking skills in order to be used in individual and group work and to be related to a subject addressed in real life. In addition to the fact that problem solving skills include other higher-order thinking skills such as decision-making among the most important building blocks of problem solving skills, it is closely related to the fact that students maintain their own responsibilities in an autonomous structure in the education process (Özüpek, 2023).

Problem solving skills play an important role in students' academic and professional success. There are four basic steps accepted by Polya as the basis of problem solving skills and these steps are understanding the problem, creating a plan for solution, implementing the plan, and backtracking (Polya, 1957; Maulyda et al., 2019; Shirali, 2014). The four problem solving steps for the problem solving process proposed by Polya are still used today. It is stated that the reasons for this are teaching problem solving skills and evaluating the problem solving process (Altun & Arslan, 2006; Gökkurt et al., 2015; Yazgan & Bintaş, 2005).

The relationship between robotics and coding education and problem solving skills is through reviewing the movements and behaviors of robots, understanding problems, producing solutions in groups, implementing the plan and reviewing the process again to evaluate the whole process. In other words, the behaviors exhibited by students during robotics and coding trainings and the problem solving process are conjugate (Kanbul & Uzunboylu, 2017). In the study conducted by Uzunboylar (2017) in which teacher and student opinions were taken, the majority of the students stated that they developed skills in identifying a problem during robotics and coding trainings, that they applied different solutions to the problem, that they did not give up in this process when they could not solve it despite applying the first idea that came to mind, and that they found different solutions more easily, and teacher opinions also support the thoughts expressed by the students. In the study conducted by Konyaoğlu (2019), the students who were applied to the robotics and coding education program defined the differences in the movements of robots as a problem, and instead of avoiding the problems that arise, they exhibit the behavior of going over the problem reviewing the whole process again and adding new features to the product obtained. In addition, according to the results of the study, students stated that problem solving skills should be applied to different courses. In this context, in the study conducted by Norton et al., (2007), flowcharts were created by teachers for students who were involved in robotics and coding education so that they could form their thoughts more easily and learn concepts more easily. According to the results of the study, it was found that students who adopted the flowchart during the robotics and coding education process increased their problem solving levels. Many studies have been conducted that robotics and coding education improves students' problem solving skills (Azaz, 2021; Caliskan, 2020; Dizdar, 2021). In addition, it has also been suggested that robotics and coding education make limited contributions to problem solving skills, but these results need in-depth research and studies (Taşcı, 2021; Turan & Aydoğdu, 2020).

Developing problem solving skills for gifted students is of particular importance. The main reason for this is closely related to the fact that gifted children have faster processing capacity and advanced mental processing skills (Önal & Büyük, 2020). In this way, although problem solving skills are more advanced for gifted students who can think more flexibly than their peers, not providing education for their interests in the classroom may cause unexpected failures (Yaman & Oğurlu, 2014). For this reason, students' interests should be taken into consideration in differentiating the program prepared for gifted students (Kanlı, 2011). Kılıçkıran et al., (2020) emphasized that robotics and coding education is within the field of interest of gifted students and the reason for this is that robotics and coding courses are related to different disciplines and students solve the problems they face in daily life in a more fun way. Kılınç et al. (2020) examined the behaviors of gifted students in the problem solving process in the science course differentiated with robotics education and according to the results of the study, gifted students stated that they wanted to solve new problems by transferring what they learned to different disciplines, that there were improvements in their problem solving skills thanks to collaborative work, which is closely related to the nature of robotic coding courses, and that the courses attracted their interest. There are similar findings in the literature that robotics and coding education improve the problem solving skills of gifted students (Mauch, 2014; Wang et al., 2014). Considering the studies, it can be said that robotics and coding education contribute to the problem solving skills of gifted students and they enjoy robotics and coding lessons while exhibiting high-level thinking skills.

3. ROBOTİC CODİNG AND COMPUTATİONAL THİNKİNG SKİLLS

Computational thinking is an effort to abstract a problem based on computer-related concepts, to create new systems for solution, and to understand the behavior of machines and humans (Wing, 2006). Computational abstract thinking is a cognitive process that involves algorithmic design, evaluating the findings and process at hand, and generalizing the findings (Selby & Woollard, 2013). Computational thinking, which is adapted to educational environments on the basis of robotics

and coding, simultaneously employs computer literacy as comprehension and application of computer applications, computer fluency as a high level of understanding of the schema of technological systems, and reasoning skills as the application of the information obtained (Serim, 2019). In this context, computing has become an important issue for the development of technology in modern societies (Wing, 2006).

Since computational thinking skills have become a part of our lives, how to teach these skills to people has also become a topic of discussion and as a result, it has been seen as a necessity to teach them to students (Wing, 2008). Although the teaching of computational thinking is seen as a necessity, teachers and researchers have not been able to develop a clear template on how to teach these thinking skills to students. One of the main reasons for this is the popularity of computational thinking in the last decade and the problems in integrating it into other disciplines. In order to integrate computational thinking into courses, it is necessary to establish outcomes related to the nature of computational thinking and these outcomes should be aimed at developing basic sub-skills (Arslanhan & Artun, 2021). On this basis, the integration of computational thinking skills into educational environments has been realized through project-based learning, collaborative learning, game-based learning and robotics training (Hsu, Chang, & Hung, 2018). In the study conducted by Serim (2019), the effect of robotics and coding education through gamification on students' computational thinking levels was examined and positive contributions were found as a result of the research. In the study conducted by Kaya et al. (2020), it was observed that students who received robotics and coding education through gamification had significant differences in collaborative learning, creative thinking, critical thinking and problem solving skills, which are sub-dimensions of computational thinking. These findings provide us with indicators that presenting robotics and coding education through gamification has a positive effect on computational thinking.

In order to develop computational thinking skills for students with different developmental characteristics, educators need to create an appropriate classroom culture. In this context, different needs should be taken into consideration and students' strengths should be addressed. In order to equip students with these skills, teachers' primary actions should include raising students who are confident in computers, emphasizing diverse cultural and computer achievements, ensuring equal participation, and eliminating exclusionary factors (Velenzuela, 2020). Considering all these factors is in fact addressing the cognitive and emotional characteristics of students. The emotional development of students is one of the reasons for organizing the educational environment for gifted education. The importance of computational thinking education for gifted students is closely related to addressing the emotional dimensions of thinking and preventing the problems they experience in learning. In order to develop the computational thinking skills of gifted students, it is presented together with robotics and coding, which also serves as a mediator by improving students' self-efficacy and understanding of the course (Avcu & Ayverdi, 2020). In addition, the gender factor is also very important in the education of gifted students. As a result of the transfer of social prejudices to educational environments, it is possible for gifted female students to show unexpected failure and mask themselves (Freeman, 2004). Among the common outcomes of the computational thinking skills offered by robotic coding, it is believed that there are no differences according to gender and that it provides an increase in academic achievement (Top & Arabacıoğlu, 2021).

4. ROBOTİC CODİNG AND CRİTİCAL THİNKİNGS SKİLLS

Critical thinking is one of the most popular topics today. Critical thinking seems to be shaped around the ideas of investigating the accuracy of data or information to weigh the evidence, basing ideas on factual information to explain the problem or issue, evaluating one's attitude by recognizing one's own prejudices, gaining perspective by evaluating different solutions, and examining the results obtained (Ennis, 1996; Ennis, 2015). There is an important relationship between critical thinking and robotic coding. This relationship is considered a way of questioning the different thoughts that students exhibit during education and developing new strategies. For example, an error that occurs during robotic coding requires analysis to be solved again, and students develop skills to solve the error. Questioning, evaluation and logical thinking steps are required to solve the error (Çömek & Avcı, 2016).

In the experimental study conducted by Çelik (2019), the effect of robotics and coding training on students' critical thinking skills was investigated. According to the results of the study, a significant difference was found between the pre-test and post-test scores of the students. In the study conducted by Tekin (2020), students were taught

robotics and coding with STEM content. According to the results of the research, the findings obtained showed a significant difference in students' critical thinking skills compared to the pre-test. According to the qualitative findings obtained, the students stated that their development in the sub-dimensions of critical thinking such as tolerance to error, finding error and openness to different ideas was positive. Skelton et al. (2011) examined the higher-order thinking skills of engineering students receiving robotics education. According to the results of the study, it was stated that students showed improvements in critical thinking skills.

Critical thinking is of particular importance for gifted children. The reasons for this are closely related to the fact that gifted students think from different perspectives and as a result question the information. Their independent thinking while analyzing information and forming their ideas can be considered one of the other factors in the development of critical thinking skills (Boran, 2016). In the STEM activities study conducted by Yurtbakan and İskenderoğlu (2023), the opinions of gifted students on problem solving skills were taken into account. According to the results of the research, it was found that students sought different solutions and improved their thinking skills. Considering the dimension of critical thinking skills in producing different solutions, this study confirms that they contribute to the critical thinking skills of gifted students. In the study conducted by Şen et al. (2021), gifted students were included in robotics activities. According to the results of the study, students stated that robotics activities contributed to their critical thinking skills. Especially critical thinking dimensions such as problem solving, decision making, and idea generation were among the prominent ideas in the study.

5. ROBOTİC CODİNG AND CREATİVE THİNKİNG SKİLLS

Creativity makes many contributions to the personal and social development of individuals in the process of generating appropriate and original ideas. It also has an important role in solving various problems and generating new ideas by going beyond traditional thinking. When creativity is considered in terms of education, it appears to be a very important component in developing students' problem solving skills. Thanks to creative thinking, individuals' creative potentials are revealed and it is seen that many aspects of individuals develop (Karabey & Yürümezoğlu, 2015).

Mednick (1962) explains creative thinking as associative thinking. Individuals' establishing close or distant associations between different objects and concepts is seen as a factor that develops creativity. Guilford (1956) considered creativity a sub-dimension of intelligence. Guilford defined creativity as the process of generating different ideas and resulting in a product instead of ordinary solutions to a problem thanks to the content we receive from the environment. According to Torrance and Shaughnessy (1998), creativity is being sensitive to the problem, solving the problem, being flexible towards different ideas and generating original ideas. When all these definitions are examined, it is concluded that creativity is the process of addressing a problem, finding a solution that is suitable for its purpose, and original.

According to Guilford (1950), creativity can be developed through the use of appropriate strategies and creativity is important not only in literature and art but also in technology. Creating different environments instead of traditional ones and engaging students with many disciplines, including technology, provides an opportunity to create an educational environment that will develop their creativity (Sawyer, 2011). The integration of technology into educational environments in order to develop creativity has reached an advanced level with robotics and coding trainings (Bayburt & Eğin, 2021). Especially with the prominence of robotics and coding in STEM education programs, students' creative thinking processes has been among the issues that attract attention (Nemiro et al., 2017; Tiryaki & Adıgüzel, 2021). In this context, the creation of areas of interest in students in robotics and coding education, combining with different disciplines and utilizing one's interest shows us the importance of robotics and coding education in terms of creativity.

Robotics and coding education contribute to the development of creativity at preschool, primary and secondary school grade levels. In the preschool period, where the development of basic skills of students between the ages of 0-6 is emphasized (Uyanık & Kandır, 2010), the development of more productive students is important in terms of education (Canbeldek, 2020). One of the most important reasons for this situation is that it is closely related to the fact that a large proportion of an individual's mental development develops in the preschool period (Kabadayı-Siper, 2019). In case traditional materials are insufficient in the process of developing creativity, which is among the mental skills, reflecting three-dimensional

objects on the screen with robotics and coding training is seen as a great improvement in creating appropriate materials (Geist, 2016). In this direction, when the studies conducted in the field of robotic coding education and creativity are examined, a significant difference is observed in the creative thinking test of preschool students participating in block-based robotics and coding education in the study conducted by Siper and Kabadayı. In the study, in which student opinions were also taken, it is clearly seen that students stated ideas about problem identification, sensitivity to the problem and solution, which are among the most important factors of creativity (Kabadayı-Siper, 2019). In this direction, it can be said that block-based robotics and coding education has an important effect in the preschool education. In addition, in the experimental study conducted by Çakır et al. (2021), WeDo 2.0 robotics and coding training was given to preschool students. According to the results of the study, a significant difference was found in students' creativity and creativity subscale verbal creativity scores. In the mixed research conducted by Şanlı-Seda (2021), the robotics and coding course program for preschool students was structured as understand-define-solve-apply-test-evaluate and produce a product. According to the quantitative results obtained, significant differences were found in students' creativity sub-dimensions of fluency, flexibility, originality and enrichment. In the opinions of parents and teachers, which support the findings obtained, asking open-ended questions and collaborative work have an effect on students' mental skills. In the light of these findings, it is seen that robotics and coding education contribute positively to the creative thinking skills of preschool students.

In order to students to reach a good level in academic life, the success achieved in primary and secondary school is very important and new approaches in educational environments emphasize the use of games for educational purposes (Öztemiz, 2013). When the literature is examined, it is thought that robotic coding trainings prepared for primary school students improve students' creative thinking skills as a result of being intertwined with different disciplines, having fun and alternative content, and directing students to abstract thinking (Göksoy & Yılmaz; 2018; Öz & Topdağı, 2022). Haymana and Özalp (2020) investigated the effect of robotic coding education on creativity in a study conducted with fourth grade students. The study examined the formal and verbal creative thinking scores, which are the sub-dimensions of creative thinking, and it was determined that the experimental group scored significantly higher in the formal creative thinking subscale than the control group, while there was no significant difference between the two groups in the verbal creativity subscale.

Many different strategies are used to develop creative thinking (Khawaldeh & Ali, 2016; Poon et al., 2014). The most common of these strategies is SCAMPER. The Scamper strategy is used to improve students' creative thinking process and each letter expresses a different way of thinking related to creative thinking (Gündoğan, 2019). For example, S (Substitute) is called substitution and is related to developing new ways, while E (Eliminate) can be shown as an example of eliminating negative situations (Gladding & Henderson, 2000; Özyaprak, 2016). Scamper technique is used in many different fields to improve students' creative thinking skills (Baş & Kaptan, 2021; Çilci, 2019). In the study conducted by Noh and Lee (2020) on the effect of robotics and coding education on creativity with primary school students, the activities of understanding the codes for blocks, finding problems in the codes and solving problems were restructured with brainstorming and Scamper strategies. According to the results of the study, there were significant differences in students' creative thinking scores. This shows that robotics and coding education as a course contributes to creative thinking strategies.

Developing creativity is also important for gifted students. Giftedness is a combination of above average ability, motivation and creativity. Therefore, it is necessary to use interesting materials to increase the motivation of gifted students in educational environments and to develop their creativity (Renzulli, 2002). When the studies on robotics and coding are examined, it is seen that they contribute positively to the creativity levels of gifted students (Seo & Lee, 2010). In addition, considering the success of gifted students in different fields, it is seen that robotics and coding education is open to different disciplines such as art and music and this contributes to creativity (Jagust et al., 2018). On the basis of the findings that gifted female students showed low interest in robotic coding education, Kim et al. (2015) found a significant difference in favor of the posttest in the pretest-posttest creative thinking levels of gifted female students attending the fifth and sixth grades included in the study.

In summary, it can be concluded that robotics and coding education contribute to the development of creative thinking skills of both primary and

secondary school students. However, when the research were analyzed, there were no studies on the effect of robotics and coding education on creativity levels. Studies on the development of creativity levels of students in the advanced age group are generally studied with STEM activities (Çakır et al., 2021). It is possible to say that the effects of robotics and coding education on the creative thinking skills of high school and university students will be investigated with its inclusion, development and renewal in school environments over time (Danahy et al., 2014).

6. ROBOTİC CODİNG AND LANGUAGE SKİLLS

Considering the studies on the language development of students in early childhood, many studies have been conducted to improve language skills (İşlek & Turan, 2023; Sağlam & Özyürek, 2022). Early literacy skills are among the most basic language skills that preschool students should acquire. All of these basic skills will help students to better comprehend the text they read in the future and thus become more successful students in the academic field. Early literacy skills consist of many dimensions. Among these skills, phonological awareness is related to distinguishing, hearing, combining and discarding sounds (Wright & Jacobs, 2003). Letter knowledge represents the basic skills that students should acquire about the spelling of the letter (Foy & Mann, 2006). While print awareness is necessary for students to understand that the words they see mean something and to increase their awareness of spelling rules (Pullen & Justice, 2003), vocabulary knowledge aims to enrich the words that students have in terms of number and variety of meanings. Finally, listening comprehension skills are related to students' listening time and attention skills (Ergül et al., 2016). All these skills are also considered as receptive and expressive language (Turan & Topçu, 2018). Especially nowadays, the most basic language skills that should be taught to kindergarten children are taught through robotics and coding education along with traditional methods. Among the main reasons for this are factors such as children learning by having fun. In this direction, in the study conducted by Canbeldek and Işıkoğlu (2022), significant differences were observed in students' receptive and expressive language skills in robotic coding education offered to preschool students with game-based activities. In addition, KIBO robots, which are among different robotic applications, are used to support students' early literacy and language development. Thanks to KIBO robots, vocabulary knowledge is enriched by matching pictures and words. At the same time, KIBO blocks are designed according to the eye movements that students exhibit during reading and writing, or in other words, they are designed to be ordered from left to right. Thus, students gain awareness of syntax rules that can be sorted from sounds to syllables, syllables to words and words to sentences. Thus, it contributes to expressive and receptive language in students' language development (Bers, 2018).

Different strategies are used to teach language skills to all students studying at school (Sulak & Erdoğan, 2019; Türkben & Karaca, Maltepe, & Gültekin, 2017). One of the main purposes of using these strategies is to enable students to produce products related to their mother tongue (Tunalı, 2022). However, when situations such as students' lack of motivation and lack of student interest are considered in this process, it will be an inevitable result that many students will fail (Altun, 2009). Therefore, trying to increase students' motivation and communication will directly affect their story creation skills. At this point, it is seen that students working with robots develop expressive language skills in terms of designing the creative story process and telling the stories they create in the process of brainstorming (Sugimoto, 2011).

Analyzing and synthesizing during the reading of a text is also a very important factor. Analyzing a text means that students divide it into parts and examine them in detail. Synthesis, on the other hand, is defined as combining and interpreting the information groups divided into parts with new information within or outside the text (Çiftçi & Temizyürek, 2008). People who analyze and synthesize the text they read become better readers and develop critical reading skills (Coşkun, 2002). Therefore, the reading process, which is among the language skills, should be carried out or designed consciously (Epçeçan, 2009). In line with this requirement, Arts & Bots robotics education based on the project-based curriculum is being studied to improve students' first language skills. In the study, in which the participants were students with grade levels ranging from 7 to 12, it was ensured that students synthesized and analyzed poems and texts containing metaphorical and symbolic language structures through games at the point of reading comprehension. Considering the opinions of students and teachers participating in the study, it was reported that robotics were effective in teaching new words and symbolic language structure (Cross, 2017).

The development of language skills through social interactions provided by robots is among the issues discussed in terms of education. One of the main reasons for this is that social support increases

student motivation and is closely related to the formation of student profiles that are more prone to success (Ceylan & Gündoğdu, 2018; Göksoy & Yılmaz, 2018). In this context, Searbeck et al. (2010) investigated the effects of robots that provide social support and robots that only provide information on students' language achievement. The robots that communicate through social behaviors were also designed to interact with students verbally and non-verbally. According to the results of the study, socially communicative robots made a significant difference in terms of improving language skills compared to robots that only provided information. Student opinions also support the quantitative data.

Learning a foreign language has become a necessity for students who come together for different reasons. Along with this necessity, the inadequacy of materials that students experience in foreign language learning is closely related to the lack of rich materials, the lack of student interest, and the lack of integration of technology into foreign language education (Kaplan, 2013). As a result of such inadequacies in educational environments, students' success is negatively affected (Engin, 2006; Özer & Korkmaz, 2016). Robots fill a big gap in foreign language teaching due to both an inappropriate educational environment and low student interest. IROBI, which is one of the robots used to enrich the educational environment, attract students' attention and increase their motivation, has started to be used in South Korean schools. IROBI, which has different sensors, responds to students' expressions and questions, as well as their movements. IROBI robots, especially those equipped with facial expressions, touch screens, pictures and sound effects, have a very qualified structure in terms of content. With the use of IROBI robots, it was seen that it were very useful in the foreign language learning process of South Korean students attending the sixth grade (Han et al., 2008). Louie et al., (2021) found that students who came together from different countries completed an important task in learning a different language in terms of using robots in different environments, participating in family cooperation, and increasing student interest. In the study conducted by Gordon et al. (2016) with preschool students learning Spanish as a second language, robots recorded students' emotional reactions. After the students' reactions were recorded by the robots, the students were reinforced according to their emotions and the verbal and non-verbal behaviors they exhibited during the learning process in order for learning to take place autonomously. In this direction, it is seen that there are significant improvements in students' Spanish vocabulary learning level. In the study conducted by Alemi et al., (2014), a different language was taught to Iranian middle school students with robots. These robots, called RALL, were designed to use not only the definition of the word but also the word in sentences. According to the results of the study, the vocabulary knowledge of the experimental group of students who learned foreign languages with RALL showed a significant difference compared to the control group. In addition, in the follow-up session test conducted to measure the retention of the words, it was stated that the students remembered the words and the experimental group learned foreign words much faster.

In the study conducted by Shin et al. (2013), gifted students were taught the Scratch coding language. The social interactions of the students were investigated throughout the study. Significant differences were observed in the communication skills of the students participating in the study. The results of the study emphasize that gifted students share and collaborate more in the process of learning different software languages. Robinson et al. (2014) investigated the effect of problem-based STEM activities on students' scientific concept learning skills. According to the results of the study in which both the experimental and control groups consisted of gifted students, the experimental group students showed a significant difference in their ability to learn new scientific concepts compared to the control group.

7. CONCLUSION AND DISCUSSION

In this study, a literature review was conducted to answer the contributions of robotics and coding education to higher-order thinking skills and language development of typically developing and gifted students. As a result of the literature review, it was seen that it contributed to students' higher-order thinking skills such as problem solving, critical thinking, computational and creative thinking, but no study was found on decision-making skills, which are among the higher-order thinking skills. In this direction, it is important to investigate decision-making skills in the context of both students with normal development and gifted students in studies to be conducted with robotic coding education. Researchers' focus on decision-making skills will provide new contributions to the literature.

When the studies conducted on the basis of robotics and coding education are examined,

studies on higher-order thinking skills have generally been developed with the restructuring of the curriculum and programs for the robotics coding course. In this direction, researchers should focus on new studies within the scope of differentiated instructional models of robotics and coding education developed for both students with nongifted and gifted students.

When the integration of robotic coding training into educational programs is considered, it is clearly seen that robotic coding is effective in developing creativity, critical thinking, problem solving, computational thinking dimensions and language skills. Based on these findings, it is very important for educational institutions and teachers to consider making robotic coding activities a part of the curriculum. Teachers can be encouraged to further develop these skills by presenting robotic projects, coding activities and problem solving tasks in classroom environments.

When the studies conducted are examined, it is seen that robotics and coding trainings are intertwined with different disciplines. Therefore, it has come to the fore that not only teachers graduated from technology-related departments but also other branch teachers should improve themselves in this field. Therefore, teachers should be given training on robotic coding and given opportunities to improve themselves. Thus, teachers can effectively use robotic coding tools to support students' creativity, critical thinking, problem solving and computational thinking skills.

When the existing research is examined, it is seen that achievements between genders are positive. However, more efforts should be made for gender equality and greater participation of female students in the field of robotic coding. Gender-based stereotypes in schools and society should be combated, girls' access to robotics coding should be increased, and special programs and activities should be organized to support them in this field.

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