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Research Paper

Student Perspectives on Project Development in Coding and Robotics Courses

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ABSTRACT

This study aims to understand students' views on project development in coding and robotics courses. Focusing on student study groups in this field seeks to provide a broad view using qualitative and quantitative methods. The study group consists of students taking the coding and robotics course. A semi-structured interview form developed by the researcher was used. The data collected during the research were obtained through face-to-face personal interviews. As a data collection tool, the interview form consists of 22 questions. Within the scope of the study, open-ended questions were analyzed through content analysis, and frequency and percentage distributions were used to determine their opinions. With the findings obtained, it was tried to reveal the difficulties encountered by students in coding and robotics courses and their strategies to overcome these difficulties, the effects of the skills they gained (e.g., problem-solving, creativity, communication) on their daily lives, how students develop teamwork, cooperation skills, technology use, and computer programming skills, and the effects on students' self-confidence, motivation and learning. This study will be an essential step in understanding the impact of coding and robotics courses on students' project development processes.

INTRODUCTION

In the age of technology, coding and robotics disciplines constitute one of today's most essential and dynamic fields. These two fields complement each other, offering innovative solutions to many of humanity's problems and shaping the technological development of the future. While coding refers to creating and developing computer programs, robotics enables the implementation of these programs through robots, which are physical entities.

Today, coding and robotics play an essential role not only in computer science and engineering but also in different sectors such as education, health, industry, transportation, and even art. For example, automation systems increase efficiency in production lines, and surgical robots in the healthcare sector improve patients' treatment processes. In education, robotic education programs improve students' creativity and problem-solving skills.

Coding and robotics courses have become vital to today's education system. The primary purpose of these courses is to teach students problem-solving skills, logical thinking, and how to interact creatively with technology. Students who participate in these courses gain various experiences in the project development process and have the opportunity to improve their skills in this field. Therefore, understanding the effects of coding and robotics courses on students and their contributions to project development is very important for the education system. A detailed analysis is needed to understand students' views in such courses. Research should be conducted on students' perspectives on the courses, the difficulties they face in the project development process, the gains they have achieved, and the effects of these courses on their future career choices. When the literature in this field is examined, various studies have widely examined the integration of coding and robotics into education, highlighting its benefits and challenges across different educational levels and contexts.

Gains and Benefits of Robotics and Coding Education: Göksoy and Yılmaz (2018) found that coding and robotics courses improve students' problem-solving, creative thinking, numerical reasoning, efficient work habits, and systematic and analytical thinking. They also emphasized the importance of family participation and out-of-school reinforcement in student success, particularly in numerical courses. Similarly, Şanal and Erdem (2017) analyzed the impact of coding education on students' problem-solving skills, showing that students who engaged in coding and robotics displayed significantly better performance in technical problem-solving than those who did not. However, both groups exhibited similar approaches to social problem-solving.

Impact on Cognitive and Social Development: Kanmaz (2023) explored preschool teachers' perspectives on robotic coding education, concluding that it positively influences cognitive and social development and enhances creativity. Despite these benefits, teachers noted challenges such as the high cost of materials, lack of training programs, and insufficient instructor preparation. Relatedly, Polat et al. (2023) examined pre-service preschool teachers' opinions and found that they primarily associated robotic coding with cognitive development and mathematics activities. Turan and Aydoğdu (2020) also demonstrated

that robotics education enhances preschool children's scientific thinking, problem-solving, and analytical skills, further emphasizing its importance in early childhood education.

Effects on Student Perception and Academic Achievement: Eskici et al. (2020) analyzed the impact of coding education on middle school students' mental images, showing that it reinforced positive perceptions of robotics and emphasized its complexity. Supporting this, Ramazanoğlu (2021) investigated how robotic coding practices affect middle school students' attitudes toward computers and computational thinking, revealing that these activities decreased computer anxiety and improved self-efficacy. Similarly, Soypak and Eskici (2023) conducted a content analysis of scientific publications on robotic coding in mathematics and science education, highlighting its association with academic achievement, problem-solving skills, and meaningful learning in STEM fields.

Challenges and Implementation Strategies: Karataş (2021) discussed the definition of coding education, its place in curricula, and its significance in national development plans. The study recommended compulsory coding and robotics courses, addressing school infrastructure deficiencies, and implementing centralized educational projects. Complementing this, Yumbul et al. (2022) examined classroom teachers' views, revealing that while most teachers understood robotic coding as software-based learning, few had received formal training. The lack of infrastructure and equipment in schools was also a significant concern.

Specialized Applications and Inclusion: Several studies focused on specific groups and unique applications of robotics education. Kılıçkıran et al. (2020) examined its effects on gifted primary school students, demonstrating positive impacts on problem-solving and block-based coding self-efficacy. Knight et al. (2019) explored block-based coding with high school students diagnosed with Autism Spectrum Disorder (A.S.D.), which improved focus, problem-solving, and engagement with technology. Similarly, Bers (2018) discussed integrating robotic coding tools like K.I.B.O. and ScratchJr into early childhood education, highlighting their potential to enhance literacy and play-based learning.

Online Learning and Educational Platforms: The role of online learning platforms in supporting coding and robotics courses was analyzed by Demertzi et al. (2018), who emphasized content structure, interaction patterns, and student motivation. Additionally, García-Carrillo et al. (2021) examined teachers' experiences integrating STEM-based coding and robotics education at the primary school level, identifying challenges related to material selection and instructional strategies.

Collaborative and Play-Based Learning Approaches: Heljakka et al. (2019) studied the impact of toy robots and gamified coding on play-based learning, finding that these approaches increased children's interest in technology. Similarly, Abou Assi (2022) explored how coding and robotics activities in group settings enhance attention control, problem-solving, and creativity.

Project-Based Learning and Future Recommendations: Gültepe (2018) evaluated the Düzce Kodluyor project, assessing its contributions to students and sustainability strategies. The study underscored the need for continued investment in teacher training and infrastructure to maximize coding education's benefits. The collective research indicates that while coding and robotics education significantly enhances problem-solving, creativity, and STEM competencies, addressing challenges such as infrastructure, cost, and teacher training remains crucial for its widespread implementation.

Unlike other studies in the literature, this article presents a student-centred evaluation of coding and robotics education by focusing directly on students' experiences in project development processes, the difficulties they experience and their solutions.

Research in this area emphasizes the importance of collaboration, communication, and teamwork in student groups' project processes. Interaction between groups can improve project quality while allowing students to learn from each other and develop their social skills. Research indicates that coding and robotics courses increase students' creativity and problem-solving skills. In addition to providing students with technical skills, these courses can also play an essential role in developing the ability to generate solutions to real-world problems. Some studies have conducted more in-depth analyses of the effects of coding and robotics courses on students, focusing on student views and experiences. These studies have revealed students' attitudes, experiences, and suggestions regarding the course's project development processes and have provided valuable guidance for educators.

Overall, the studies in this literature provide an essential basis for understanding student views on project development in coding and robotics courses and for improving educational strategies in this area. These innovative educational approaches are expected to increase students' interest in technology and contribute to the future workforce.

PURPOSE OF THE RESARCH

Taking the opinions of students taking coding and robotics courses about project development is essential in increasing the applications in this field. The research contributes to the literature. The study aims to examine in depth the views of students taking coding and robotics courses on project development and to understand how this course affects students' creativity, problem-solving skills, teamwork skills, and interest in technology. This study was conducted to evaluate the effects of the

coding and robotics course on developing students' abilities and aims to examine in detail the students' experiences with the projects, the challenges they faced, their achievements, and the contributions of the course to their overall learning experience. The results of this study will provide important information on how coding and robotics courses develop students' knowledge and skills. They will form the basis for more effective planning of educational system and course content design.

Sub-objectives in line with this purpose:
1. By examining in detail the project development processes of the students taking the coding and robotics course, what difficulties do they face, and what are their strategies for overcoming them?
2. What skills (e.g., problem-solving, creativity, communication) do students gain in coding and robotics projects, and how do these skills affect their daily lives?
3. How do the projects carried out within the scope of coding and robotics courses improve students' teamwork and collaboration skills?
4. How does the project development process improve students' use of technology and computer programming skills?
5. How do coding and robotics projects affect students' self-confidence, motivation and learning?

Scope
This study aims to understand the views of students taking coding and robotics courses on project development processes. Qualitative and quantitative methods were used, focusing on student study groups and trying to provide a broad perspective. The study is limited to students participating in the coding and robotics course. It examines the effects on the development of these students' problem-solving, creativity, communication, teamwork, collaboration, technology use and computer programming skills.

Limitations
The study was limited only to students taking coding and robotics courses. The data used in the study were collected through face-to-face interviews using a semi-structured interview form. The interview form consists of 22 questions. Participants' responses were analyzed within the framework of these questions.

METHOD

The research model, study group, data collection tools, validity and reliability, data collection techniques, data analysis, and limitations are detailed in this section.

Research Model

This study aims to examine the views of students taking the coding and robotics course on project development, and for this purpose, the qualitative research method was preferred. Within the scope of the research, qualitative research techniques such as semi-structured interview techniques were used.

Qualitative methods help to understand the relational nature of social capital by exploring the perspectives of different groups of people. Asking a group of people specific questions can provide more detailed information than surveys (Dudwick et al., 2006). A qualitative approach to cultural assessment contributes to understanding the behaviour of organizations by exploring values, beliefs and assumptions. Moreover, its broad and open-ended nature allows participants to highlight issues that they consider essential (Yauch and Steudel, 2003).

It can be said that the qualitative research approach has features such as having a holistic approach, the participatory role of the researcher, and an inductive analysis (Yıldırım & Şimşek, 2005).

Working Group

The research study group comprises 52 students who took the Robotics and Coding course at Gazi University Gazi Faculty of Education, Department of Elementary Mathematics, in the 2023-2024 academic year. When the gender distribution of the participants in the study group was examined, 73.1% of the 52 participants were female (38) and 26.9% were male (14). When the status of having a personal computer was evaluated, it was seen that 84.6% (44) of the participants answered yes and 15.4% (8) answered no. Considering the duration of computer use, 17.3% (9) of the participants have been using computers for less than two years, 9.6% (5) for 2-4 years, 15.4% (8) for 4-6 years, and 57.7% (30) for six years or more. Regarding project development status, 71.2% (37) of the participants in the study group developed a project, while 28.8% (15) did not develop a project.

Data Collection

Developing the data collection tool started with a literature review in which various questions were identified. Then, a questionnaire consisting of open-ended and semi-structured interview questions was prepared as a result of the literature review

and reviewed by three field experts. In line with the feedback of the three experts, the semi-structured interview form was finalized. The items of the interview form consisting of 22 questions used to collect data are presented in Table 1.

Table 1: Research questions

Item No	Question
1	At which stages of the project development process did you experience the greatest difficulties (idea generation, design, coding, testing, etc.)?
2	Can you explain the specific technical problems you encountered in a project you had difficulty with?
3	What can you say about the communication challenges that arise during teamwork?
4	What strategies did you use to work within the timeline of your project?
5	What methods did you use to detect and correct errors in your project?
6	How did you improve your problem solving skills in coding and robotics projects?
7	How did you develop original ideas in your projects using your creativity?
8	How did you develop your leadership skills during coding and robotics projects?
9	How did you deal with the challenges you faced in your projects?
10	How did you collaborate with team members on your projects?
11	How did you contribute to the success of the project?
12	How did you resolve any conflicts or mismatches you encountered during teamwork?
13	What communication tools did you use in your projects?
14	How did you organize communication within the team and share information?
15	What technological tools or software did you use in your projects?
16	What kind of projects did you develop using these tools and what experience did you get?
17	How did you deal with coding or hardware problems in your projects?
18	What strategies have you used to improve performance on your projects or use resources more effectively?
19	How has your confidence and confidence in projects affected you during coding and robotics projects?
20	How have the successes and positive experiences you have experienced in your projects affected your motivation?
21	How did you learn from the challenges and mistakes in your projects and how do you make improvements to future projects?
22	How has your desire to learn new topics increased during coding and robotics projects?

The interviews were conducted voluntarily with the Department of Elementary Mathematics students. Before the interviews, the purpose of the study was explained to the students, and an environment of trust was created by answering their questions. The 22 questions prepared by the researcher were finalized after the expert review, and the questionnaire was then administered to the Department of Elementary Mathematics students.

Validity And Reliability Studies

The most critical issue in questionnaires is content validity. The most scientific method is utilizing expert opinions to increase content validity (Çepni, 2010). In order to ensure the content validity of the questionnaire containing open-ended questions, the views of three field experts were obtained. In order to increase the reliability of the questionnaire, it was applied to 10 elementary mathematics students, and the comprehensibility of the questions was questioned.

The reliability of the interviews was ensured by submitting the interview forms to expert opinion. Participant control is another essential criterion that increases the reliability of interviews (Maxwell, 1996; Merriam, 1988; Yıldırım & Şimşek, 2005). Participant control was conducted to complete the deficiencies of the data obtained from the interviews and to eliminate misunderstandings. The forms for data collection were first prepared by utilizing the literature and presented to three field experts working in information technologies. After the application permissions were obtained, preliminary interviews were conducted with the students who volunteered to participate in the study, information about the survey was given, and their opinions were obtained through questionnaires.

Data Analysis

The descriptive analysis method was applied to analyze the data in the research process. Based on the results of these analyses, the research aimed to attempt to reflect the views of elementary mathematics students on developing projects related to coding and robotics courses. Interview data were subjected to content and descriptive analysis. In descriptive analysis, the data were summarized and interpreted according to predetermined themes and used to reflect the views of the participants with direct

quotations (Yıldırım & Şimşek, 2005). In addition, unnoticed concepts and themes were revealed through content analysis, and the data were subjected to deeper processing (Çepni, 2011; Ekiz, 2013; Yıldırım & Şimşek, 2005). During the descriptive and content analysis process, the data were coded. Thus, tables containing the views of each participant on the research question were created. In the analysis process, meaningful results were drawn from the data obtained, and the interview analysis was completed. Student opinions obtained from the questionnaire study were analyzed using the content analysis technique, and student opinions obtained from the interviews were evaluated using the descriptive analysis method.

FINDINGS

It includes students' general views on the coding and robotics course, their experiences related to the project development process, a comparison of survey and interview results, and findings on the effectiveness of the training program. For the five sub-objectives, the difficulties encountered by the students in the project development process and strategies to overcome these difficulties, which skills the students gained in coding and robotics projects and the effects of these skills on their daily lives, how the projects carried out within the scope of coding and robotics courses developed students' teamwork and cooperation skills, how students developed their technology use and computer programming skills in the project development process, and the effects of coding and robotics projects on students' self-confidence, motivation, and learning.

Findings Regarding the Difficulties Encountered By Students In Project Development Processes And Their Strategies For Overcoming These Difficulties

This section summarizes the challenges faced by the participants during the project development process and their coping strategies. Based on the responses to the questions posed to the participants, the problems experienced at various stages and their solution strategies are outlined.

Table 2: At which stages of the project development process did you experience the greatest difficulties (idea generation, design, coding, testing, etc.)?

Themes emerging from the answers to the questions	**f**	**%**
Coding challenges	15	29
Ideation challenges	23	44
Design challenges	7	13
Testing challenges	3	6
Cabling challenges	2	4
Difficulties in identifying problems	2	4
Total	**52**	**100**

According to these data, it is clear that the participants experienced the most significant difficulties in the project development process at the idea generation and coding stages. Idea generation was the most frequently cited difficulty with 44%, followed by coding difficulties with 29%. The design and testing phases, on the other hand, were less challenging. Wiring and troubleshooting challenges were reported at lower rates. These findings show that finding the right ideas at the beginning of the project and transitioning these ideas to the coding process are the most critical challenges for the participants.

Table 3. Can you explain the specific technical problems you encountered in a project you had difficulty with? Codes from the answers they gave to the question

Themes emerging from the answers to the questions	**f**	**%**
Coding Challenges	26	50
• Lack of coding knowledge		
• Technical problems (e.g. code not working, difficulty transferring code to Arduino)		
• Difficulty creating algorithms		
• Difficulty understanding and using code sequences		
• Not knowing the programming language		
Design and Connectivity Challenges	12	23
• Lack of material knowledge		
• Difficulty assembling and connecting components (for example: connecting cables correctly)		
Ideation Challenges	6	12
• Difficulty in generating ideas		
• Difficulty transferring ideas to the project		
• Uncertainty about the feasibility of the idea		

Other Challenges • Difficulty in error correction during the testing phase • Deficiencies in computer usage knowledge • Difficulty in group communication • Problems related to computer inadequacy and programs not working	8	15
Total	**52**	**100**

50% of the participants reported coding difficulties, which shows that most technical problems are experienced during the coding process. Coding challenges can often include issues such as the software's complexity, the debugging process's difficulty, or difficulties in understanding algorithmic logic. Design and connectivity challenges come second with 23%. These challenges can include issues such as the physical connection of hardware components, circuit design, or mechanical arrangements. Ideation challenges were mentioned by 12%, which refers to difficulties in developing a suitable idea at the start of the project. Other challenges account for 15%.

Table 4. What can you say about the communication challenges that arise during teamwork? Codes from the answers they gave to the question.

Themes emerging from the answers to the questions	**f**	**%**
Communication difficulties	10	19
Difficulty generating ideas	4	7
Time asynchrony	10	19
Lack of coordination	5	9
Division of labor challenges	3	6
Difficulty gathering	2	4
Different ideas	6	11
Inability to express	2	4
Group work challenges	3	6
Mismatch of class hours	2	4
Lack of compliance	2	4
Other Communication Challenges	5	9
Total	**54**	**100**

19% of the respondents reported communication difficulties, indicating that communication is the most common problem during teamwork. Communication challenges often include communicating ideas, time mismatches, a lack of coordination, and managing different ideas within the group. Idea generation challenges were mentioned by 7%, which refers to team members' difficulties in coming up with appropriate and innovative ideas. Time mismatch and lack of coordination are the highest at 19%; this relates to team members' challenges in arranging work in different time zones or schedules and the inability to coordinate work in an orderly manner. The management of diverse ideas is at 11%, which refers to team members' difficulties in harmonizing various ideas together. Other communication difficulties account for 9%.

Table 5. What strategies did you use to work within the timeline of your project? Codes from the answers they gave to the question.

Themes emerging from the answers to the questions	**f**	**%**
Planning and time management	19	35
Division of labor and task sharing	10	19
Group collaboration and meetings	6	12
Project completion and success	5	10
Dealing with technical problems	2	4
Planned and organized work	4	8
Flexibility and adaptability	3	6
Planning ahead	3	6
Total	**52**	**100**

According to this data, among the most common strategies used by the participants to work according to the project's timeline, planning and time management were the most frequently mentioned, with 35%. This result indicates that the participants attach importance to planning and managing their time effectively to complete the project successfully. Division of labor and task sharing were also mentioned at a notable rate of 19%, indicating that the participants worked on the project by sharing work and assigning tasks. Group collaboration and meetings were also mentioned by 12%, indicating that the respondents regularly communicate and collaborate within the group.

Table 6. What methods did you use to detect and correct errors in your project? Codes from the answers they gave to the question

Themes emerging from the answers to the questions	f	%
Trial and error method	13	22
Access to information through the Internet	9	15
Detecting and correcting errors	21	36
Getting help and consulting experts	10	17
Don't repeat from the beginning	4	7
Communication and Collaboration	2	3
Total	**59**	**100**

According to this data, among the most common methods used by the participants to detect and correct errors in their projects, detecting and correcting mistakes was the most frequently mentioned, with 36%. This result shows that the participants attach importance to actively finding and correcting errors. Trial and error came second with 22%; this indicates that participants seek solutions through trial and error in case of making a mistake and prefer to learn in this way. Getting help and consulting experts ranked third with 17%. This result shows that the participants consulted the people around them and benefited from their experiences to overcome the difficulties they encountered during the project.

Findings Regarding Which Skills Students Gained In Coding And Robotics Projects And The Effects Of These Skills On Their Daily Lives

This section presents the findings on how specific skills related to coding and robotics projects were developed and utilized based on the responses to various questions. Participants shared their experiences in problem-solving, creativity, leadership, coping with challenges, critical thinking, and process management.

Table 7. How did you improve your problem-solving skills in coding and robotics projects? Codes from the answers they gave to the question

Themes emerging from the answers to the questions	f	%
By conducting research	13	32
Trial and error	7	17
Utilizing the Internet	5	12
Exchange of ideas and teamwork	5	12
Improvement in the problem-solving process	4	10
Using materials effectively and dealing with constraints	2	5
By receiving training	1	3
Patience and time planning	1	3
Getting help from experts	1	3
Watching videos	1	3
Total	**40**	**100**

The most common methods used by the participants to improve their problem-solving skills in coding and robotics projects were research (32%), trial and error (17%), and using the internet (12%). These results show that participants prefer to research the topic and then learn by experimentation to solve the problems they encounter in their projects. The exchange of ideas and teamwork (12%) was also an important strategy. This shows that working together and exchanging ideas with each other was effective in solving the problems that arose in the participants' projects. Improvement in the problem-solving process (10%) was another theme, indicating that the participants continuously improved themselves to overcome the difficulties they encountered in their projects and increased their problem-solving skills. Using materials effectively and dealing with constraints (5%), receiving training (3%), being patient and planning time (3%), getting help from experts (3%), and watching videos (3%) were mentioned at lower rates. However, it is seen that these methods were also used by the participants in the problem-solving process.

Table 8. How did you develop original ideas in your projects using your creativity? Codes from the answers they gave to the question

Themes emerging from the answers to the questions	f	%
Inspiration	8	10
Creative thinking and Innovation	16	21
Practical application and trial and error	7	9
Use of information sources	3	4
Needs and usability thinking	2	3
Looking at real-life problems and finding solutions	8	11
Group collaboration and exchange of ideas	4	5

Design process and creativity	20	26
Theme and topic selection	2	3
Brain storm	4	5
Application & functionality	2	3
Total	**76**	**100**

As seen in Table 8, the most mentioned theme was “Design process and creativity” (26%). This shows that the participants developed original ideas using creative design processes in their projects and maximized their creativity. Another important theme was “Creative thinking and innovation” (21%). This shows that the participants generated original ideas using creative thinking processes and innovative approaches in their projects. The themes of “Practical application and trial and error” (9%) and “Looking at real-life problems and generating solutions” (11%) also have an essential place. These themes show that participants developed original ideas in their projects by drawing inspiration from practical experiences and real life. “Brainstorming” (5%) and ‘Group collaboration and exchange of ideas’ (5%) were also among the strategies used by the participants to develop creative ideas. This shows that the participants brought together different perspectives and used collective intelligence to generate original ideas. In addition to these themes, “Inspiration” (10.26%), “Use of information sources” (4%), “Need and usability thinking” (3%), “Theme and topic selection” (3%), and “Application and functionality” (3%) were among the other strategies used by the participants to develop creative ideas.

Table 9. How did you develop your leadership skills during coding and robotics projects? Codes from the answers they gave to the question

Themes emerging from the answers to the questions	**f**	**%**
Group work and collaboration	14	23
Development of leadership skills	12	20
Communication and coordination	7	11
Planning and organization	7	11
Advancement and defense of ideas	4	7
Taking responsibility and distributing jobs	4	7
Becoming a pioneer and directing	3	5
Positive development and experiences	3	5
Do not be aware of your own development	2	3
Impact of knowledge and experience on leadership skills	2	3
Active role-playing and contribution	2	3
Authority use	1	2
Total	**61**	**100**

Participants stated that they developed their leadership skills in various ways during their coding and robotics projects. The most mentioned theme was "Group work and collaboration" (23%). This suggests that by working together on projects, participants developed their leadership skills within the group and increased their ability to collaborate. The theme "Development of leadership skills" (20%) was also significant. Participants indicated that they developed their leadership skills by taking on leadership roles in projects and directing group members. The theme "Communication and coordination" (11%) is also noteworthy. This theme shows that the participants strengthened their leadership skills by communicating effectively and coordinating project tasks. The theme of "planning and organization" (11%) also plays a vital role in developing project leadership skills. Participants stated that they developed these skills by assuming leadership roles in the planning and organization of projects. Other themes included "Putting forward and defending ideas" (7%), "Taking responsibility and distributing work" (7%), "Leading and guiding" (5%), "Positive development and experiences" (5%), "Being aware of one's development" (3%), "The impact of knowledge and experiences on leadership skills" (3%) and "Taking an active role and contributing" (3%). These themes show that the participants developed their leadership skills differently and assumed leadership roles by participating actively in the projects.

Table 10. How did you deal with the challenges you faced in your projects? Codes from the answers they gave to the question

Themes emerging from the answers to the questions	**f**	**%**
Group work and collaboration	27	28
Getting help and advice from friends	23	24
Do not research	15	15
Try and learn and try again	11	11
Do not be patient and do not motivate	5	5
Getting help from the internet	5	5
Solving problems together	5	5
Sharing knowledge and experience	4	4
Understanding the problem and finding solutions	3	3
Total	**98**	**100**

Participants' strategies for coping with the challenges they faced in their projects were categorized into several themes. The most common themes were "Group work and collaboration" (28%) and "Help and advice from friends" (24%). These themes indicate that participants tried to overcome the challenges they faced in the projects by working with group members and getting help from friends. The theme of "conducting research" (15%) is also essential.

Participants tried to find solutions to overcome the difficulties they encountered in their projects by researching and acquiring new information. The theme of " learning by trying and trying again" (11%) is also noteworthy. Participants tried to find solutions to the challenges they faced in their projects by experimenting and trying again.

Other themes include "Being patient and motivating" (5%), "Getting help from the internet" (5%), "Solving problems together" (5%), "Sharing knowledge and experience" (4%), and "Understanding the problem and finding solutions" (3%). These themes show that the participants tried to overcome the difficulties they encountered in their projects through various methods and diversified their coping strategies.

Findings Regarding How the Projects Conducted Within The Scope Of Coding And Robotics Courses Develop Students' Teamwork And Collaboration Skills

This section presents the findings on teamwork, collaboration, communication, and conflict management in projects based on the responses to various questions. Participants shared their experiences on how they collaborate with team members, how they contribute to the success of projects, conflict resolution methods, communication tools, and information-sharing strategies.

Table 11. How did you collaborate with team members on your projects? Codes from the answers they gave to the question

Themes emerging from the answers to the questions	**f**	**%**
Collaboration and Task Sharing	29	71
Planning and Coordination	4	10
Communication & Cooperation	1	2
Use of Talents and Contribution	2	5
Mutual Support and Teamwork	4	10
Group Dynamics and Cooperation Process	1	2
Total	**41**	**100**

Participants' collaboration experiences with team members in their projects were categorized into various themes. The most common theme was "Collaboration and Task Sharing" (71%). This theme reflects participants' experiences working with team members in their projects and sharing tasks effectively. Team members tried to collaborate to address different aspects of the project, distribute tasks, and work together to complete the project.

Among the other themes, "Mutual Support and Teamwork" (10%) is noteworthy. This theme reflects the team members' experiences supporting each other and providing mutual support when working together. By capitalizing on each other's strengths, team members contributed to the successful completion of the project. The theme "Planning and Coordination" (10%) is also essential. This theme reflects the team members' experiences working together in the planning and coordination of the project. By planning and coordinating the different phases of the project, the team members ensured the successful completion of the project.

Table 12. How did you contribute to the success of the project? Codes from the answers they gave to the question.

Themes emerging from the answers to the questions	**f**	**%**
Creating and sharing ideas	28	33
Researching and acquiring knowledge	13	16
Coding and programming	13	16
Fulfilling tasks and contributing	12	14
Reporting & documentation	7	8
In-group communication and compliance	6	7
Design & planning	5	6
Total	**84**	**100**

Participants' contributions to the project's success were categorized into various themes. The most common theme was "Generating and sharing ideas" (33%). This theme reflects the participants' experiences generating ideas for the project's success and sharing these ideas within the team. Participants contributed to the project's progress by developing creative ideas and actively sharing these ideas within the team to create a shared vision for the project. Other important themes included "Research and information gathering" (16%) and "Coding and programming" (16%). These themes reflect the participants' experiences of researching and integrating the knowledge necessary for the project's success and using coding and programming skills.

Participants contributed significantly to the project by researching the information needed to meet the project requirements and using appropriate coding techniques. The theme "Fulfilling tasks and contributing" (14%) is also noteworthy. This theme reflects the participants' experiences of successfully accomplishing their assigned tasks within the project and contributing to the team's overall success. The participants contributed significantly to the project's success by completing the assigned tasks promptly and effectively. The other themes of "Reporting and documentation," "Communication and cohesion within the group," and "Design and planning" also contributed significantly to the success of the project.

Table 13. How did you resolve any conflicts or mismatches you encountered during teamwork? Codes from the answers they gave to the question.

Themes emerging from the answers to the questions	f	%
Solving problems by talking	33	57
Don't live in conflict and work in harmony	19	32
Conflict of ideas in decision-making processes	2	4
Voting or obeying the majority's decision	2	4
Problem-solving with leadership or position changes	2	4
Total	**58**	**100**

Participants' experiences resolving conflicts or incompatibilities encountered during teamwork were categorized into various themes. The most common theme was "Solving Problems by Talking" (57%). This theme shows the participants resolved their problems through open communication and talking. The team members solved the issues by addressing them directly, communicating with each other, and talking them through. The other important theme is "Avoiding Conflict and Working in Harmony" (32%). This theme reflects that team members solved problems harmoniously and avoided conflicts. Team members worked in harmony by accepting different ideas and respecting each other.

The other themes, "Conflict of Opinion in Decision-Making Processes," "Voting or Following the Majority Decision," and "Problem-Solving through Leadership or Position Changes," are less common. This suggests that participants resolve conflicts through direct communication and working in harmony. Participants generally adopted positive approaches to dealing with conflict or disharmony, such as communication, cooperation, and harmony. These approaches contributed to the efficient and effective conduct of teamwork.

Table 14. What communication tools did you use in your projects? Codes from the answers they gave to the question.

Themes emerging from the answers to the questions	f	%
Telephone	22	37
Tablet & Computer	22	37
Internet	2	3
WhatsApp	5	9
Face to face	5	9
Email	2	3
Online messaging apps	1	2
Total	**59**	**100**

When we evaluate the communication tools used in the projects in terms of percentages, we see that the most commonly used communication tools are phones and tablets/computers. Both stand out as the participants' most preferred means of communication, each with a rate of 37%.

WhatsApp and face-to-face communication are other tools that are similarly used in the projects, with a share of 9% each. These tools may have been preferred to meet the participants' needs for interaction and fast communication. Email and online messaging applications were less preferred, with 3% each. This may indicate that respondents prefer faster and more efficient means of communication and that they often use the less used tools for more specific needs. As the internet is a general category, it was used less prominently than the other communication tools, accounting for only 3%.

Table 15. How did you organize communication within the team and share information? Codes from the answers they gave to the question.

Themes emerging from the answers to the questions	f	%
WhatsApp	28	31
Telephone	17	19
Face to face	12	14
Messaging	8	9
Through social media	5	6

Group building	11	12
Sharing information	8	9
Total	**89**	**100**

When we evaluate the various communication tools used by the participants to organize communication and share information within the team, we see that WhatsApp is the most preferred communication tool. 31% of the respondents preferred WhatsApp, which shows that it is the most frequently used tool for intra-team communication. The phone is in second place with 19%. Face-to-face communication was used by 12% and ranked third. 9%, social media used texting by 6%, and group communication by 12%. These results show that respondents mostly prefer instant communication and practical and fast information-sharing solutions.

Findings On How Students' Technology Use and Computer Programming Skills Developed In The Project Development Process

In this section, in line with the answers given to various questions, the findings obtained regarding the technological tools and software used in the projects, the development process of the projects, the problems encountered, the follow-up and integration of technological innovations, performance enhancement strategies and the integration of the acquired knowledge into daily life are presented.

Table 16. What technological tools or software did you use in your projects? Codes from the answers they gave to the question.

Themes emerging from the answers to the questions	**f**	**%**
Computer	29	25
Tinkercad	12	11
Mblock	24	20
Telephone	9	8
Scratch	2	2
Cables	2	2
Code.org	4	3
YouTube	4	3
Robotic coding parts	31	26
Total	**117**	**100**

Most participants (26%) stated that they used robotic coding parts in their projects. Robotic coding parts provide students with interactive and hands-on experiences by bringing hardware and software together. This allows students to realize real applications in projects that affect the physical world and involve programming.

Computers (25%) were also used quite extensively. This shows that projects are often designed and coded on a computer-based platform. Other software, such as Mblock (20%) and Tinkercad (11%), were also used. These are usually tools that help students with coding and design.

Other technological tools and software were also used in the projects but represented by lower percentages. This shows that respondents use various technological tools and software in their projects.

Table 17. What kind of projects did you develop using these tools and what experience did you get? Codes from the answers they gave to the question.

Themes emerging from the answers to the questions	**f**	**%**
Technology and Product Development	19	37
Education and Teaching Materials	16	31
Game Development and Entertainment	10	19
Coding and Programming	7	13
Total	**52**	**100**

Most respondents (37%) indicated that they develop projects focused on technology and product development. Such projects usually aim to build a new product or technology, improve an existing product, or create technological solutions. These projects typically provide practical experiences and allow participants to understand the product development process and experience its applications.

Projects related to education and teaching materials (31%) were also commonly mentioned. Such projects usually focus on exploring how technology can be used in education. Participants may have had the opportunity to enhance their learning experience and improve their teaching process by developing educational materials or tools.

Game development and entertainment projects (19%) also account for a significant share. Such projects allow students to experience the game development process and learn while having fun through games.

Coding and programming projects (13%) have a smaller share. These projects allow participants to improve their coding skills and create software applications. These projects help participants develop algorithmic thinking skills and problem-solving abilities.

Table 18. How did you deal with coding or hardware problems in your projects? Codes from the answers they gave to the question.

Themes emerging from the answers to the questions	f	%
Research and Acquire Knowledge	39	43
Getting Support and Consultation	37	40
Re-Try and Debugging	16	17
Total	**92**	**100**

Most participants (43%) said they dealt with coding or hardware problems in their projects by researching and obtaining information. This shows that participants used online resources to overcome their challenges and researched to get the needed information.

Seeking support and consultation (40%) was also a widespread strategy. Participants sought help from people around them or experts to solve problems. This emphasizes the importance of team collaboration and community support. Retrying and debugging (17%) is also an important strategy.

Table 19. What strategies have you used to improve performance on your projects or use resources more effectively? Codes from the answers they gave to the question.

Themes emerging from the answers to the questions	f	%
Research and Acquire Knowledge	25	41
Communication and Business Department	10	16
Resource Use and Learning Methods	9	15
Strategy and Problem Solving	11	18
Technology Use and Application	6	10
Total	**61**	**100**

Most participants (41%) used research and information strategies to improve their performance or use resources more effectively in their projects. This strategy shows that the participants actively used a variety of sources to total the information needed for their projects and to identify best practices. The communication strategy and division of labor (16%) are also essential.

Participants improved communication within the team and distributed tasks more effectively to improve their performance in their projects. This strategy shows that the participants tried to increase collaboration within the team and ensure that each member made the best use of their strengths. Other strategies included resource utilization and learning methods (15%), strategy and problem-solving (18%), and technology use and application (10%). These strategies reflect the various approaches participants used to improve their project performance. The participants worked more efficiently and effectively on their projects using these strategies.

Findings on the Effects of Coding And Robotics Projects On Students' Self-Confidence, Motivation And Learning

In this section, in line with the answers to various questions, the findings on self-confidence, motivation, willingness to learn, learning from mistakes, and how experiences shape learning during coding and robotics projects are presented. Participants' experiences shed light on their development and learning processes in these areas.

Table 20. How has your confidence and confidence in projects affected you during coding and robotics projects? Codes from the answers they gave to the question.

Themes emerging from the answers to the questions	f	%
Positive emotions and experiences	10	20
Confidence and self-belief	16	32
Education and professional development	7	14
Personal development and experiences	5	10
Technology and skill development	12	24
Total	**50**	**100**

32% of the participants stated that their self-confidence increased during coding and robotics projects. This shows that participants' confidence increased as they succeeded in these projects and developed new skills. This increased self-confidence

can enable participants to gain more experience and dare more significant projects. Responses around technology and skills development are also substantial (24%). This shows that respondents' self-confidence increases with technology and skills development.

Learning new technologies and acquiring new skills can increase participants' confidence and encourage them to undertake more complex projects.

Other responses included themes related to education and professional development (14%). This suggests that participants' confidence in their professional development and education increased with their success in coding and robotics projects. Their achievements through these projects can enable them to further progress and succeed in their future careers.

In general, most of the participants stated that their self-confidence increased while working on coding and robotics projects. These projects can change the participants' approach to technology and make them stronger and more self-believing individuals.

Table 21. How have the successes and positive experiences you have experienced in your projects affected your motivation? Codes from the answers they gave to the question.

Themes emerging from the answers to the questions	**f**	**%**
Increasing Motivation	32	86
Increasing Self-Confidence	5	14
Total	**37**	**100**

86% of the respondents stated that the successes and positive experiences they encountered in their projects increased their motivation. This result shows that achievements strengthen people's motivation and encourage them to go further.

As they achieve success in their projects, participants can gain more self-confidence and become even more motivated. This can help them approach future projects more enthusiastically and achieve higher goals. On the other hand, 14% stated that the successes they encountered in their projects increased their self-confidence. This shows that achievements increase motivation and the participants' self-confidence. Achievements can reinforce participants' belief in their abilities and skills while encouraging them to pursue more challenging goals.

Overall, achievements and positive experiences in projects increase participants' motivation and self-confidence. This can enable participants to progress further and focus more strongly on future projects.

Table 22. How did you learn from the challenges and mistakes in your projects and how do you make improvements to future projects? Codes from the answers they gave to the question.

Themes emerging from the answers to the questions	**f**	**%**
Planning & Organization	18	32
Experience and Obtaining Knowledge	12	21
Developing Coding Capabilities	7	11
The Better Communication and Business Division	4	7
Patience and Self-Sacrifice	3	5
Materials & Research	3	5
Learning from Mistakes and Challenges	3	5
Openness and Improvement to Innovations	2	4
Group Selection and Group Size	2	4
Increasing Skills in Computer Use	1	2
A Good Preliminary Preparation and Planning	1	2
Communication and Time Management	1	2
Total	**57**	**100**

32% of the respondents indicated that they focused on planning and organizational skills to overcome the challenges they faced in their projects. This highlights the importance of developing an effective strategy to deal with challenges.

Planning and organization can run the project more efficiently and avoid potential problems. Gaining experience and knowledge comes second with 21%. Respondents used their expertise and knowledge to learn from the challenges they faced in their projects. This emphasizes the importance of continuous learning and development.

Table 23. How has your desire to learn new topics increased during coding and robotics projects? Codes from the answers they gave to the question.

Themes emerging from the answers to the questions	**f**	**%**
Interest and Curiosity	24	28
Learning Demand and Motivation	20	24

Obtaining Information and Research	11	13
Developing Coding Skills	10	12
Technology-Related Innovations and Applications	5	6
Fun & Enjoyment	4	5
Motivation Based on Progress and Success	4	5
Electronic and Programming Capabilities	3	4
Tinkercad and Design Request	2	2
Mblock and Software Usage	2	2
Total	**85**	**100**

28% of the participants mentioned their interest and curiosity as the main factors increasing their willingness to learn new topics. This shows that participants are committed to their projects and motivated to learn more about the issues they are interested in. Willingness and motivation to learn ranked second with 24%. The participants stated that a high desire and motivation to learn makes them more eager to explore and learn new topics. This emphasizes the importance of being motivated and committed to a continuous learning process. Other important themes were acquiring and researching knowledge, developing coding skills, and innovations and applications related to technology. These themes reflect the participants' interest in continuously improving themselves and following innovations in the field of technology. In this way, their willingness and motivation to learn new topics increases.

DISCUSSIONS AND CONCLUSION

Regarding the findings obtained as a result of the data analysis related to the research questions determined for the study, the following conclusions were reached, and these results were discussed together with the results of other studies on the subject.
This study provides a comprehensive analysis of the challenges faced by the participants in coding and robotics projects, their strategies, and their contributions to the project's success. The findings show that the most significant challenges were experienced during the project's idea generation and coding phases. The difficulties encountered in the idea-generation process are related to finding appropriate and innovative ideas at the beginning of the project. At this point, participants need to focus on their creative thinking process and use techniques such as brainstorming to develop better ideas.

Considering that students' creative thinking skills are developed through brainstorming, it is predicted that they will be more motivated to do their work, and the efficiency and quality of the work may increase. In addition, it is stated that with the brainstorming method, students can improve their thinking skills by working together in any learning environment (Şahin, 2005). It was determined that coding difficulties were related to technical problems. Generally, it included issues such as the software's complexity, the debugging process's difficulty, or difficulties in understanding algorithmic logic. This suggests that participants need more resources and training to develop coding skills.

Zinovieva et al. (2021) emphasize that online simulators are essential for developing coding skills. Their study states that these simulators encourage students to participate more actively in the coding process and allow them to consolidate their existing knowledge through practical applications. In addition, it is stated that online simulators contribute to the learning process as a supportive tool for acquiring professional competencies.

Communication difficulties were found to be the most common problem area during teamwork. In the communication process, the sender's failure to determine the purpose of the communication before initiating it can constitute an essential barrier to communication. Therefore, the sender should clearly define their purpose before initiating communication (Bolat, 1996). Developing communication skills and implementing strategies to strengthen communication, such as regular meetings, are essential. This situation indicates that team members need to make more effort to exchange ideas, time mismatches, and need for coordination.

Lack of motivation and low morale were also identified as common problems in the later stages of the project. This shows that the participants need more support and motivation to keep their motivation high during the project process. Therefore, providing continuous support and encouragement within the team may affect the project's success. In their study, Açıkgöz and Günsel (2014) concluded that the team leader's command of the project details, close monitoring of the processes and directing the team members to fulfill their tasks successfully increased the emotional commitment of the members to the team goals and objectives. This increases the intrinsic motivation of the members.

It was found that the most used strategies in the research phase were research, trial and error, and using the internet. These strategies show that the participants prefer first to obtain information and then learn by experimentation to solve the problems they encounter in their projects.

Factors that contributed to the success of the projects included:

- Generating and sharing ideas.

- Conducting research, coding, and programming.
- Fulfilling tasks and making contributions.

These findings show that the participants played an active role in different areas to support the project's success and included their various skills in the project.

The study evaluated the participants' teamwork experiences, communication tools, the technologies they used in their projects, their solution strategies, and the results they achieved under various themes. The findings reveal that the participants prefer direct communication and working in harmony in team communication. Participants tended to talk and address issues openly to resolve conflicts and incompatibilities. This suggests that effective team interaction is critical for solving problems and completing projects. Koç, Terzi, and Gül (2015) emphasized that developing practical problem-solving and communication skills can be essential in overcoming issues in interpersonal relationships and establishing positive communication. It was stated that developing these skills can increase self-confidence, control anger, and solve problems positively.

According to a different perspective on this issue, Turan et al. (2015) argue that experienced individuals are more successful in scanning, generating, organizing and evaluating information than inexperienced individuals. In this direction, the literature has stated that experienced individuals show significant differences in online search strategies such as control, trial and error, problem solving and evaluation, unlike inexperienced individuals.

In addition, the findings regarding communication tools show that participants generally preferred instant communication tools such as phones and tablets/computers. These tools allowed for continuous and effective intra-team communication. The widespread use of instant communication applications such as WhatsApp reflects that they meet the participants' needs for mutual interaction and fast communication. According to Yazıcı (2015), young people find texting faster, more effective, and more practical than talking on the phone and often prefer this communication method. In addition, the fact that these applications are cheaper and even accessible on the internet increases the preference rate.

The findings regarding the technological tools and software used in the projects show that the participants generally used robotic coding parts and computers. This reflects that participants combine hardware and software to provide practical and interactive experiences in their projects and often work on computer-based platforms.

The findings regarding solution strategies are also noteworthy. It is seen that most of the participants used techniques such as planning, organization, and gaining experience to deal with challenges. These strategies show that the participants have developed a practical approach to solving problems and constantly strive to learn and improve.

In conclusion, this study emphasizes the importance of understanding the challenges faced in coding and robotics projects and developing effective strategies to deal with these challenges. Strengthening communication within the team, maintaining motivation, and incorporating different skills and abilities into the project can lead to successful project completion. Future research could confirm these findings on a larger sample and examine the effectiveness of more specific strategies. The study discussed the participants' teamwork experiences, communication tools, technologies used in the projects, solution strategies, and outcomes in depth. The findings show that the participants succeeded in their projects through active communication, technology use, and solution-oriented approaches. These results emphasize the importance of teamwork and technology in education and guide future educational practices.

RECOMMENDATIONS

Creative thinking techniques such as brainstorming should be encouraged to be used more widely in coding and robotics projects. These techniques can help participants find innovative and effective solutions by improving their idea-generation processes. It shows that there is a need for more resources and training to enhance participants' coding skills. In this context, there should be more emphasis on coding education in schools and educational institutions, and students should be taught coding skills from an early age.

Communication difficulties were identified as an essential problem in the teamwork process. Therefore, training and workshops should be offered to students to develop practical communication skills. In addition, implementing strategies to strengthen communication within the team should be encouraged.

Lack of motivation and low morale were identified as a common problem in the later stages of the projects. Therefore, support systems should be created to keep students' motivation high, and strategies should be adopted to increase motivation within the team.

Participants generally used technological tools such as robotic coding parts and computers. In this context, educational institutions and schools should provide environments that encourage students to use technology effectively and facilitate access to technology.

Multicenter research can be conducted better to understand participants' experiences in coding and robotics projects. Studies comparing participants' experiences from different geographical regions and cultural backgrounds can provide broader

perspectives. Applied studies can be conducted to verify the effectiveness of the strategies identified in coding and robotics projects. These studies can evaluate how the approach works in real-world settings and provide more concrete recommendations for future educational practices.

Long-term monitoring and evaluation studies can be conducted to understand the long-term effects of coding and robotics projects. These studies can help us better understand the impact of students' project experiences on their academic achievement, career choices, and problem-solving skills.

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