SCIENCE e-ROBOT

A METHODOLOGICAL GUIDE TO ADAPTATION OF ROBOTIC-ASSISTED SCIENCE TEACHING TO MODERN LEARNING AND TEACHING MODELS

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PREFACE

This methodological guide, which is the 2nd Intellectual output of the "Science e-Robot" project, was created to be a mentor resource containing innovative pedagogy and teaching methods with technology content to guide people who teach / will teach science to improve science teaching professionalism. The guide presented as a holistic methodological strategy for the acquisition of key competencies and skills; It is one of the main optimization tools of our project in reducing the failure in science and thus improving science literacy.

It is designed to allow the adaptation of robotic technology to modern education approaches/strategies and science teaching with innovative teaching models developed towards them.

This methodological guide is structured in 5 Modules. Module 1, in partner countries; science education, the use of technology in education, educational robotic applications and types of robotics, the place of technology in education and training and the problems encountered. Module 2; includes 21st-century skills and key competencies, scientific literacy status in the project partner countries, and the relationship between scientific literacy and 21st-century key skills. Module 3; includes the national importance and sample applications of educational robotics-assisted science teaching and learning applications, the introduction of structural, electronic and software dimensions of robotic materials used in applications, and the positive and negative effects of educational robotics on science learning and teaching. Module 4; Science teaching in different learning models and the relationship of these models with educational robotics studies, the first intellectual output of the project, the introduction and explanation of the e-workbook platform, sample educational robotic science activities for the ages 10-13 and 14-17, the e-workbook platform and the experiences of the project partners. and sharing ideas.

We hope that this guide, which reflects a common science teaching perspective, will positively affect science teaching and learning in the classroom of science teachers in different countries, become a facilitator for them and be used as a learning-teaching material.

Consortium

PROJECT PRESENTATION

This project, whose focus is on the relationship between core competencies and scientific literacy, is the 21st century core competencies that we call critical thinking, problem solving, creativity, communication and collaboration that determine how individuals approach complex challenges. It is based on the fact that it affects the skills applied to daily events such as reading, arithmetic mathematics and scientific literacy.

In order to increase the level of acquisition of 21st century basic skills, the aim of this project is to increase the quality of education by contributing to the integration of technology into the learning and teaching process; to improve scientific literacy within the consortium by contributing to the development of basic competencies by integrating educational robotics technology into scientific learning and teaching process.

This project has been co-financed by the European Commission, within the Erasmus+ Program, contract Project nº: 2020-1-TR01-KA201-092601

The fields of education that benefits from project activities and outputs are: School Education.

The project as a duration of 24 months, starting at 31/12/2020 and ending on 30/12/2022

General goal;

In order to increase the level of acquisition of 21st century basic skills, the aim of this project is to increase the quality of education by contributing to the integration of technology into the learning and teaching process; To improve scientific literacy within the consortium by contributing to the development of basic competencies by integrating educational robotics technology into scientific learning and teaching process.

Our objectives throughout the project:

1- Developing an innovative science learning-teaching strategy compatible with the educational context of the partner countries related to the scientific learning teaching process in which educational robotics is integrated for the target groups by developing 3 intellectual outputs,

2- Increasing the knowledge and skills of 42 staff from partner organizations on different teaching models, measurement and evaluation and robotic methods / techniques in interdisciplinary science teaching,

3- By organizing 5 large-scale multiplier activities and other dissemination activities; Improving the knowledge skills of at least 200 science teachers, 50 teacher candidates and 100 experts on the use of intellectual outputs developed under this partnership,

4- Developing basic competence and scientific literacy of 10-17 age group students through educational robotics,
5- To develop long-term innovative cooperation between partners.

Main activities of the project;

The project includes;
• 3 transnational project meetings
• 2 short-term staff training
• 5 dissemination activities (multiplier events)

As an innovative trend among the project results, we have 3 important intellectual outputs such as e-workbook open education resource, methodological guide for implementation and comprehensive assessment and evaluation toolset.

Project intellectual outputs;

We have 3 intellectual outputs within the scope of the project.

O1	Integration of Educational Robotics into the Scientific Learning Teaching Process Open Education Resource (OER)	It is pedagogically compatible with the target group age levels and triggers the creativity and critical thinking of the student; It can be easily implemented by teachers and students where there are activities that require problem-solving skills to work and enable collaboration; improves the basic competencies of teachers and students, has been adapted to various scientific themes and sub-subject areas in different modern teaching models and has a positive attitude towards science and has learning and teaching scenarios for individuals. E-workbook platform, which provides dynamic, personalized teaching-learning and user convenience, which will influence innovative science activities with robotics content. Related link; https://www.scienceerobot.com/eworkbooks
O2	Practical Methodological Guidelines for Robotic Assisted Science Teaching	Helps overcome the obstacles to gain students' acquisition of scientific theme and sub-subject areas for the target group age levels determined by the partners; a practical guide to the project partners and in English, describing the application of robotic pattern science activities in various modern teaching models and providing guidance in the use of the open educational resource.
O3	Comprehensive Measurement and Evaluation Toolkit	Testing robotic supported science learning activities; it will provide guidance on assessing their strengths and weaknesses.

Target groups;

The following target groups are identified in the frame of the project:

• Science teachers and teacher candidates, staff of partner organizations, students, parents;

• School networks, local and national governments and education authorities, education experts, academics and institutions;

• Civil society, commercial, sectorial and global organizations and the general public.

Partnership;

The consortium was established with 7 organizations from 5 different program countries:

P0 - Coordinator (Hadiye Kuradacı Science and Art Center - Türkiye) is a public school that implements differentiated and enriched education in a hands-on workshop style with a learning-by-doing pattern in order to maximize the cognitive and general ability development of gifted students aged 7-17.

P1 - Ministry of Education General Directorate of Special Education and Guidance Services (Türkiye); It is a national education authority responsible for coordinating Science and Art Centers at the country level.

P2 - Mersin University (Türkiye)is an institution that trains teachers with a deep-rooted history in different academic branches.

P3 – RobyCode UG(Germany); is a German organization that develops smart solutions, carries out various collaborations and develops the innovation ecosystem with innovative projects.

P4 - Agrupamento De Escolas De Portela E Moscavide (Portugal), especially by creating digital technologies and classrooms of the future; It is a Portuguese school that aims to maintain students' interest in learning and achieve better learning outcomes.

P5 - Istituto Istruzione Scolastica Superiore “Carlo Alberto Dalla Chiesa” (Italy) school curriculum; It is an Italian school built on European skills, 21st century competences, active citizenship skills and the arts.

P6 - National High School of Informatics (Romania), with 53 years of history, under different names, is a highly prestigious Romanian educational institution offering an adaptable multicultural learning environment.

MODULE 1

1.1. SCIENCE EDUCATION IN TURKEY

MODULE 1

At the end of the First World War, the Ottoman Empire collapsed and the Republic of Turkey was established in 1923. Atatürk is the founder of the Turkish Republic. With the establishment of the new Turkish Republic, education has become one of the areas of great importance (Grossman, Onkol, & Sands, 2007). In 1924, the Turkish Education System was centralized with the Law of Tevhid-i Tedrisat. Madrasahs (formal education schools) were abolished and all schools except military schools were transferred to the Ministry of National Education (MEB) (Sözbir et al.,2012).

The Turkish Education System was built in accordance with the Ataturk Reforms. Since 1924, there have been several reforms in the education system including (Ayas, Çepni, & Akdeniz, 1993; Turkmen & Bonnstetter, 2007; Turkmen, 2007)

- The acceptance of Latin characters as the official script in 1928 instead of Arabic characters,
- Expansion of secularism in the social, educational, and legal areas,
- Implementation of new curriculums
- Reforms in teacher training

In Turkey, schooling consists of four main components:

- Elementary education (age 6–9),
- Middle (age 10-13),
- Secondary education (lycees or senior high schools including vocational and technical schools, age 14–18, 4 years);
- Higher education (universities).

The main authority in education in Turkey is the Ministry of National Education (MoNE). The country is composed of provinces divided into counties for administrative purposes and the MNE has offices in all provinces and counties. The offices in provinces and counties carry out relevant work and procedures for the implementation of the MNE's decisions taken in the capital. All the basic and strategic decisions (e.g., staff recruitment, curriculum issues, construction of new school buildings, etc.) are taken at the MoNE's headquarters in Ankara despite the efforts to delegate the central authority to provincial directorates (Yaz, Kurnaz, 2020)

Eight years of primary and secondary education and 4 years of high-school education are compulsory for all in the country and are provided for free in public schools. The first 12 years is compulsory starting from 2012.

1.1.1. The Place of Science Education in Turkish Education History

MODULE 1

Teaching science has been given special attention and importance in Turkey. Reconstitutions of teaching curricula have been made in the education system several times since the foundation of the Turkish Republic. After the foundation of the Republic in 1923, basic reconstitution of the primary school curriculum was carried out in 1924, 1926, 1936, 1948, 1962 and 1968. (Sözbir et al.,2012) identified four stages of development in science teaching curricula (Ünal, et al., 2004; Yaz, Kurnaz, 2020):

(a) the period until the Alphabet Reform (1923–1928);

(b) the period until the 1960s (1928–1960);

(c) the period of Modernization (1960–1984), and

(d) Comprehensive Curriculum Development Period (1984-)

However, none of them lived up to the expectancy of society for various reasons (see Ayas et al., 1993). On the other hand, the five years of compulsory primary education were increased to eight years in 1997 as part of this new educational reform movement. Later, in 2005, secondary education was also extended from three to four years (Yaz, Kurnaz, 2020).

The emergence of the Republic of Turkey in 1923 led to society-wide reforms, especially in education. Since the majority of people living in rural areas were still illiterate one of the important aims of the young Turkish republic was to disseminate basic education to all citizens.

It was decided that elementary education should be provided nationwide, including more science and health education. On the other hand, foreign experts were invited to Turkey (e.g. John Dewey in 1924) to get their advice to overcome education problems. In Dewey’s report, it was mentioned that in rural areas it was necessary to open another type of village teacher school to meet the needs of local people (Türkmen, 2007). Dewey, in his report, which included his findings and suggestions for the Turkish education system, stated the importance of teachers' education, improvement of their economic situation, and course materials and equipment. He also emphasized that there is a need for a vocational training program that the rural community can use in their region. In line with the report, two different teacher schools were opened for the city and the village, namely the "Primary Teacher's School" and the "Village Teacher's School". Village teachers’ schools aimed to train teachers to educate villagers and their curricula included more agricultural courses than science courses. (Sözbir et al.,2012)

John Dewey's visit to Turkey in the 1930's created another science education curricular shift as elements of experimentalism and pragmatism were added to the Turkish science curriculum. Starting from 1936, it was planned to open village institutes starting from the places where the trainer courses were held (Alican, 2015; Ezer, 2020; Türkmen, 2007). In the establishment of the village institutes, a path was followed in accordance with the conditions of Turkey, customary tradition and culture, and guided by the scientific framework. In addition to the theoretical courses, the teacher candidates trained in these schools graduated by gaining vocational and technical equipment with the qualifications to guide the villagers. During the establishment phase, the workforce of the students was used most of the time, and as a result of the practice lesson studies in the schools, a large amount of production was made on the lands of the schools (Ezer, 2020). Village institutes were considered as both schools and production and living spaces. Lessons were not only held in private classrooms but also areas such as barns, beehives, fields, vineyards and gardens. According to the conditions of the region, fishing, animal husbandry, beekeeping, citrus production etc. areas of expertise were tried to be established (Gümüşoğlu, 2015).

After the Second World War, Turkey became a full member of NATO, and expanded its connections with western countries. After that, the next major science education development occurred and the modern science curriculum was created. During the 1960's, many countries followed the lead of the USA, Australia and the UK in adopting big-budget, discipline-knowledge-based curriculum movements such as Chemical Education Material Study (CHEM Study), Physical Sciences Study Committee (PSSC) (Sözbir et al.,2012), Biological Sciences Curriculum Study (BSCS), Chemical Bond Approach (CBA) (all in the US), Nuffield Science (UK), and the Australian Science Education Project (ASEP). Turkey also translated some US curricula into Turkish, but this curriculum implementation was not successful throughout the country (Ayas et al., 1993). MONE and the Turkish Scientific and Technological Research Council (TUBITAK) made a great effort to adapt the new science curricula. For instance, science lab classrooms had been opened in every secondary school (Türkmen, 1997). Although numerous improvements were made during the Republican Era and applied with a great deal of excitement, unfortunately, science education problems were not completely solved (Özden, 2007).

To improve the quality of teacher education in Turkey, The National Education Development Project (NEDP) was developed. It was implemented under the loan agreement concluded between the Turkish Government and the World Bank. The NEDP was funded by the World Bank and administered by Higher Education Council (Grossman et al., 2007; Güven, 2007; Kavak et al., 2007; Tercanlioglu, 2004).

The objective of the project was to contribute to the improvement of pre-service teacher education. The focus of the project was curriculum development and materials production, the development of student-teacher experience in schools, the establishment of a system of faculty-school partnerships, and the development of a set of standards in teacher education. It also assisted with the provision of long-term and short-term fellowships and in upgrading the facilities of all schools of teacher education. As a result of NEDP, schools of teacher education (the name of courses and academic structures of teacher training colleges) and curricula (the content of courses) were set up across the nation in 1998 (Türkmen, 2007).

In 2003–2004, four years after the end of the project and the restructuring, a major study of their effects was conducted (Grossman et al., 2007). This study suggested that the “participation [which] occurred in the project implementation was insufficient in the teacher education community. Nonetheless, participation had a positive effect on a person’s view of reform.

The aim of the teaching curriculum introduced in 2000 was to catch up with the era emphasizing a transformation with the millennium. The period covering the year 2000 was considered as the Modern Curriculum Period (5th stage). The curricula implemented during this period were developed after the Catching up with the Era in the 2000 education project conducted by the MoNE and as part of the negotiations on the EU chapter on “Education and Culture.” During this period, curriculum changes were made four times in 2000, 2005, 2013, and 2017 (Yaz, Kurnaz, 2020). Compulsory education has been lengthened to 12 years starting from 2012–2013.

In 2004, a new primary curriculum was implemented gradually as an important part of the new educational reform initiative (MoNE, 2004) and also secondary curriculum was started in 2008 (MoNE, 2008). Both curriculums were based on the philosophy of constructivism and student-centered active learning.

When the last programs implemented are compared, it is seen that there is a general similarity between factual and conceptual knowledge in terms of distribution rates regarding the distribution of knowledge dimension in taxonomy. However, it can be said that conceptual knowledge is more prominent in the 2005 and 2017 curricula. In addition, it is seen that metacognitive knowledge is more common in the 2017 curriculum than in other curriculums. In the last curriculum, the number of acquisitions related to factual and conceptual knowledge has been reduced (Yaz, Kurnaz, 2020).

The 2013 curriculum included fewer achievements than the 2005 curriculum, thus increasing the number of teaching hours and providing an advantage for teachers to teach more effectively (Karatay, 2013). Considering similar criticism, the MoNE (2018) reported that the number of outcomes was further reduced in the 2017 science curriculum.

The main objectives of the 2018 science curriculum are to acquire scientific knowledge in the fields of astronomy, biology, physics, chemistry, earth sciences and engineering; to use scientific process skills and twenty-first-century skills in understanding nature and solving daily problems, to understand scientific method and ethics in science, to analyze the relationship between the environment and economic development. To achieve these goals, the Ministry of National Education provides some digital tools to help teachers in science education classes with the EBA platform, as well as environments and especially science centers where STEM studies can be carried out (Aydin, Kaya, Atasoy, Diyarbakirli, 2022).

Studies are carried out on the extent to which the science curriculum in Turkey provides students with 21st-century skills and how adequate it is in this regard. Accordingly, the science curriculum in Turkey primarily aims to provide new generations with the ability to understand and apply knowledge about classifications, categories and theories, models, and structure. Thus, in parallel with the findings of the European Commission's (Eurydice) 2011 report in Turkey, it has been understood that "science" has a higher position than "knowing science". This can be considered a trend, and this trend in science teaching curricula is important when considering the age group addressed. On the other hand, the reflections of the curricula implemented in Turkey are compared with the results in other countries, it is stated that none of the four curricula is sufficient. This is explained by the fact that no real reform has been made in the curriculum changes (Yaz, Kurnaz, 2020).

1.1.2. The Development of Researches in the Field of Science Education in Turkey

MODULE 1

Research in the field of science education in Turkey is limited before 1990. At that time, few publications were made as science education books and science education research articles. (Bağ, Kara and Uşak, 2002; Sozbilir and Canpolat, 2006). The recent educational reform movement started in 1990's, and increased interest in science education research in Turkey. At the same time, the first research papers focusing on science education started to appear in national journals and then increased dramatically on the national (see i.e. Sozbilir & Canpolat, 2006; Sozbilir & Kutu, 2008) and international stages (see i.e. Chang, Chang, Tseng, 2010; Lee, Wu, Tsai, 2009).

Science education research in Turkey was not conducted until the early 1990s. However, after the restructuring of the teacher training system in 1997, there was a sharp increase in the number of research articles. The studies carried out at that time, studies were carried out on issues such as the methodological deficiencies of the Turkish science education community and the tendency to follow world trends instead of developing independent research areas (Sözbilir, Canpolat, 2006).

Although there were few studies published irregularly (49 out of 1249) before 1999, science education research started to increase in 1999 (Sözbilir, 2012). A significant increase has been observed in the number of science education research papers published in Turkey, peaking in 2005. This interest in research in science education is in line with the restructuring of schools of teacher education in terms of their functions and departmental structures by the Higher Education Council. After the reform in the teacher training programs, academic staff in schools of teacher education directed their attention toward carrying out more educational research than discipline-based research (Güven, 2007; Tercanlioglu, 2004; Türkmen 2007).

The fields of study of science educators around the world are learning, teaching, educational technology, curriculum, learning environments, teacher education, environmental education, measurement and evaluation, equality, history and philosophy of science, scientific literacy, nature of science, and society. cultural issues in science, teacher training, curriculum studies, integration of ICT (computer communication technologies) into teaching, environmental education, socio-cultural issues in science, and evaluation in science education. The areas of interest to Turkish science educators are also similar to these subjects. Besides, teaching (as an intervention), concept analysis, determining students' attitudes and interest toward science and identifying students' misconceptions about various scientific concepts, studies carried out by the Turkish science education research community. (Chang vd., 2010; Lee et al., 2009).

As many international studies such as TIMSS and PISA suggest that students' level of scientific literacy is alarming in many countries including Turkey. The results of many international assessments such as TIMSS and PISA show that students' scientific literacy levels are lower than expected in many countries, including Turkey. In this context, the adequacy of the curriculum in Turkey is discussed together with the results of international exams such as PISA (Programme for International Student Assessment) and TIMSS (Trends in International Mathematics and Science Study) (MoNE, 2018). TIMSS is an international exam that is held every 4 years and evaluates the scientific knowledge and skills of 4th and 8th-grade students. The results obtained from TIMSS are counted among the reasons for curriculum changes. In a broad sense, TIMSS aims to compare student performance in participating countries and to evaluate differences between education systems. The IEA (International Association for the Assessment of Educational Achievement) report on TIMSS evaluations in 2007, 2011 and 2015 shows that Turkey's science grade point average is below the TIMSS average in all administrations (MoNE, 2011, 2014a, 2014b, 2015, 2017, 2018). The results were similar for the PISA exam assessments. PISA exams evaluate skills such as reasoning, using knowledge and skills in real-life situations, and whether students are aware of the opportunities that scientific competencies gained at school can create (Anıl, 2009; Yaz, Kurnaz, 2020).

When the Turkish science curriculum is compared with the science curriculum of different countries, it is understood that they show some similarities in general. When the Turkish science curriculum is examined together with the science programs of Singapore, Estonia and Finland, it is seen that 21st-century skills including skills such as information and communication technologies, creative thinking, critical thinking, taking initiative and entrepreneurship and basic competencies specific to science courses are emphasized. It has been determined that the science curricula of America and Germany include basic competencies specific to the field of science, including scientific process skills (Aran, Derman, 2020).

Parallel to the science curriculum, changes are also made in the science teacher training programs. It is important to make necessary updates in teacher training programs to train qualified role models with knowledge and skills related to the field. In this direction, YÖK teacher training programs were updated in 2018 to respond to the changing needs and demands. One of the reasons for updating the new undergraduate programs is to train prospective teachers to be technology literate, socially and culturally aware, role models in terms of ethics, moral values and personality, as well as having knowledge and skills related to their field (Aran, Derman, 2020).

It has been observed that in the YÖK 2018 Science Teaching Undergraduate Program, competencies related to "scientific process skills" are included in Turkey. Science teachers who are trained with a teacher training program that focuses on scientific process skills will ensure that both themselves and their students are equipped in terms of these process skills. One of the reasons for updating YÖK undergraduate programs is stated as "raising teacher candidates as moral and cultural leaders who will take an active role in the construction of a more humane and virtuous country and the world, recognizing universal, national and local/regional cultures and the common and different aspects between them" (YÖK, 2018a). On the other hand, the fact that pre-service teachers emphasize these features less or not at all in the compulsory courses they take shows that they will grow up deficiently in terms of social, and cultural skills and self-management (P21, 2019), which are emphasized in 21st-century skills.

Teacher training programs in Turkey are also supported by the studies of relevant institutions. In this context, TÜBA (Turkish Academy of Sciences) carries out programs related to the examination of science teaching from preschool to higher education and the creation and dissemination of participatory models in student-centered education and teaching practices. The primary target audience of these programs consists of teachers (especially secondary school teachers), school administrators and parents who play an active role in directing young people to scientific studies. Within the scope of the program, it is aimed to bring together educators specialized in course content and pedagogy, scientists who are experts in their fields, teachers and other relevant people, to carry out studies on the correct explanation and implementation of science education and to make scientists role models for young people (TÜBA).

1.2. TECHNOLOGY USE IN EDUCATION IN TURKEY

MODULE 1

Today, technology is an indispensable part of every field. In recent years, this situation has begun to affect the fields of education and training to a great extent. One of the goals of the education system in our country is technology literacy. When talking about the use of technology in education, the first thing that comes to mind is smart boards and tablets. In many countries in the world such as Switzerland, South Korea, Russia, Japan, India, North Korea, America, China, tablets and computers are trying to be integrated into the education environment. Smartboards can be used in the following ways as a facilitating factor in teaching in the educational environment.

• Ability to show videos that help explain the concepts,
Showing their homework to students in front of the class,
• Ability to write by hand,
• Ability to record for reuse,
• Ability to write and draw shapes in different colors,
• Choosing appropriate software for the course content (Acrobat Reader, PowerPoint, Flash Player, Microsoft Journal, Media Player, Internet Explorer, etc.),
• Allows quick and easy editing of text and figures.

The FATIH project was initiated by the Ministry of National Education in 2010.,In this Project, smart boards were provided to each class and a tablet was provided to each student. The components of this project are shown in the figure.

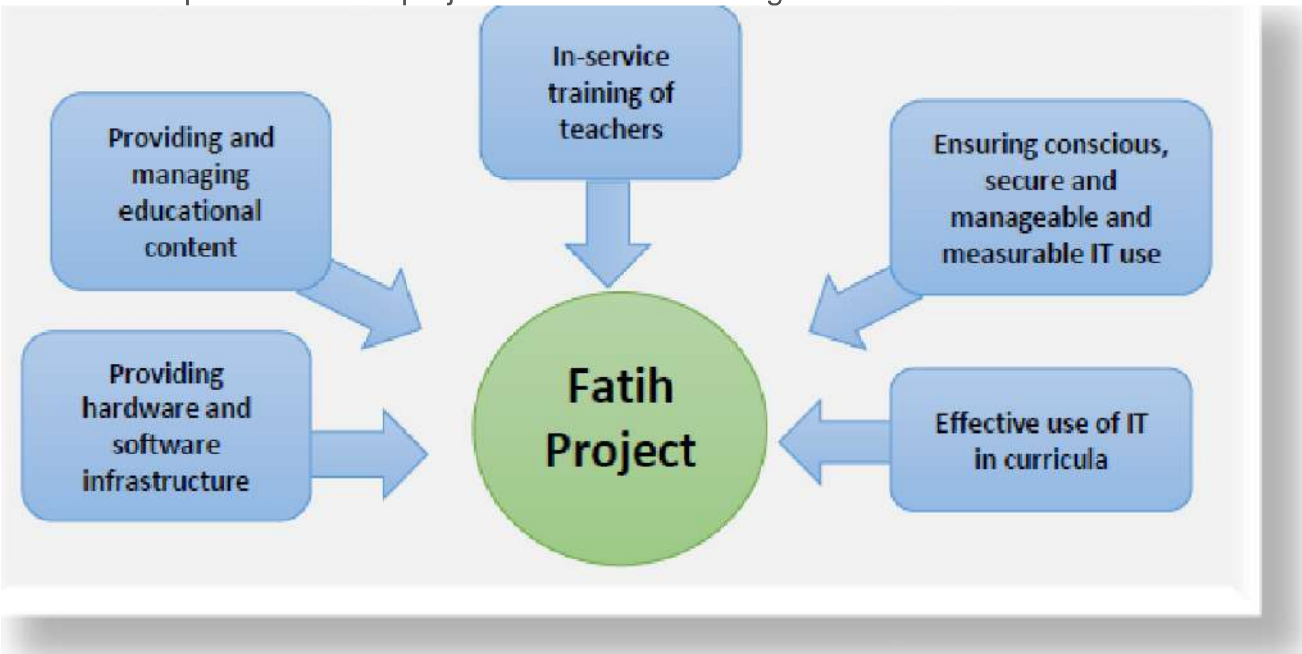
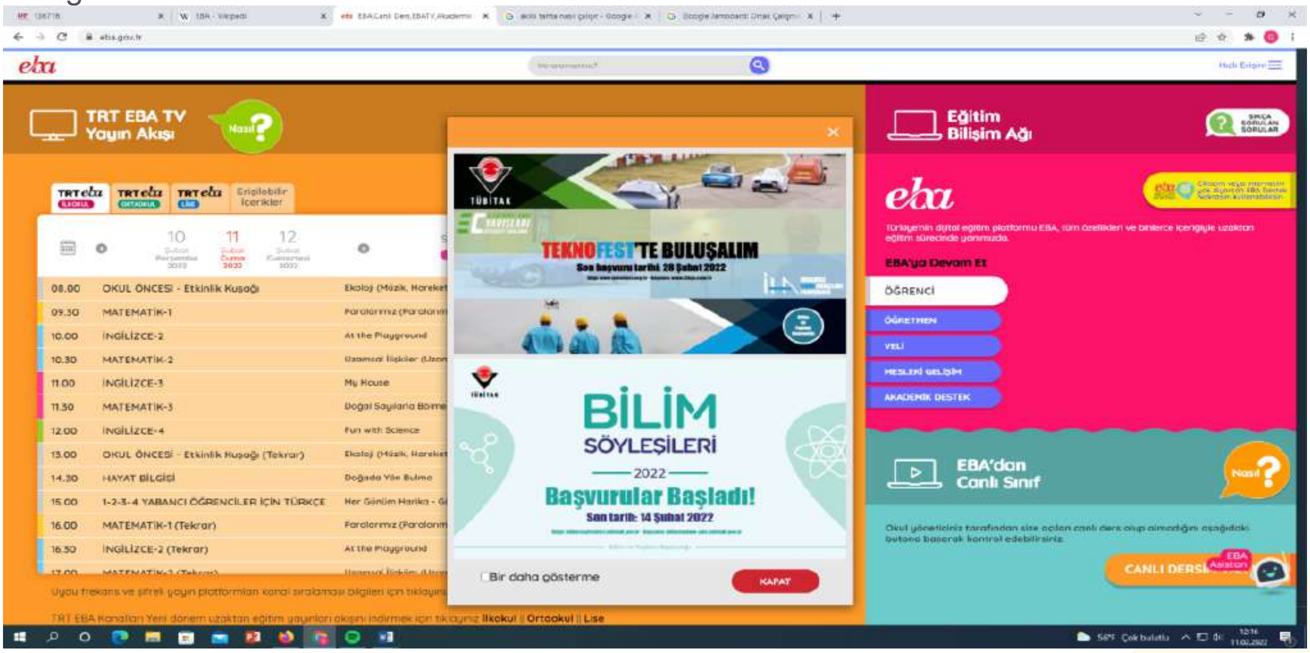


Figure 1.1.The Components of FATIH Project.

When we look at the components of the project, we can easily see that it is not just a hardware project. Some of the aims of this project are given below:

- Increasing domestic production, production diversity and added value,
- Carrying out research and development activities for new technologies and products,
- Ensuring equal opportunity in education and technology
- 21. Developing century skills

Together with the Fatih project, a network containing educational electronic content, defined as the Education Information Network (EBA), was designed by the General Directorate of Innovation and Educational Technologies affiliated with the Ministry of National Education of the Republic of Turkey. The course materials needed in the educational environment are developed in this system and offered to the users free of charge.



Source: https://www.eba.gov.tr/

In a study conducted by Ergin in 1995, it has been shown that computer-assisted instruction increases success by 10-18% compared to traditional instruction in studies conducted on the contribution of a computer to education. In addition, the use of technology in education:

- Increases the quality of learning
- It helps to concretize abstract concepts with simulation and models.
- Reduces the time students and teachers spend on reaching the goal
- Increases teacher's effectiveness
- Provides effective and permanent learning
- Increases motivation for the lesson
- Makes the student active in the environment
- With the help of some virtual experiment programs, they can interactively perform experiments in the computer environment that they cannot do in the classroom environment for various reasons.

Today, while students keep up with the rapidly developing technology more easily, teachers should not lag behind it. The use of mobile devices is very common in today's students. Mobile devices are social, enable rich social interaction, and are suitable tools to enhance group work and communication in potential educational settings. Today, students can connect to the internet from anywhere with their mobile devices such as mobile phones and tablets. Educators should take advantage of the educational potential of such an environment. Web 2.0 tools contain these environments.

Web 2.0 was first used by O'Reilly Media in 2004. The second generation of the Web (Web 2.0) has been named the 'social Web' because, unlike Web 1.0, its content can be created and published more easily by users. In addition, it is possible to add to the content created in these tools. Web 2.0 tools that can be used in all areas of life especially support the enrichment of education and training activities. With Web 2.0 tools, students can exchange ideas with each other and/or with their teachers inside and outside the school and enabling them to work in collaboration. In the rapidly changing world of the 21st century, it is a fact that schools should focus on raising technologically equipped children and young generations.

As the name suggests, Web 2.0 describes a set of next-generation Internet technologies. These protocols and tools make it easy to create online applications that behave dynamically much like traditional PC-based software. They are also highly social and encourage users to manipulate and interact with content in new ways. Web 2.0 transfers computing power from the desktop to the Internet, meaning less time and money spent on computer software administration. As a general rule, Web 2.0 tools are also less expensive than traditional software, and many are even free. Since they are web-based, all you need to get started is an up-to-date browser. (https://www.cbsnews.com/news/what-is-web-20/)

Web 2.0 allows groups of people to work on a document or spreadsheet at the same time, while a computer in the background keeps track of who changed what, where and when. In general, the main features of Web 2.0 are: That web-based applications can be accessed from anywhere.

Table 1. Social Software examples for mobile devices

Device	Blog options	RSS	Instant Messaging	Social Book marking	Web Services – Moodle, Elgg, Wikis etc...
Cell phone	1. SMS via letmeparty 2. mobileBlogger (Java) 3. MoJungle – (image & video via SMS) 4. Mobispline 5. Flickr via email 6. ShoZu	1. Litefeeds –set-up feeds on web, download Java reader to cell phone 2. RSSReader (Java) 3. Google reader Mobile – via Opera mini browser.	1. eMSN (Java) 2. IM+ (Java) 3. Mobispline	1. Deliciousmona.com 2. mobilicio.us – delicious formatted for mobile devices	1. Opera Mini (Java) 2. KaBlog (Java) – supports Elgg Blog via Metaweblog API
Smart phone	1. Built-in app 2. All above 3. SplashBlog	1. Built-in app 2. All above	1. All above 2. Yehba	1. mobilicio.us	1. All above 2. Opera for Symbian or PPC 3. mobile google 4. mobile yahoo
WiFi PDA Palm OS	1. uBlog 2. Vagablog 3. SplashBlog 4. MoBlog	1. LiteFeeds 2. QuickNews 3. mRSS	1. Agile Messenger 2. MunduIM 3. Verichat	1. mobilicio.us	1. Blazer 2. Opera Mini 3. Xiino
PSP	1. Built-in web browser login to Blogger.com	1. Built-in RSS reader	None yet	1. Built-in web browser & RSS reader	1. Built-in web browser

Source: (Cochrane, 2017)

- You can do a lot with Web 2.0 tools. These ;
- You can use social networks such as Facebook, Twitter, Linkedin
- You can write and share online content. Online surveys, quizzes
- You can write and comment on blogs.
- You can share your presentation and different works.
- You can add links to blogs and websites you like to favorite items for later use. (social web bookmarks / Bookmarking)
- You can track RSS (Rich Site Summary) data. RSS are servers that provide information about the daily news feed or innovations of a site or blog. Thanks to RSS, updates, the latest news and changes are sent to you instantly.
- With online game providers, you can play games for both educational and entertainment purposes, and you can create your own game or have your students do it.
- You can create and publish online videos, presentations, ebooks, magazines, and newsletters for your eTwinning projects.

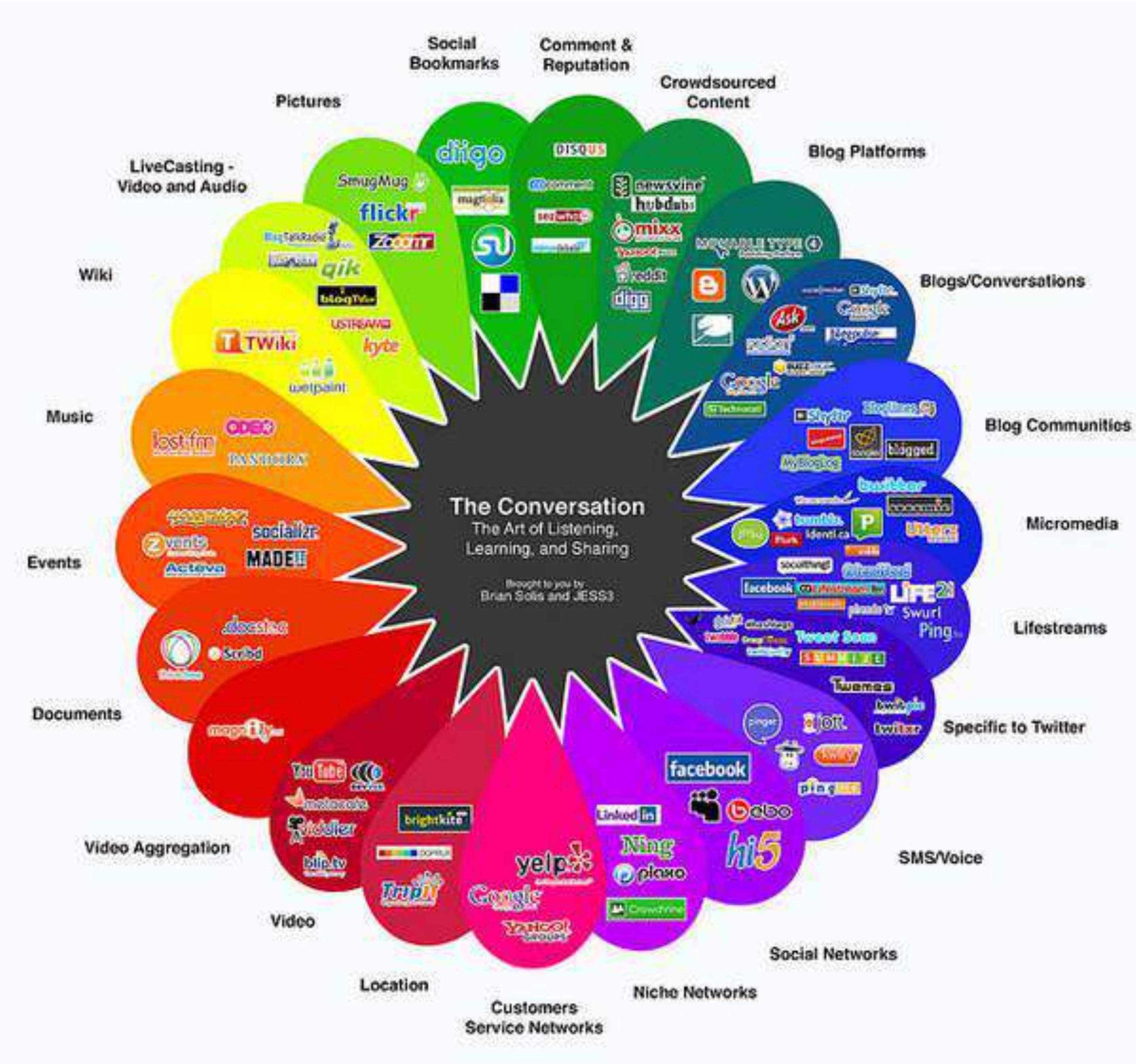


Figure 1.2. Some Web 2.0 tools (https://www.trendhunter.com/trends/media-tools)

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1.2.1. Educational Robotic Applications in Turkey

Educational robotics is an interdisciplinary learning environment based on the use of robots and electronic components to increase the skills and competencies of children and young people. It is used specifically in STEAM disciplines, although it may include other fields such as linguistics, geography, and history. Educational robotics can also be used in education and training settings to motivate and facilitate the teaching of other often fundamental subjects, such as computer programming, artificial intelligence or engineering design, from elementary school to graduate programs. Today, with the developing technology, programming skills are an important competence for students and the business world. Educational robotic tools play an important role in making students familiar with programming. In addition to these skills, by using educational robotics, activities suitable for the gains to be given in the course can be designed and the gains can be gained to the students in this way. In addition, the following skills can be gained by students with educational robotics.

Some of the skills that students develop thanks to educational robots:

Educational robots can be divided into four main categories of robots:

- Physically coded robots,
- Entry programmable robots,
- Computer programmable robots and
- Kit-based robots.

1.2.2. Educational Robots Used in Educational Environments in Turkey

MODULE 1

Today, there are many educational robots for children and teenagers. Among the most popular are:

Makeblock mBot: This is a wheeled robot designed to introduce children to robotics, programming and electronics. It is easy to assemble and control, thanks to the Scratch-based software designed for children. Its compatibility with the Makeblock platform and electronics based on the Arduino open-source system allows more experienced users to build more complex robots. (https://www.iberdrola.com/innovation/educational-robots)

Robo Wunderkind: It consists of a series of blocks from which children can build their robots as they wish. Each block has a function defined by color (camera microphone, motion sensors...) and once kids have made their robot, they can use an app to program it to react to certain sounds, avoid obstacles or play music when someone approaches, among other functions. (https://www.iberdrola.com/innovation/educational-robots)

OWI 535: It is a robotic arm suitable for young people aged 13 and over. It can lift objects weighing up to 100 grams and has a wide variety of moves that students can program customizations with. This robot is also recommended for vocational training cycles. (https://www.iberdrola.com/innovation/educational-robots)

LEGO Mindstorms EV3: This allows students to move, shoot, crawl, etc. It is a robot set that includes various sensors, three servo motors and more than 500 LEGO Technic components, with which you can build different robots. It is controlled by simple and intuitive programming. Interface and available in two versions: Home and Education. This robot is recommended for children over 10 years old. (https://www.iberdrola.com/innovation/educational-robots)

NAO: It is one of the most popular educational robots in the world. It is a 58 cm high humanoid robot that is constantly evolving. Along with two cameras and four microphones, it has numerous sensors that allow it to interact with the environment in a similar way to humans. NAO can observe, listen, chat and teach any subject. Its faculties and various programming levels ensure the integration of students into the learning process from the age of 5 to the university level. (https://www.iberdrola.com/innovation/educational-robots)

In recent years, educational robotics have started to be used in educational environments in Turkey and many graduate-level academic studies have been carried out on this subject. Some of those:

The Effect of 3d Printer and Robotic Coding Applications on Pre-service Teachers' 21st Century Learner Skills, Stem Awareness and Stem Teacher Self-Efficacy	(Güleryüz, 2021)	21st century learner skills, 3D printing and robotic coding practices within the scope of STEM education have had a positive and significant impact on teacher candidates. It was determined that pre-service teachers, 3D printer and robotic coding applications made within the scope of STEM education, increased the interest and attitude towards science subjects, there would be no problem in the integration of science subjects, and these applications were instructive, entertaining and useful.
Coding Using Robotic Tools and Equipment for 6-12 Age Groups Application and Analysis of Teaching	(Şahin, 2019)	In this study, children between the ages of 6 and 12 were selected as a sample, and many methods and results of the literature review on coding education were examined at the national and international level. One of these methods, robot kits that also contain gamification, and coding education are discussed.
Modular Robot Design and Application for the Development of Children in Mechatronics and Automation	(Kayaalp, 2019)	In this study, the effects of activities using ready-made automation sets on 4th grade students, their motivation for scientific process skills and other integrated technologies were investigated. As a result of the study, it was seen that the students enjoyed when they made their own designs and exhibited positive attitudes towards programming. In addition, the use of visual blocks in the software of the system increased the interest of the students and it was seen that they understood the software more easily.
The Effect of Problem-Based Learning on Primary School Students' Problem Solving Skills in Educational Robotics Applications	(Tatlısu, 2020)	The purpose of this research is to examine the effects of problem-based educational robotic applications on the problem-solving skills of primary school students and their views on educational robotic applications. According to the results obtained within the scope of the research, it was concluded that the problem solving skills of the students increased, they found the robotic activities fun, and they felt happy during the lesson. In addition, the students also stated that they will continue to learn robotic studies in the coming years.
Investigation of the Effects of Coding and Robotic Education Program for Producing Children in Early Childhood Education	(Canbeldek, 2020)	The aim of this research is to examine the effects of the "Producing Children's Coding and Robotics Education Program" applied to 5-6 year old children on some cognitive development skills, language development and creativity of children, and the views of the teachers regarding the program. The results of the research show that there are statistically significant increases in the cognitive, language and creativity scores of the children in the experimental group.

A Case Study on Coding and Robotics Teaching	(Erten, 2019)	Coding and robotics teaching is considered necessary and important by pre-service teachers in terms of teaching the conscious use of technology, providing an opportunity to develop smart systems and providing orientation to the profession. Students, on the other hand, see coding and robotics as the profession of the future and think that they make life easier. In this study, it has been determined that students, teachers and teacher candidates mostly prefer to use Arduino robotic technology. When the interdisciplinary educational materials developed with teacher candidates are designed and designed for Arduino robotics technology, it can be said that the robotic-supported interdisciplinary educational materials will increase the student's interest in the course and academic success, facilitate the memorability of information and provide permanent learning as it offers easy and interactive learning opportunities.
Robotic Supported Science and Technology Laboratory Applications: Robolab	(Şenol, 2012)	In this study, students' views on robotics were determined, and the effect of robotic-supported experimental activities on the "Force and Motion" unit of the 7th grade Science and Technology lesson on the students' scientific process skills and their motivation for the Science and Technology lesson was examined. As a result of the research, it was determined that the students had very positive opinions about robotics, and it was determined that the science process skills of the students in the experimental group in which the robotic-assisted science experiments were carried out and their motivation toward the Science and Technology lesson differed significantly from the students in the control group.
Use of Robotic Technology in 7th Grade Light Unit Teaching	(Kılınç, 2014)	In this research, "Is Absorption of Light" and "Is White Light Really White?" of the "Light" unit of Science and Technology Lesson. and "Refraction of Light", the effects of activities developed in accordance with the 5E learning model enriched with Robotic Education Sets on the academic achievement and motivation levels of 7th-grade students for science education were examined. As a result of the study, it was concluded that the activities developed had a significant effect on the academic success of the students and their motivation levels for the Science and Technology course. In addition, it has been determined that the use of the robotic training set increases the interest, active participation and self-confidence in the lesson, and provides the opportunity to make observations, meaningful learning and different activities.

1.3. THE PLACE OF TECHNOLOGY IN EDUCATION AND PROBLEMS IN TURKEY

MODULE 1

Since the beginning of the twenty-first century, technological developments have offered new products and services that will make our lives easier in many areas. Technological developments in many fields such as communication, transportation, housing, agriculture, etc. are increasing day by day. In this case, it is out of the question not to benefit from technology in an important field such as education (Saklan ve Ünal, 2019). The methods and techniques used in education and training are changing day by day, and educational environments are changing. As in every field, it is necessary to benefit from technology in education. After the important communication tools such as letters, telegraph, radio and television, nowadays, with the rapid progress of technological developments, the use of virtual classrooms and environments including virtual reality elements in distance education and teaching becomes widespread (Kırmacı, 2018). Another environment where technological products are used is simultaneous learning environment (Akkuş, 2017). Conferencing, video, e-mail, chat, blog forum, etc. in simultaneous learning environments by using virtual web 2.0 tools, learners and teachers can communicate regardless of time and place (Vonderwell, 2007). In addition, the learner and the teacher can teach interactive lessons with the "virtual classroom application" in simultaneous learning environments (Akkus, 2007). In this way, simultaneous learning can be provided in online learning environments (Lightning, 2011). Being able to record the lessons offers the learner the opportunity to follow the lessons asynchronously (Ilgaz, 2014; Simonson et al. 2014).

The use of technology in education enriches the learning environment and increases the motivation of the students and their interest in the lesson. It is expected that the use of technological tools will facilitate learners' understanding of the subjects and increase retention.

In addition to these, it is foreseen to remind the pre-learning and to provide the conditions for new learning subjects (İşman, 2005).

It is thought that information technology products both facilitate learning and make the process more enjoyable in education, as in almost every field. Thanks to these products, the time spent for the information desired to be reached has been shortened and on the contrary, the amount of information reached has increased (Seferoglu, 2007). Researchers have stated that if an analysis is made from the beginning of humanity to the present, the information and knowledge created thanks to the development in information technologies in recent years is very high, and even the accumulation of knowledge doubles every 2 years (Seferoglu, 2007).

In the study conducted by Saklan and Ünal (2019), science teachers argued that the use of technology in the education process is very beneficial and increases the efficiency of the lesson. They stated that it is very advantageous, especially in terms of time use and emphasized that it allows abstract subjects to be taught by concretizing. It has been stated that experiments and activities that cannot be done in crowded classroom environments due to the limited time and insufficient materials can be carried out in line with technological possibilities and that the danger that may occur in the process can be eliminated.

In the study conducted by Kırmacı and Acar (2007), the problems experienced by learners in simultaneous learning were examined under five different sub-titles. These;

- Infrastructure situations
- Individual Attitudes
- Time-dependent situations
- Location-related situations
- They are interactive problems.

“Computer” or “internet access” were identified as infrastructural problems. They form the basic building blocks of online learning. However, as a result of the research, at least one of them emerges as an infrastructure problem faced by learners. The problems are that the learners do not have computers, try to attend the lesson with their mobile phones, and in this case, the "virtual classroom" is not opened. Another infrastructure problem is that learners cannot attend the lesson simultaneously due to internet access. Internet access in the dormitories where most students stay is not sufficient (Kırmacı and Acar, 2007). As problems based on individual attitudes, students see virtual classes as boring and a waste of time and also think that they are useless. They also classified the problems arising from time-related situations as "sessions not being timely" "long course durations" and "students don't have time". They stated that the learners experience difficulties depending on the place due to their stay in the dormitories and that the noisy and crowded environments affect their participation in the classes negatively. He divided the systemic problems into three different groups communicative, educational and systemic. As to the communicative problems, they stated that they were not aware of the lesson hours and that they had more problems if the lesson hours in the programs were changed. As an educational problem, they mentioned the problems caused by not knowing the system fully, and they also gave the problems they encountered such as the “virtual classroom not opening”, error while opening, and freezing (Kırmacı and Acar, 2007).

Teachers have an undeniable role in the improvement and development of education. Well-trained manpower is an important factor in the development and development of society. For this reason, the education given in schools must be qualified (Seferoglu, 2007). It is thought that teachers' use of technology in the education process will increase the quality of education. However, teachers need to be competent in terms of technology. It should be ensured that teachers are technology literate and then environments, where they can present what they have learned, should be provided.

Looking at the literature, it is stated that even though teachers know how to use new technological tools, they feel inadequate and incomplete in this regard (Çakıroğlu, Güven and Akkan,2008). Although there is no mention of technical difficulties in schools in general in the studies, it has been stated that there is a lack of equipment in schools in some studies (Seferoğlu, Akbıyık and Bulut, 2008).In some studies, it is reported that teachers think that technology will negatively affect students, lead them to memorization and blunt their processing abilities. In the research articles, it has also been concluded that teachers need professional development in the fields of technology and pedagogy (Demir and Bozkurt, 2011).

1.4. SCIENCE EDUCATION IN ITALY

MODULE 1

The sciences of education and training are the set of disciplines that systematically study the education and training of man. It is therefore a transversal discipline, which mainly draws its foundations from pedagogy, psychology, philosophy and sociology.

The genesis of the term

The first use of the term educational sciences is given by the faculty of the same name of the Salesian Pontifical University, established on 4 September 1973. The Salesians were the first to recognize the need to consider interdisciplinarity and the orchestration of several sciences that enrich pedagogy, such as methodology and experimental research.

The term however began to spread in the nineties, replacing the term pedagogy, because the latter, understood as a humanistic discipline, was focused only on history, authors and reflection on previous theories and not on the construction of new paintings of reference or experimental research. Another important reason saw pedagogy as only childhood education, therefore lacking the adolescent educational component and adult education. Finally, pedagogy was not the only discipline involved in the study of educational and training processes, drawing much of the work from cognitive sciences and psychology.

The disciplinary areas

Given the interdisciplinary nature of the subject, the following sciences are examined:

- Pedagogy
- Didactics, Children's Literature and Methodology and technology of didactics, games and animation
- Psychology
- Sociology
- Philosophy

1.4.1. The role of education sciences in the history of Italian education Italy

MODULE 1

In the academic year 1936 the faculty of teaching was born with the 4-year degree course in pedagogy, which remained in force until 1993-1994, when the faculty of education sciences was born and new diploma courses were introduced in several universities 4-year degree in education sciences with specializations ("upper secondary school teachers", "extracurricular vocational educators" and "experts in training processes") and primary education sciences ("primary school teachers", "school teachers of childhood "), both lasting four years; however in Italy, just when the new terminology was being consolidated, with the university reform there was a tendency to reuse the term "pedagogy" by universities.

With the 1999 reform, on the basis of which the collegial bodies of the individual sites can autonomously establish the names of their courses of study within the classes defined at central level, there was a massive return of the term "pedagogy": they were established 5-year single-cycle specialist degrees in primary education sciences for the teaching of kindergartens and primary schools, while the term "educational sciences" persisted for the first three-year degree cycle. This term, which included pedagogy in the sciences of education in the academic vision, was confirmed in 2004, with the establishment of the new three-year degrees, two-year master's degrees and five-year single-cycle master's degrees. Furthermore, from the faculty of education sciences, in 2010, he passed to the department of human sciences and the psycho-socio-pedagogical high school, the former teaching institute, became high school of human sciences.

Primary education sciences

The five-year single-cycle master's degree course in primary education sciences aims to train teachers of kindergarten and primary school. The didactic offer of the degree course consists of lectures, workshops and internships, which are divided into indirect and direct.

At the end of the course of study, one possesses a qualification enabling the profession of teacher in kindergarten and primary school, whether these institutions are public or equal.

History

Until the end of the twentieth century, Italy was the only country among the most advanced not to take into consideration the training of teachers.

You became elementary school teachers with four years of teaching school, while with three, kindergarten teachers. But these paths were no longer able to guarantee adequate training for the needs of a mass school system in an advanced society. Therefore, at the end of the second millennium there were the same methods of teacher training conceived by Giovanni Gentile in 1924.

Even if the need for complete university education for all teachers was already sanctioned in 1974, it was only in 1990 that a degree course for teacher training was established for kindergarten and elementary school, called "primary education sciences". The new degree course in primary education sciences was born in the 1998-1999 academic year with the mold of the old system, ie it was born as a four-year course, with a previous admission test with a limited number of students; it is made up of a common two-year period followed by two courses: one for kindergarten and one for elementary school; moreover, under the guidance of a permanent teacher, or tutor, an internship is foreseen, which is the first experience of a serious and generalized path for didactic training.]

The Italian education and training system is organized based on the principles of subsidiarity and the autonomy of educational institutions.

Education today in Italy

In Italy, the State has exclusive legislative competence for the "general rules on education" and for the determination of the essential levels of services that must be guaranteed throughout the national territory.

Furthermore, the State defines the fundamental principles that the Regions must respect in exercising their specific competencies.

The Regions have concurrent legislative power in the field of education and exclusive in the field of education and vocational training.

State educational institutions have didactic, organizational and research, experimentation and development autonomy.

The education system is organized as follows:

- Zero-six-year integrated system, not compulsory, with a total duration of 6 years,
- The first compulsory education cycle, lasting a total of 8 years, is divided into:
- Primary school¸ lasting five years, for pupils aged 6 to 11;
- Lower secondary school, lasting three years, for pupils aged 11 to 14;
- The second cycle of education is divided into two types of pathways:
- Lower secondary school, lasting five years, for female students and students who have successfully completed the first cycle of education. The schools organize high school, technical institutes and vocational institutes courses for female students aged 14 to 19;
- Three-year and four-year courses of education and vocational training
- Tertiary education courses offered by universities
- Tertiary education courses offered by the institutions of the AFAM (Higher Education in Art, Music and Dance)
- Professionalizing tertiary training courses offered by ITS (Higher Technical Institutes)

1.4.2. The Development of Research in the Field of Education in Italy

MODULE 1

Development of research in Italy

Article 9 of the Italian Constitution which states: "The Republic promotes the development of culture and scientific and technical research", to which article 33 of the Constituent Charter is linked: "Art and science are free and free it is teaching ".

The most recent ISTAT report on Research and Development in Italy, referring to 2018-2020, opens with an apparently positive data: compared to the previous period, Italy spent 25.2 billion euros on research and development (R&D). euro, with an increase of 6% compared to 2017. However, if we compare the figure with respect to the trend in the gross domestic product at current prices, investments for research and development are essentially stationary with respect to the overall growth of GDP. At a geographical level, the ISTAT report photographs a very uneven Italy: in 2017 over two-thirds of the expenditure in the Italian National Commission for UNESCO is permanently concentrated in five regions: 68% of national expenditure is conveyed by Lombardy, Lazio, Emilia-Romagna, Piedmont and Veneto. Applied research is confirmed as the main investment item, with an expenditure of 10 billion euros (42.1% of total expenditure). This is followed by experimental development activities with an expenditure of € 8.5 billion (35.7%) and, finally, basic research with approximately € 5.3 billion (22.2%). In terms of employees, in their various types, the R&D sector employs a total of 526,620 personnel in 2018, with a growth of 9.1% compared to 2017.

However, there are problems related to the gender gap: women represent about 31.84% of researchers, but their growth is slower than that of men and in 2017 it marks only + 7.2%. If we look at the composition of employed by gender in the light of EUROSTAT data, the Italian panorama appears in line with that of other OECD countries: according to the Research and Development database, the percentage of female researchers is 28% in Germany and 26%. % in France, while the EU 28 average stands at 33% (2016 data). Japan is at the bottom, with 16% of women employed as researchers. In its Report on research and innovation in Italy, published in 2019, the CNR addresses, in an articulated analysis, the state of the R&D sector, providing numerous indicators on the competitiveness and attractiveness of our country compared to European partners. If we consider the Italian participation in the European Framework Programs - an essential way not only to find funding for research and innovation, but also to collaborate directly with research groups from other countries - the CNR notes how Italy contributes with the 12.5% to the total budget of the EU-28 Framework Programs but manages to obtain funding equal to only 8.7%. This result - observes the CNR - is undoubtedly due to the smaller number of researchers in our country, and therefore to a smaller pool of potential applicants.

Yet the fact that Spain, with a lower number of researchers than Italy, can obtain funding equal to 9.8% must ask some questions to ascertain whether the incentives provided to researchers and the support in the preparation and management of projects by the administrative structure of our country are adequate. As highlighted by the comparative analysis, the success rate of the projects presented by our country is only 7.5%, compared to a total average of 13.0% for Horizon 2020. In other words, there are important areas for improvement that need to be pursued. If we look at the OECD data for 2018 - and in particular the Main Science and Technology Indicators - we can see that Italy ranks well below the OECD average as regards the percentage of R&D expenditure compared to GDP (1.426% against 2.379%) and below the average of Europe 28 (2.025%), which as a whole remains very far from the top performers South Korea (4.528%), Japan (3.275%) and the United States (2.826%) and instead in line with investments from China (2.141%). However, it should be noted that China achieves a constant growth in the number of scientific publications globally, passing from an international production of about 2.5% in 2000 to a percentage of over 15% in 2018 according to the elaboration of the CNR from the World Of Science. Italy, on the other hand, is just below the 5% threshold, with a stable trend in the last twenty years in terms of global coverage, but with a positive increase in the average citations normalized by publication, which go from 1% to almost 1, 4%, reaching levels above France and Germany and well above 1.1% of the EU 25 average. in 2018 it ranks very far from Germany (26,734), France (10,317) and the Netherlands (7,140), in a ranking led by the United States with 43,612 patents. In light of the data set out above, it is clear that it is necessary to identify priority issues for intervention, to be addressed to strengthen and relaunch the research sector in Italy. The major thematic areas identified by the high-level working group dedicated to Research and Development are: University and Research Research funding Science and technology Science and society Within each thematic area, critical aspects have been identified for which are proposed interventions that can be implemented excluding macro-reforms of the university system and its recruitment.

Scientific research is naturally and all over the world closely linked to university education. Training and research are dynamic and constantly updated processes, which mutually enrich each other. However, it is equally true that training, teaching and organizational burdens for student management, for entrance and post-graduate orientation, subtract time and resources from research, especially in the very early stages of their career. On the other hand, while University researchers are often engaged in teaching activities, the research staff of Public Research Bodies (EPR), having no teaching load, have an advantage in managing time, but suffer from a lower dynamism due to the lack of direct contact with the new generations. Furthermore, in the national university system, researchers are required to carry out, in addition to research, institutional, management and third mission activities which are of great importance for the territory, but which again divert energy from research.

The system is therefore characterized by some critical issues. The numerical ratio of teachers / students. In Italy, the number of university staff is significantly lower than that of other more developed European countries, as well as that of PhDs per year (in Italy 9,000, in Germany 28,000). This is the result of a continuous reduction in teaching staff since the beginning of the new millennium (12,000 fewer than in 2009). It follows that the ratio between teachers and students is among the worst in Europe and among OECD countries, despite the fact that the number of university students and graduates is also among the lowest. In the same years, the public research bodies also had similar problems with staffing. Despite this, the scientific productivity of Italian researchers, measured as the number of excellent publications per researcher or number of citations, is higher than that of the French and Germans. The obvious solution is to ensure a greater number of university professors, by investing more in the human capital of universities and public research bodies. It is also important to establish the criteria, the time schedule and the transition between different types of contracts. For recruitment, meritocracy and excellence must be the dominant criteria. The distribution of new research positions in universities should aim above all to mitigate existing criticalities such as the teacher / student ratio, also in consideration of the almost twenty-year reduction in funding. It is then necessary to enhance and reward the quality and / or excellence of research within individual universities, if not within the departments, rather than universities as a whole or just some disciplinary sectors. As an adjustment to the second order, we can think of lightening the teaching load for researchers by extending part of the teaching to external consultants, such as contract teaching (already existing but very poorly paid).

The establishment of professional degrees, more oriented to the needs of the productive world, the territory and its industrial fabric, will usefully contribute to expanding the tools for accessing university training. To avoid this leading to the transformation of universities into "large high schools" it is however important to maintain the link, including individual ones, between university teaching and research. However, if the balance of time and attention dedicated to the first is higher than the second, even at the level of a single university, this must not result in penalizing the individual (for career purposes) or the institution (for financing purposes) thus providing mechanisms that recognize the different vocations and characteristics of individuals and universities with articulated assessments capable of appropriately recognizing and enhancing, with different assessment methodologies, and also with specific contracts linked to results and the percentage of time dedicated to a specific vocation. Similarly, specialization in basic research applied for research and technology transfer and third mission activities should be encouraged and evaluated. This occurs in Anglo-Saxon countries and in many parts of Europe, where university teachers can opt for part-time schemes, collaborating (and being paid) by industrial research centers for the time spent at these structures, with the possibility of individually modulating and with specific contracts the percentage of time linked to research.

The Italian training system is subject to the need to adapt teaching methods to current concepts and methodologies, exploiting technologies and new forms of interaction, as well as new methods for the preparation of educational and testing tools. Especially in the first few years, the inability to use up-to-date methodologies often creates frustration and dilation of the time dedicated to teaching. This quality problem arises from the observation that the 'training to train' is completely lacking in the higher university education path leading to the teaching career. This problem can be solved by applying to train the trainer training courses.

The Italian research system is mainly composed of Universities and Public Research Bodies (EPR), subject to administrative law, and private law Foundations with public participation (such as IIT and Human Technopole), governed by the more agile private legislation. The panorama of Italian EPRs is made up of 12 Research Bodies supervised by the MUR (including for example CNR, INFN, INAF and INGV) and by another 8 EPR supervised by other Ministries (including for example ENEA, ISPRA, ISS and ISTAT) . Unlike Universities, which have specific legislation, EPRs are subject to the rules of the Public Administration, which greatly limit their action, particularly with regard to recruitment, where for example the rules for hiring brilliant young researchers are not the same as foreign universities or research institutions, but those of municipal employees, with an obvious reduction in the competitiveness of the Italian research system. The rules for the financial part are the same for the University and EPR, but once again greatly limit the effectiveness of the Italian system. The rigidity of the public law rules that characterize the University and the EPR is an obstacle both to the circulation of scientists and to relations between universities, research centers and private companies. At the same time, excessive autonomy over the years has also been opposed due to fears of possible mismanagement of spending. To increase the efficiency of the system, targeted interventions are possible. - The “Research and University” sector and the Public Administration have different needs. Often the procedures required by law effectively block the fluidity of work between researchers, administrative officials and the business world. It is, therefore, necessary to free the public research sector from a rigid application of administrative rules, with particular reference to the contractual regime of University and EPR employees, which often prove to be incompatible with the times and methods of scientific research. It is necessary to promote the flexibility of contracts to allow permeability between public research bodies, universities and businesses and a real sharing and systemization of resources.

It is necessary to simplify the rules on the transparency of financial statements, reducing the steps and time required while ensuring accurate control of expenses. Shifting autonomy and at the same time the responsibility for spending more and more downwards. In practice, give greater autonomy, and associated responsibility, to individual centers at the department or institute level and individual researchers/professors, introducing ex-ante checks (of merit on the planning and quality of proposers to receive funding) and ex-ante checks posts, very punctual, to evaluate the results. Introduce evaluation systems for individuals, departments, and universities: at all levels and with adequate frequency as well as methods that do not reduce everything to a mere exercise of performance indicators. - As regards in particular recruitment and mobility, it would be desirable to recognize the legal status of the researchers of the institutions in analogy to the corresponding university figures, rewarding the quality of the staff. Excess administrative burdens and research support The current system setup provides an excessive administrative burden for researchers. To the load of the lessons must be added the time for administration (councils, commissions, etc.), as well as a very high number of hours to devote to reporting, updating the catalogs of scientific production, the tasks of the so-called “Third mission”, which includes topics of great importance such as the connection with the territory, public engagement, work with local public bodies or, for doctors, with hospitals. It is not just a question of teaching versus research, but of supporting all the activities necessary to excel in research. It is necessary to proceed with a widespread and homogeneous (at national level) digitalization of the offices coupled with serious and continuous training in the digital, linguistic and technical fields of the personnel. At the same time, qualified administrative staff needs to be recruited, which current public law rules often do not allow for recruitment. It is necessary to provide structures that offer better research support to stimulate and improve obtaining competitive and industrial financing as well as to encourage technology transfer (office for relations with companies, patents, etc.). These offices must have highly trained professionals. Technicians and non-bureaucrats. We are talking about concrete help in preparing projects, building technology transfer paths, relating to companies, etc. also from a technical point of view and not only from a formal/contractual one.

It is also advisable to request that the administrative managers in universities and EPR tend to have a doctorate and, on the other hand, that in all the EPR supervised by MIUR or other ministries, the heads of structures or departments constituted by a large majority of researchers have a congruent technical training and not administrative. Encouraging mobility between the university system and that of institutions would favor research in both institutions. Mobility in the current system involves additional costs, the overcoming of which requires both financial incentives to cover the additional costs and targeted regulatory interventions on recruitment systems. In addition, more young people should be included in the research system (both at the level of PhD students and fellows as well as researchers) with reduced teaching loads and activities focused on research. It is necessary to increase the ability to network between universities and EPR to share research laboratories and infrastructures, creating a system in which large, medium and small companies can offer an efficient and fully integrated contribution, at the service of both the scientific community and businesses. , assuming and encouraging collaborative participation in Horizon Europe programs. It is necessary to increase the usability of laboratories and infrastructures, enhancing the specificities and exploiting the possible synergies or complementarities, and expand their use and their usefulness by exploiting the potential linked to the training of highly specialized personnel or practical, industrial or in any case applications with impact on society, also and above all for less frontier or smaller infrastructures. More modern infrastructures, inserted in favorable contexts and in dialogue with the environment and the territory, can become attractors for researchers and international investments and guarantee an improvement in working and living conditions. Finally, a more structured collaboration between universities and EPR is desirable, overcoming the problems that sometimes make it difficult, including the local dimension of the universities, their autonomy and the national dimension of public research bodies.

1.5. TECHNOLOGY USE IN EDUCATION IN ITALY

MODULE 1

The technologies and digital tools that have spread in recent decades have become part of the national school scenario and thanks to them teaching has been enriched. When we talk about digital culture, we want to highlight the digitization of traditional cultural processes and with them also of the educational environment. Digital teaching can be implemented according to multiple channels that have different characteristics and purposes. A review of the digital and technological tools used in the school environment and of the teaching methodologies that can be created with them will then be provided.

Digital technologies have radically changed today's society and with it the habits and customs of individuals. As a result of social evolutions, teaching and the school universe have also been involved in a process of restructuring the teaching and learning system which has emphasized the integration of technologies and digital tools for the transmission of knowledge. With the digital culture that has introduced the digitization of cultural processes themselves, technology has permeated the various social sectors, modifying all their traditional aspects. The main role in the transmission of culture and knowledge is entrusted to the educational institution: it has therefore become evident the need to integrate digital technologies with new teaching methodologies that break into the system based only on the passive transmission of knowledge through texts and lectures (Paolo Di Sia, 2019).

Didactics 2.0

Didactics is the discipline that exposes teaching theories and practices. It deals with the general features of educational techniques and the characteristics of the individual learning subjects. The suffix 2.0 was added to the aforementioned term perhaps due to emulation of the definition of Web 2.0 2 and the habit of indicating with a version number the improvement variants of software. The term Didactics 2.0 was born without a precise and shared definition, but it can be interpreted as the didactics that use the tools of Web 2.0 or more generally the new technologies. It is a teaching and learning process that takes place in a new context and which sees the overcoming of traditional teaching methods based on the centrality of the teacher and the transmission of content, promoting the active role of students and the acquisition of new skills. Didactics 2.0 stands as an innovative medium for teaching, inclusive of traditional techniques and enhanced by the opportunities offered by digital technologies, which is why it is often identified with the term digital teaching. With this second term, we intend to embrace the broader concept of digital school, with which we want to indicate not a school different from the traditional one, but a school that places emphasis on the innovation of the school system itself.

It is therefore legitimate to say that teaching 2.0 is the daughter of digital culture, a discipline that began to come to life in the 1960s thanks to the internet and network-related projects.

The digital culture was born with the internet and develops thanks to practices related to new technologies that have brought about changes in terms of individual and collective action. It is characterized by three elements: participation, digitization and reuse of information.

- The participation of users implies an active role of the same, individuals who participate in the culture are no longer simple users of a message or content but become authors and actors of the information society. In this way, the relational model with which the subjects are approached is also transformed, which changes from "one to many" into "many to many".

- Digitization, on the other hand, concerns the conversion of contents into digital format, an action made possible by new technologies and data homogeneity. Images, texts and sounds can coexist on the same device, be easily stored and transported.
- Finally, the reuse of content consists in the possibility of facilitated access to information that, thanks to technologies, can be shared, consulted and reused.

These characteristics have changed the way of learning and have introduced the concept of e-learning, which is the complex technological means made available to users for the distribution of multimedia educational content.

The birth of the internet did not have immediate consequences on the level of the national school organization. The adoption of technology within institutions has proved to be slow and gradual: about a decade ago, while the new media5 had already changed social communication channels, only a few computers were made available to the classrooms, which did not always allow access to the network as well.

The technological delay has always characterized the school environment and the reasons lie precisely in the poor basic training of staff in the field of web technologies and languages. The integration of technologies into the world of learning is tiring because the education of teachers often does not follow a set pattern but is lost among the many innovations of a constantly changing context. Furthermore, another aspect that emerges in the organization of teaching is the tendency to combine the figure of the digital expert with that of the universal teacher, a juxtaposition that could be resolved with the intervention of a humanist computer scientist able to manage the organization of ideas, methods and tools for digital learning. In this regard, the Government has taken on a new operational vision to intervene simultaneously in the area of tools, skills and training, with the aim of opening the school system to the opportunities of digital education.

National Digital School Plan

The Ministry of Education, University and Research (Miur) with the "Digital School" project aims to change the learning environments by introducing the use of technologies to support daily teaching. The world of schools must benefit from the innovation that develops outside of it and for this purpose the Ministry of Education has drawn up the National Digital School Plan (PNSD). It is a legislative document (law 107/2015) that deals with the overall innovation strategy of the Italian school.

The project, awarded in 2008, contains a series of objectives to be gradually achieved by 2020:

- From 2008 to 2012 the LIM (Interactive Multimedia Whiteboard) action was launched with the aim of disseminating an object similar to the traditional blackboard but with innovative functions within the classrooms, with the aim of helping teachers and students to become familiar with new technologies, without upsetting traditional habits.
- In 2011, thanks to the good investment strategy adopted by the government, it was possible to start the other planned projects: Action Scuol @ 2.0 and Cl @ ssi 2.0. According to the indications of the PNSD, technological devices and multimedia devices equipped with internet connection equipment have been made available to students and teachers.
- In 2016, the electronic register entered schools and gradually replaced the paper version, reporting all the elements and integrating new ones. Its adoption, now accepted in most national institutions, was obviously made possible by the extension of the Wi-Fi network in the school environment.
- Didactics, contents and skills are the other fundamental elements that the PNSD intends to achieve: staff training, the complete digitalization of the school administration, the definition of the skills of teachers and students in the use of the network and information technologies will be the objectives to be achieved in the next few years.
- Italy is promoting the use of digital also through public announcement, that allow schools to buy technological materials.

Bando pnsd. 2021

- Italy promotes the use of digital technology starting from preschools. Much used is Bee Bot, which allows children to enter the mentality of coding and logical and sequential thinking.

-Bee Bot: is programmed directly with the buttons on the back
-Ozobot: line-follower robot.
It’s programmed by inserting
series of colors in the path
-Mind Designer Robot

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1.5.1. Educational Robotic Applications in Italy

MODULE 1

For teaching to be truly effective, pupils must be involved in the learning process. Students involved within a social context such as the use of technology is in all areas of daily life, also for this reason alone the lecture in its traditional form does not meet their needs.

To motivate students, improve their learning and become more incisive, it is useful to make the most of the opportunities offered by the network, integrate ICT into school life and create a virtual environment to facilitate the exchange of ideas, materials and information.

To meet the needs of the new school, there are multiple platforms structured and connected to textbooks, different application software and sites that make possible to implement innovative, authentic and stimulating teaching.

The use of technology in the Stem world is:

- Creativity, because a problem can be solved differently
- an opportunity to have experiences, projects and challenges on real problems.
- Teamwork and strengthen collaboration between the kids
- Stimulating for skills that will serve in the job
- Fun and constructive, because through the game you learn

The use of technology in the Stem world allows you to:

- personalize teaching, bringing out the talent of each student
- implement cognitive and metacognitive skills as well as social and relational skills including
- empathy, responsibility and collaboration
- Helping children with disabilities to integrate and collaborate with their peers in an active
- Improve problem solving skills
- Mistakes stimulate improvement and commitment

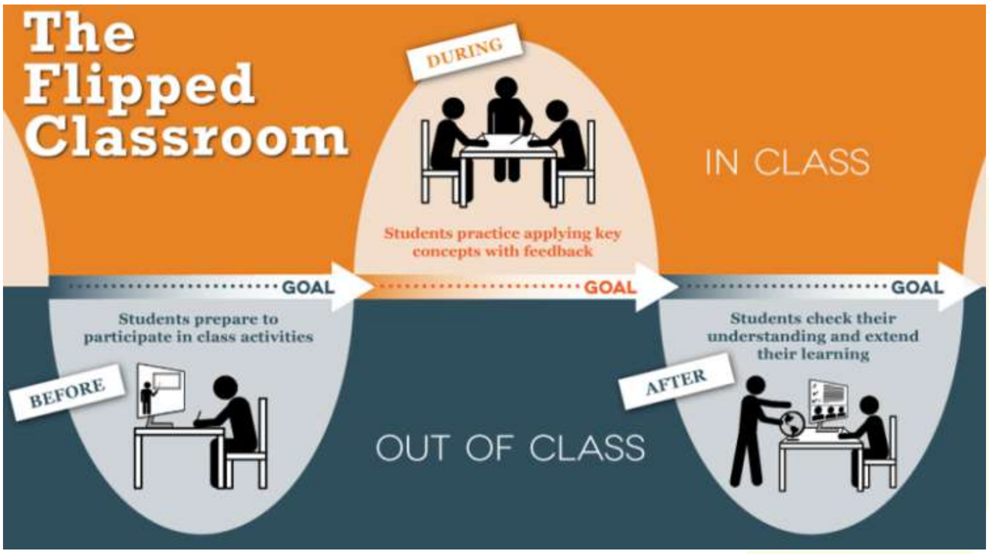
G -Suite: Google Apps For Education

It is a set of software hosted by Google to schools for communication and collaboration. The set of products made available is free and can be used with any device and includes Google web applications including Gmail, Google Drive, Google Hangouts, instant messaging software, Google Document and Google Classroom, a service that exploits the potential other existing services, to simplify class life and improve the organization and work within the school. It is an easy, intuitive and entirely online tool accessible from any device, at any time and place that allows teachers to create and manage a virtual classroom by adding students. Once the class is created, you can assign assignments to students, check deliveries and record grades. You can also set up notifications, messages and reminders to send to students. The use of the Google Suite offers numerous advantages such as the guarantee of security and privacy, entrusted to modern security systems, connection and interoperability, which allow documents to be saved directly on the web, making them available online and simplified and efficient communication.

Flipped Classroom

The flipped classroom is undoubtedly one of the most innovative teaching methods. The upside-down teaching is proposed as an experimental model that overturns the traditional system based on the explanation in the classroom by the teacher, on the individual study phase of the pupil at home and on a moment of verification and questioning in the classroom.

The tool used in this teaching method is above all the video, both in the form of tutorials and video-lessons. The teaching activity starts at home, students are entrusted with the task of informing themselves about a given topic established by the teacher through digital tools such as maps and interactive documents. In this way, the students are prepared to come to class with questions and curiosities to be addressed to the teacher and classmates. At school then the teacher proposes a dialogue with the pupils, taking up the proposed themes and stimulating discussion, proposing collaborative activities and deepening what has been learned at home.



Digital laboratories

The education system innovation strategy envisaged by MIUR encourages the activity carried out within laboratories for the development of digital skills. The proposals concern the integration of the use of ICT in the performance of all educational activities. The digital laboratories cover the entire spectrum of teaching and include different levels:

- Communication, for the development of transversal skills.
- Learning, to strengthen basic skills and enhance the methods of learning,
- Thinking, to develop computational thinking and enhance pupils' design skills,
- Exploration, for the development of digital creativity.

BYOD: Bring Your Own Device

In Italian, "bring your device" is an expression that describes the company policies that allow employees to use their personal devices in the workplace. The use of BYOD policy is also present in the educational field and is envisaged by the PNSD to provide a new, innovative teaching strategy to the Italian school. The BYOD action refers to every device and not only to smartphones: children will thus be allowed, under the guidance and control of the teacher, to access the web during the course of the classroom lesson, join social networks for teaching and answer quizzes and surveys directly using your device. the added value of BYOD compared to traditional teaching lies in the possibility of working at school with all the tools that the student has and can also use at home. The BYOD policy therefore attempts to overcome the idea of using software that only the school is able to license.

Digital Storytelling

Storytelling is a didactic practice that uses the narrative device: remembering a story or a tale is undoubtedly easier than remembering an explanation. The effectiveness of the narrative lies in the use of strategic schemes and in the expression through a language placed on the same level as the everyday one and that of the disciplines. The didactic use of storytelling includes a first phase during which the grammatical structure of the narrative is taught, and a second phase which involves the creation of stories as a tool for the development of new skills. Digital storytelling is the new frontier of story creation and is based on the combination of the art of inventing a story and the use of multimedia tools (graphics, audio, video and web). The storytelling through digital tools is even more effective than the traditional one but requires a detailed planning of the operations to be carried out and the need and ability to use different technological tools. Eight steps can be identified for the creation of a digital storytelling:

1. Define the initial idea through a short description, a diagram, a question
2. To research, collect, study information on which the story will be built
3. Write the story by defining the style of the narrative
4. Translate the story into a script
5. Record images, sounds, videos
6. Assemble and reassemble the material
7. Distribute the product
8. Collect and analyze feedback (Paolo Di Sia, 2019).

Through this articulation, storytelling takes on a strong impact on a cognitive and educational level, showing itself to be a valid tool for approaching a topic, while increasing transversal, digital and linguistic skills.

TEAL: Technology Enhanced Active Learning

Technology Enhanced Active Learning, in Italian active learning enabled through technology, is a teaching methodology that combines the types of lectures, simulations and laboratory activities on computers for a learning experience enriched by technologies and based on collaboration. The TEAL method was designed in 2003 by MIT in Boston and was initially designed for teaching physics in the university environment, with the aim of minimizing school failure and ensuring well-being for children in a functional, colorful and modular space. We try to create a welcoming atmosphere that can foster educational success, motivation and the predisposition to be a group. The protocol provides for a classroom with a central position for the teacher around which some round tables are arranged that host groups of students in odd numbers and who work cooperatively. In each working group the students take on different roles: from the speaker, to the mediator, to the coordinator. The classroom is equipped with some projection points on the walls for use by student teams. The TEAL didactic plan makes use of the use of some platforms for the transmission of knowledge and covers not only the field of humanities but also that of scientific and mathematical subjects, allowing in this case to overcome the problem of the abstractness of some concepts.

E-Learning: piattaforme MOODLE

moodle

Moodle is the acronym for Modular Object-Oriented Dynamic Learning Environment, a modular, dynamic, object-oriented learning environment. It is a learning platform designed to provide teachers, educators, administrators and students with a single robust, secure and integrated system for creating personalized learning environments. The Moodle digital environment is built for learning globally, proven and trusted around the world, and designed to support both teaching and learning. It is free with no license fees, highly flexible and customizable. You can use it anytime, anywhere and on any device. The Moodle platform was designed by Martin Dougiamas, a network administrator at Curtin University in Australia, with a degree in computer science and an expert in the field of education. The ideology behind Moodle coincides with that of giving space to technologies to overcome space-time limits and allow students to submit and correct their assignments online. On the teacher will be able to view all the student logs and view which ones have not been connected for the longest time. Moodle leaves the teacher the ability to manage their own course by themselves, also orienting it towards achieving results. The tools available for each course are forums, blogs, chats, glossaries and quizzes.

Educational Technology Applications al I.I.S.S. Dalla Chiesa

In our school each class is equipped with the LIM. This allows us to use various digital resources in teaching:

- Physics simulators (like PHET)
- Access to the G-Suite package (Sites, Classroom, Modules)
- Mathematical sites (Desmos Graph, GeoGebra, WolframAlpha)
- Platforms (Moodle)
- Video creator
- Gamification programs (Genially)

In our school there are:

- 3d printer: can be printed
- any piece useful for making and thinkering;
- virtual reality viewer, used to paint in 3D space with Open Brush;
- Arduino kit

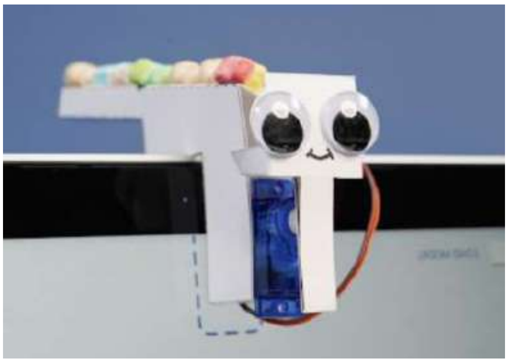
ARDUINO

Tiny Sorter: example of Machine Learning built through Arduino and the Teachable Machine website

The term sorter means sorter, classifier. In logistics, these are those systems consisting of some entrances connected to many exits by a conveyor belt. Sorting systems increase productivity and reduce operating costs. The sorting possibilities are different and the choice depends mainly on the type of product and the investment you intend to make.

This project uses a laptop's built-in camera to identify the color of the balls. The computer then sorts them according to a model that can be "educated" via the Teachable Machine website. A circuit communicates with the computer to decide when to move the ball left or right based on the color via a servo motor.

Video: Tiny Sorter project



De' Medici Web site

The site was created in the 2020/2021 with Google Sites.

The palaces of the Medici family were created in 3D with Tinkercad.

The project involved: history of art, English, mathematics, IT, Italian, technical drawing.

1.5.2. EDUCATIONAL ROBOTS USED IN EDUCATIONAL ENVIRONMENTS IN ITALY

MODULE 1

From kindergarten to secondary school, among the school desks we will talk more and more about the protection of the territory and water, climate change, biodiversity, we will study how not to waste food, how to recycle materials and collect waste separation, we will address the issue of pollution in cities and how to improve the quality of life of those who live there. Not leaving all these issues to the sensibilities of individual teachers, but building a broader project, with a precise horizon: the environmental natives. " At the fifth edition of the Robotics Olympics, the competition dedicated to selected students from upper secondary schools, the goal was to promote, encourage and support the educational potential of robotics to protect the environment. Three projects have won the first prize of the Robotics Olympics.

- Air Sector: Heartquake ('Galileo Galilei' Institute of Higher Education in Crema). A carbon fiber drone that thanks to IBM's visual recognition is able to understand from a photo taken at a house what are the chances of finding people still under the rubble. A drone that allows you to make reconnaissance of the area and, through this data, to guide the rescue teams

- Water Sector: Hydrocarbot (Institute of Higher Education 'Fortunio Liceti' of Rapallo) Starting from environmental disasters such as the storm that hit the Gulf of Rapallo, they have created a robot that can clean up a stretch of sea of hydrocarbons, so that they can be reused . To do this, a special sponge capable of collecting hydrocarbons is used, mounted on a catamaran built with PVC pipes.

- Earth Sector: Giorgi ('Giovanni Giorgi' Technological Institute of Brindisi) A "rescuer" robot to be used during environmental disasters to explore the environment, capture images and sounds, make contact with survivors. The robot, therefore, can operate in hostile environments, with high temperatures or strong pollutants which allows to acquire voices and images but also to carry audio messages.

1.6. THE PLACE OF TECHNOLOGY IN EDUCATION AND PROBLEMS IN ITALY

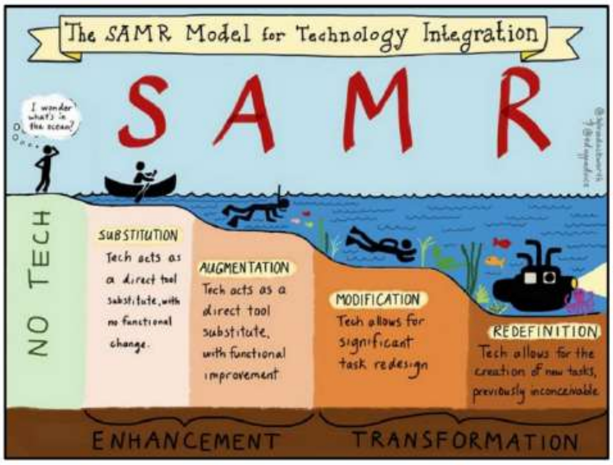
MODULE 1

Files and documents extensively illustrate the aspects of digital teaching and show how to use innovative teaching tools, supports and methodologies to be introduced in the national digital teaching plan. These materials are important for teachers, for which they constitute valid guides to be taken into consideration when setting up school lessons. Equally important is the voice of the pupils who live the school every day, who have witnessed the change and taken part in it: their direct experience highlights the importance of ICT and the role they play in the institutional school environment. On the basis of short interviews submitted to students of Italian schools of different grades, interesting experiences and considerations emerged regarding the opinion that they have of the role of technology within the educational environment. Digital tools allow you to work in a different way: for kids, technology is important and making projects with the computer is an interesting way to acquire knowledge. From the questions submitted a particular positive opinion emerged regarding the IWB, used by many teachers to project video lessons and tutorials to support the frontal explanations. From the stories of direct experiences, a particular interesting element emerges: the expedient of gamification. This practice consists in the use of playful applications for educational purposes, among which the name of MinecraftEdu has arisen, an open source platform that promotes the collaboration and creativity of the students who are entrusted with the task of producing an inhabited world and who teachers exploit for the simulation of the different historical communities of each epoch. Pupils argue that with the use of digital devices, studying is easier, more productive and less burdensome. For some, technology in the school environment is apparently not important but having the possibility to take notes with a computer, attend a multimedia lesson or be able to use digital means in general certainly makes the teachers' explanations more captivating.

For children, technologies are part of everyday life and even in the educational environment they are not a superfluous element, but many teachers still have a different opinion about it. Outside of school life, technology is within everyone's reach and young people, who continually use it, do not leave school aside and when they need it they exchange materials, projects, notes and homework through social networks and group chats. Among the students, the little ones are enthusiastic about the new methods proposed by the digital school but complain about the lack of personal skills that forces them to limit the use of technologies to school hours and to use the traditional book at home.

The invitation of the pupils is therefore to continue to integrate technologies in the field of education and promote their use in the classrooms of schools of all levels.

Digital teaching has entered national schools through multimedia tools at the service of pupils and teachers. This educational methodology can be implemented according to multiple channels that have different characteristics and purposes and in this sense it is necessary for educators and teachers to develop in-depth knowledge on the subject, in such a way as to transmit it to students as well. Changing a national institution rooted in society is not a simple task to complete but this operation becomes necessary when the educational methods no longer adapt to the needs of those who participate in it. In a social context in which digital culture plays a leading role, the world of schools must also benefit from the innovation that develops outside of it and include in its tools all the means deemed necessary.



Thanks to this representation, we can understand in which phase of use of the technology we are. In phase S (Substitution), we are using the technology as a mere substitution of other media without major change. In phase A (Increase), the technology acts as a replacement but also brings about a noticeable improvement. In phase M (Modification), the technology allows a significant didactic redesign while in phase R (Redefinition), the technology allows to totally rethink the task. In phases M and R, therefore, we have the greatest advantages and changes due to the introduction of technology in the learning-teaching scenarios. This does not mean that one phase is better than another, rather it is important to be aware of what we are doing to observe advantages and disadvantages.

1.7. SCIENCE EDUCATION IN ROMANIA

MODULE 1

The early history of Dacia (established 168 BC) outlines a well developed agro-military society come. The Roman conquest (101 – 106 AD) by Trajan leads to a fusion of the two cultures – Dacian and Roman, with the Latin language supreme and substantial Roman settlement. After the formal withdrawal of the Romans (275 AD), Romanity remains a characteristics. The Romanity of the culture of all three Romanian provinces survives Slav, Magyar and Turkish oppression, and appears in the translation of religious texts, into Romanian, and the setting up of Romanian language schools in the seventeenth century. During the eighteenth century, public, primary and grammar schools prepare a minority for higher education in France. After the independence of Moldavia and Wallachia in 1859, education at all levels develops, French influence prevailing. At the end of the century, Spiru Haret lays the foundations for generall public education. 1944 and the Soviet Red Army ensures a period of sovietisation of every aspect of life, but after 1965, the Romanity of institutions and people is once again stressed by Nicolae Ceausescu. 1968 marks the beginning of a new 'Romanian way' (Roy M.H.,1977).

Since the collapse of communism in 1989 the Romanian educational system has been in a continuous reforming process and experienced both progresses and setbacks. The general education system (K12) is highly centralized.

Education in Romania is based on a free-tuition, egalitarian system. Access to free education is guaranteed by Article 32 in the Constitution of Romania. Education is regulated and enforced by the Ministry of National Education.

Kindergarten is optional under the age of five. Compulsory schooling usually starts at age 5, with the last year of kindergarten (*grupa mare*), which is mandatory in order to enter primary school. Schooling is compulsory until the twelfth grade (which corresponds with the age of eighteen or nineteen). The school educational cycle ends in the twelfth grade, when students graduate the baccalaureate. Higher education is aligned onto the European Higher Education Area. In addition to the formal system of education, to which was recently added the equivalent private system, there is also a system of tutoring, semi-legal and informal.

The pre-university system includes the following levels:

- early childhood education including ante-preschool (0-3 years) and preschool (3-6 years);

- primary education including the preparatory class and grades 1-4 (6 – 10 years olds);

- secondary education including lower secondary education, i.e. classes 5-8 (11 – 14 years olds) and upper secondary education including 9-12 classes (15 – 19 years olds) with the following optional directions: general, vocational and technical. Vocational education can last from 6 months to 2 years.

General upper secondary education is offered by the lycee, which is attended by about 75 % of pupils in upper secondary education. Lycee studies are four years in length, all four years compulsory since 2020. Lycee studies end with the completion certificate (Bacalaureat). Professional school studies end with the certificate of professional competences. Access to university studies can be obtained through the baccalaureate exam and some universities have their own set of exams.

1.7.1. THE PLACE OF SCIENCE EDUCATION IN ROMANIAN EDUCATION HISTORY

MODULE 1

Higher institutions of education in Romania had been dealing with scientific education as early as the seventeenth century, i.e. St Sava Princely Academy in Bucharest or in Iasi – Academia Mihaileana in 1835. Both played an important role in preparing the foundations of the two universities to come.

Romania ranks 6th in the all-time medal count at the International Mathematical Olympiad with 316 total medals, dating back to 1959. Ciprian Manolescu managed to write a perfect paper (42 points) for gold medal more times than anybody else in the history of the competition, doing it all three times he participated in the IMO (1995, 1996, 1997). Romania has achieved the highest team score in the competition, after China and Russia, and right after the United States and Hungary. Romania also ranks 6th in the all-time medal count at the International Olympiad in Informatics with 107 total medals, dating back to 1989.
There are up to 15 compulsory subjects (usually 8–13) and up to 5 optional subjects (usually 1 or 2). However, unlike in the United Kingdom or France, these optional subjects are chosen by the school and imposed on the student – they are known as School Decided Curriculum (*Curriculum la Decizia Școlii – CDȘ*) and are usually extensions to the compulsory subjects.

For the duration of the elementary school, each student must take various subjects, among which:

- **8 years of mathematics**, Romanian, music, art and physical education;
- **2 years of science** (without Environmental Knowledge which is 2 years);
- **4 years of biology;**
- **3 years of physics;**
- **2 years of chemistry**;
- **4 years of IT** (optionally).

During lycee years **Science** can be studied as follows:
In the *Theoretical program:*

- **Science — *Profil Real* ("mathematics and computer programming" or "natural sciences") — this is the most demanding of all the academic programs, and the most sought-after by the students who want to get S.T.E.M. related degrees. There are 15 different subjects per year, with 30–35 hours weekly : e.g. Math for 4 years (4–7 hours/week — Calculus, Trigonometry and Algebra), Computer Programming (4–8 hours weekly — 4 years), Chemistry and Physics (4 years, 2–4 hours weekly each)** and other subjects related to communication and general knowlegde.

It is divided in two sections, both offering classes suited accordingly: **Intensive Mathematics-and Computer programming — *Mate-info* which provides more classes of Math and Computer programming (up to 5 hours per week each), and Natural Sciences — *Științe ale naturii* which extends knowledge in Biology, Chemistry and Physics (up to 3 or 4 hours per week each).**

The *Math and Computer programming* branch can provide an intensive course in programming which ends with a diploma. These are not, however, available at every highschool (different schools decide their own programs) and the majority of students make their highschool choice based on what classes they want to take. Every student has a fair chance of entering a higher level of education regardless of the chosen profile (https://en.wikipedia.org/wiki/Education_in_Romania)
Technical programs — Profil tehnic will give a qualification in a technical field such as electrician, industrial machine operator, train driver, and mechanic, etc. A lot of subjects are technically based (e.g. Calibration of Technical Measurement Machines, Locomotive Mechanics), with some **math, physics and chemistry** and almost no humanities.

The official curriculum is organised around 8 key competences areas:

- Literacy (mother tongue)
- Multilingual competences (foreign languages)
- Mathematical competences (problem solving)
- Digital competences (use of ICT)
- Personal competences (learning to learn)
- Social competences (citizenship)
- Entrepreneurship
- Cultural awareness and expression (interculturality)

1.7.2 TECHNOLOGY USE IN EDUCATION IN ROMANIA

MODULE 1

Using technology in education is without a doubt the most effective way to provide students with access to quality education anytime, anywhere.

Educational technology or EdTech is a systematic approach to educational processes and resources to improve student performance. The technology allows the identification of the students 'needs and the adaptation of the instructive-educational process to them in order to ensure the students' development. Educational technology is a relatively new field in education, and not all teachers are ready to start implementing such technology-based programs.

Although many teachers prefer traditional teaching methods, there are various benefits of combining them with methods that integrate technology. The introduction of technology in education has allowed teachers to adapt their lessons to the learning styles of students and to promote differentiated learning.

Technology may simplify access to educational resourcesas it is a part of every student's life. Children use smartphones and tablets daily to communicate with friends and to solve various school tasks. They can also be used responsibly in class, with the student being more involved in academic learning when using a familiar tool.

Some say that technology improves students' learning experience, giving the fact that the evolution of technology is proceeding at a fast pace and this allows teachers to develop creative, challenging and innovative lesson plans, providing them with memorable learning experiences.

Using technology students can learn at their own pace; it facilitates individual learning and tends to eliminate educational differences between students. Thus, each student can access anytime and from anywhere the educational content provided by the teacher to understand certain concepts.

Technology is constantly being used in a lot of areas. Introducing it into the classroom will help students become familiar with the use of devices and in formal contexts. Moreover, technology can be an opportunity to improve social interactions and encourage cooperation, skills needed for the future job.

Students feel comfortable in the presence of technology; many use it from an early age. The introduction of new educational content with the help of digital tools, known and used by students, makes them feel more confident in their ability to learn the new material and eager to help their peers in using technology.

Eliminating the need to use physical textbooks, the option to take online courses without leaving home or even home, and the existence of databases have significantly reduced the costs of education. Thanks to technology, education is becoming more flexible and accessible. Online courses are gaining more and more popularity, which is why more and more schools are complementing traditional education with them in order to increase the academic performance of students.

Today, teachers can enjoy a wide range of digital tools and applications that can enhance the learning experience of students, such as: **Kahoot!**, **Trello**, **Nearpod**, **Presidential**, **Prezi**, **ClassDojo,** etc.

The use of technology in schools is a necessity in the current context. It not only streamlines the instructional-educational process of teachers, but also improves students' learning experiences. Accepting and using technology as part of the learning process should become the norm.

1.7.3 THE PLACE OF TECHNOLOGY IN EDUCATION AND PROBLEMS IN ROMANIA

MODULE 1

The Human Rights Measurement Initiative (HRMI) finds that Romania is fulfilling only 65.1% of what it should be fulfilling for the right to education based on the country's level of income. HRMI breaks down the right to education by looking at the rights to both primary education and secondary education. While taking into consideration Romania's income level, the nation is achieving 48.5% of what should be possible based on its resources (income) for primary education and 81.6% for secondary education (https://en.wikipedia.org/wiki/Education_in_Romania).

Romania has dropped from fifth to 37th, in a ranking of internet speeds around the world in 2019. There were 14,387,477 Internet users in December 2018, representing 73.8% of population, according to Internet World Stats5. This means an important increase comparing with the penetration of 62.8% in 2017 and the doubling in 6 years of the percentage of 39.2% reported in 2012 (Grosseck G., Holotescu, C.,2019). The download speed is 21.8 Mbps.

Digital inclusion is a high priority in Romania.The core goals are:

- developing the ICT infrastructure and internet connection for the Romanian education institutions
- training teachers
- developing quality online resources
- providing access to online learning spaces

Major programs (Holotescu, 2012) being implemented in Romania in order to turn education digital are:

- *EUR200 Program*
- *SEI Program*
- *Knowledge Economy Project (KEP)*
- *Wireless Campus*
- *IT system for educational management7*
- *Digital platform for OER — Virtual Library*

In Romania, low-performing students are clustered in certain schools to the same extent as the OECD average and high-performing students more often clustered. A disadvantaged student has a 13% chance, on average, of being enrolled in a school with those who score in the top quarter of reading performance (OECD average: a 17% chance). Even though “the education system does not sufficiently prepare people for employment and better social integration” (EC COMM SWD (2019), 1022) there is a particular sector were Romania has a fastest-growing rate, namely - the Information and Communication Technology (ICT) sector. Romania is the leader in Europe, and sixth in the world, in terms of the number of certified ICT specialists, with density rates per 1,000 inhabitants greater than in the US or Russia (Grosseck G., Holotescu, C.,2019).

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MODULE 2

2.1. 21st CENTURY SKILLS

MODULE 2

Studies clearly showed that education falling short in preparing students for 21st century work and students graduating from secondary schools, technical colleges, and universities are sorely lacking in some basic skills and a large number of applied skills (Trilling & Fadel, 2009):

- Oral and written communications
- Critical thinking and problem solving
- Professionalism and work ethic
- Teamwork and collaboration
- Working in diverse teams
- Applying technology
- Leadership and project management

As education adapts learning methods to meet the demands of the 21st century, schools, districts, states, provinces, education departments, and ministries all over the world are shifting their practices toward a new balance, leaning more to the right of the range of each of these practices (Trilling & Fadel, 2009).

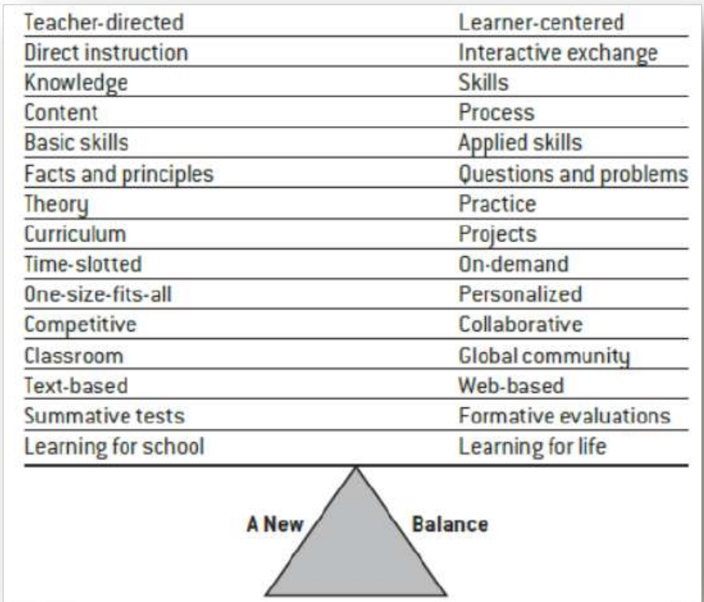

Figure 2.1. 21st Century Learning Balance

In order to successfully prepare our students for their future, with the approaches on the right side of the chart becoming more and more important as we move through our century. The educational balance is shifting, and a new teaching and learning balance is evolving in schools around the globe that better meets the demands of our times and the times to come (Trilling & Fadel, 2009).

21st Century skills are one of the most popular topics in education, especially in middle and high school classrooms. But it can be difficult to teach these skills when you don't even know where to begin. Thousands of middle and high school teachers use to teach 21st Century skills in their classrooms. By mastering 21st Century skills, your students will be better equipped to start and grow in whatever career path they choose. In addition to helping prepare students for their future careers, 21st Century skills can help students be better learners. The students will carry this skills with them as they further their education.

2.1.1 P21 FRAMEWORK DEFINITIONS

MODULE 2

Partnership for 21st Century Skills (P21), a coalition of business leaders and educators, proposed a Framework for 21st Century Learning, identified essential competencies and skills vital for success in twenty-first century work and life (P21, 2007a, 2011). To help practitioners integrate skills into the teaching of key academic subjects, the Partnership for 21st Century Learning (P21) has developed a unified, collective vision for learning known as the Framework for 21st Century Learning. This Framework describes the skills, knowledge, and expertise students must master to succeed in work and life; it is a blend of content knowledge, specific skills, expertise, and literacies (Battelle for Kids, 2019).

P21 is employing a three-part strategy to promoting and sustaining the 21st century skills agenda (Trilling & Fadel, 2009):

- Combining the power of three key stakeholder groups— education, business, and government—to work hand in hand toward a common vision of 21st century learning

- Using a broad range of communication tools—surveys, reports, magazine articles, press releases, online examples and case studies, and presentations at conferences —to get the word out about the need for 21st century skills, what they are, and how they can be learned

- Working directly with education, business, and government leaders to highlight education initiatives in their own regions and to have them share their leading practices

Although it is focused primarily on the American education system, P21's message is being echoed across the world, spreading through its network of global member organizations while likeminded advocates for educational modernization develop similar ideas in other countries

The term 21st century skills refers to a “broad set of knowledge, skills, work habits, and character traits that are believed by educators, school reformers, college professors, employers, and others to be critically important to success in today’s world.” In simple terms, 21st Century Skills refer to the skills that are required to enable an individual to face the challenges of the 21st century world that is globally-active, digitally trans forming, collaboratively moving forward, creatively progressing, seeking competent human-resource and quick in adopting changes (21st Century Skills: A Handbook).

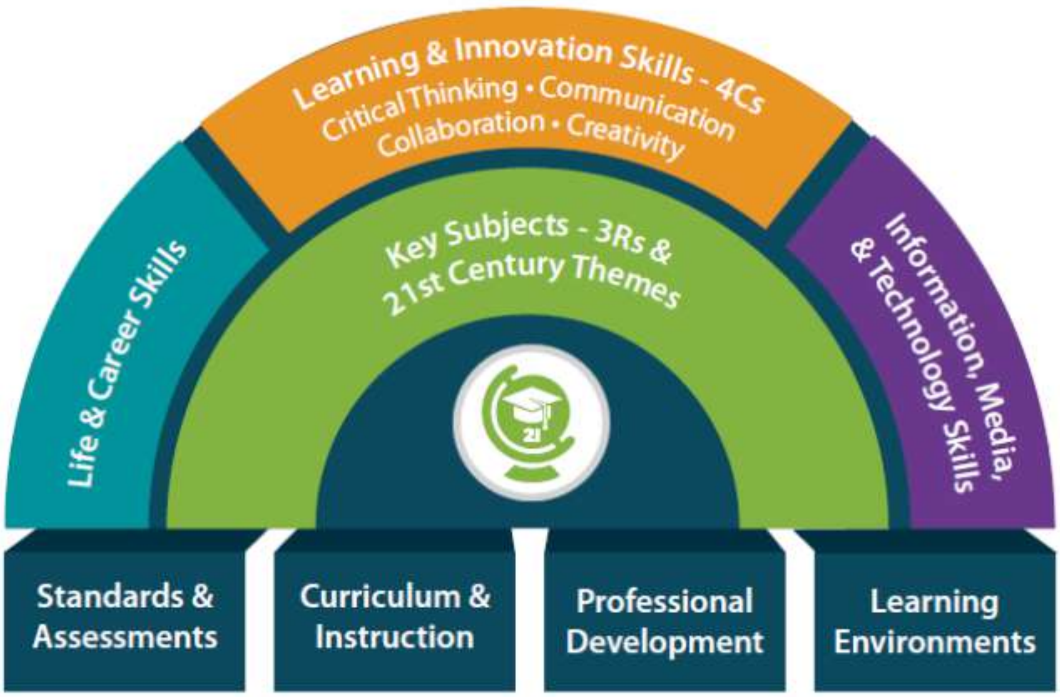

Figure 2. 2. P21 Framework-21st century student outcomes (Battelle for Kids, 2019)

As shown in the Figure (2), 21st century student outcomes” (represented by the skills rainbow) are the knowledge, skills, and expertise students should master to succeed in work and life in the 21st century (Battelle for Kids, 2019). The skills of the P21 learning rainbow offer a memorable image of what students will need to learn to be successful in the 21st century.

21st Century Skills included 'The 4Cs' – communication, collaboration, critical thinking and creativity, which are to be taught within the context of core subject areas and twenty-first century themes. This framework is based on the assertion that twenty-first century challenges will demand a broad skill set emphasizing core subject skills, social and cross-cultural skills, proficiency in languages other than English, and an understanding of the economic and political forces that affect societies (UNESCO Working Paper'The Future of Learning 2).

On the basis of the historical development of 21st Century Skills, it can be stated that 21st century skills broadly consist of three main skill sets or 3 Ls – namely (Trilling & Fadel, 2009);

- Learning Skills,
- Life Skills and
- Literacy Skills

21st century skills of the P21 framework even more memorable, reshuffl es and condenses the eleven skill sets into seven, all beginning with the letter "C."

• 4Cs: Critical Thinking, Creativity & Innovation, Collaboration, Communication

• IMT: Information Literacy, Media Literacy, Technology Literacy

• FLIPS: Flexibility and Adaptability, Leadership and Responsibility, Initiative and Self-Direction, Social and Cross-Cultural Interaction

P21 Skills	*7Cs Skills*
Learning and innovation skills	
Critical thinking and problem solving Communications and collaboration Creativity and innovation	Critical thinking and problem solving Communications, information, and media literacy Collaboration, teamwork, and leadership Creativity and innovation
Digital literacy skills	
Information literacy Media literacy ICT literacy	[included in Communications] [included in Communications] Computing and ICT literacy
Career and life skills	
Flexibility and adaptability Initiative and self-direction Social and cross-cultural interaction Productivity and accountability Leadership and responsibility	Career and learning self-reliance [included in Career and learning self-reliance] Cross-cultural understanding [included in Career and learning self-reliance] [included in Collaboration]

Table 2.1. P21 and 7C Skills (Trilling & Fadel, 2009)

"7Cs" skills of 21st century learning and "3Rs" skills of Reading, 'Riting and 'Rithmetic (Trilling & Fadel, 2009)

• Critical thinking and problem solving

• Creativity and innovation

• Collaboration, teamwork, and leadership

• Cross-cultural understanding

• Communications, information, and media literacy

• Computing and ICT literacy

• Career and learning self-reliance

If we take the basic "3Rs" skills of Reading, 'Riting and 'Rithmetic and multiply them by the 7Cs, we now have a handy formula for successful learning in the 21st century. like any good formula, its value lies in its appropriate application to solving real world challenges (Trilling & Fadel, 2009).

3Rs × 7Cs = 21st Century Learning

2.1.1.1 Learning & Innovation Skills

Learning and innovation skills are what separate students who are prepared for increasingly complex life and work environments in today's world and those who are not. These skills include (Battelle for Kids, 2019):

- Creativity and Innovation
- Critical Thinking and Problem Solving
- Communication
- Collaboration

2.1.1.2 Information, Media & Technology Skills

Today, we live in a technology and media-driven environment, marked by access to an abundance of information, rapid changes in technology tools, and the ability to collaborate and make individual contributions on an unprecedented scale. Effective citizens and workers must be able to exhibit a range of functional and critical thinking skills, such as (Battelle for Kids, 2019):

- Information Literacy
- Media Literacy
- ICT (Information, Communications, and Technology) Literacy

2.1.1.3 Life & Career Skills

Today's students need to develop thinking skills, content knowledge, and social and emotional competencies to navigate complex life and work environments. P21's essential Life and Career Skills include (Battelle for Kids, 2019):

• Flexibility and Adaptability

• Initiative and Self-Direction

• Social and Cross-Cultural Skills

• Productivity and Accountability

• Leadership and Responsibility

2.1.1.4 Key Subjects & 21st Century Themes

MODULE 2

The core subjects and interdisciplinary 21st century themes are surrounded by the three sets of skills (Trilling & Fadel, 2009). Mastery of key subjects and 21st century themes is essential to student success. Key subjects include;

Native Language/Reading, World Language(s) including English, Arts, Geography, History, Economics, Mathematics, Science, Government/Civics

In addition, schools must promote an understanding of academic content at much higher levels by weaving 21st century interdisciplinary themes into key subjects. These are (Battelle for Kids, 2019; 21st Century Skills: A Handbook):

- Global Awareness
- Financial, Economic, Business, and Entrepreneurial Literacy
- Civic Literacy
- Health Literacy
- Environmental Literacy

2.2 COUNCIL RECOMMENDATION ON KEY COMPETENCIES FOR LIFELONG LEARNING

In our world where the rapid development of technology, structural changes and socio-economic developments in the workforce are experienced, individuals who want to find better jobs and take part in society as active citizens need a wide range of competencies.

These qualifications, which are of fundamental importance for the European Education Area, are called key competencies. In addition, these competencies are valued and encouraged for personal development, employment, sustainable lifestyle, inclusive and active citizenship. In an updated Council Recommendation on Key Competencies for Lifelong Learning published in 2018, the European Commission defines eight key competencies that are seen as an important factor in increasing the innovation capacity, productivity and competitiveness of the EU as follows:

- Literacy
- Multilingualism
- Numerical, scientific and engineering skills
- Digital and technology-based competencies
- Interpersonal skills and the ability to adopt new competencies
- Active citizenship
- Entrepreneurship
- Cultural awareness and expression

Key competencies that appear to be an important factor in lifelong learning are expressed as a combination of knowledge, skills and attitudes. In the study named “Key Competencies for Lifelong Learning” published by the European Commission in 2019;

- Information

Knowledge consists of concepts, facts and figures, ideas and theories that are already established and support the understanding of a particular field or subject.

- Abilities

Skills are defined as the ability to run processes and use existing knowledge to achieve results.

- Attitudes

Attitudes describe the tendency and mindset to act or react to ideas, people or situations

2.3 THE STATUS OF SCIENTIFIC LITERACY IN TURKEY

MODULE 2

The concept of science literacy is not always used in the same sense (Bybee, 1997), it has been used in the literature for more than sixty years (Gallagher & Harsch, 1997). Norris and Philips (2003) suggest that the concept of science literacy consists of the following components:

- Distinguishing scientific and non-scientific knowledge,
- To understand science and its applications,
- To know what counts as science,
- Being independent in learning science,
- Scientific thinking ability,
- Ability to use scientific knowledge in problem-solving,
- Necessary knowledge for rational participation in science-based issues,
- Understanding the nature of science, including its relationship to culture,
- Scientific curiosity and desire,
- Information about the risks and benefits of science,
- Think critically about science and engage in scientific expertise.

In the National Education Development Project report submitted to the World Bank by the Higher Education Institution in our country, the components of scientific literacy are discussed as follows (World Bank, 1997a):

- Being familiar with the natural world,
- Recognizing both its diversity and unity,
- Understanding key concepts and principles of science,
- Being aware of some important links connecting science, mathematics and technology,
- Understanding that science, mathematics and technology are the products of human efforts,
- Recognizing the strength and limitations this brings for those areas,
- To have scientific thinking capacity,

One of the most important aims of science programs in countries is to raise scientifically literate individuals and to improve science literacy. Turkey has taken the necessary steps in this regard and the Progress in International Reading Literacy Study (PIRLS), the International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA) have taken the necessary steps. Taking into account the results obtained in international studies such as PISA, it entered into a systematic program development process that started in 2004. In this direction, reform-like changes were made in all programs from primary education to university education programs (Bulut, 2007).

2.3.1. The situation of Secondary School Students in Turkey in the Context of Science Literacy

MODULE 2

The most important of the studies that reveal the science literacy of students in Turkey is the PISA study. PISA is international research conducted by the OECD in three-year cycles that evaluates the knowledge and skills of 15-year-old students in certain fields. PISA research is carried out to measure the mathematical literacy, science literacy and reading skills of students in the 15 age group who continue their formal education (MoNE, 2019)

According to the 2018 PISA report, the rate of students who fall below the 2nd level in science in Turkey is 25.2%. These students can use their knowledge of everyday subjects at a basic level to explain scientific phenomena. Students below the 2nd level are not successful in finding correct explanations of simple scientific facts and in stating whether an inference can be correct according to the data presented. It is observed that the proportion of children who do not have basic competencies in science has decreased compared to 2015. According to the 2018 PISA report, the rate of students with the highest achievement in science is 6.7% compared to the average of OECD countries, while the rate of students at the same level in Turkey is only 2.4%.. It is seen that 15-year-old students in Turkey are behind their peers in the average of OECD countries in terms of proficiency levels. In particular, the high rate of students below the 2nd level indicates that it is difficult to read and understand a simple text, and learning poverty is common (ERG, 2020).

While Turkey ranks 39th among 79 countries participating in Pisa in the field of science literacy, it ranks 30th among OECD countries. When the 2018 Pisa report is examined, approximately 75% of the students in Turkey are at the second level. This value is below the average of OECD partner countries. At this level, students know the correct explanation of familiar scientific phenomena. At the highest levels, 5 and 6, only 2% of students in Turkey have (the OECD average is around 7%). These students can use their knowledge creatively and authentically, even in diverse and unfamiliar situations.

Like the PISA research, another international study that we can consider scientific literacy is TIMSS. In TIMSS, proficiency levels (advanced, upper, intermediate and lower) are defined and the difference in scores between each proficiency level is 75. According to the 2019 TIMMS Report, 12% of the fifth-grade students in Turkey are at an advanced level in science. On the other hand, it is seen that 10% of the fifth-grade students cannot reach the lower proficiency level in science. The rate of children who cannot reach the lower proficiency level in the eighth grade is 12%. The fact that one out of every five students among eighth-grade students cannot reach even the lowest level is a result that should be carefully considered (ERG, 2020).

There are also studies in the literature that reveal the situation of students in Turkey in the context of science literacy. Some of the variables that affect the scientific literacy levels of primary school students appear as the student's grade level and the availability of tools and equipment to be used in research (Şahin & Say, 2010). In developing students' science literacy, scientific discussion supported teaching on socio-scientific issues is effective (Gülhan, 2012), and teaching science lessons with activities that improve science literacy increases students' academic achievement, attitudes towards science and scientific process skills (Güçlüer, 2012). It is said that the inquiry-based science teaching method affects science literacy positively (Çolak, 2014). In addition, socio-scientific, life-based studies positively affect students' science literacy.

Berberoğlu (2017) states in the ERG Education Monitoring Report that Turkey should first define high-level theoretical processes, develop a common understanding across the country, create good examples, and prepare curriculums and books by taking these into account. The ratio of students at high proficiency levels in Turkey's PISA and TIMSS studies is low compared to OECD countries. Regardless of the subject area in our country, it does not seem possible to increase the quality of education unless a system focused on thinking processes is taken as a basis. Berberoğlu (2017) stated that determining the theoretical basis on which the curricula are based, defining the objectives and achievements within the scope of this basis, setting good examples for the development of these achievements should be the starting point of the process, and then he mentioned the factors such as quality differences between schools, socio-economic level, feeling of belonging to the school, motivation, and teacher proficiency affect students' science literacy.

2.4. THE RELATIONSHIP BETWEEN SCIENTIFIC LITERACY AND 21ST CENTURY CORE COMPETENCIES

Scientific literacy plays an important role in human daily lives. Promotion of scientific literacy has been recognized as a major goal of science education in the world (BouJaoude, 2002; National Research Council [NRC], 1996). Scientific literacy is the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and engagement in economic productivity. It also includes specific types of abilities." (National Academy of Sciences, 1996). It includes mathematics and technology and encompasses all scientific fields including life science, physical science, the natural world, the human-made world, and the unifying forces between them. Scientific literacy is evolving as an essential literacy for modern citizens, due to the rapid development of science and technology in the 21st century. As Miller (2002) mentioned that 21st century society requires a public with knowledge about scientific and technological issues for the democratic process to function properly.

21st century students need to be able to solve various problems by thinking creatively and the use of technology. To overcome the challenges of the twenty first century in science and technology sector, students need to be equipped with the 21st century skills. Scientific literacy has been recognized as an important characteristic that every citizen in a modern society should possess. Terefore, science education which includes 21st century skills is critical for developing students' scientific literacy (Turiman et al., 2012).

Qualified science education has an important place in students' 21st century skills. In this concext, importance is given to science education both abroad and in Turkey, and studies are being carried out with the reforms carried out in education to train science literate individuals (Bağcı-Kılıç, Haymana ve Bozyılmaz, 2008). Threfore many changes and innovations have been done in the science curriculum and the science curriculum has been updated several times since the 2000s in Turkey. In 2005, the Ministry of National Education created curriculums according to constructivist understanding, updated the curriculums in line with the 4 +4 +4 education system introduced in 2013, and partially revised the curriculum in 2017 and re-revised in 2017 in 2018 as a result of evaluations (Şentürk and Aydoğmuş, 2017).

The vision of the 2005 and 2013 curricula was "educating all students as science literate individuals" but the vision of 2017 and 2018 curriculum was not mentioned. However, the basic philosophy of the 2017 curriculum has been elaborated as the development of individuals who live and keep alive the national spiritual values, internalize universal values, have responsibility, have confidence, have critical and innovative thinking skills, have new understanding and can look at the World from different windows. In act, these skills are handled in many sources as 21st Century skills. It can be said that, the basic philosophy of the updated 2017 and 2018 curriculum aims to give students 21st Century skills. In addition, the continuous reforms in science education resulted in new trends such as science, technology, engineering, and mathematics (STEM) and in the 2017 curriculum, science, engineering and tehnology applications are included (MoNE, 2017, 2018). With these applications, students are expected to work on solving the problems encountered in daily life within the scope of the topics covered in science courses and to develop product / inventions that will solve the problems (Şentürk and Aydoğmuş, 2017).

The idea of developing and enhancing scientific literacy with the use of literature while meeting the Next Generation Science Standards and being responsive to the 21st Century Skills may seem contrived Science students have been cultivated by scientific literacy and science process skills through science classes. With these two skills, it is hoped that the science students have developed some skills needed in 21st century skills (Turiman, 2012). The four critical areas of development identified in the Partnership for 21 Century Skills framework that include collaboration and teamwork; creativity and imagination; critical thinking; and problem solving, are mirrored in the call to integrate the teaching of science (Tomovic, et al., 2017)

In the 2018 Science curriculum, the subject areas defined as field-specific skills has three dimensions called “Science Process Skills, Life Skills (Analytic Thinking, Decision Making, Creative Thinking, Entrepreneurship, Communication and Team Work) and Engineering and Design Skills (Innovative Thinking)” while “Living Things and Life, Matter and Change, Physical Events, the Earth and Universe” (MoNE, 2018).

Science Process Skills are addressed under the heading of field-specific skills in the 2018 Science curriculum (MoNE, 2018). In order for the development of 21st century skills, it is necessary to contribute to the training of individuals who are competent of Science process skills (SPS) and are scientific literate (Turiman, Omar, Daud and Osman, 2012). In teaching and learning of science, science process skills are used as teaching approach.

Science process skills are behaviours that promote the formation of skills applied to acquire knowledge and then disseminate what is obtained thus increasing the use of optimum mental and psychomotor skills (Turiman, 2012).

Through hand-on activities like science experiment, students use different senses by touching, feeling, moving, observing, listening and smelling and sometimes testing materials in a controlled manner. This help students to progress from concrete thinking levels to more complex thinking levels (Jones et al., 2003) which promotes higher 21st order thinking skills in century skills. Other than observing, communicating is also needed in both science 21st process skills and century. Communicating can take many forms including using words, action, or graphic symbols to describe an action or event. It requires students to put information that they have gathered from observations so that it can be shared with others. With good communication skills students will be able to describe the natural phenomena in science class. (Bilgin, 2006; Turiman, 2012).

The explanation regarding Socioscientific Issues is given in the special objectives of the 2018 Science curriculum; “Developing reasoning, scientific thinking and decision making skills by using socioscientific issues”. SSI refer to issues which cause individuals to experience dilemmas when encountered in daily life, which individuals find difficult to decide on and on which no consensus has been reached particularly among scientists such as climate change, genetic engineering and biotechnology implementations and nuclear energy. Hofstein, Eilks, and Bybee (2011) pointed out the importance of integrating Science curriculums with societal problems that are a part of daily life, as in SSI. The students can develop reasoning ability, scientific thinking habits and decision making skills by using socio-scientific subjects that is very important in 21st century copetencies.

The basic philosophy of science curriculum aims to give students 21st Century skills. The 2005 curriculum is based on a constructivist learning approach that adopts a student-centered approach. The 2013, 2017 and 2018 curriculum is also based on a student centered approach; but learning environments were designed to be based on learning based inquiry, problem solving, project, design based, argumentation and collaborative learning. With these learning approaches positive attitude towards learning science is nurtured and thus teamwork and social interaction are developed (Turiman, 2012).

Science, engineering and entrepreneurship implementations are handled in the 2018 curriculum and its importance is emphasized. Therefore STEM education approach included in the 2018 Science curriculum in Turkey. In the 2018 Science curriculum, the necessity of imparting engineering and design skills to students is emphasized within the scope of field-specific skills. With these implementaions sthe students are expected to define a need or a problem from daily life related to the subjects studied in the units. In the solution of a problem, they need compare alternative ways of solution and select the most suitable one on the basis of the criteria, make plans on the selected solution and create a product. Also they are expected that required to create strategies to market the product (MoNE, 2018; Yapıcıoğlu, 2021).

Innovative thinking skills have also been added to the 2018 Science Curriculum as part of engineering and design skills (MoNE, 2018). In 2018 curriculum, it can be seen that the number of innovations associated with project development and innovative ideas can be increased (Deveci, et al., 2018).

Creative thinking skills are seen as a new idea development process (Conklin, 2011). Also, Puccio and Murdock (2001) suggested that creative thinking is a basic life skill. In 2018 curriculum, the number of acquisitions aimed at developing students' creative thinking skills is small in number (Deveci, et al., 2018)..

Entrepreneurship skills are seen as personal skills that enable an idea to be implemented (European Commission, 2011). Entrepreneurial skills in middle schools are based on gaining entrepreneurial attitudes and skills related to the development of personal qualities rather than the creation of new enterprises (European Commission, 2004). These skils were intended to be developed by students under the theme of life skills in both the 2013 and the 2018 science curriculum in Turkey. However, the number of acquisitions aimed at developing students' entrepreneurship skills is small in number in 2018 curriculum (Deveci, et al., 2018).

The communication skills involves exchanging information and sharing meaning through a common understanding (Castells, 2009). The communication skill of the students in particular can be improved with the help of the 2018 science curriculum acquisitions. Similarly, Deveci and Çepni (2017) found that the 2013 science curriculum acquisitions aimed to improve communication skill more than other skills. This situation can be seen as a result of the student-centered approach adopted in the curriculum in recent years.

In recent years, it has become accepted that the student is active, has the right to speak and to express his/her opinions freely, to explain concepts in his/her own words, and to present models, designs or innovative ideas they have made. In this process, the communication skills of students are expected to be the most clearly emphasized life skills.

Students with scientific literacy knowledge and understanding of science concepts and processes required to engage in the digital era society. Students can ask questions, get, or determine answers queries issued from daily experience. Then they have the ability to describe, explain and predict natural phenomena. Students must also be able to read with comprehension of scientific articles in the popular media and to engage in social discussion of the validity of its findings. In addition, students can identify scientific issues whether at local or national level and provide the scientific and technological information. Students also can assess the quality of scientific information on the sources and methods used to produce it. Apart from that, students should be able to present and evaluate arguments based on the evidence and to produce a summary of the debate is appropriate (NCREL, 2003).

In conclusion, teaching the 21st century knowledge and skills through the curriculum in Turkey is one of the primary goals of education. The critical and creative thinking, problem solving, decision making, communication, research, use of information technologies and entrepreneurship were emphasized in curriculum change in Turkey. Considering integration of information and communication technologies into educational practices in Turkey, FATIH Project introduced in 2010 have led to provide schools with equipment and software infrastructure, to integrate information technologies into curriculum, and to provide teacher training on the use of

technology in teaching and learning process (http://fatihprojesi.meb.gov.tr...). Therefore, it is possible to maintain that integration of technology into educational practices is emphasized and reflected on curriculum in Turkey. Considering the curriculum development and educational reform movements in general in Turkey, it can be stated that 21 century competencies are taken into consideration.

2.5. IMPROVING SKILLS FOR THE 21ST CENTURY: PREPARING YOUNG PEOPLE

MODULE 2

Social and economic changes in the European Union are harbingers of new opportunities and challenges. Today, young people need a wider range of skills than ever before in order to succeed in a globalized economy and increasingly diverse societies. Many will do jobs that do not yet exist today. Many will need advanced language, intercultural and entrepreneurial skills. Technology will continue to change the world in ways we can't imagine today. Issues such as climate change will require a radical adaptation effort. In this increasingly complex world, creativity and the ability to continue learning and innovating will count just as much, if not more, than specific sectoral knowledge potentially destined for obsolescence.

The European Council has repeatedly emphasized the key role of education and training for the future growth, long-term competitiveness, and social cohesion of the Union. To achieve this, it is crucial to develop the full innovation and creativity potential of European citizens. Within the framework of the "education - research - innovation" knowledge triangle, the element of education should be strengthened by starting as soon as possible, i.e. already in schools. The skills and learning habits acquired at school are in fact essential to develop new skills in view of the new jobs that await children in the future life. The Commission stated that promoting well-being in the face of the challenges of the 21st century requires a new approach based on the need to provide citizens with adequate opportunities for self-fulfillment, access to education, employment, health care and social protection, in a context of solidarity, social cohesion and sustainability. In this context, the Commission has established that investing in youth will be a key priority.

The Council concluded that Europe's growth and prosperity depend on the active participation of all young people. The goals achieved by children in compulsory education have significant and direct repercussions on their future social integration, on their future education or training paths, as well as on their future income level. However, access to high-quality school education is not fair, with the result that education systems often exacerbate economic and social inequalities. Education ministers pledged to improve the quality and fairness of education systems.

The Council adopted for 2010 three reference targets directly related to school education (early school leavers, reading skills and completion of upper secondary education). But the progress made is still insufficient. Consequently, the European Council urged the Member States to reduce appreciably the number of young people who are unable to read fluently and the number of young people who leave school prematurely, as well as to improve the education levels of pupils from migrant families or disadvantaged groups. As part of the annual reviews of the National Reform Programmes under the Lisbon Strategy, the Commission has made recommendations to several Member States to improve certain specific aspects of their education systems.

2.6. THE STATE OF SCIENTIFIC LITERACY IN ITALY

MODULE 2

The school system was custom-built of the classical lyceum. But humanistic education must be supported by a robust dose of method and scientific facts. Otherwise the risk is to screw on the obvious effects of a nefarious illiteracy.

Many, to try to find an explanation for the inability of the average Italian to cognitively access even the most modest explanations of what happens based on the scientific method and on the use of arithmetic and elementary logic, cite a now widespread and permanent state of scientific illiteracy of the ordinary citizen, who, since school, has neither been instructed nor encouraged to practice the use of the elementary techniques of analytical thought. The statistical proof of this claim would lie in the spread of scientific illiteracy in Italy, a measure detected with several different methods constantly over time by many different investigators of this problem.

As is immediately evident, however, to invoke the spread of illiteracy as an explanation of illiteracy is an obvious tautology, and therefore some somewhat more in-depth considerations are necessary, especially under the urgency of being able to address the causes that lead to the persistent and irreducible breadth of a mental condition that leads to not understanding the evidence, albeit temporary and probabilistic, that scientific research brings us in cases such as those that occurred during the present pandemic, when certainly a greater elementary preparation on certain issues would also have led to a greater capacity for prudent choices on vaccines, prevention measures, drugs and more.

To try to identify at least one of the obstacles that still prevent many fellow citizens from progressing from a cognitive point of view, regardless of their educational path and their scholastic, academic and professional career, a simple experiment is proposed to the reader: try first of all to list or obtain the list of eminent characters of the Italian humanistic world – writers, musicians, poets, writers, philosophers etc. - who populated our country in the past times. Names such as Manzoni, Petrarch, Dante, Leopardi, Machiavelli, Carducci, Verdi, Mascagni, Vivaldi, Michelangelo, Giotto and many others will probably be known to most of the subjects questioned, along with some notion of why they brought luster to our country. The question then arises of listing some of the Italians who have contributed most to the advancement of thought in the scientific field. Galilei will be mentioned by all, probably together with Leonardo, but already few will remember Alessandro Volta or Guglielmo Marconi. No one will remember the name of Camillo Golgi, Giuseppe Levi, Enrico Fermi, Amedeo Avogadro, Renato Dulbecco, Ettore Majorana, Emilio Segré, Bruno Pontecorvo, Giulio Natta, Giovanni Cassini, Vito Volterra, Ugo Amaldi, Bruno De Finetti and many others.

Of course, if you ignore these names, even more so you ignore the contributions of these Italians to modern thought; but it is the disappearance of their memory in Italy, compared to that maintained for the counterpart in different humanities that points to a precise and voluntary removal.

The reason for this removal is not one, and is intertwined with multiple socio-cultural phenomena that have intervened for centuries in our country; however, it is perhaps worth remembering a precise moment of a century ago, which saw very clearly expressed the precise will to direct the preparation of Italians in a wrong direction, because it was hostile to basic scientific training. The philosopher, Benedetto Croce epigon of Italian neorealism, wrote in 1908: "Men of science [...] they are the embodiment of mental barbarism, coming from the substitution of schemes for concepts, of piles of news to the philosophical-historical organism." A few years later, the generous effort of the mathematician Federigo Enriques to merge philosophy and science, and to place this fusion at the center of the formation of Italians, was definitively blocked by Croce and his associate Giovanni Gentile, who in a famous public controversy crushed not only the vision of Enriques, but clearly expressed a vision in which the statute of science was poor and unsuitable for true culture and true progress. intellectual. As Armando Massarenti recalls, scientists were called "minute ingenuities", and Gentile, who became Minister of Education, built an educational system centered on the Liceo classico, reserved for the elites and the only one to give access to all university faculties, and on the compression of mathematics, physics and science – so that today Italians ignore even those among them who have achieved great results in these fields, helping to elevate the scientific understanding of the world.

2.6.1. The Situation Of Secondary School Students in Italy in The Context Of Scientific Literacy

The National Indications of the specific learning objectives for high schools represent the disciplinary declination of the educational, cultural and professional profile of the student at the end of the high school courses. The Profile and the Indications constitute, therefore, the framework on which the educational institutions draw their Plan of the training offer, the teachers build their own educational paths, and the students are put in a position to achieve the learning objectives and to mature the skills of high school education and its articulations.

The problem of the low level of scientific culture is felt not only in Italy, but throughout the European Union. The alarm signal was launched by the University that for many years has witnessed a constant and significant decrease in enrollment in scientific degree courses: in Germany, for example, enrollment in the degree course in physics has halved since 1991 and the German country increasingly resorts to the recruitment of Indian graduates in scientific subjects to support its economy; France has also seen a decline in enrolment in scientific faculties, amounting to 12% since 1996; in Belgium there is an annual decrease of 5% in the degree courses in civil and industrial engineering; Finally, Great Britain is beginning to raise the problem of the recruitment of university professors.

In Italy the situation is no better, even our country like those already mentioned above must fear the repercussions on economic development of a small number of graduates in scientific disciplines. But in the Italian case, the country is preparing to face a new emergency: according to data held by the European Union, the age of Italian teachers of mathematics and science is on average higher than in many other states (the average is over 50 years). This circumstance, together with the decline in enrollment in scientific faculties, will cause in the coming years a problem of recruitment of teachers of scientific subjects in every order of school.

2.6.2. Indications For The Italian School System

MODULE 2

- ***Number of pupils per class:***

In Italy and Finland the classes are about 20 students, while in Asian countries they are 40 – 50 students. However, according to those responsible for the research, it is difficult to establish a correlation between the size of the class and the results obtained in the tests, since the policies and teaching practices vary enormously from one state to another. Corrections are often introduced in the case of very large classes, establishing smaller classes for deepening or for recovery.

- ***National and/or local curriculum?***

In almost all countries, middle school curricula are defined exclusively at the national level, with the exception of the United States, Australia and Canada. The Italian curriculum is among the oldest (1979) and has not undergone changes. This issue is particularly topical for our country.

- ***Importance of resources***

Research data confirm that better results are obtained if there is greater availability of resources for education (funds for substitutes, buildings and school facilities, air conditioning and lighting systems, computers, libraries, audiovisual materials).

- ***Integrated or disciplinary courses?***

In the eastern states, which achieve excellent results in learning mathematics and science, an integrated rather than disciplinary didactic approach is preferred at the level of lower secondary schools.

- ***More space for experimental activities:***

As far as science is concerned, at the international level the frontal lesson remains the most practiced activity (24%) followed by experimentation conducted by students (15%) and student activity led by teachers (14%). It should be noted that of the 12 countries where the experimentation conducted by students constitutes 20% of the lesson time, 8 obtained in the average tests 9 significantly higher than the international average. In Italy, however, experimental practice by students is limited to 5% of the time. This result poses a problem with regard to the initial training of teachers. Teachers of mathematics and science in middle schools often do not have adequate experimental university preparation. The SSIS must therefore take care of properly integrating this aspect of a teacher's cultural background.

- ***Strengthen teaching methodologies:***

Internationally, a high didactic value is recognized to "problem solving" and scientific reasoning. With this last expression we mean a complex of activities required of students:

- Explain the reasoning behind an idea;
- Represent and analyze data using tables, graphs and maps;
- Work on problems for which it is not possible to immediately identify an obvious solution method;
- Write explanations about what was observed and why it happened;
- Sort objects and events according to a certain criterion and explain the chosen criterion.

In Italy, compared to 1995, the emphasis attributed to these methodologies has grown, (Italy is in second place out of 36 countries in the ranking of the importance attributed to these issues in the teaching of mathematics), but this does not yet translate into an improvement in student performance.

- ***Attention to the ability to communicate and solve non-routine problems***:

In the teaching of mathematics, which teaching approach is preferred according to the national curricula in the various countries? In Italy it seems that greater emphasis is given to the understanding of concepts, the application of mathematics to real life, the integration of mathematics with other disciplines and a thematic and multicultural approach, while a relative importance is attributed to the ability to communicate mathematically and to the resolution of non-routine problems. These last two aspects have recently received increasing attention in teaching methodology; the fact that as many as thirty-three countries (including ours) pay at least moderate attention to these issues is positively evaluated by the TIMSS managers.

2.7. The Relationship Between Scientific Literacy And 21st Century Core Competencies in Romania

MODULE 2

Teachers should implement STEM-specific training methodologies to develop relevant learning outcomes. At national level, it started 4 years ago to implement new methodologies that are developed and applied in the teaching of many STEM disciplines. In Romania, the methodological suggestions in the school curriculum emphasize the importance of intuitive methodologies, especially in primary education, research methodologies, projects that support argumentation of reasoning or problem-solving methods, the interpretation of graphs, but also those that propose the use of software without any exemplification of any kind.

For many years, our education system has claimed that more than half of the graduates are ready for work. Unfortunately, employers report much lower, less than 20%, graduates are ready for work. In 2002, the Partnership for 21st century was set up as a coalition with the purpose to bring the business community, educational leaders and policy makers together to initiate a debate on the importance of the 21st century skills for all students. Since then, our country has been adopting the same policy.

The question of the content of learning has been raised by Plato, but the start of using the world curriculum was in the 16th century. With the institutionalization of learning and the development of formal education systems, the need to plan and predict the teaching process that takes place in schools has become more and more important.

Through STEM education, all kinds of skills necessary for a person in the knowledge society are targeted:

1) scientific, achieved at:

a) explanatory, experimental level- standardfor natural sciences.

b) interpretive, hermeneutic level–standard for socio-human sciences.

c)logic-mathematics level–standard for mathematical and computer sciences;

2) applied, achieved at:

a) socially applied sciences (level oftechnology and production);

b) sciences and arts(the level of aesthetic education and psychophysical education).

2.7.1. Short overview of the curriculum

MODULE 2

The curriculum assumes the complex planning of the educational process, from the formulation of the educational goals to the method of evaluation. There are basically two levels of curriculum in our country: the core (common) curriculum and the local curriculum.

Romania has made substantial progress in latest decades to improve its education system and enhance student learning outcomes. Though, while the system allows some students to excel, too many go through school without mastering basic competencies and a large part leave education before completing upper secondary education (Kitchen et al., 2017; Eurostat, 2019).

In 2016, the Educated Romania project began a multi-year national consultation to discuss key challenges for education in the country and identify objectives for 2030. The Educated Romania report puts forward a set of goals to increase access to quality education for all social groups, and in particular students from disadvantaged and under-represented groups. The report recommends that Romania:

- Improve access to high-quality education for all children.
- Help struggling students early on in their education career.
- Help motivate students by creating a developing environment and holding high expectations for all students, with support targeted to those who are struggling.
- Distribute resources more equitably across schools and encourage social diversity.
- Give schools more freedom to decide what to teach and how to assess student progress.
- Involve parents, local communities, and offer special programmes to support children with vulnerable backgrounds, including students in rural areas, those from socio-economically disadvantaged families and those with disabilities (http://www.romaniaeducata.eu).

Some of these recommendations could involve a regulation of curriculum levels. It would be important for curriculum developers to assess and summarize what goals they want to achieve and how. The curriculum is always linked to education systems: it is most often interpreted in the system of schools, subjects and teaching units (teaching hours). The curriculum also regulates formal education systems through mediation and content processes.

There is a global trend that, although international organizations do not wish to influence the priorities and content of national education systems, the role of the supra-level curriculum is growing, the same is happening in our country. We are in the middle of process of changing the curriculum at highschool level, including science curriculum.

Science literacy defines the capability of a person to understand scientific laws, theories, phenomena and things. This involves the obligation of each person to have the essential scientific knowledge to doalmost any educated decision of his life. Scientific literacy can be classified into four categories (Shen, 1975, Trefil, 2008):

1. Cultural Scientific Literacy - means understanding the science by a person with average intelligence and education of a culture;
2. Civic Scientific Literacy- represents the level of scientific understanding necessary a person to make informed decisions with regard to legislation and public policy;
3. Scientific Literacy Practice - refers to scientific knowledge that a person needs to solve practical problems (e.g. determining the most efficient way to heat home);
4. Aesthetic Literacy and Consumer Science - indicates to what extent the understanding of scientific laws and phenomena enhances our appreciation of life itself through intellectual beauty of scientific ideas.

In comparison with other European countries, the Romanian educational system could lack a long-term strategy. The Educated Romania project overcomes this lack. Our government is aware of the importance of carrying out larger population training projects/ lifelong learning, in line with the needs of Romania's economy. The development strategy must therefore consider the real and relevant links between education and the labour market. The improvement of the education system will, of course, lead to a reduction in the unemployment rate and the risk of poverty, as well as an improvement in living standards and life expectancy (Leiciu, Zafiu, 2021).

The effort of raising the level of scientific literacy is also influenced by the regulatory power of international pedagogical measurements and assessments: for instant, a lot of developments and curricular reforms have been caused by the results of PISA test in Romania.

Despite a long series of reforms in education, student performance is still low compared to EU standards and that of the OECD. Study performance indicators values approaching international average, but are still below that of the EU, OECD and even neighbouring countries in Central and Eastern Europe. Romania hasn't ranked on a top position in PISA. Although student performance, as shown in the study of international trends in mathematics and science (TIMSS) is still close to the international average and it remains below the OECD average. Moreover, Romania's performance is below average for all European and Central Asian countries and significantly below the EU countries. The values of these performance indicators for Romania stagnated, while in other countries have improved. A high percentage of students recorded good results, but there is a substantial polarization of performance: student test scores are either very high or very low; few are situated in the middle (Stanef R.M., and Manole A.M., 2013).

One reason for these poor results could be in performance measurements. In our country there are central performance measurements at the end of gymnasium and also at the end of high school. They have an impact on education since they have some stakes for the school, such as influencing parents 'choice of school. According to international surveys related to the natural sciences (OECD, 2005), the mere existence of performance measurement (e.g. competence measurement) also encourages educators to follow the content elements more strictly (for instant in mathematics) and there are less cross-curricular approach.

If we are looking for reasons, teacher training and further training could be also one. The teacher prefers to teach what he or she has achieved, i.e. what he or she has learned during teacher training: this is also typical for content elements, but the task of training and further training is also to prepare teachers for content development and involvement in such work. In our country teacher education and training focuses on the acquisition of content and scientific innovations, while there is a growing international trend to prepare teachers for independent development work.

Douglas A. Roberts (2007) basically links the definition of curriculum content for science literacy to two approaches:

Vision I: looking inward to science itself

The results and processes of science form the basis of the content elements, and the (scientific) education is the knowledge of them. That is, (scientific) education means knowledge within (natural) science, but its application may even be related to issues outside its territory.

Vision II: looking inward from situations to science

Cognition is linked to situations that have a (nature) scientific component and that students may encounter as citizens in their daily lives. The content of (scientific) education is the knowledge of these components and the practical application of the (natural) scientific principles, methods of knowledge and rules.

The above contents can appear in two types of curricula. In the so-called "collection curriculum", the layout of the curriculum follows the logic of the sciences, there are rigid boundaries between the subjects, and strong teacher control is characteristic. In the "integrated curriculum", complex, integrated subject-specific, problem-centered content is processed, with flexible teacher guidance and high student autonomy. In parallel with competency-based content management, integrated content processing is becoming more common worldwide. In Romania, the collection curriculum is applied at gymnasium and high school, only in the primary education works the integrated curriculum.

Cognition is linked to situations that have a scientific component and that students may encounter as citizens in their daily lives. The content of (scientific) education is the knowledge of these components and the practical application of the (natural) scientific principles, methods of knowledge and rules. Since our approach is based on strict boundaries between the science subjects, the cognition could be also less flexible.

The new school curricula for gymnasium (it started in 2017) aimed to consistently indicate the competencies pursued and the offerproposed by a particular field of study. From this perspective, the school curriculumit is the first document that any teacher, from any discipline, must know. Newprograms have thus taken on the role of answering a few extremely direct questionsimportant in any authentic didactic approach:

- What do I specifically want to pursue in my learning activities with my students?
- Why do I have to pursue these goals?
- How do I get there effectively, how do I make sure every student of mine can succeed?
- How do I know if what I set out to do has been achieved?

The current primary and secondary school curricula translate into a discipline of study of specific perspective on the interconnection of key competences. Therefore the subsequent idea of allprograms is that each discipline has a contribution to structuringthe training profile of a student focused on key competencies and that all these contributions must beconvergent. This is done for the reason that a key competency is not developed in isolation and is not the prerogative of a particular discipline. None of the disciplines is in a clearly delimited territory, in which the science disciplines have epistemological and knowledge cutsrigid, but in a modern paradigm, in which each discipline has the responsibility and the meansto contribute to the development of skills in the training profile. Thus, the new programin different subjects explicitly targets components of various key competencies.

Of course, each subject may have a key competency to focus on, but the approach proposed by the European Recommendation is that any of the key competencies won't grow in isolation. Therefore, ignoring other skills as not being specific to a discipline is an unproductive teaching practice, which in fact undermines evenspecial methodological

Also, the current school curricula have been developed in accordance with the status thateach subject has it in the curriculum (number of hours allocated, class (s)studies, the level of education at which it is studied, the curricular area to which it belongs).

Challenges identified in STEM education (and not only) could be solved by applying a set of policy priorities such as:

1. Achieving greater efficiency and equity of education systems in the context of its decentralization.
2. Increasing the quality of education
3. Increasing labour competitiveness in Romania through - the provision of higher qualifications of graduates by increasing the number of students enrolled in secondary education, and increasing the quality and relevance of curriculum and teaching
4. Finding the optimum degree of coordination from the Ministry of Education –
5. Encouraging input from and addressing the needs of all parties involved (Stanef R.M., and Manole A.M., 2013)

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MODULE 3

3.1 NATIONAL IMPORTANCE OF ROBOTIC ASSISTED SCIENCE EDUCATION APPLICATIONS (TURKEY)

MODULE 3

Today, while defining qualified human power, expressions that include 21st century skills that can think critically, develop human creativity and produce rational solutions to problems are used. These features can also be used as skills that enable individuals to change from consuming to producing (Karataş, 2021). Robotics and coding education related to digital skills, which are directly included in 21st century skills, have become the common point of many skills. This situation has brought new configurations to the agenda by affecting many foreheads of countries from their education systems to their economies. In addition, today's educational approaches have an understanding that allows for interdisciplinary work, where digital skills are used more. The use of learning-teaching models in which technology is integrated will increase the level of achievement of learning goals, as well as positively affecting the attitude towards scientific subjects.

These tools, which are called robotics and enable the realization of activities, are electronic tools that can be programmed and coded to perform a specified task (Dönmez, 2017). Robotic coding is not only simple applications on the computer, but also a factor that positively affects computational thinking skills and an important part of the reasoning process (European Commission, 2014; Karataş, 2021).

Coding is seen as an important educational tool preferred to develop computational thinking skills (Voogt et al., 2015). Because individuals try to produce solutions by thinking multivariate during coding. In addition, coding education and skills encourage individuals to think computationally with their problem-solving situations and enable them to produce creative solutions to the problems encountered (Karabak & Güneş, 2013; Lye & Koh, 2014).

Robotic applications not only provide fun and convenience to individuals in transferring complex relationships in lessons, but also enable them to develop scientific process skills (Çayır, 2010). From another point of view, coding training improves individuals' digital literacy, human creativity, analytical thinking skills, collaborative working skills, learning by doing and experiencing, their skills to reach results by analyzing the process, and their spatial thinking skills (Akpınar & Altun, 2014; Demirer & Sak, 2016; Karatas, 2021).

With the developing technological equipment and skills, the understanding of production has increasingly focused its priority on computers and coding. In the production process,, people are no longer those who intervene directly, but those who carry out the management of robotic devices through computers and coding. During coding applications, while the individual thinks analytically, he can transform the virtual data he has obtained into concrete products through robots.. Thus, education becomes more enjoyable.

Robotic Assisted Science Teaching Practices: Example Practices at the National Level

There are activities to diversify and increase robotics and STEM education in Turkey. In this context, 4-5-6-7 grades to the Science curriculum updated in 2018. With the addition of the Science, Engineering and Entrepreneurship Applications in 8th and 8th Grades science curriculum, the first step was taken within the scope of transition to STEM education. In 2018, a Coding Guidebook that can be used within the scope of robotics applications in 5th and 6th grades, and an Outcome-Centered Sample STEM Practices Book that can be used at pre-school and primary school levels were published in 2019 (Büyük and Koç, 2019). In addition, in the Design Skills Workshops opened by the Ministry of National Education in recent years, applications are made on the basis of the Science-Technology-Engineering-Mathematics approach.

Today, robotic coding applications are encountered especially in STEM and STEAM education. While the robotic coding practices used in the STEM education improve the social and cognitive skills of the students (Ekin, 2022), they also offer opportunities for them to reflect their analytical thinking skills. This education model allows robotic applications for the education of individuals in almost every age group.

The use of robotics and coding applications in science education is seen as a positive effect of technology on education so that individuals can achieve the gains in the curriculum (Cavas et al., 2012). Students make original designs by actively using engineering materials such as gears, motors and sensors in robotics and coding applications (Guven, 2020). Thus, technological integration takes place at a high level.

Based on master's and doctoral theses in sample applications, there are some studies carried out with students and teacher candidates in the literatüre:

In their research, Büyük and Koç (2019) tried to carry out Robotic Assisted STEM (RoboSTEM) applications using Lego Mindstorms EV3 robotic technology within the scope of STEM education, where the main discipline is Science, and to determine the effect of these applications on the problem-solving skills of secondary school 5th grade students. Within the scope of the research, it was determined that there was a high increase in the problem solving skills of the experimental group participants who participated in the robotic supported scientific activities. Akkoç aand colleagues. (2019), on the subject of "States of Matter and Heat", examined the students' changing scientific process skills and their attitudes towards the Science course, using educational robotic technology to help them reach the solution of a scientific problem. They stated that the robotic supported activities with the experimental group improved the scientific process skills of the students and increased the positive attitude towards the Science course. Karaahmetoğlu (2019) examined the effects of project-based arduino and educational robot applications on students' perceptions of computational thinking and basic STEM skill levels The experimental and control groups were compared, and it was stated that the activities suitable for the block-based robotic programming tool carried out with the experimental group significantly improved the STEM skills of the individuals. Güven (2020) determined the effects of Arduino supported robotic coding applications on secondary school 5th grade science subjects on students' attitudes towards technology use and Science lesson, and student opinions. He stated that individuals' attitudes towards science lessons and the use of technology in lessons were positively affected, and that students could produce robotic solutions to their daily life problems. Aydın (2021) investigated the effects of robotics and coding education on primary school 4th grade students' attitudes towards STEM, basic skills and STEM career interests. He stated that robotics and coding education had a positive effect on learners' STEM attitudes, their basic skills improved, and their STEM career interests increased. Güven, Kozcu Çakır, Sülün, Çetin and Güven (2020) tried to determine the effects of arduino supported applications integrated into the 5E learning model on learners in their studies. In this study conducted with 6th grade students, they stated that a wide variety of ideas were formed and produced about robotic coding, and positive attitudes increased in creativity and attitude levels.

Yıldırım (2020) examined the effects of STEM-based arduino robotic activities in teaching the nervous system on the academic achievement and engineering design process skills of teacher candidates. They stated that there was an increase in the academic achievement of the participants, there was an improvement in their engineering skills and their motivation was positively affected. Alaylı (2021), examined the effects of science teacher education teacher candidates on the use of robotic applications in STEM (FeteMM) approach on their scientific creativity, STEM awareness and self-efficacy regarding Arduino supported project-based teaching. He stated that the participants had a positive effect on their STEM awareness, and that there were significant differences in Arduino-supported project-based teaching self-efficacy. Secer (2020) examined the effects of arduino coding and pen and paper coding applications on students' computational thinking skills, problem solving skills and STEM attitudes in the information technologies and software course. He stated that the participants had positive results on their computational thinking skills, problem solving skills and STEM attitudes. Güleryüz (2020) examined the effects of 3D printing and robotic coding applications on teacher candidates' 21st century skills, STEM awareness and STEM teacher self-efficacy. He stated that STEM-based science activities contributed positively to the development of students' 21st century learner skills, and that STEM education had a positive effect on learners' STEM awareness. Çoban and Erol (2021a) developed an arduino-based STEM educational material in their research and studied the energy theorem and stated that the participants were positively affected. In another study, Çoban and Erol (2021b) developed a STEM teaching material on the verification of Newton's second law with Arduino and explained that the developed material had positive effects on learning.

3.2. NATIONAL IMPORTANCE OF ROBOTIC-ASSISTED SCIENCE EDUCATION APPLICATION (ITALY)

MODULE 3

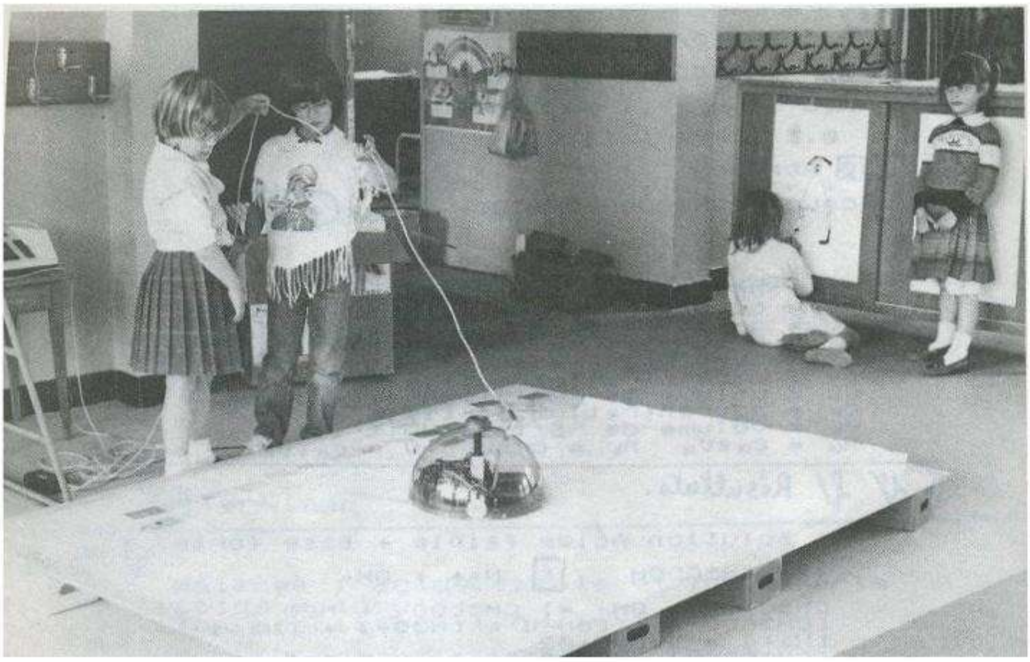
"The robot strengthens the self-esteem of the student who becomes aware of his or her training by understanding and programming the technology and not being subjected to it and being "programmed" by it.

The robot requires the student to learn to understand and overcome the error which thus becomes an essential learning tool."

Morgane Chevalier

Robots entered schools almost simultaneously with the first computers. At the end of the 1970s, the early 1980s, the Jeulin tortoise appeared on the market

The turtle could be programmed using punch cards but also with a personal computer. The language used was LOGO, a programming language not designed for schools, but which made it possible to demystify the use and interaction with the computer, as was the case with the BASIC language.



Since then, the interaction and programming interfaces have been greatly improved from an ergonomic point of view. Robots have been in schools for over ten years. Today we find some robot classes Lego® EV3 (the evolution of Mindstorm), Thymio II, Beebot®, Mbot® etc.

Different platforms that each use their own programming language.

There are several activities that use robots in the classroom. The scientific literature offers several contributions. A meta-analysis presents an overview of the results of robotics in schools, reporting the following: “Most scientific studies (80%) explore research related to the fields of physics and mathematics. The skills that can be developed or improved thanks to robotics concern in particular problem solving skills, logic and the method of scientific research. "

Mitnik adds that "most of the applications of robotics in education are focused on supporting the teaching of subjects related to the technical field." At this point, it seems evident that robots, like computers, are considered tools to discover computer science, engineering and robotics. These applications focus on some fundamental concepts. For example, Magnenat demonstrated that the joint use of the robot and the Aseba Thymio II / VPL visual programming environment promoted students' knowledge of the concept of event management, a central concept in computational science widely used in software development of interfaces and for robot programming. In addition, Ko conducted a longitudinal study (over six years) to investigate the measurable long-term effects on student performance in the use of robotics in computer science teaching. Ionita reports that "robotics becomes an interesting way to tackle educational topics".

It seems that robotics in particular is used to promote learning in the field of "computational science" (Computer Science), and for the development of "computational thinking" (Computational Thinking), as well as for mathematics and science. However, the scientific literature also contains numerous references regarding the use of robots to promote the learning of a native or foreign language, literature, art and other non-technical disciplines such as civics, food, etc.

In addition to the development of disciplinary skills, robots play an interesting role in the development of transversal skills such as the application of the scientific method (anticipation, formulation and testing of hypotheses, variables ...) or learning strategies, developing opinions, ability to choose , comparison between points of view. The robot also strengthens the self-esteem of the student who becomes aware of his or her training by understanding and programming the technology and not being subjected to it and being "programmed" by it.

A central element of educational robotics is the emphasis on error: the robot requires the student to learn to understand and overcome the error. Mistakes become an essential learning tool.

The robot makes learning more concrete. One study explained that “the robot allows children to develop fine motor skills and hand-eye coordination, to engage in activities that require collaboration and teamwork. Through robotics, children can experience engineering concepts as well as storytelling and the creation of contexts for their projects. " Furthermore, “robotics activities are very popular, because we reify the abstract behavior of algorithms and programs as concrete artifacts”. Indeed, "tangible computational tools have the potential to make the manipulation of symbolic and abstract concepts more concrete and understandable to children". These studies therefore assert that physical manipulation favors the learning of abstract concepts. Robots can be seen as the vehicle for transforming thought into action.

We can summarize by saying that through educational robotics, students become protagonists of learning, creators of their own product; they feel involved in the learning process. Educational robotics helps them to develop the cognitive skills typical of computational thinking, to learn how to design their own work, to increase skills in solving complex problems. Educational robotics does not fall exclusively into the field of computer science and mathematics, but on the contrary proves to be an interdisciplinary activity capable of stimulating students to put into practice, and therefore strengthen, also the logical, analysis and synthesis skills.

Robotic-Assistedted Science Teaching Practices: Example Practices At The National Level

In the teaching of the disciplines it is possible to introduce educational robotics as an attractive element with a strong emotional and motivational impact on students. The proposed activities lead students to confront, study and experiment with solutions, this stimulates their imagination but also stimulates the research, study and implementation of innovative solutions. Each student has the opportunity to report their ideas and argue to convince others of the validity of their project. The choice of the "best" solution is shared with the work group first, and then with the class group. This process allows you to understand the need for clear, complete and concise documentation. Students are free, without censorship, to propose imaginative solutions, to criticize the work of their peers, to identify critical issues, strengths and weaknesses. In this phase, a good documentation of the work carried out and of the research, of the approach and motivations that led to propose a solution, can be of great help for oneself and for others, and allow you to keep track of the various experiences in a to be able to go back to the previous version and move forward with certainty, thanks to having already produced a good part of the technical documentation essential to document the projects developed.

The didactic methodology implemented allows to face the study of complex systems through the realization of a robot that is not a machine for its own sake, but a set of inputs-processing-outputs, sensors and actuators that allow the robot to interact with the surrounding environment in the most varied lighting conditions, surfaces, frictions, obstacles and everything necessary to realistically simulate work situations. Students, individually and in small groups, learn how to divide the complex system into subsystems to address the problems and solve them separately and then reassemble everything together with the others in a teamwork perspective, simulating as much as possible company procedures. and industrial. The need to work in a team, to enhance excellence and to be of support to others, puts students in a favorable condition for openings and, coordinated by teachers, a new dynamic is born that makes the teaching-learning process pleasant and constructive both for students and teachers.

Applying the didactic robotics of the disciplines does not mean teaching industrial automation or robotic design as an end in itself, the values put in place have a broader impact in educational terms. Robotics is not taught to students, but robotics is used as an attractive tool to inspire young people to study scientific disciplines and at the same time technical-scientific problems. Educational robotics is the tool that helps to build a didactically innovative path also for non-technical disciplines, the technological approach also leads to the study of the problems connected to the spread of the use of robotics in society.

Often it is the students themselves who offer innovative solutions that the teacher, even after years of teaching, had not thought of. This dynamic transforms the student-teacher relationship and highlights that, once the goal has been set, the ways to go can be diversified, tested, verified, in order to choose, all together, the best solution. Subsequently, particular attention is paid to programming languages to experiment and verify different solutions, the mechanisms underlying complex systems are addressed to implement prototypes and verify their functionality, particular attention is paid to the interfacing of input / output devices and to their control by programming language. The interdisciplinarity allows you to put together all the different skills and employ the students themselves for a technology transfer between "different experiences".

The workshop class group becomes a lively simulation of the working environment in which students have the opportunity to experience group work in the field in order to highlight the strengths, criticalities and requirements necessary to obtain the best results.

According to European and national guidelines, the basic methodological approach of the proposed work is found above all in many aspects of the key competences for lifelong learning of the 2006 European Recommendation which reads (http://www.liceofermics.gov.it/):

- Communication in the mother tongue is the ability to express and interpret concepts, thoughts, feelings, facts and opinions in both oral and written form and to interact appropriately and creatively on a linguistic level in a whole range of cultural and social contexts;
- Communication in foreign languages which, in addition to the main skills required for communication in the mother tongue, also requires skills such as mediation and intercultural understanding;

- Mathematical competence and basic skills in science and technology is the ability to develop and apply mathematical thinking to solve a variety of problems in everyday situations, with an emphasis on aspects of process, activity and knowledge . Basic skills in science and technology concern the mastery, use and application of knowledge and methodologies that explain the natural world;

- Digital competence consists in knowing how to use information society technologies (IST) with familiarity and a critical spirit and therefore requires basic skills in information and communication technologies (ICT);

- Learning to learn is linked to learning, the ability to persevere in learning and to organize it both individually and in a group, according to one's needs, and to awareness of methods and opportunities;

- Social and civic competences are those personal, interpersonal and intercultural competences and all forms of behavior that allow people to participate effectively and constructively in social and working life. Social competence is linked to personal and social well-being. It is essential to understand the codes of conduct and manners in the different environments in which people act. Civic competence and in particular knowledge of socio-political concepts and structures (democracy, justice, equality, citizenship and civil rights) equips people with the tools to commit to active and democratic participation;

- A sense of initiative and entrepreneurship means knowing how to translate ideas into action. This includes creativity, innovation and risk-taking, as well as the ability to plan and manage projects to achieve goals. The individual is aware of the context in which he works and is able to seize the opportunities that are offered to him. It is the starting point for acquiring the more specific skills and knowledge needed by those who start or contribute to a social or commercial activity. It should include awareness of ethical values and promote good governance;

- Cultural awareness and expression imply awareness of the importance of the creative expression of ideas, experiences and emotions through a wide variety of media, including music, performing arts, literature and the visual arts.

Also in the key competences of citizenship, exposed in the DM 139/2007, we find competences that educational robotics allows to acquire: Learning to learn: organizing one's own learning, identifying, choosing and using various sources and various ways of information and training (formal, non-formal and informal), also according to the time available, one's strategies and one's study and work method.

- Design: elaborate and carry out projects concerning the development of one's study and work activities, using the knowledge learned to establish meaningful and realistic objectives and related priorities, evaluating existing constraints and possibilities, defining action strategies and verifying the results achieved.

- Communicate or understand messages of different kinds (daily, literary, technical, scientific) and of different complexity, transmitted using different languages (verbal, mathematical, scientific, symbolic, etc.) through different media (paper, computer and multimedia) or represent events, phenomena, principles, concepts, norms, procedures, attitudes, moods, emotions, etc. using different languages (verbal, mathematical, scientific, symbolic, etc.) and different disciplinary knowledge, using different media (paper, computer and multimedia).

- Collaborate and participate: interact in a group, understanding different points of view, valuing one's own and others' abilities, managing conflicts, contributing to common learning and the realization of collective activities, in recognition of the fundamental rights of others.

- Acting autonomously and responsibly: knowing how to insert oneself in an active and conscious way in social life and asserting one's rights and needs within it while recognizing those of others, common opportunities, limits, rules, responsibilities.

- Solving problems: addressing problem situations by constructing and verifying hypotheses, identifying sources and adequate resources, collecting and evaluating data, proposing solutions using, according to the type of problem, contents and methods of the various disciplines.

- Identify links and relationships: identify and represent, by elaborating coherent arguments, links and relationships between different phenomena, events and concepts, even belonging to different disciplinary fields, and distant in space and time, grasping their systemic nature, identifying similarities and differences, consistencies and inconsistencies, causes and effects and their probabilistic nature.

- Acquire and interpret information: critically acquire and interpret the information received in the various areas and through different communication tools, evaluating its reliability and usefulness, distinguishing facts and opinions.

- Encourage collaborative learning;

- Promote awareness of one's way of learning;

- The objectives to be pursued and the skills and competences to be developed in educational robotics are finally supported and confirmed in the national guidelines of the MIUR for the curriculum, where some methodological principles are outlined to create a suitable context for an effective training action: experience and knowledge of pupils, to anchor new content;

- Implement adequate interventions regarding diversity, to ensure that they do not become inequalities;

- Encourage exploration and discovery, in order to promote a taste for the search for new knowledge;

- Carry out educational activities in the form of a laboratory, to facilitate operations and at the same time dialogue and reflection on what is being done.

3.3. NATIONAL IMPORTANCE OF ROBOTIC-ASSISTED SCIENCE EDUCATION APPLICATION (ROMANIA)

MODULE 3

Robotics is one of the newest branches of industrial engineering and represents the most important and consistent part of mechatronics with its main parts: mechanics, electrical engineering, electronics and computer science. Robotics is a "multidisciplinary field of science and technology that studies the design and technique of building mechanical, computer or mixed systems and robots for the purpose of partial or total replacement of man in technological processes, in action on the environment" which has two significant variants, namely: the industrial robot and the non-industrial robot, including the humanoid robot.

In Romania, the beginnings of robotics can be dated back to 1976 when the first work on robotics was published and then in 1980 the first Scientific Symposium dedicated specifically to Industrial Robots took place. In the 1970s, more timidly, but much more intensely after 1980, several academics from the main university centers: The Polytechnic of Bucharest, the Polytechnic of Timișoara, of Iasi, of Cluj-Napoca, the University of Brasov, the University of Craiova, the University of Oradea, etc. turned their attention to the field of robotics. These academics came from the field of mechanics, automation and informatics and can be found in the lists of members of the branches of the Romanian Robotics Society.

Romanian Robotics Society

The general assembly for the establishment of the "ASSOCIATION OF ROBOTICS IN ROMANIA" - ARR took place in Timisoara, on December 6th, 1990. It groups and represents the specialists and institutions in Romania that have concerns in this area. Romanian Robotics Society members are highly trained individuals, students or persons with secondary education, as well as legal entities that carry out different activities in this field: research-design, installation-exploitation, education or trade. Under the generic name of "National Symposium of Robotics", 15 scientific events with national and international participation were organized in Romania.

For a while, there has been a trend of reduction in academics involved in robotics, but in recent years there is a chance of revival amid the increase in the number of companies specializing in robotic applications, the number of industrial robotics applications and some new subfields of robotics, which are beginning to develop, such as medical robotics. For this reason, the bachelor's and master's specializations in the field of Mechatronics and Robotics are very important, which have been established and have an increasingly large audience in the university centers of: Bucharest, Timisoara, Iasi, Cluj-Napoca, Brasov, Craiova, Sibiu, Galați, Bacău, Tărgovişte, Tg. Mureș etc.

For example, the University of Bucharest offers bachelor's and master's courses specializing in Robotics within the Faculty of Industrial Engineering and Robotics. Since robotics is an interdisciplinary field, students follow a study program that includes several skills required by a robotic engineer. Some of these training lines: software programming, computer-aided design, electrical and pneumatic drive, robot control and robotic processes, robot mechanics, robot integration into various applications, creativity and technological innovation. For the practical area, the Robotics specialization approaches both industrial robotic systems and humanoid robotic systems (with social applications), robotic systems for special applications (space, defense, fires, other emergency situations, constructions, etc.) and medical robotic systems.

Robotic-Assistedted Science Teaching Practices: Example Practices At The National Level

Educational robotics, a new concept related to the 2000s when MIT and the LEGO toy company are launching a technology-based educational project: LEGO parts and a programming language geared towards learning at affordable prices for children, are increasingly trying to be included in the school world especially in the light of new trends in the labor market in which robotics professionals are increasingly in demand.

Globally, educational robotics is increasingly implemented in the classroom and in extracurricular activities that are proposed to students, this branch of engineering stimulating creativity, curiosity, programming and conflict resolution in learning processes. Teaching robotics contributes to the development of motor skills, language, improves memory and concentration, teamwork and favors socialization.

In Romania, educational robotics appeared with timid steps, especially with support from the private environment from the initiative of which a series of institutions have been established that offer training and extracurricular activities in the field of robotics: workshops, camps, online lessons, etc. Examples: Logischool offers courses and workshops in robotics and LEGO programming, the Academy of Robotics offers young people from different age categories scratch online programming courses and Small.Academy offers robotics courses that include elementary notions of physics (experiments related to speed, force, power, electricity, etc.), electronic circuits (electronic schemes, circuits in series and in parallel, etc.), familiarity with the mBot and its control using the graphical interface, and finally, integrated automation projects but also STEAM activities.

It has also experienced an exceptional development among young high school students, the branch of competition robotics, a field in which many teams set up in high schools in Romania have achieved remarkable results at international level.

With the support of the Nation through Education Foundation that promotes STEM education in Romania for high school students and mentors in 2016, young people can register through their teams in the First Tech Challenge competition being organized every season regional and national qualification competitions. The Foundation offers means and resources necessary for design, construction and programming activities, online courses, webinars, robotic summer camps, educational and cultural exchanges are organized, the Romanian delegation for the World Championship and FIRST Global Robotic Olympics, with the main purpose of providing more learning opportunities to Romanian high school students. Partnerships have been created with a number of technical universities in Romania to recognize the results of the top FTC robotics team/team members: POLITEHNICA University of Bucharest, West University of Timisoara, Technical University of Cluj Napoca, Gheorghe Asachi Technical University Iasi.

Over 3000 high school students and 400 mentors are involved, from 80 cities in Romania promoting "learning by doing" and "having fun" as the main concepts of an innovative educational project from FIRST – firstinspires.org at the same time supporting teams to build a competition robot from scratch. Through the competition platform https://www.firstinspires.org/resource-library/ftc/robot-building-resources are provided guides and resources necessary for building (REV, TETRIX), design (PTC, SOLIDWORKS) and programming (Android Studio, Onbot Java Tool), resources used by students in their work.

At the national and government level in recent years there is some concern for the field of educational robotics. The digitalization of education was the object of a large project part of the Strategy on the digitalization of education in Romania and was launched into debate on February 15, 2021.

The strategic priorities of the project are:

- Developing a high-quality digital educational ecosystem
- Strengthen digital skills for digital transformation in the context of rapid progress of new technologies such as artificial intelligence, robotics, cloud computing and blockchain.

On October 26, 2020, the Ministry of Education and Research launched the process of developing the Strategy on the digitalization of education in Romania 2021 – 2027, called SMART.Edu – a concept centered on the following key concepts: Modern, Accessible School, based on Digital Resources and Technologies.

Among the operational plans of measures contained in the strategy we can mention:

- integration of key competences (2018) throughout theoretical and practical learning, in formal/ non-formal contexts from the perspective of critical thinking, creativity and innovation (reconsideration of the approach of digital competences, entrepreneurial competences, STEM, in complementarity with the other key competences for the green economy and those for everyday life skills) through optional modules to stimulate creativity and innovation, as well as computational thinking, starting in primary education (e.g. robotics, 3D print, RPA, IoT).
- restructuring of qualifications / specializations from the theoretical, vocational and technological route, high school education, from a cross-disciplinary perspective (development of new specializations / emerging qualifications for example mathematics-informatics-robotics, mathematics-physics-electronics, mathematics-physics-automation (Rădut I. M.,2021).

The project proposes to modernize the Learning Infrastructure by equipping at least 13 university practice, teaching and research laboratories / year (91 laboratories by the end of 2027) which would contribute to the development of advanced digital and technological skills. Emphasis will be placed on university facilities aimed at improving and developing the skills required by the labour market in terms of ICT, biotechnologies, nanotechnologies, artificial intelligence, robotics, programming automation (RPA), the Internet of Things (IoT), blockchain, autonomous transport, virtual reality, 3D and 4D printing.

A new project promoted in the educational environment and supported by the Ministry of Education is the Nextlab.tech platform. It is the largest educational robotics initiative in Romania and even in South-Eastern Europe, an educational engine based on artificial intelligence for adaptive learning. It can be used for various educational activities such as: designing learning units, organizing hackathons, robotics competitions, evaluations, automating the delivery of lessons, school courses and preparatory activities for students up to 16 years of age. The Nextlab.tech engine provides the necessary environment for the national robotics competition Nextlab.tech conducted by the Association "Club of Economic Informatics - CyberKnowledgeClub". The platform brings together coordinating teachers and students from high schools across the country offering online robotics lessons, educational robot kits and the opportunity to participate in online robotics competitions.

Robotics study programs are increasingly present, both between courses offered by universities and between the optional classes of high schools. The increase in interest is justified in education by the increasing interaction between artificial intelligence and young people. An example is the High School for the Visually Impaired in Cluj. in which with the help of a robot written texts are converted to audio files in support of children who have problems with sight. Robots in education are used to stimulate students' interest in science. There are elite educational units, such as the Elf School, that have created robotics laboratories, and middle school or high school students can use special kits to create the robots.

The new secondary school programs integrate the study of robotics in the school curriculum, the students studying a new discipline, namely Informatics and ICT, a discipline that aims at digital literacy, the formation of competences for the use of new technologies but also the formation of computational thinking necessary for their efficient and intelligent use. These curricula from the discipline of Informatics and ICT, integrate the study of robots, having provided virtual programming of robots in the vii-th and viii-th grades. Although the construction of robots is decisive in the formation of interdisciplinary skills, as a result of the very high costs it was decided to keep only the programming part.

Examples of STEM activities treated in the 7th and 8th grades:

- the use of a virtual environment for programming robots with didactic purpose, visualizing the values read by the robot's sensors
- instructions/commands for implementing repetitive structures in the programming language
- the use of the values read by the sensors of the virtual robot (e.g. ultrasonic sensor for obstacle detection, color sensor, pressure sensor, microphone, infrared sensor, gyroscopic sensor, compass, etc.)
- elaboration of the source code for the control of the virtual didactic robot by using and interpreting the data received from its sensors
- elaboration of the source code for the control of the virtual didactic robot by using and interpreting the data received from its sensors: maintaining the balance, specific reactions to the detection of light
- elaboration of the source code for the control of the virtual didactic robot by using and interpreting the data received from its sensors: specific reactions to the detection of light or the identification of a marked route.

Different media and programming languages are suggested, at the teacher's choice such as Open Roberta and the Nepo language for carrying out specific activities.

Learning through robots is a way of acquiring and using knowledge through action, it is a thinking activity oriented towards solving problems that stimulate the learning process. It is active, participatory learning, while stimulating students' initiative and creativity. This method of learning can materialize in competitive activities designed for groups of students or with individual participation. In the activities carried out each student can act at his own pace in solving the tasks by the means at his disposal. Thus, learning through robots activates students in the instructive-educational process and targets each student separately, thus ensuring a differentiated education.

3.4. VISUAL AND TEXTUAL EXPLANATION OF STRUCTURAL, ELECTRONIC AND SOFTWARE DIMENSIONS OF ROBOTIC MATERIALS USED IN APPLICATION

MODULE 3

LEGO MINDSTORMS EV3

Lego Mindstorms EV3 features versatile build system and intuitive icon-based programming. Generally, 8+ age can use it.

A. Structural Features

Lego Mindstorms EV3 consists of three basic structural parts.

These;1- Lego Brick,

2- Motors,

3- Sensors,

It also has spacers to enable the construction of the planned design.

1. Lego Brick

BUTTONS

1: Back
- Undo
- Stop Program
- Turn Off Robot

2: Center Button
- Choose Preferences
- Run Program
- Open Robot

3: Right, Left, Up, Down
- Navigating the Menus

PORTS

There are four sensor ports:

1, 2, 3, 4

There are four motor ports:

A, B, C, D

TABS ON THE SCREEN

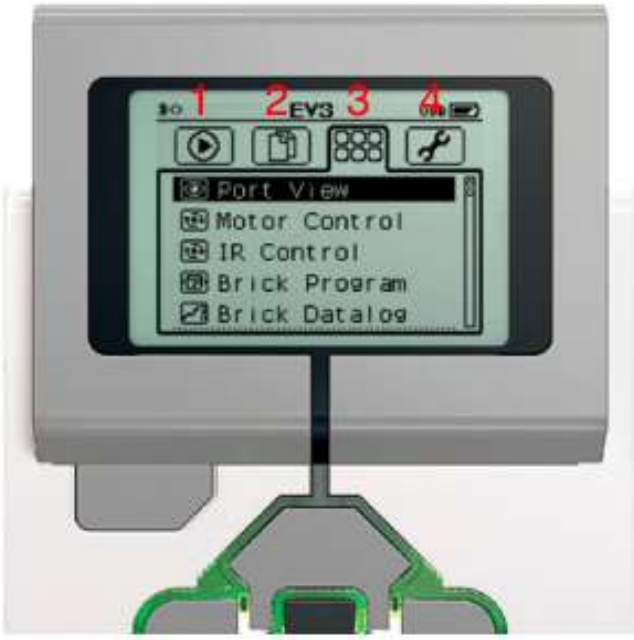
1. Last Run

Find programs you've recently run

2. File Navigation

Find all programs by project

3. Brick Applications



2. Motors

The Lego Mindstorms EV3 has two large motors and a medium engine. Motors are always connected to ports A, B, C or D.

3. Sensors

The Lego Mindstorms EV3 set has these sensors:

1: Touch Sensor: measures contact with the surface.

2: Ultra-sonic Sensor : measures distance to near object / surface (up to 255 cm)

3: Color Sensor: measures color and light intensity. Recognizes 7 colors and no color mode.

4: Gyroscopic Sensor : measures the rotation of the robot depending on the angle (adjusts the balance)

5: Infrared Sensor : Measures the signals of the infrared remote control

It also has a temperature sensor.

Port, Sensors and Motors Overview and Other Structural Parts

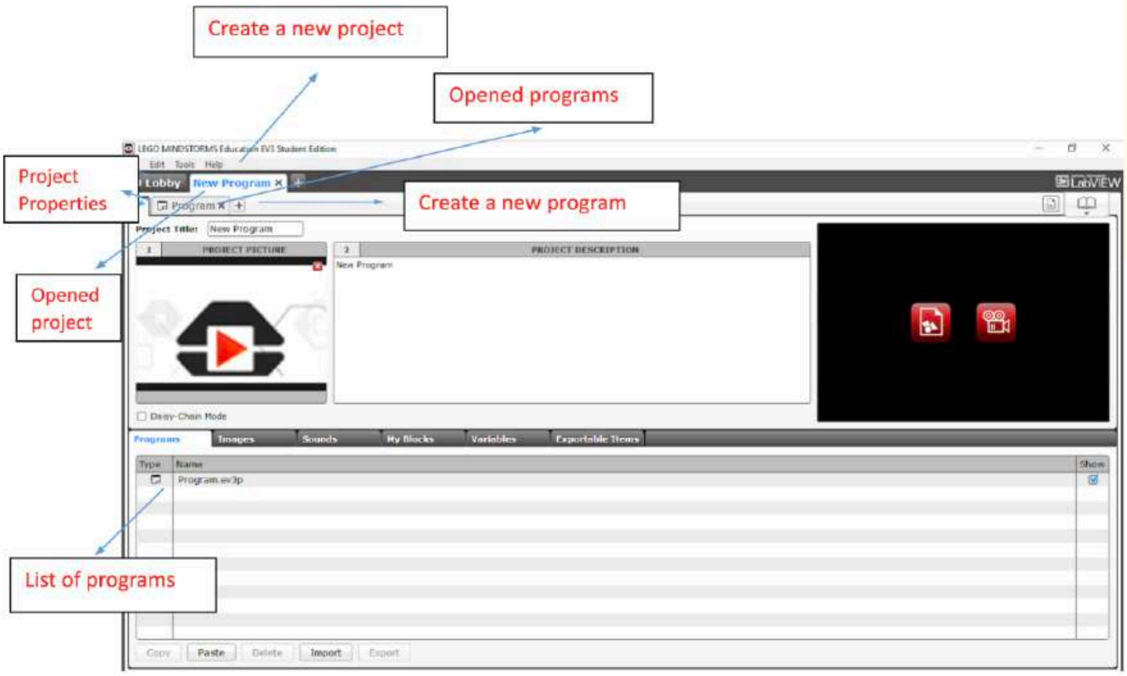
A. Electronic Features

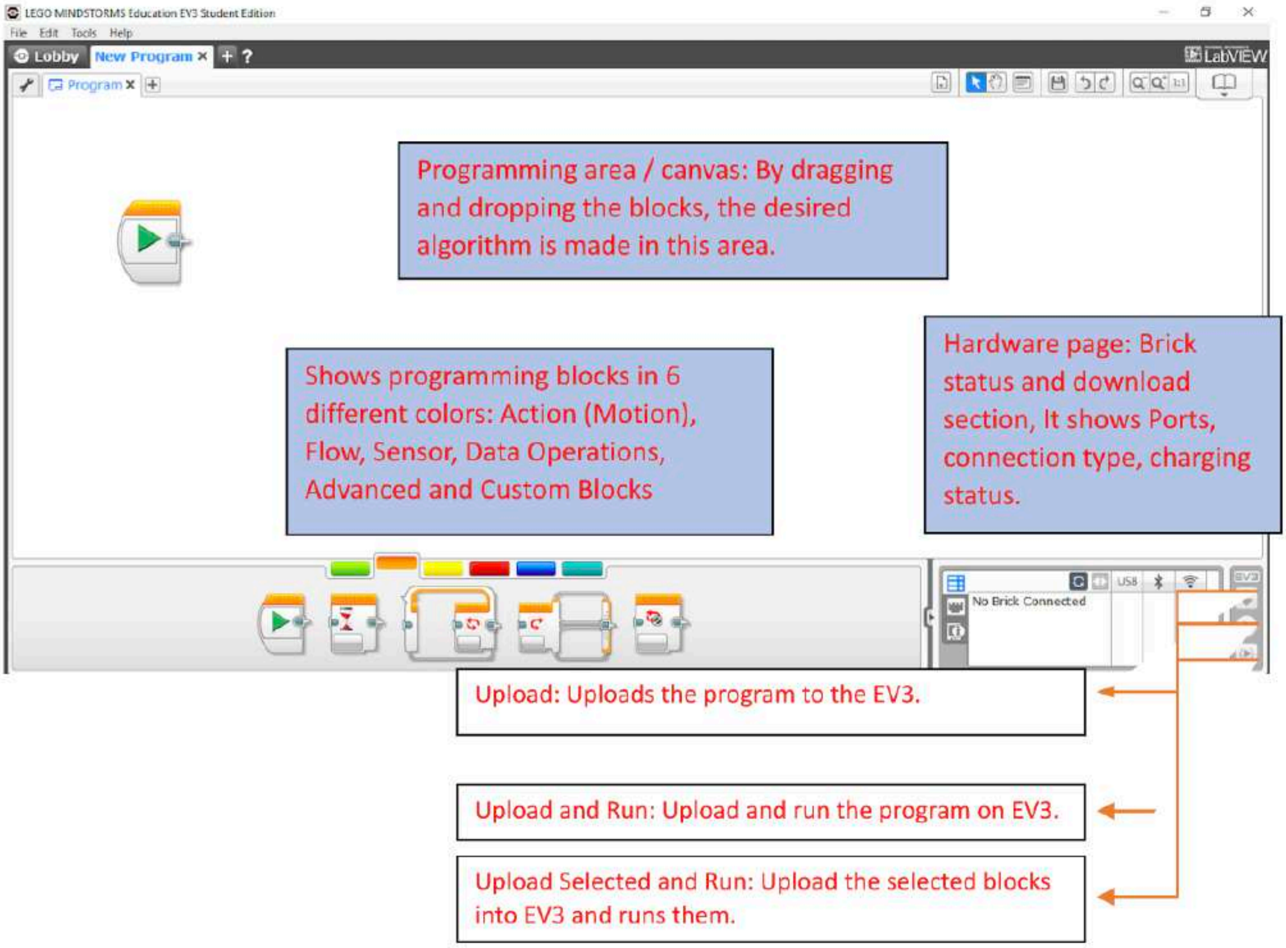
A Lego Mindstorms EV has these connecting cables:

The sensors receive the warnings from the environment and transmit them to the brick. The brick runs the program according to the pre-designed program algorithm and the robot reacts.

B. Software Features

Lego Mindstorms EV3 features intuitive icon-based programming. It has two types of programming: Student and teacher version.





1: List Programs in Project: List of all programs in the project

2: Select: The cursor looks like an arrow and you can select specific blocks or area of the screen

3: Pan: The cursor is similar to a hand. When you click and move the mouse, you can move within the program when it goes beyond a screen.

4: Comments: Click this icon to create the comment box

5: Save Project: Save the current version of your project

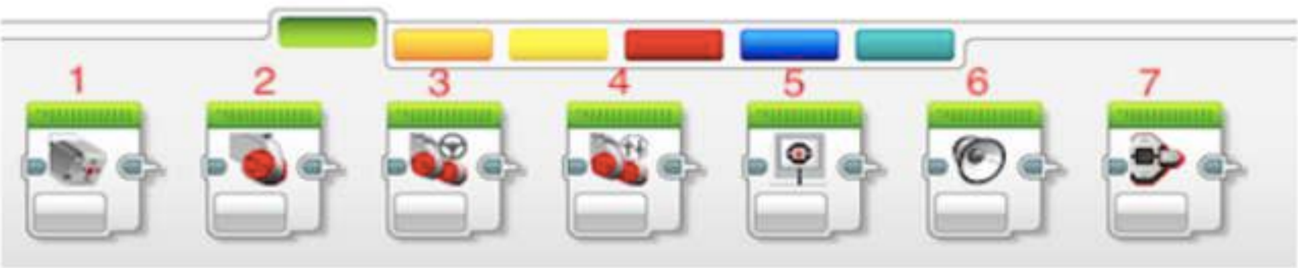
6: Undo and Redo: Undo or redo last actions

7: Zoom Out, Zoom In and Zoom In Reset: Reset to reduce, increase or enlarge (https://ev3lessons.com/en/)

8: Content Editor: Used to document the project using images, text and videos.

Programming Blocks

Action Blocks



1: Medium motor, 2: Large motor, 3: Move steering, 4: Move tank, 5: Display,

6: Sound block, 7: Brick status light

Flow Control Blocks

1: Play / Start, 2: Wait block, 3: Loop block, 4: Switch, 5: Loop interrupt

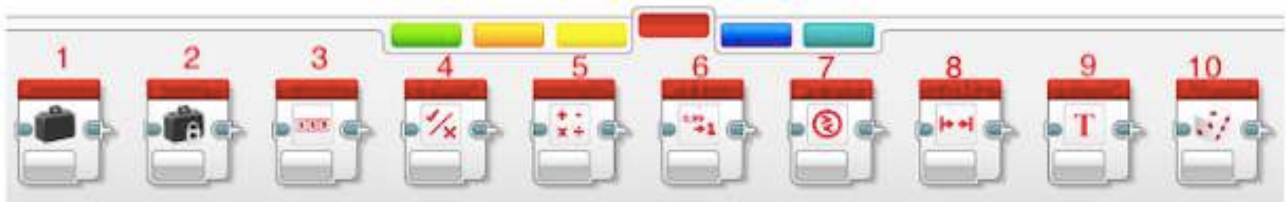
Sensor Blocks

1: Brick buttons, 2: Color sensor, 3: Gyro sensor, 4: Infrared sensor, 5: Motor rotation,

6: Temperature sensor, 7: Timer, 8: Touch sensor, 9: Ultra-sonic sensor, 10: Energy meter

11: NXT sound sensor

Data Operations Blocks



1: Variable, 2: Constant, 3: Array operations, 4: Logic operations, 5: Math, 6: Round,

7: Compare, 8: Range, 9: Text, 10: Random

Advanced Blocks

1: File access, 2: Data logging, 3: Messaging, 4: Bluetooth connection, 5: Keep awake,

6: Raw sensor value, 7: Unregulated motor, 8: Invert motor, 9: Stop program, 10: Comment

My Blocks

There are special blocks that you create. After My Block is created, you can insert the single block into future programs in the same project.

Robot Maker II

RoboMaker® is a kit that was created with the aim of governing children (recommended 10+) through a real educational path to discover robotics and coding. Using the more than 250 interchangeable components present in the box, it is possible to create 5 different robots, and then program them manually or through the APP. As can be seen from the following graph, building and programming the 5 models in the order proposed, the learning level will grow steadily. At the end of this path you will have all the skills to be able to autonomously build and program shaped robots.

MODEL X1 – EXPLORER

The Explorer is a robot in the shape of a space rover with which to start this exciting journey into the world of robotics. Equipped with two electric motors, it will allow you to take the first steps to understand Clementoni's block programming.

MODEL X2 – SPIDER

The Spider is an arachnoid robot (with the shape of a spider) which constitutes the second step in the educational path that is proposed to you.

After learning the basic elements of programming with the Explorer, through this second model you will have to learn to manage 3 motors simultaneously and you will have to understand the usefulness of cycles and conditions, two fundamental elements in any programming language. The Spider is equipped with 3 electric motors and an infrared sensor.

MODEL X3 – SUMOBOT

The SumoBot is a robot capable of carrying out two completely different activities without undergoing structural changes. With this model you will learn to manage two infrared sensors at the same time, advancing your electronic knowledge and skills.

MODEL X4 – GUARDIAN

Along the proposed educational path, the Guardian is the first robot to be equipped with the touch sensor. For the first time, therefore, in addition to having to check the infrared, you will also have to learn how to program this type of sensor. As you will notice later, during the transition from activity 7 to 8, you will have to make important structural changes.

MODEL X5 – DROID

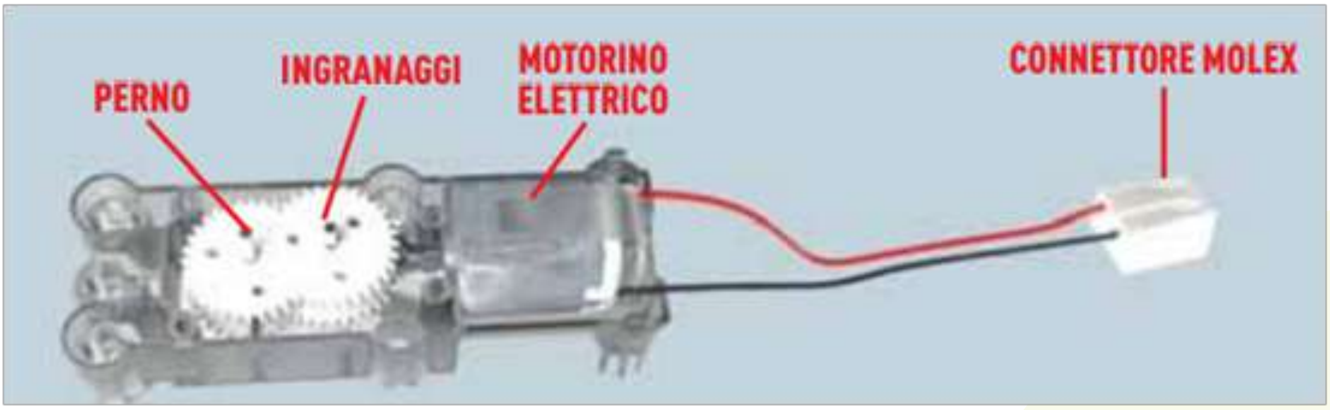
The Droid represents the apex of the proposed educational path and has the shape of a real super evolved droid. By assembling and programming it, you will acquire all the knowledge and skills necessary to be able to use the free Create mode independently. Being the last of the five models proposed, it is the one for which you have to use more plastic components and it is the only one for which it is necessary to use and program all the electrical and electronic components (the board, two IR sensors, the Touch sensor, the speaker). In short, it is the full optional robot of the entire kit!

Structural Features

- **Electric motors**

As you can see from the figure, the motors that make your Robot move are made up of two distinct parts: the actual electric motor and a box with a series of gears. The latter is used to reduce the rotation speed of the motors, which would otherwise make the various parts of the Robot move too fast. In the kit there are two types of motors (identifiable by the codes printed on their shell and by the color):

- S1 fast and not very powerful engine, orange in color
- S2 powerful and not very fast engine, black color



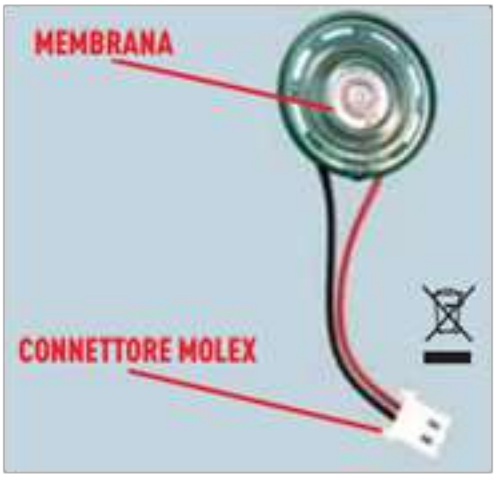
- **The battery compartment**

The battery compartment is nothing more than a container for the batteries, through which the Robot is able to absorb energy. Inside the compartment there are metal plates that allow the flow of electric current.

Structural Features

- **The speaker**

The speaker is the electronic element through which the Robot can emit sounds. Its main components are a magnet, a plastic membrane and a copper coil. The magnetic field generated by the magnet and the electric current transmitted by the coil cause the membrane to vibrate which, by generating a displacement of air, produces sound.



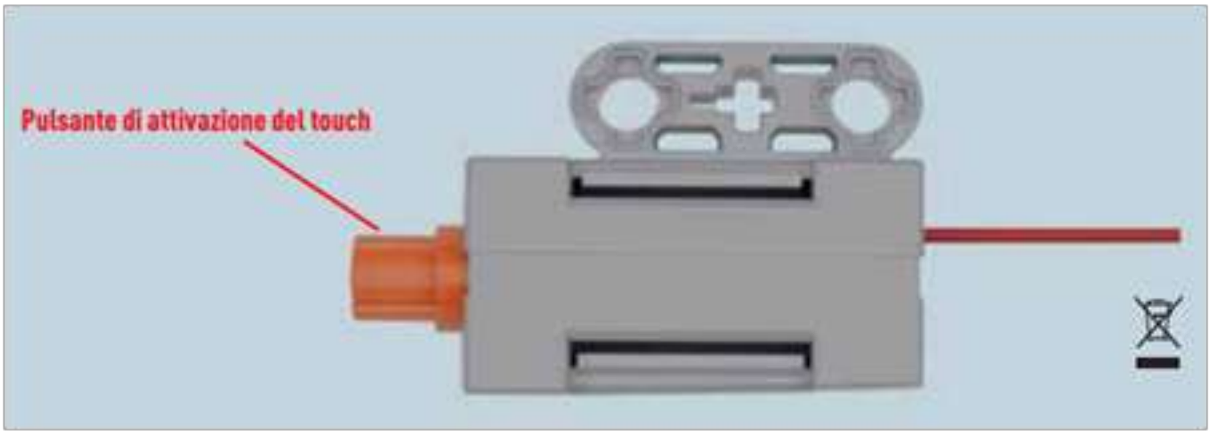
- **The infrared (IR) sensor**

The infrared sensor (abbreviated, IR sensor) consists of an emitter LED and a receiver photodiode and has the function of identifying objects, or even to understand if they are light or dark. If an object is present, the emitted signal is reflected back and the receiver perceives the presence of the obstacle, with the same procedure it perceives whether an object is light or dark.

Structural Features

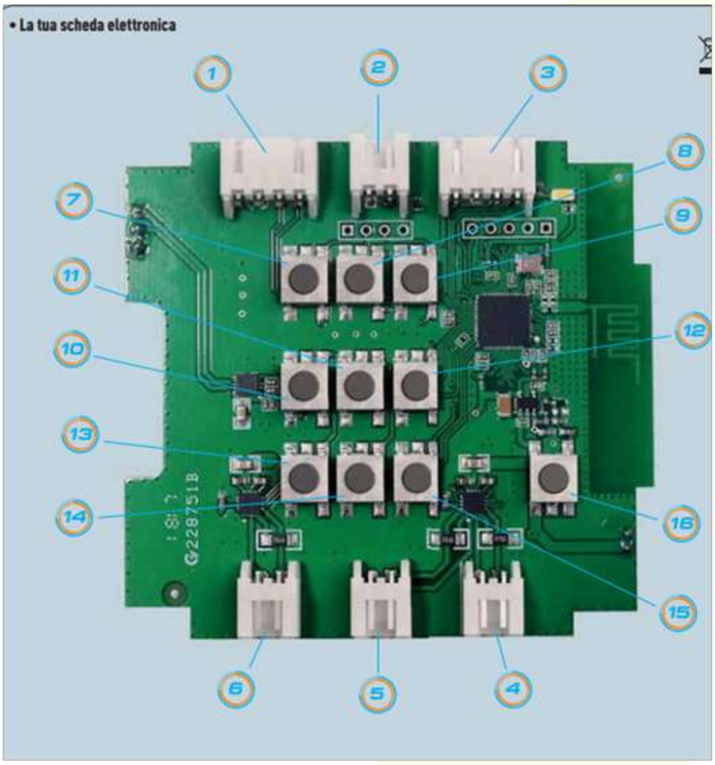
- **The TOUCH sensor**

The TOUCH sensor contained in the kit is able to recognize pressure changes and therefore to warn when it is touched and pressed. Electrically speaking, when the button is pressed or released, a pulse is sent to the motherboard, which understands that the sensor has been triggered.



- **The electronic board**

The electronic board (in English called PCB = Printed Circuit Board) is a support where all the electronic components are connected through printed electrical circuits. The board contained in the kit is made of vetronite, is of the "double sided" type and has been manufactured with SMT technology.



Structural Features

N.	COMPONENTE	N.	COMPONENTE
1	Molex sensore IR2	9	Pulsante Enter
2	Molex sensore TOUCH	10	Pulsante Motore 1 - senso orario
3	Molex sensore IR1	11	Pulsante Motore 2 - senso orario
4	Molex Motore 3	12	Pulsante Motore 3 - senso orario
5	Molex Motore 2	13	Pulsante Motore 1 - senso antiorario
6	Molex Motore 1	14	Pulsante Motore 2 - senso antiorario
7	Pulsante Suoni	15	Pulsante Motore 3 - senso antiorario
8	Pulsante Step	16	Pulsante Power

- ***Programming Blocks***

To make programming more intuitive and fun, visual block programming languages have been created. Each instruction is represented by a colored block with a particular shape that allows it to be interlocked with the blocks that represent other instructions. So the instructions come together like the pieces of a puzzle. There are many block visual programming languages, such as those used by SCRATCH, CODE.ORG and CODYROBY. As you can see by doing some research, they all have colored blocks that fit together. The advantage of using a visual block language is immediacy. You can start programming right away by composing blocks, focusing more on the process than on the language. It is precisely the visual block programming that allows you to apply coding and robotics at school in any subject, from Mathematics to Italian. Also to program the robots that can be built with this kit you have a block visual language and a real programming environment, which is particularly suitable for freely managing all the motors and sensors you decide to use to build it.

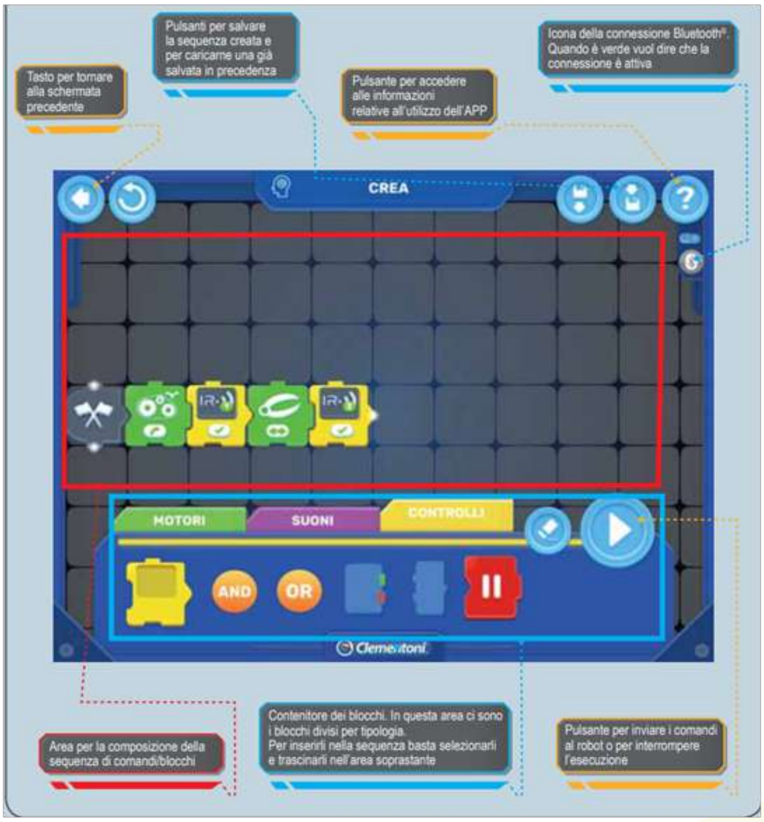
You can have different programming modes available. Once turned on, the system will automatically enter manual mode; instead, to connect the card with the application via Bluetooth®, just start the APP and the connection will take place automatically and quickly.

The APP is structured in 4 different sections:

- BUILD: In this section you can select one of the 5 Robot models that we propose, and then go and reconstruct it in 3D, piece by piece, in a dynamic and animated way. With each new component added, you can even zoom in / out and rotate the construction by 360 °, to understand how the various modules are connected. In addition, using a special button, you can scroll the entire editing timeline without interruption, from start to finish.
- LEARN: In the Learn section you will be shown the basic concepts of programming through 10 guided activities, to face which you will be asked to create specific command sequences, using block programming. As mentioned earlier, the 10 activities have an increasing difficulty. As complexity increases, you will notice that the APP will ask you to compose increasingly complex sequences, containing new blocks. To facilitate your learning, the creation of the sequence will be guided and if you make a mistake, the APP will notify you immediately, giving you the opportunity to correct yourself.

The proposed and guided activities are:

- Adjustable speed movements
- Adjustable duration movements
- Escape the predator!
- Pursue the prey!
- Sumo
- Line following
- Guards and thieves
- The Sentinel
- Locate and grab objects
- Separate objects by color



- CREATE: Once you have learned the basic concepts of programming and become familiar with our block programming, with the Create section you can indulge yourself as you wish. In this area, after building a robot of any shape, you can program it as you see fit. Being a free activity, in this case the APP will not give you any feedback on the correctness or otherwise of the sequence you entered, but you will have to realize by yourself if the result obtained satisfies your goal. Compared to the Learn section, some blocks are different and additional.
- CONTROL: The control mode does not require any use of block programming. Through it you can control and command in real time the 5 proposed robot models or a robot completely invented by you. Every command you send will be executed instantly by the robot, without any delay.

The RoboMaker® APP uses a type of block programming owned by Clementoni. This means that a graphic language different from the others on the market has been developed. The programming is based on a series of blocks and other elements that are divided by type and color and which are explained in the next chapter:

1. Start
2. Action Blocks
3. Wait
4. Program flow control blocks
5. Control buttons
6. Connection lines

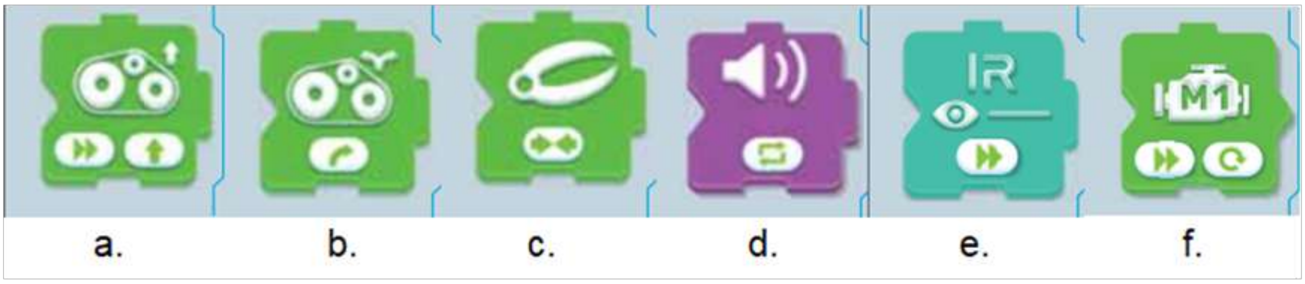
The general rule is to arrange the blocks one after the other horizontally, from left to right, in order to execute them in sequence. As for the Action blocks, however, there is also the possibility of running more than one simultaneously, simply by arranging them in the application one under the other.

1. Start

The START block is gray in color, it is always positioned at the beginning of the sequence and can neither be checked nor modified. Its function is to start the sequence of commands that the robot must execute. A series of blocks without the Start cannot exist or function.

2. Action Blocks

Action blocks represent the actual actions that robots must perform, ie movements and sounds. Their peculiarity, as also written previously, is that they can be arranged one on top of the other to execute multiple commands at the same time



a. Straight track movement. It is an Action block that is used to make the robots move in a straight line, when used, the speed (1 or 2) and the type of movement (Forward or Backward) can be set. The duration of the movement can be established by inserting the block «simple condition» with the time control on its right.

b. Curved track movement. It is an Action block that serves to make the robot turn on itself to the right or left, when using it the direction (Right or Left) can be set.

c. Movement of the gripper. It is an Action block that is used to make the gripper / claw move in the models in which it is present. The direction of movement (opening or closing) can be set.

d. Sound reproduction. It is an Action block that is used to make the robot play a sound. You can select the sound to be played and decide whether it should be played once or repeatedly.

e. Line following - Follow the line. It is an Action block that allows you to perform line following without using other blocks. When used, you can select the speed (1 or 2). The use of this command is allowed only in the Create section. In the Learn section, in fact, the line following activity is guided and by following the instructions it is possible to carry it out, creating a specific sequence of blocks. In Create mode, which is not guided, this sequence is compressed into a single block.

3. Wait

The Wait block is red and is used to put the robot in a state of stasis, waiting for something to happen. It is always followed by the simple condition block.

4. Program flow control blocks

Flow control blocks literally serve to control the flow of the program, that is, the sequence of commands. Mainly it is divided into:

- Simple conditions, yellow in color
- Blue diverters
- Multiple conditions, orange in color

- **Simple condition lock**

It is a block that causes the execution of the program to proceed when the condition of the control inserted inside it occurs. When the condition is met, the program flow will stop the actions to the left of the block and switch to those to the right of it. When using it, you have to decide which control to check among those in the menu that opens automatically: the time, or one of the 3 sensors available (IR1 sensor, IR2 sensor, TOUCH sensor).

• **Diverter block**

The diverter block is used to divide the program flow into two or more ways. According to the control that is inserted into it, it can be configured in three different ways:

a. b. c.

a. IF / ELSE configuration. It is a control block that diverts program flow in two different ways based on whether or not the condition is met. If the condition occurs, the program proceeds along the green road, if it does not occur, then it continues along the red road. To use this block in the IF / ELSE configuration, a control must be inserted inside it: IR sensor 1, IR sensor 2, TOUCH sensor, time.

b. Random configuration. It is a control block that randomly diverts the flow of the program, very useful in situations where the robot has to perform actions by randomly choosing them from a certain set. To use the diverter in the Random configuration, you must insert the button with the symbol of the two crossed arrows as a control and then select the number of random ways from which the program can choose.

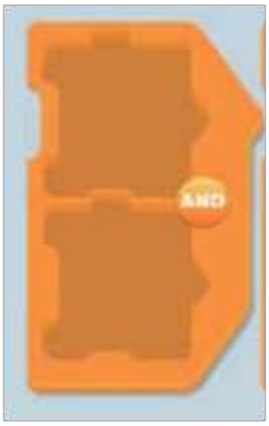
c. Counter configuration. It is a control block that counts the times the program flow passes through it. If the number of times is lower than the established one, the program continues along one road, vice versa if it is higher, another road is followed. Its behavior is therefore the same as that of an IF / ELSE. To use the switch in the Counter configuration, you must insert the button with the symbol of the two arrows chasing each other as a control, and then select the number of times the program must pass through the block.

There is also another block which is part of the diversion blocks:

d. Multiplexer block. It is a control block that brings together the branches of the program in a single way. When the program has previously been divided into several branches, this block allows you to combine them all. When you put it in the sequence, you can decide the number of inputs.

- **Multiple condition OR and AND**

They are control blocks that combine two conditions at the same time. With the OR block the flow of the program continues if at least one of the two conditions is verified, with the AND block the flow continues only if both are verified. The whole has the appearance of an orange container into which two "simple conditions" must be inserted.



5. Control buttons

The controls are the buttons that must be inserted within the blocks that control the flow of the program, i.e. all those present in the previous chapter with the exception of the Multiplexer: simple condition, diverter with its three configurations, multiple AND and OR conditions.

a b c d e f

a.b. c. Sensor checks. They can be inserted in all flow control blocks: simple condition, diverter in the IF / ELSE configuration, multiple AND and OR conditions.

d. Time control. It can be inserted only in the Simple Condition block and in the multiple AND and OR conditions.

e. Random control. It can only be inserted in the diverter block in the Random configuration, to divide the flow randomly into "n" ways.

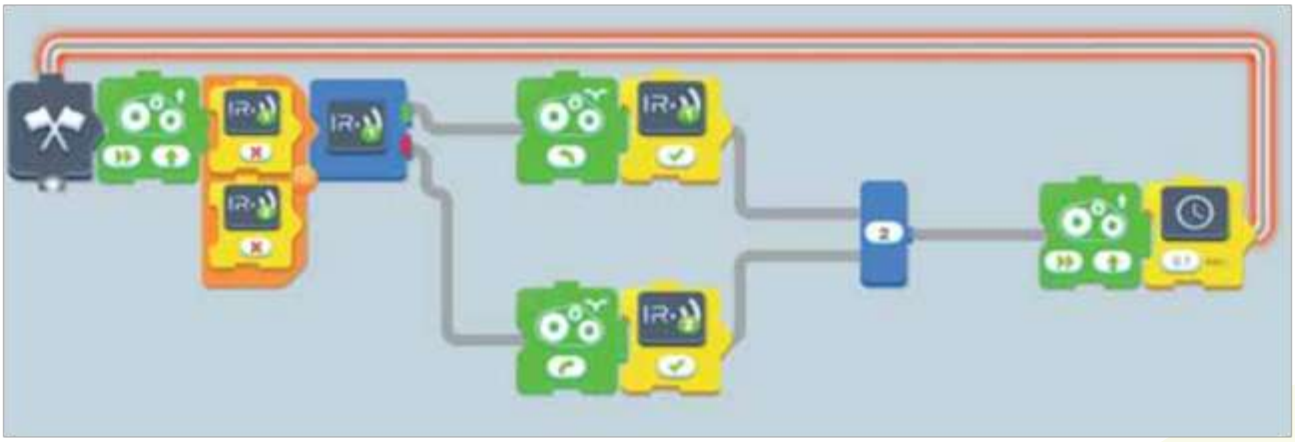
f. Counter control. It can only be inserted in the diverter block in the Counter configuration, to control how many times the program flow passes through the same point.

6. The connection line

The connection line (in the APP called flow) is used to join the blocks, especially in two situations:

CASE 1 - when you want to create cycles;

CASE 2 - when you need to split the program into n ways. In both cases, to create the line, simply touch the respective outputs of the two blocks to be connected.



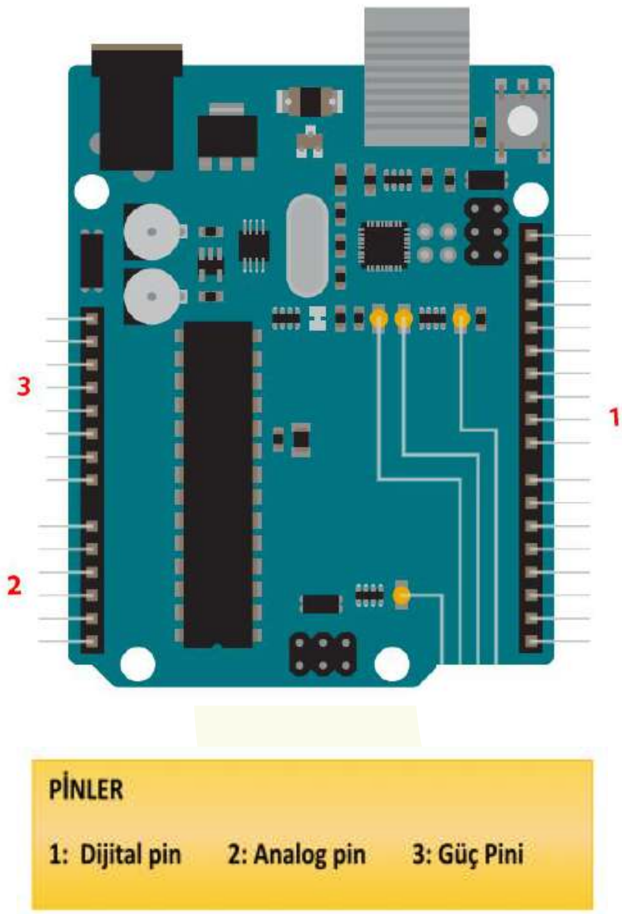
ARDUNIO UNO R3

Arduino Uno R3; It is a circuit development board with digital, analog and power pins. Although the Arduino Uno R3 circuit development board plays an important role in designing a circuit, it is not sufficient by itself to design the circuit in accordance with the purpose. The equipment needed while developing a circuit suitable for the purpose is as follows:

1. Circuit development board (Arduino Uno R3),
2. Sensors (Sensors),
3. Cables (Jumps),
4. Circuit board (Breadboard)
5. software development environment

1- Circuit development board (Arduino Uno R3)

Arduino Uno R3 is an ATmega328 based microcontroller board with 14 input and output pins (6 of which can be used as PWM outputs), 6 analog inputs, 16 MHz ceramic resonator, USB connection, power jack, ICSP header and reset. It can be connected to a computer and operated with a battery or an adapter. In the project, Arduino Uno R3 board was used to measure distance depending on person detection and to react with a buzzer depending on distance conditions. Arduino Uno R3 is shown in Image 1.



2- Sensors (Sensors)

Arduino Uno R3 board can be used with analog and digital sensors. Analog sensors are used by connecting analog pins to digital sensors digital pins. There is a 37 sensor kit used with Arduino Uno R3. The sensor kit is shown in Image 2.

Image 2.Sensor kit

3- Cables (Jumps)

It is a kind of connection cable used to connect Arduino Uno R3 and other equipment, and there are female-female, female-male, male-male types. The cable is shown in Figure 3.

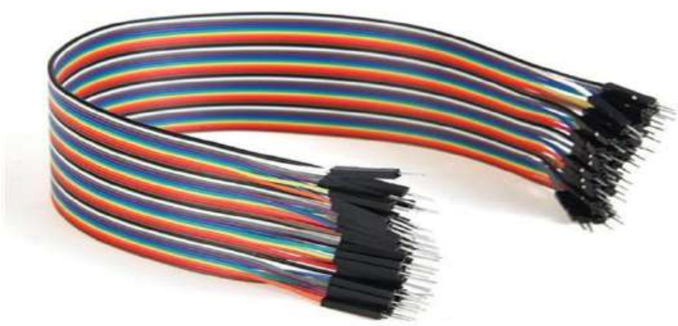


Figure 3. Cable

4- **Cables (Jumps)**

It is a tool that allows to establish a circuit without any soldering on it. Components mounted on the breadboard can be used as plug-ins. There are horizontal and vertical holes on the breadboard. While the horizontal parts provide transmission in the form of a line from one end to the other; vertical portions carry out longitudinal transmission. Figure 4. shows the Breadboard structure.

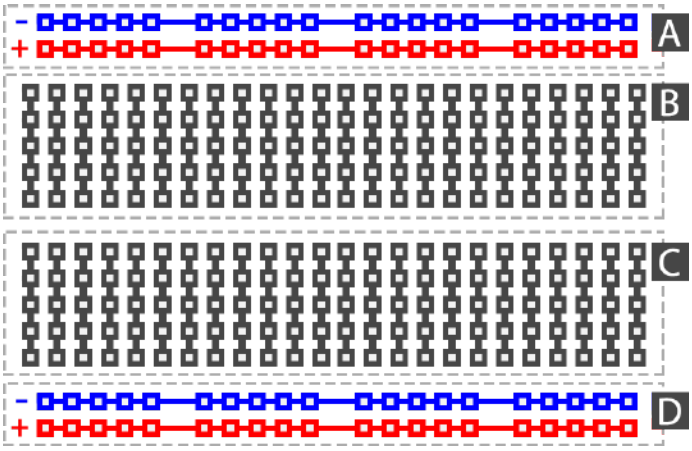


Image 4. Breadboard

Software Development Environment

Arduino Uno R3 is coded with open source processing programming language similar to C, C++, Java languages. Many libraries are used in the Arduino Uno R3 programming language. Thanks to these libraries, applications can be developed without the need for hardware knowledge. Arduino Uno R3 code system consists of void setup and void loop parts. While the void setup area consists of code sequences to be run by Arduino Uno R3 for once; void loop area consists of code sequences that our Arduino Uno R3 board will run continuously (Çavuş,Tuna, & Duran, 2017). Arduino Uno R3 software development environment interface is given in Image 5.

Figure 5. Arduino software development environment interface

3.5. POSITIVE AND NEGATIVE EFFECTS OF EDUCATIONAL ROBOTICS APPLICATIONS ON SCIENCE CURRICULUM

When we look at the robotics and coding training held in Turkey, it is seen that they are carried out in certain coding environments such as Arduino, Scratch, Idea, LegoWeDo Education 2.0, Mindstorm, Nxt Education, and Microsoft Small Basic (Karataş, 2021). Considering the studies conducted, it is seen that coding practices in education have positive effects. According to this;

- By increasing individuals' focus on the lesson, improves their coding skills and ensures permanent learning (Özdemir, Çelik, & Öz, 2009).
- It increases individuals' interest, learning, understanding, and collaborative working skills (Ersoy, Madran, & Gülbahar, 2011).
- It increases individuals' scientific creativity and science process skills (Karagöz, Oral, & Çavaş, 2012).
- It improves individuals' manual skills, and science and mathematics intelligence (Fidan & Yalçın, 2012).
- It motivates and entertains individuals and contributes to their learning to code (Çankaya, Durak, & Yünkul, 2017).
- It positively increases individuals' acceptance of devices such as tablets and computers, their self-efficacy, and their success in virtual block-based coding applications (Soykan, 2018).
- It develops the creative and algorithmic thinking skills of individuals in early childhood and their ability to establish relationships between concepts (Siper Kabadayı, 2019).
- It increases individuals' ability to produce rational solutions to problems, their coding competence, and motivation (Özer, 2019).
- It improves individuals' learning to code, acquiring 21st-century skills at a young age, problem-solving skills, and high-level and algorithmic thinking abilities (Fessakis, Gouli, & Mavroudi, 2013).

• Visual coding practices affect the academic success of individuals positively (Şimşek, 2018).

• With the use of robots in coding teaching, individuals can easily embody abstract concepts (Numanoğlu & Keser, 2017).

• Educational environments that include robotic activities attract the attention of individuals and positively affect their behavior (Küçük & Şişman, 2017).

• It attracts the attention of individuals, makes the lesson fun, and has a positive effect on their individual development (Kasalak, 2017).

• It increases and entertains individuals' creative thinking skills and motivation (Yünkül, Durak, Çankaya & Mısırlı, 2017).

• Educational robotics enable individuals to communicate with their environment and work with real-world problems (Ekin, 2022).

While robotic coding practices have an important place among 21st-century skills and behaviors that can occur with the realization of high-level skills, it does not seem possible to make applications in every field. It has been determined that there are some problems, especially in STEM education model applications. Tehese are (Akgündüz, 2016; Bayır ve Alaylı, 2021; Yıldırım ve Selvi, 2016):

1. It is considered to be built with only Legos

2. It is only for Physics lessons.

3. Applicable for gifted students.

4. It is an expensive educational application.

5. It is a simple and easy way of training.

6. For private schools only.

7. Only science and mathematics teachers can do it.

8. STEM activity is thought to be.

9. Every activity is considered STEM.

10. Those who practice robotics with sets think they are doing STEM

11. There is a perception that STEM can only be done with robotic sets.

12. Robotic kits are marketed under the name STEM kits.

13. STEM is not an approach, but a teaching technique, model, etc. is seen.

14. Coding workers and STEM applications are mixed.

15. Maker-making and STEM applications are mixed.

16. Science experiments and STEM applications are mixed.

17. STEM is thought to be practiced all over the world.

18. It is thought that the labor force statistics that emerged in the USA are also valid for Turkey.

19. There is erroneous and illogical news about STEM in the media.

20. Interest in robotic materials sometimes gets in the way of scientific learning goals.

For some time we have been talking about the evident benefits of learning scientific subjects with practical demonstrations through a robot: not only through the "usual" theory to be followed mechanically for solving problems, but through tangible and satisfactory results in the form of a real robot that carries out the instructions received.

One of the first publications on the subject, dates back to 2007, by B. Caci, A. D'Amico and M. Cardaci, relating to a study by the Department of Psychology of the University of Palermo which focused on the advantages of robotics applied to 'learning.

Today, with the growing interest in artificial intelligence and robotics in the various daily activities, knowledge of the underlying operations is increasingly necessary, from the earliest years of life.

Educational Robotics is important in the learning path of each child or young person. In fact, playing and learning to program a robot means developing those skills and abilities that are useful to the user not only from a technological - mathematical point of view but also from that of problem solving, creativity, teamwork. It is a process that allows young people to shape their future and build a new approach to life.

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For young people, building and programming a small robot implies making hypotheses and finding solutions, testing, evaluating and documenting within a real and not virtual "self-correcting" learning environment, in which the child masters and controls.

Problem solving skills are activated autonomously, the foundation of effective learning and the development of a creative mind capable of logical reasoning as a way of approaching problems not only in the school environment but as a desired "life skills".

Active learning goes beyond "professorships, desks, boredom" to immerse oneself in being, doing and using. The result, proven by research, is that children "learn to learn". The robot becomes a "physical tool" for the experimental verification of concepts.

The robot is a means and not an end, in this sense it fulfills its role as a facilitator of the integration of pupils with special educational needs.

Educational robotics activates or reactivates the potential of children, stimulates curiosity and the desire to get back into the game, get out of the margins and feel at the center.

Children are naturally predisposed to discovery, exploration and experimentation, and through creativity, imagination and curiosity they are initiated into computational thinking, that logical mental process that solves problems, following methods and using specific tools.

The tool of educational robotics is represented by "coding", or computer programming: the children are able to create a real automaton by assembling it in all its parts through an ad hoc kit, and to instruct it through the increasingly used block programming .

Specifically, block programming is a visual programming language, where each command corresponds to a graphical representation in the form of blocks. This programming system is suitable for less experienced users, who only by moving bricks on the computer screen - or tablet - are able to program a robot without writing real lines of code.

The didactic-educational advantages are innumerable:

- Generates amazement and interest;
- It solicits an emotional transference whereby robots are considered "beings in need of care";
- Stimulates and maintains attention;
- Offers the possibility of implementing strategies such as peer-education and cooperative-learning;
- Promotes learning and the generalization of skills.

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Mark Rollins, Beginning LEGO MINDSTORMS EV3

Referances 3

MODULE 3

Laurens Valk, THE LEGO MINDSTORMS EV3 Discovery Book: a beginner's guide to building and programming robots

https://www.lego.com/cdn/cs/set/assets/bltbef4d6ce0f40363c/LMSUser_Guide_LEGO_MINDSTORMS_EV3_11_Tablet_ENUS.pdf

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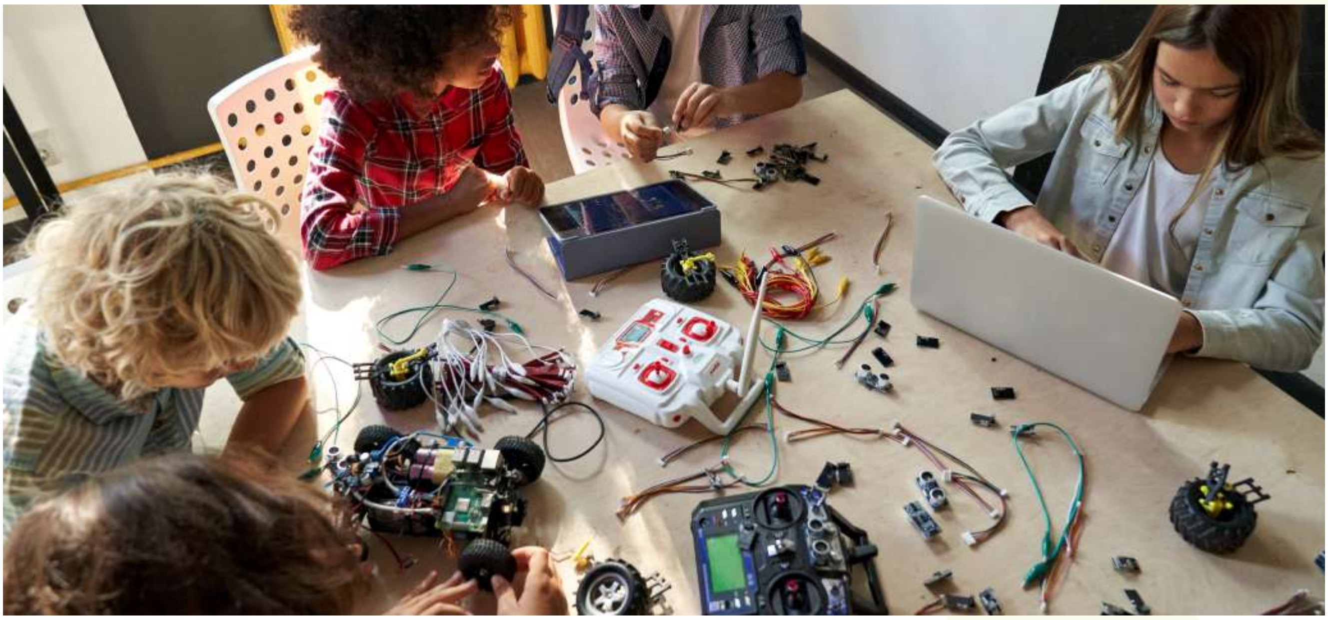
MODULE 4



4.1 TEACHING MODELS USED IN SCIENCE TEACHING AND THE RELATIONSHIP OF THESE MODELS WITH EDUCATIONAL ROBOTICS STUDIES

MODULE 4

The era of the industrial revolution 4.0 emphasizes the digital economy, artificial intelligence, big data and robotics. The shift in education in the current era requires the world of education to be creative, think critically, and master technology and digital literacy skills. This increase in the quality of human resources through education channels ranging from primary and secondary education to universities (Surani, 2019).

Skills also play a role in 21st-century learning and are an important component needed in various fields of life. Thus students must understand the skills that must be possessed in 21st-century learning. For instance, creative thinking skills play a very important role to be prepared so that students can solve problems in real life and adapt to new demands. This skill appears in the production of new and unusual ideas (Cohen, Ambrose, 1999). Students need to understand that the ability to think creatively is one of the important thinking skills and thus needs to be developed.

Learning science with robotics is the right learning to be applied according to the development of the 21st century. In the robotics learning environment, students improve positive attitudes to scientific research and they efficiently use their conceptual knowledge and their creativity (Hursen, Uzunboylu, 2009).

Robots are mainly composed of three functional elements and in some parts act as humans: Sensors, brain function, and motors. Sensors are for sensing the environment; decisions are made based on that information by the brain function, and also motors as actuators for interacting with the environment (Heilo, Margus, 2013).

To achieve the educational goals, educational robotics apply in curricula. The methods that are used while learning with robots. There have been many methodologies used to teach with robots. These approaches are explained below (Heilo, Margus, 2013).:

• İnquiry-based learning;

•collaborative learning;

• problem-based learning ;

•project-based learning;

•engineering design process;

Inquiry learning can be seen as a promising approach to increasing the applicability of robotics in learning science. Inquiry learning has its roots in scientific discovery learning (Bruner, 1961). It is a highly self-directed constructivist approach to learning and discovering through experiments or observation (De Jong, Van Joolingen, 1998). However, the effect of inquiry learning depends on both students' transformative inquiry skills and also on the level and support of students' regulative skills (Mäeots, Pedaste, & Sarapuu, 2008). In the inquiry learning process students plan, monitor, and evaluate problems, formulate research questions and hypotheses, plan and carry out experiments, analyze and interpret results, and draw conclusions. Robots can provide students with immediate visualized and tactile feedback that would even increase the attractiveness of inquiry learning – it helps to build a blended learning situation between computer-based and real activities.

The results of the studies using robots in education showed the advantages of applying robotics in the inquiry learning process. These results emphasized that statistically significant improvement in transformative inquiry skills and also different advantages of regulative inquiry skills can be seen in the case of robotics (Mäeots, Pedaste, & Sarapuu, 2009). In addition, it was mentioned that robotics has real potential for solving problems in virtual environments and developing students' regulative inquiry skills. Therefore the development of inquiry skills (transformative and regulative) accepted a new target of applying robotics. It was believed that a combination of robotics and inquiry learning could contribute to even better learning outcomes. Robotics as a tool and inquiry learning as a method would create powerful and mutually beneficial synergy as shown in Figure (1) (Heilo, Margus, 2013)

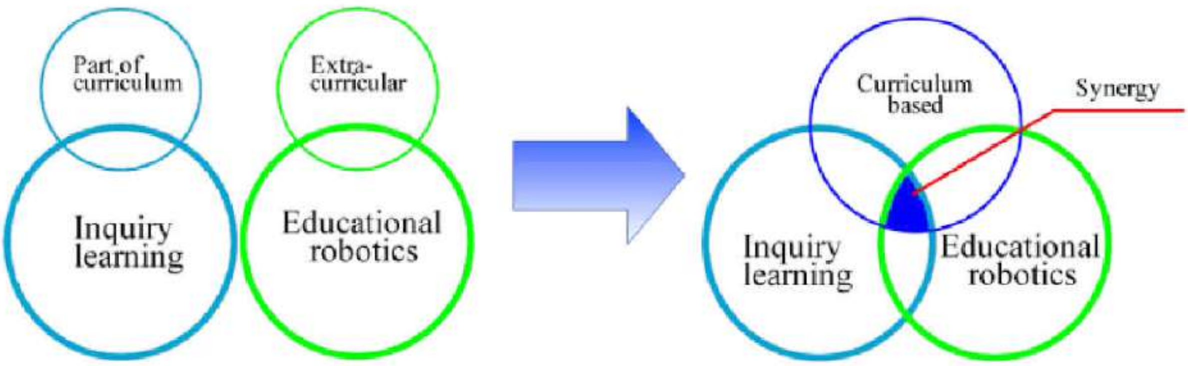


Figure: How inquiry-based curriculum and extra-curricular robotics education could benefit from a merge.

Robotics-enhanced inquiry-based learning has positive effects on students' motivation and academic achievement. Researchers designed an experimental study to examine a 10-week robotics enhanced inquiry-based learning in a formal science curriculum through experimental research in South Korea. The results showed a significant improvement in both motivation and academic achievement in the experimental group and also in students' perceptions of robotics (Park, 2015).

Collaborative learning has accepted a situation in which two or more people learn or attempt to learn something together (Dillenbourg, et al., 1999). Collaborative learning could be used in combination with any other educational approach used in robotics if pupils are allowed to communicate during the learning process. Denis and Hubert (2001) focused on collaboration to develop common robotics education projects along with problem-solving theory. Their goal was to develop strategic and dynamic skills. Educational robotics was a tool to achieve collaborative learning. Researchers targeted collaboration within groups of two to four and distributed cooperation between learners. They noted that collaboration is defined as actors sharing the same goal of task realization. Groups usually have two members, and one is responsible for hardware and the other for software by agreement. Collaboration in that context means sharing knowledge, skills, and strategies between groups. Researchers stated that collaborative learning reduces the gap between teachers and pupils as the educator will be involved in learners' interactions. This situation generates a community that shares information, which enhances educational robotics (Denis, Hubert, 2001).

Problem-solving is another learning approach to increase the applicability of robotics in learning science. The use of robots could be considered a learning methodology to develop debugging skills as when debugging on a computer. This is derived from constructionism and the physical reflection of the program in the real world (Heilo, Margus, 2013). Researchers performed a study on using robots to teach programming which aimed to find a relation to the knowledge and skills of problem-solving and the design of algorithms. Their studies involved problem-solving processes. They emphasized that Learning with physical objects enhances a learner's cognition Mindstorms were easy for students to understand and control. As a result of their studies, they found that students get frustrated while dealing with robots when they struggle with problems related to a lack of knowledge about the programming environment. In addition, they noted that professional programming languages offer many complex statements.and understanding these statements requires some pre-knowledge. The authors noticed that students test their solutions to the problem with the execution of the program on the robot. The robot reflects their commands, and the students see if the problem is solved and if the problem still exists, it is not in the same state as before. A new program created a new situation, which students take as a new starting point for further trials, or they retrieve their last changes in the program and return to a previous state and after that, they try out a new solution (Sartatzemi, Dagdilelis, and Kagani, 2005).

Project-based learning is a learning approach used with robotics in science teaching. In project-based learning (PBL), tasks that can be in investigation or research on a specific issue are assigned to students and they create teams for group work. In this process, students collaborate to support collectivism and try to apply critical thinking principles by asking and refining questions, debating ideas, making predictions, collecting and analyzing data, drawing conclusions, and communicating their findings to others (Cadaba, et al. 2009; Karahoca et al., 2011). In project based learning process the students try to refine questions, think critically, collect and analyze data, draw conclusions, and share their findings with others (Karahoca, Karahoca, and Uzunboylu, 2011).

Researchers combined PBL with collaborative learning to organize science courses in electrical circuits. They divided students into groups and assigned each team a coach and the classes followed a learning scenario consisting of eight stages of problem-based learning. As a result of this study, some of the problems with PBL were derived from collaboration and several teams did not complete the electronics project. In some teams, curious and enthusiastic students did most of the work. Groups with better communication and enthusiastic students had more ideas and better results. So, researchers emphasized the importance of the context of problem-based learning (Karahoca et al., 2011). They developed a project which focused on primary school students and we tested their interest in robots to investigate the prone of students for verbal or analytical abilities. This course was provided as lab session for primary school students to contribute the group work and project-based learning. Before this project robot as a toy for students but at the end of project they understood that robots are very complicated machines. As aresult of this study, students' technological point of view about materials which we used to make robot has changed (Karahoca et al., 2011).

In another study, students solve real-life technological problems because they are interesting and motivating. In this study students' students' thinking and problem solving skills, were assessed (Arlegui & Pina, 2009).

In literature project based learning also use to train teachers. The TERECoP project was an implementation of constructivist learning theory targeting teachers' use of the methodology. In this Project teachers teach students as they were taught in training—not as they were told. This methodology was applied in teacher training during three meetings, and each meeting played an important role in the context of PBL. The fourth and fifth meetings were developed on teachers' own projects, and the evaluated results were tested on the students. PBL was consisted of exploration, experimentation, creation features and used in training was a positive experience (Alimisis, Frangou, & Papanikolaou, 2009).

In engineering design process, students think about a problem or situation that is meaningful to them and that they'd like to address with their projects. In this learning model, students work out their own questions and answers (Duckworth, 1972). They must invent a way to solve the problem or manage the situation. Then they go about designing and constructing. Researchers examined middele school students' meaningful learning of the engineering design process during their participation in robotics activities. The results of this study showed that most of the groups demonstrated the understanding/applying level during each of the design process phases and some demonstrated the analyzing/evaluating level. However, few of them demonstrated the higher level of creating (Kaloti-Haalki, Armıni, Ben-Arı, 2019).

Educational robotics which are a part of developing technology may have great importance in the developing of students' skills. These technologies increase students' capabilities and self-confidence and also help students to learn scientific issues by experiences. Generally, the results of studies on using robotics in classrooms are positive. As the teachers' role in achieving the positive results robotics have a similar effect on student skills (Kim, Choi, Han, & So, 2012; Pedersen, 1998).

Robotics education should be a compulsory aid for school subjects rather than an instrument that applies pedagogical methods and increases motivation. Some effective learning approaches are used when apply educational robotics in science teaching. All these methodologies rely on constructivism, can be easily combined and and all the methodologies have positive properties. On the other hand, reasearhers agreed that most robotics education approaches should not be used alone as these methodologies support and enhance each other. For instance, collaborative or inquiry learning could help students share information, knowledge, and experiences and improve learning outcomes. Therefore, it was suggested to find the best way to react to these by combining them to meet 21th century skills (Heilo, Margus, 2013).

4.2. THE USE OF THE E-WORKBOOK PLATFORM

MODULE 4

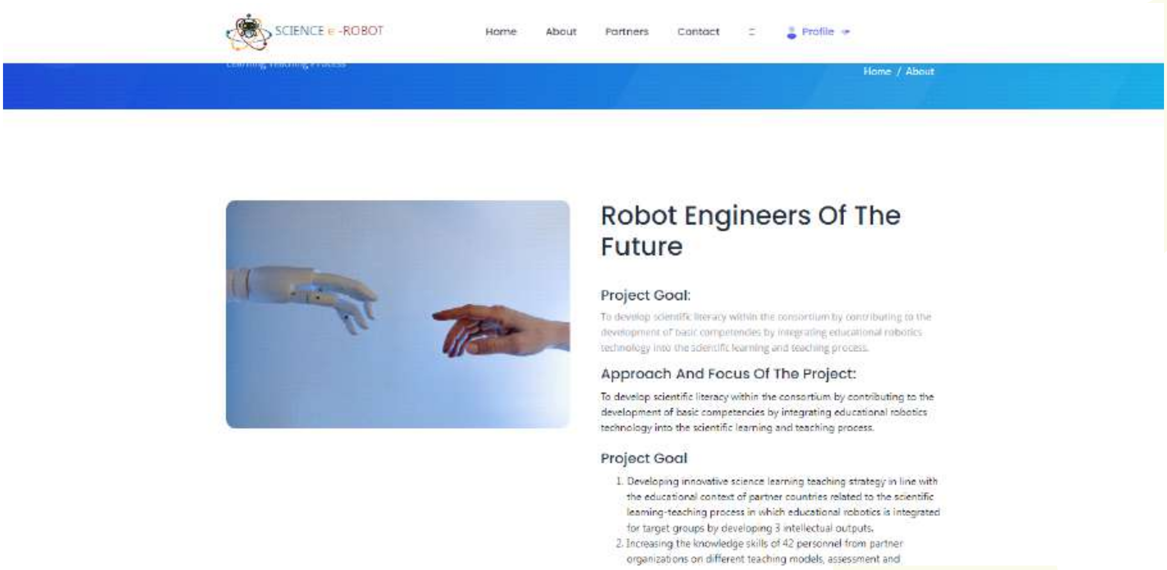
We are very happy to bring our Science E-Robot project to you!

You can benefit from hundreds of e-workbooks and training materials on our website, which has an interface that you can use very easily and you can contribute to the development of scientific literacy by creating your e-workbooks. Membership on our website, where you can follow our community and events, is free of charge.

HOME

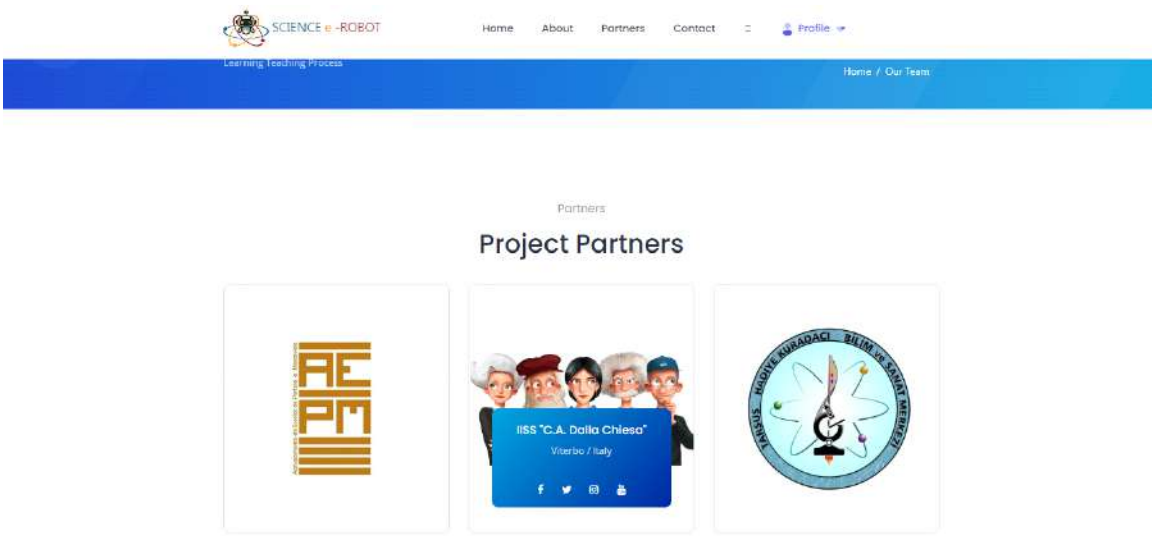
About

You can learn about the aims and focal points of our project on this page.



Partners

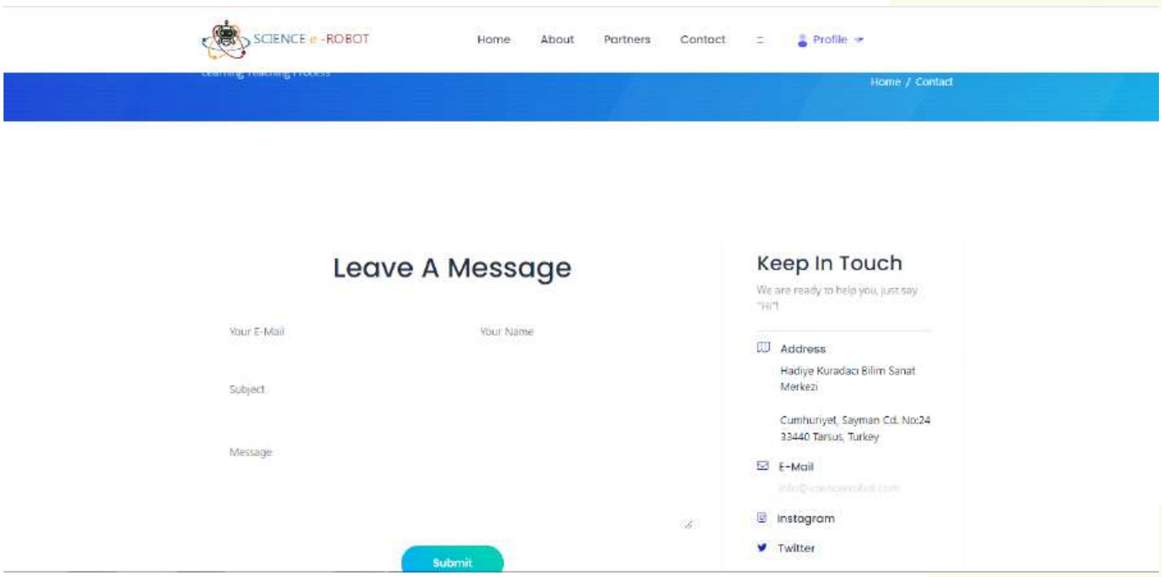
You can see the Science E-Robot project partners on this page. You can also access the social networks of all partners.



Contact

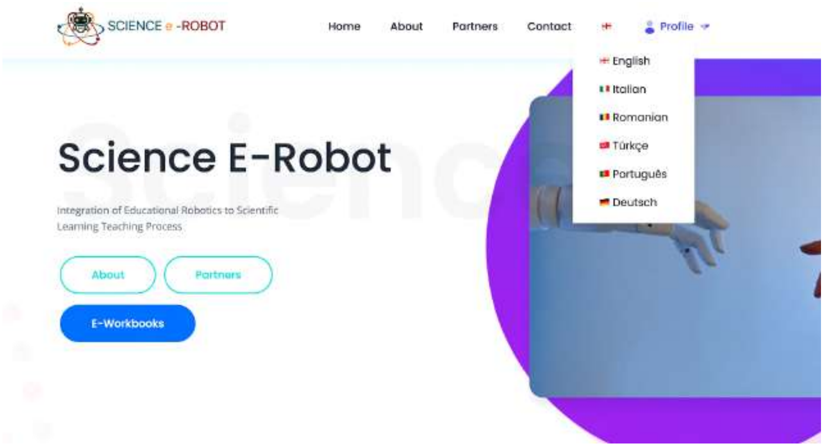
If you want to contact us, you can leave your message by typing your name, surname and e-mail address. A response will be given as soon as possible.

You can also access all our social media accounts here.



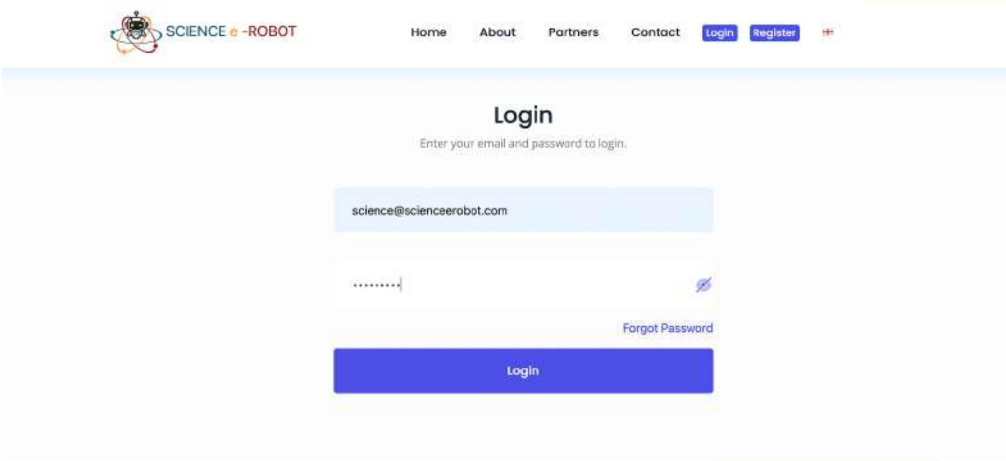
Language

You can use the site in any language you want with the language feature. The language you choose will be valid on the whole site and the site will be translated into the selected language.



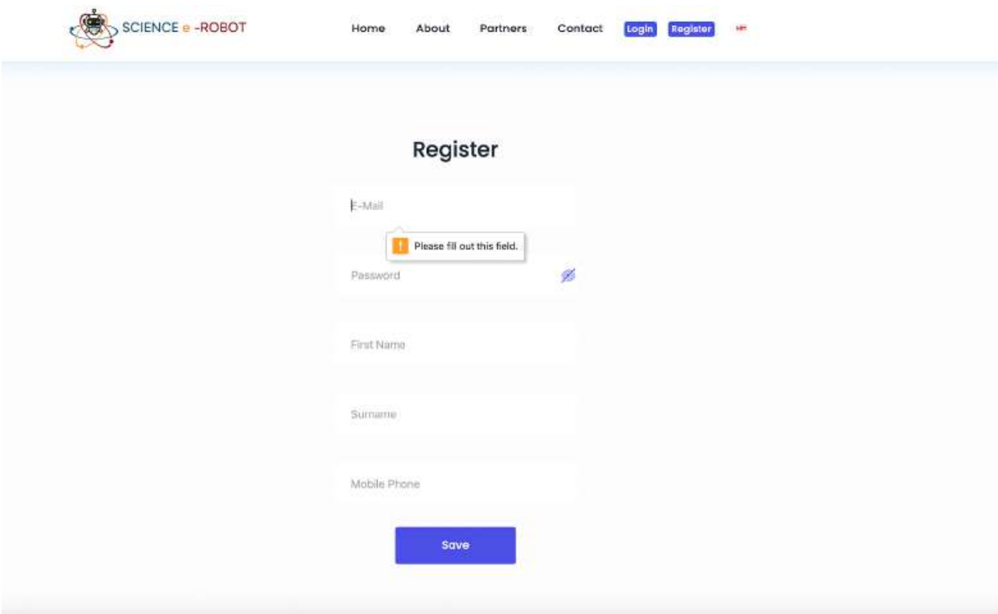
Login

The user can access his/her own account by logging in from this page.



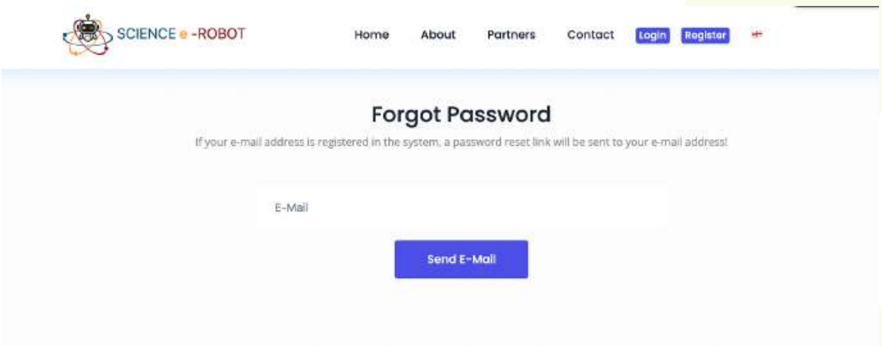
Register

Users can register themselves in the registration section. Some fields here are required fields. The system warns and register cannot be added before these required fields are filled in and a strong password is created.



Forgot Password

Don't worry if you forgot your password. Here, the user can send the password regeneration link to his/her e-mail address by typing the e-mail address of the previously created registration.



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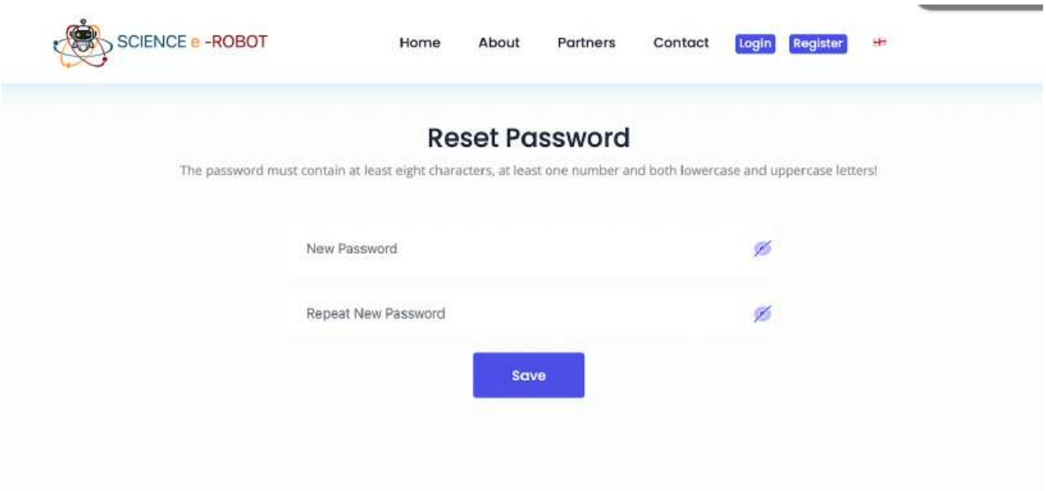
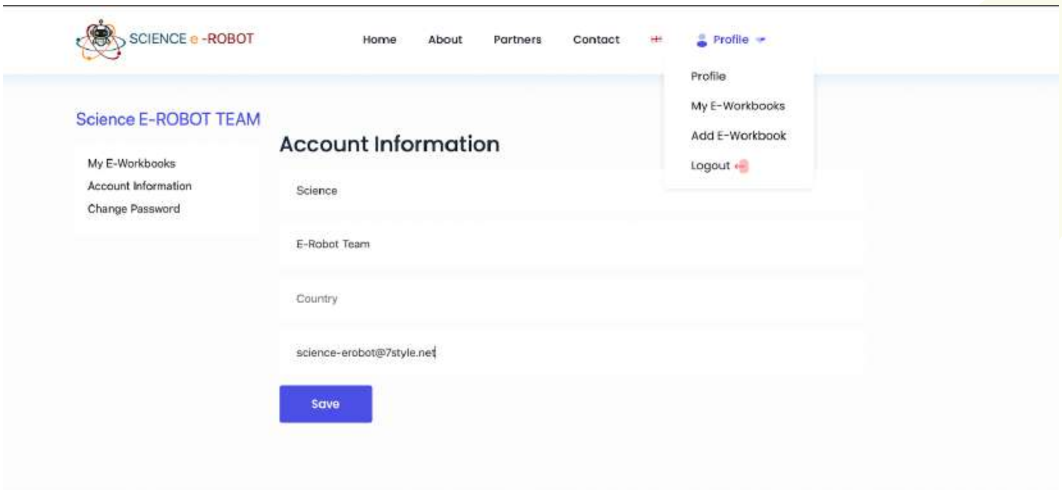
Reset Password

Clicking on the link sent to the e-mail opens this page. You can create a new password at this page.



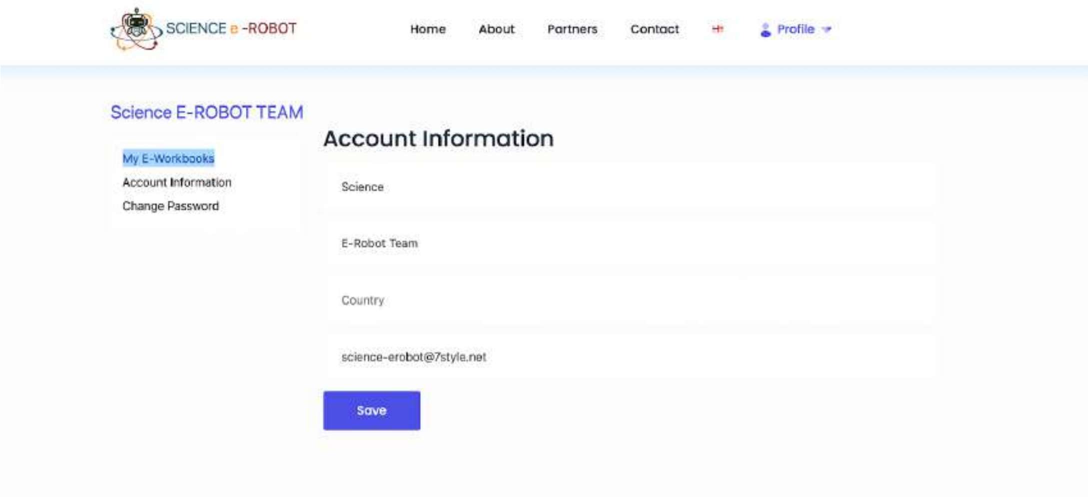
Profile

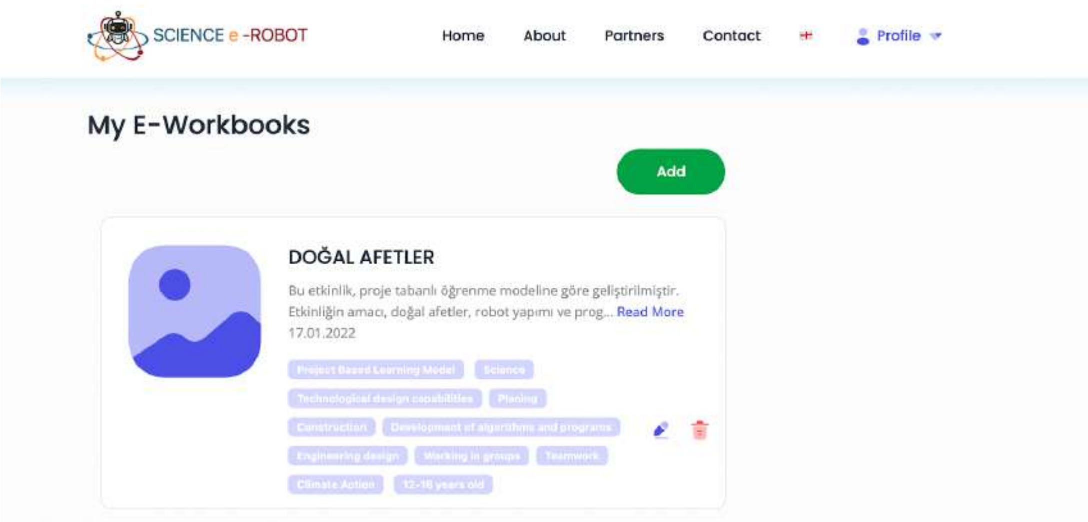
The user can update his/her account information in the Profile tab.



My E-Workbooks

The user can go to the e-books he/she has created by clicking the "My E-Workbooks" tab on the profile page. By clicking the icon, you can add new e-books, update and delete existing e-books on the page that opens.





Add E-Workbooks

You can add your own e-workbooks here.

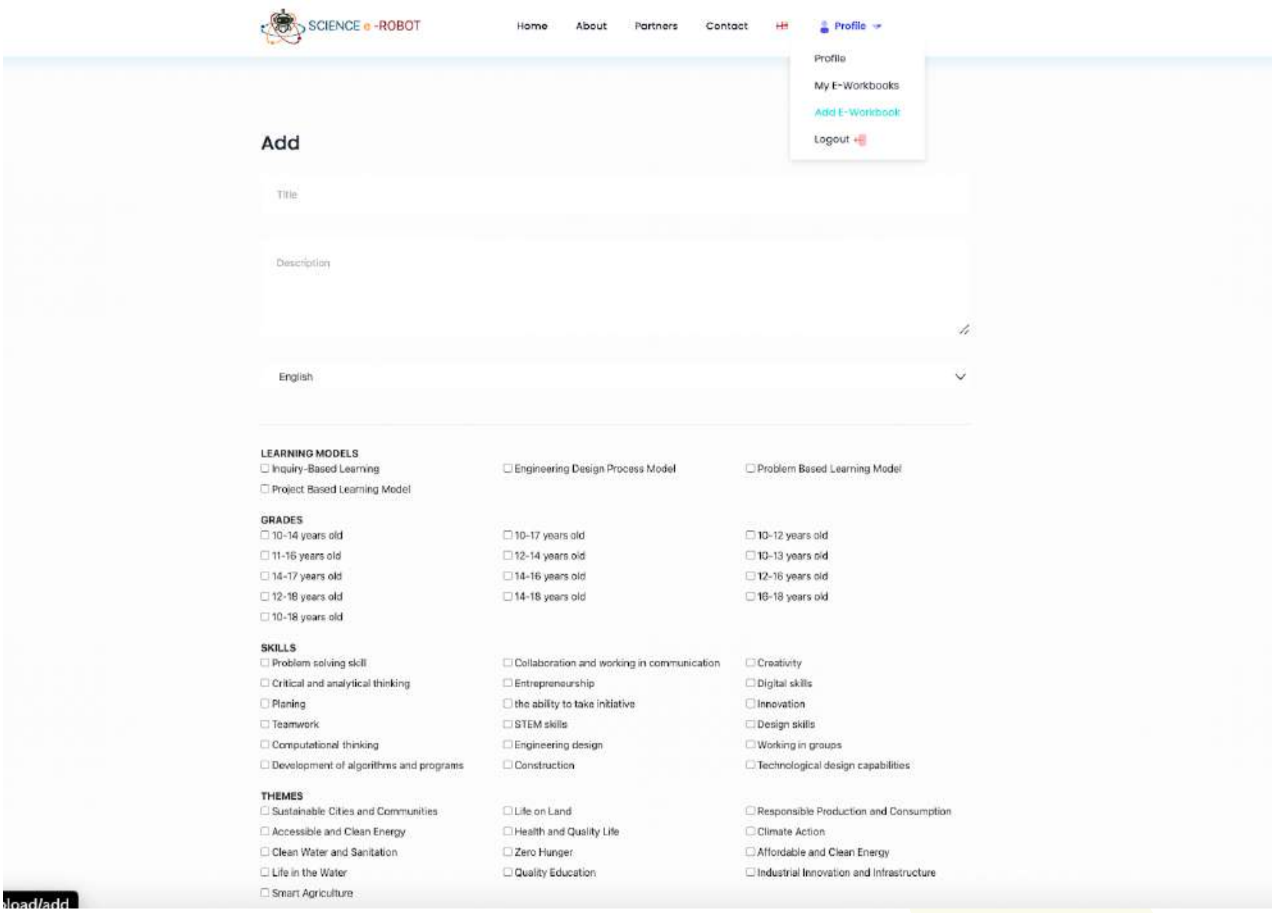
When adding an e-book:

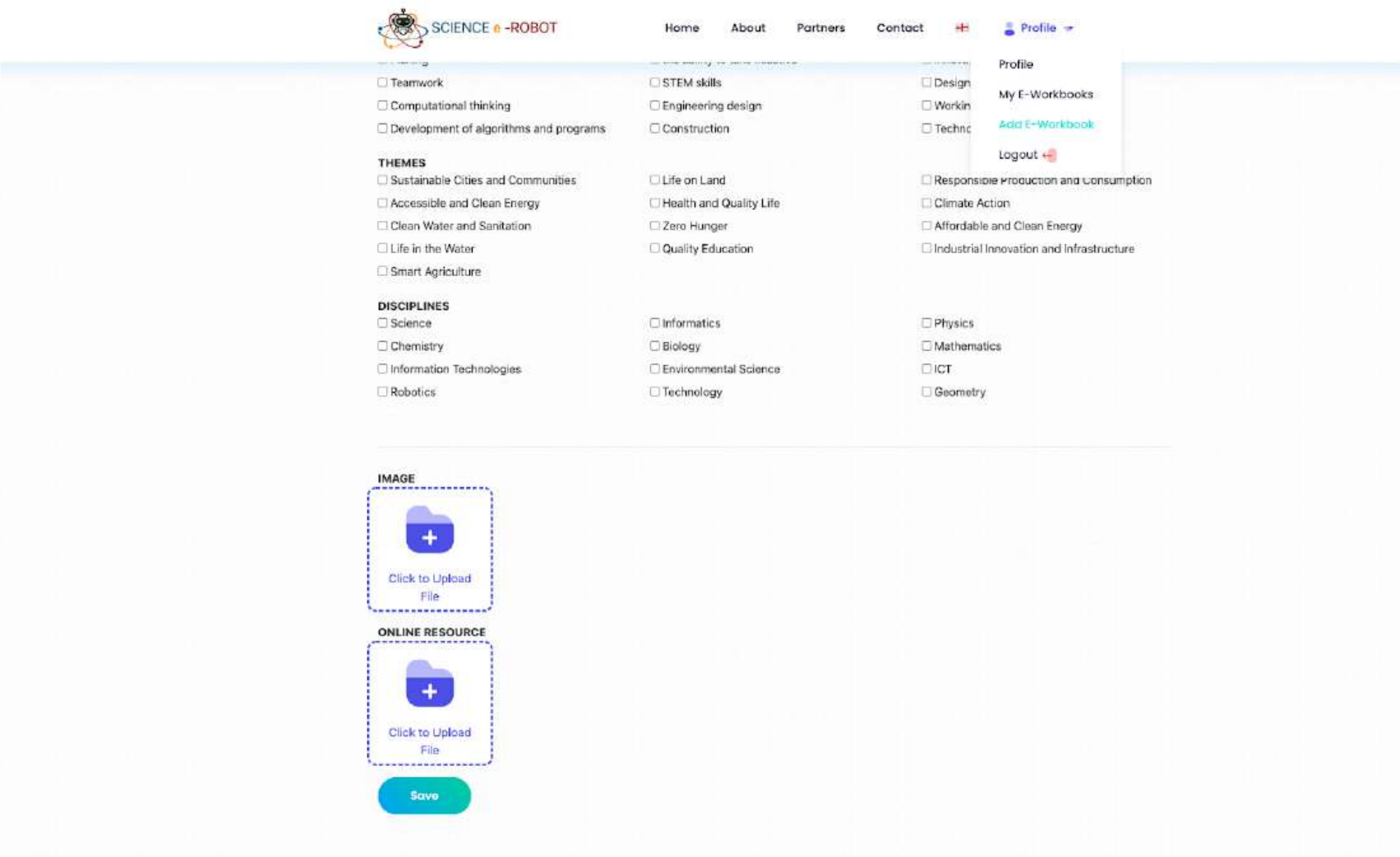
- Image, pdf, etc. files can be added.

- Language feature can be selected,

- E-Workbook features can be selected.

Choosing these features will work well for the classification of e-books.




SCIENCE e -ROBOT
Home
About
Partners
Contact
Profile
Profile
My E-Workbooks
Add E-Workbook
Logout
Teamwork
Computational thinking
Development of algorithms and programs
STEM skills
Engineering design
Construction
THEMES
Sustainable Cities and Communities
Accessible and Clean Energy
Clean Water and Sanitation
Life in the Water
Smart Agriculture
Life on Land
Health and Quality Life
Zero Hunger
Quality Education
Responsible Production and Consumption
Climate Action
Affordable and Clean Energy
Industrial Innovation and Infrastructure
DISCIPLINES
Science
Chemistry
Information Technologies
Robotics
Informatics
Biology
Environmental Science
Technology
Physics
Mathematics
ICT
Geometry
IMAGE
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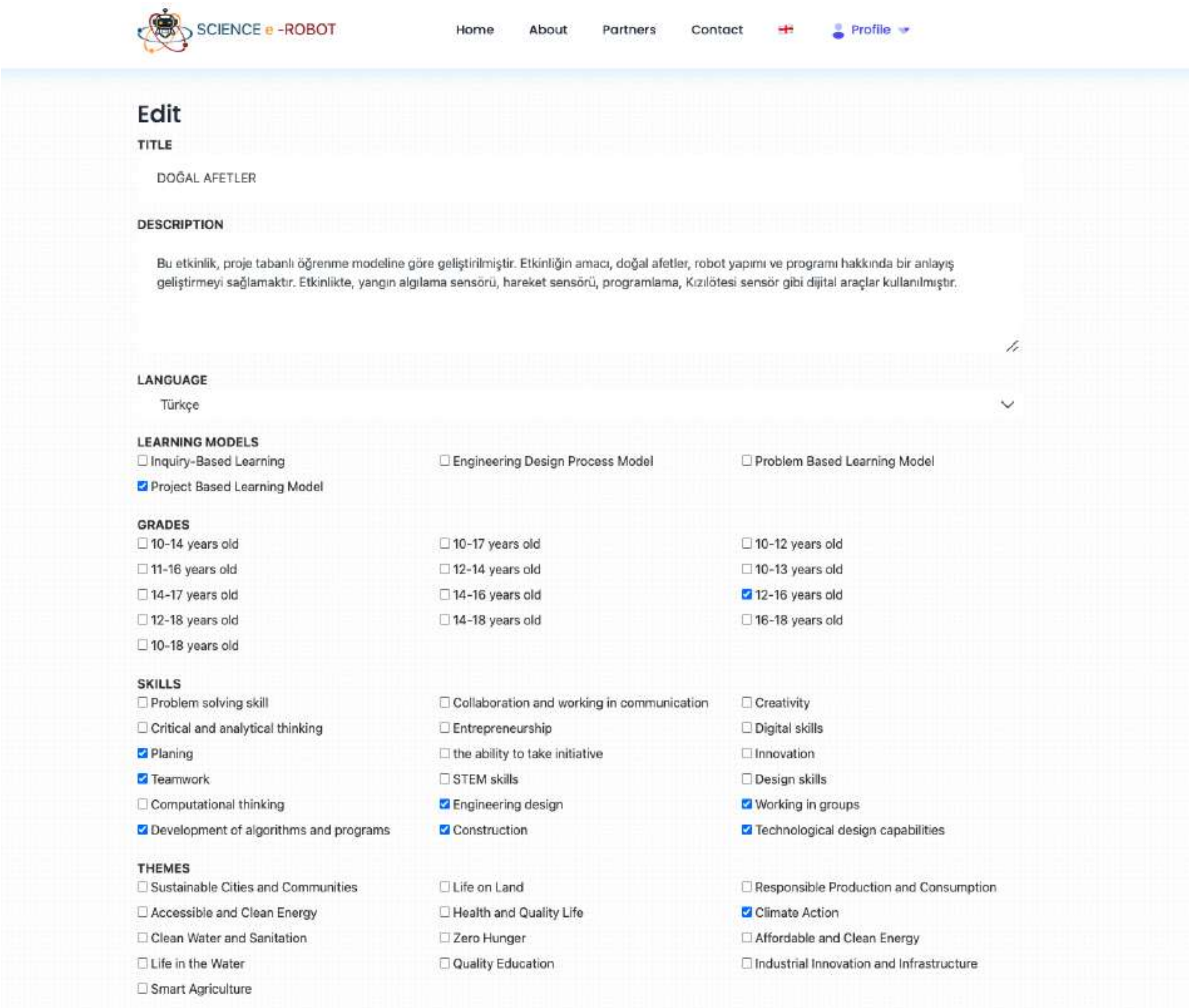
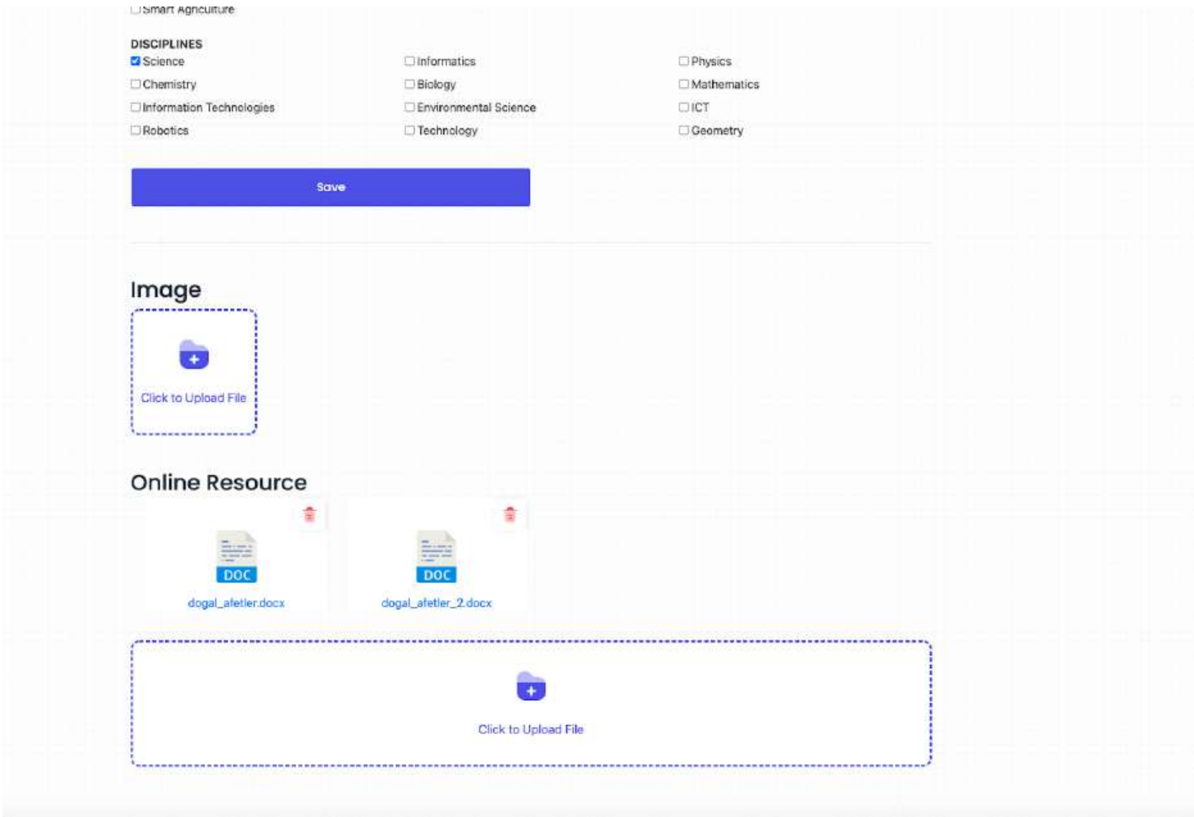
ONLINE RESOURCE
Click to Upload File
Save

A Workbooks Edit Page

The selected e-book information is loaded on this page. Then the user can update the information. You can delete the pictures you added, change the features you choose, or upload extra pictures or files.




Smart Agriculture
DISCIPLINES
Science
Informatics
Physics
Chemistry
Biology
Mathematics
Information Technologies
Environmental Science
ICT
Robotics
Technology
Geometry
Save
Image
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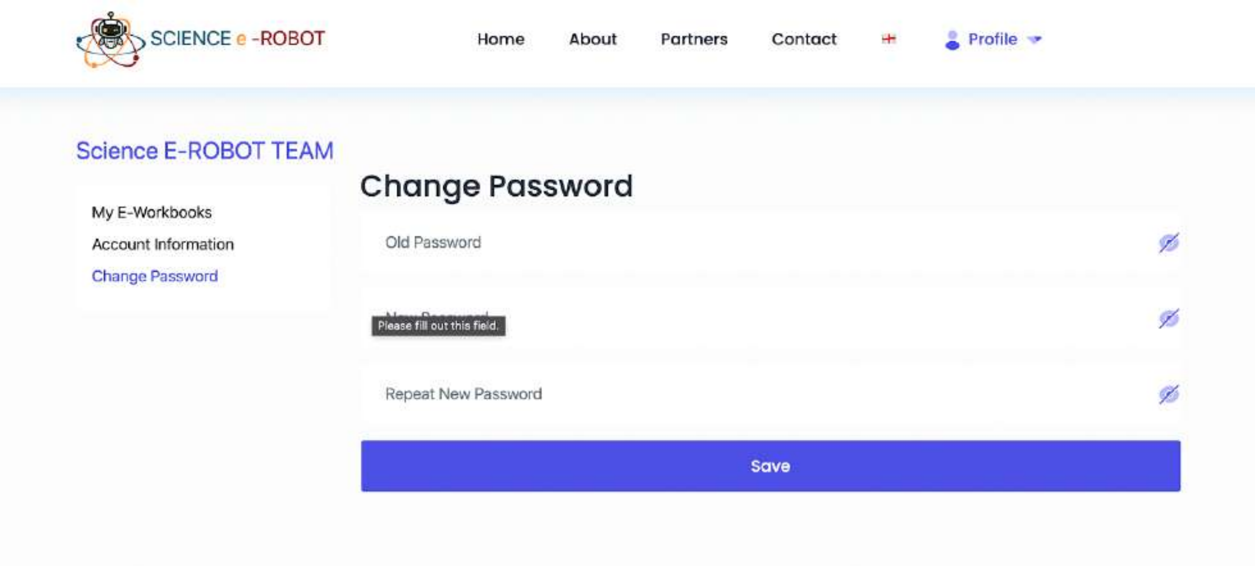
Change Password

You can change your current password by entering the "Change Password" tab after logging in to the profile page.



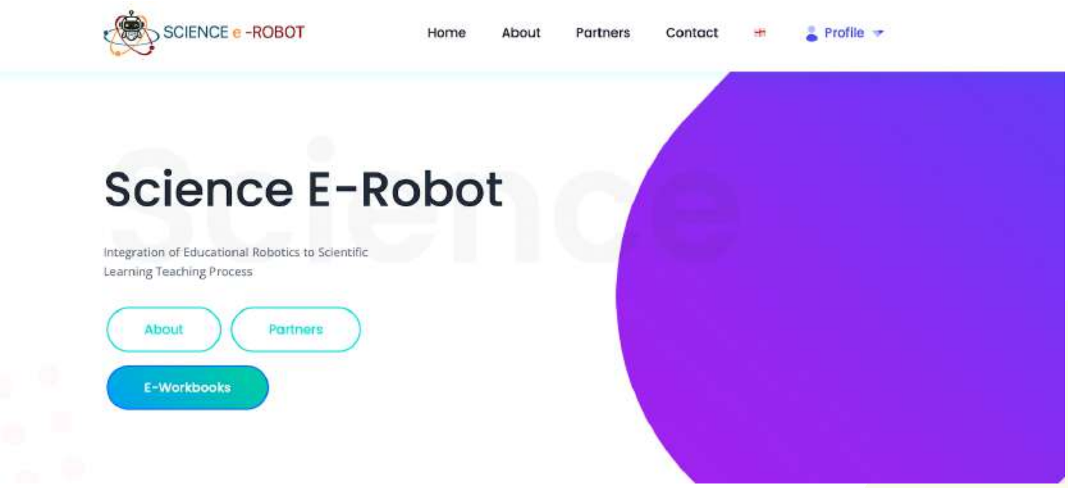
E-Workbooks

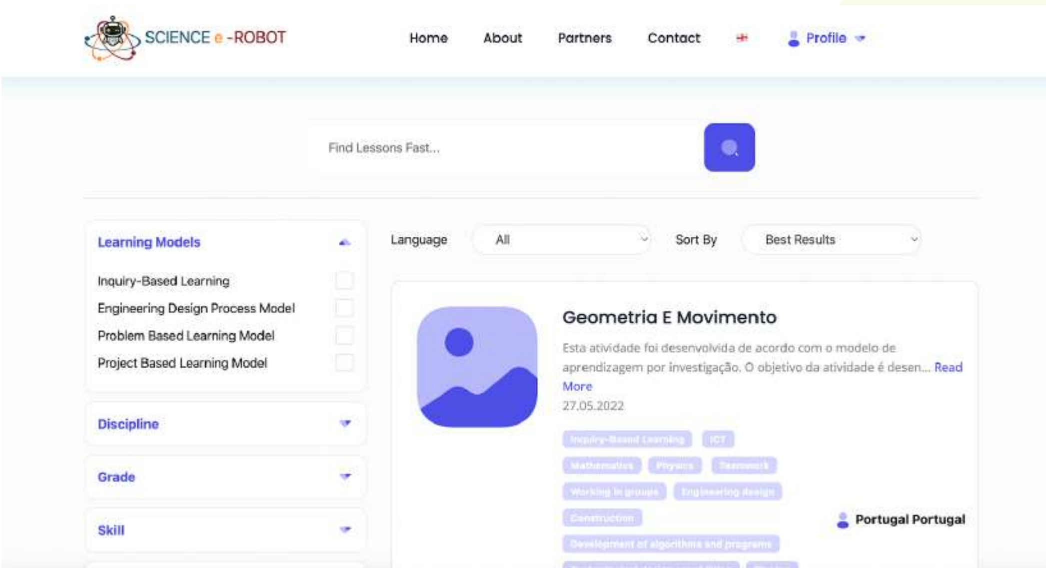
The e-books added by all users can be seen from the main page.

- E-books can be searched with the search bar.
- Languages can be filtered by language.
- With the sorting filter, the sorting can be changed by the most clicked, alphabetical order and date.

- You can quickly and easily access e-workbooks with these features by selecting

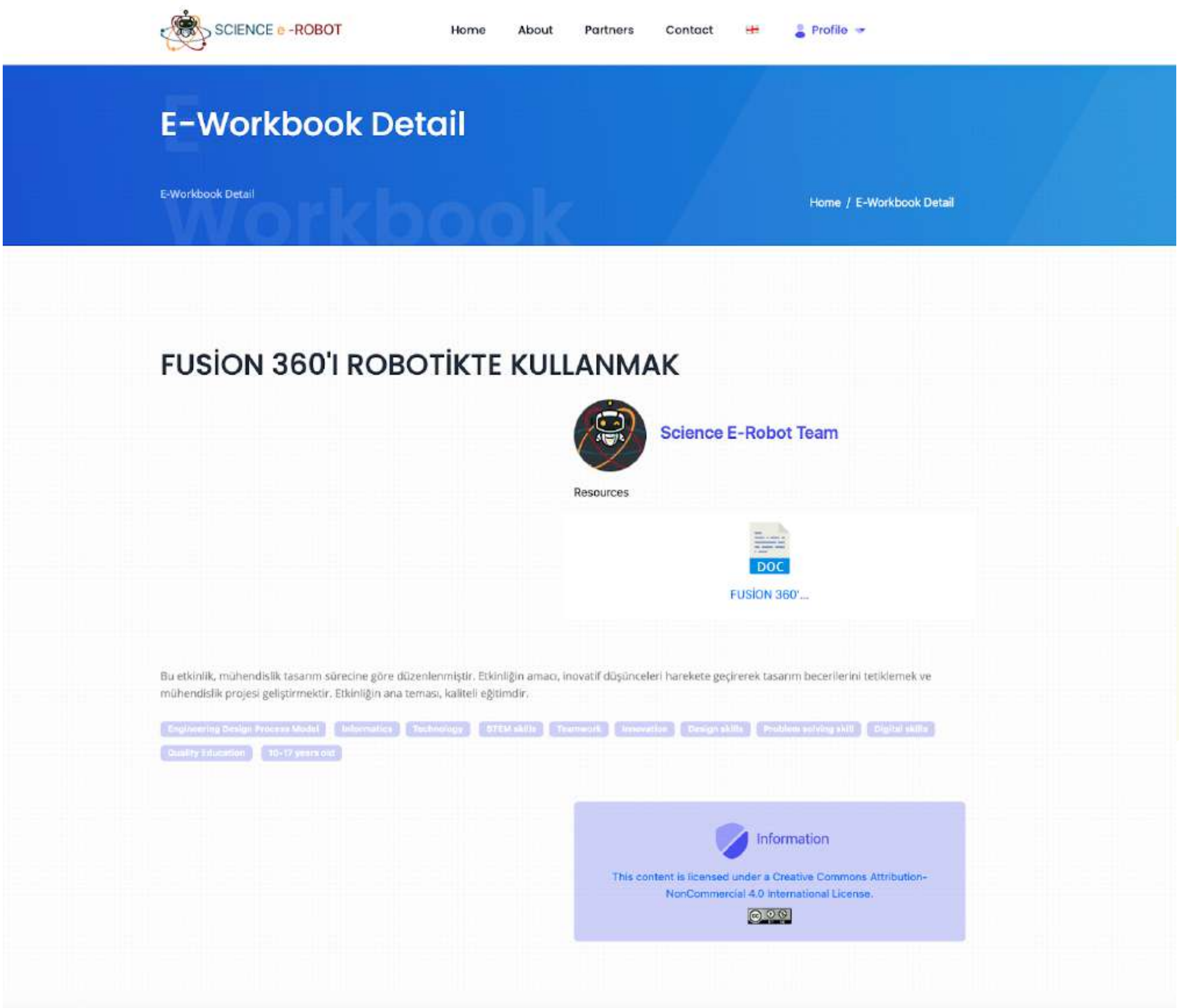
the features you are looking for with the checkboxes on the left.





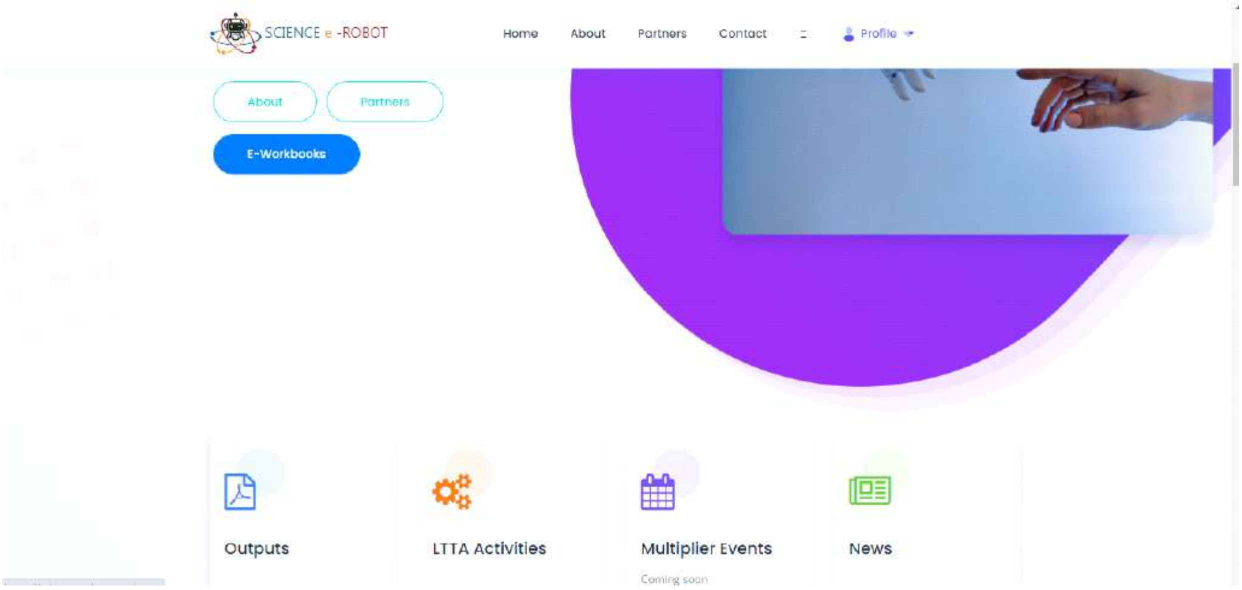
E-Workbook Detail

You can go to the detailed page of the e-workbook by clicking on the title, picture or read more in the e-workbooks listed; you can download all files and materials here.



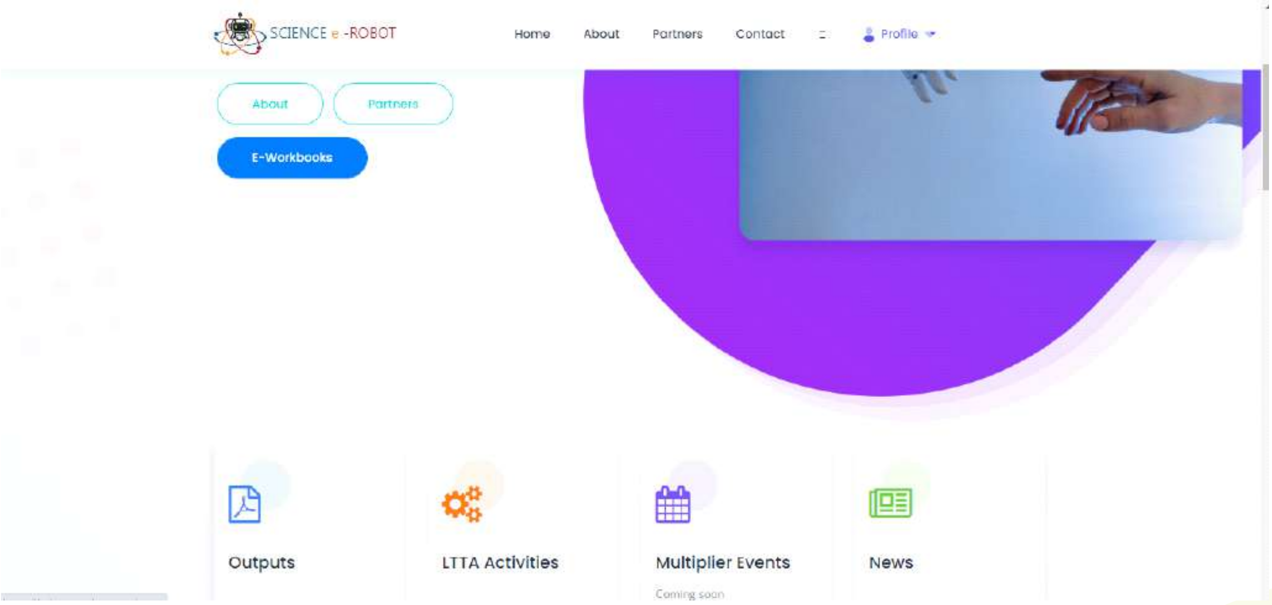
Outputs

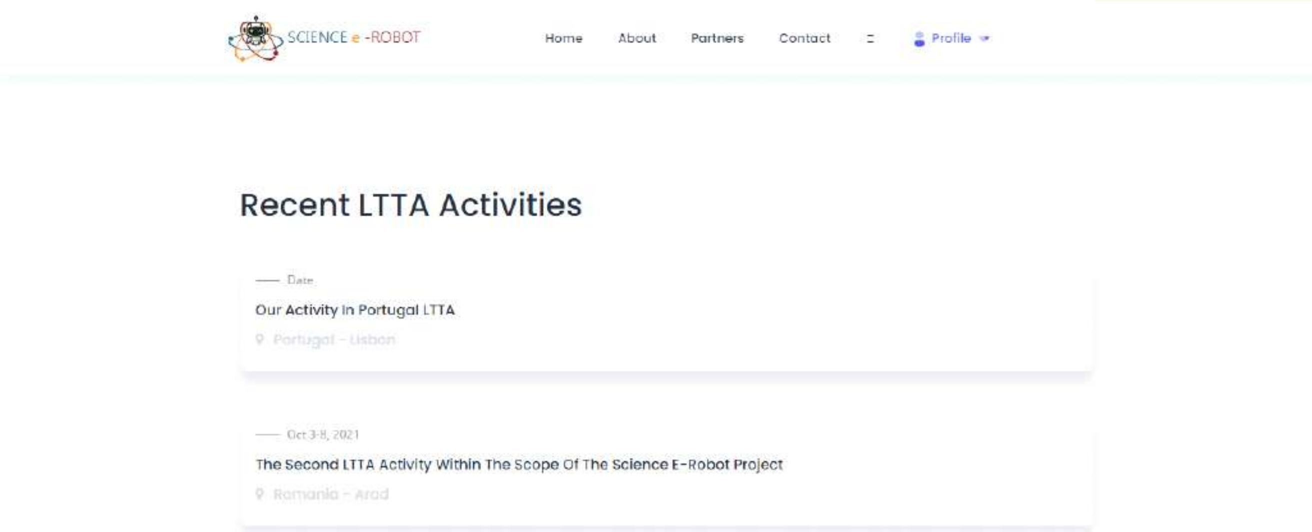
On this page, you can review outputs and analyzes on how society will benefit from our project.



LTTA Activities

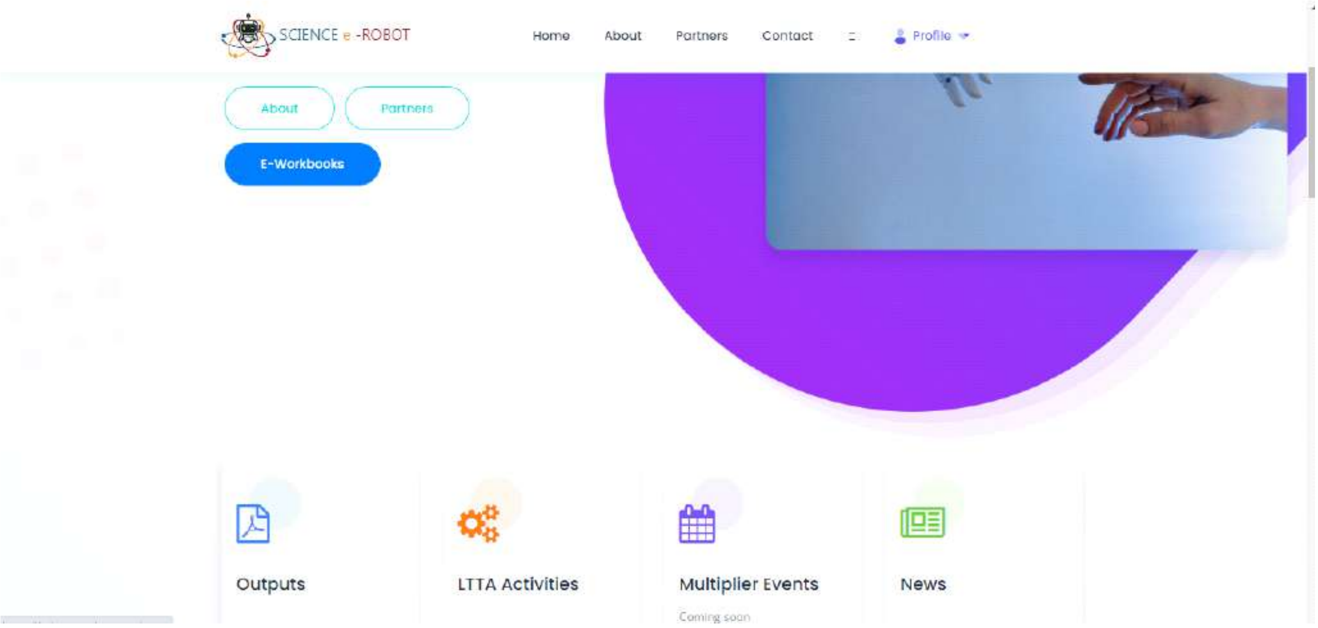
You can view our international events and meetings within the scope of our Science E-Robot project on this page. Results and images from the events are also available on this page.

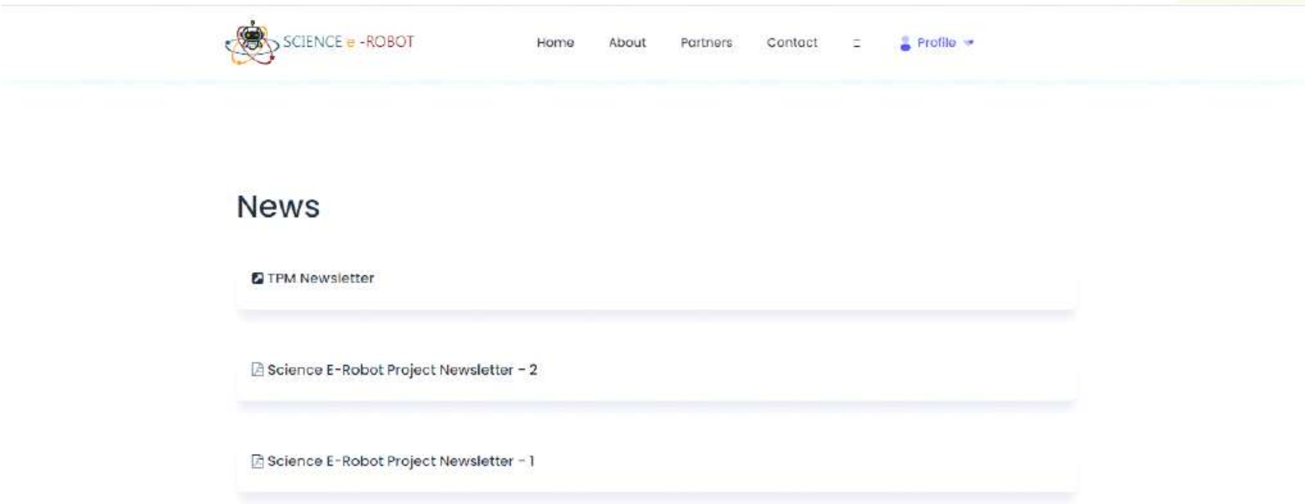




News

You can follow the Science E-Robot bulletin and news from our project on this page.





ADMIN

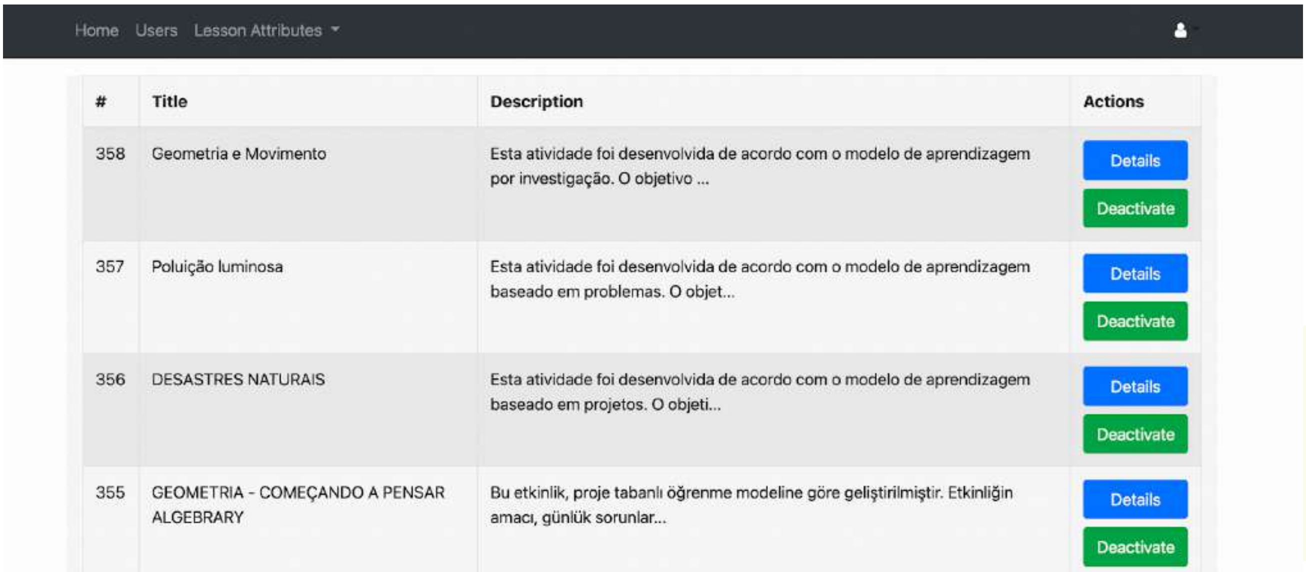
Home

Lessons are listed on this page.

Admins on this page:

-Can activate/deactivate the course you want to show/hide on the e-books page.

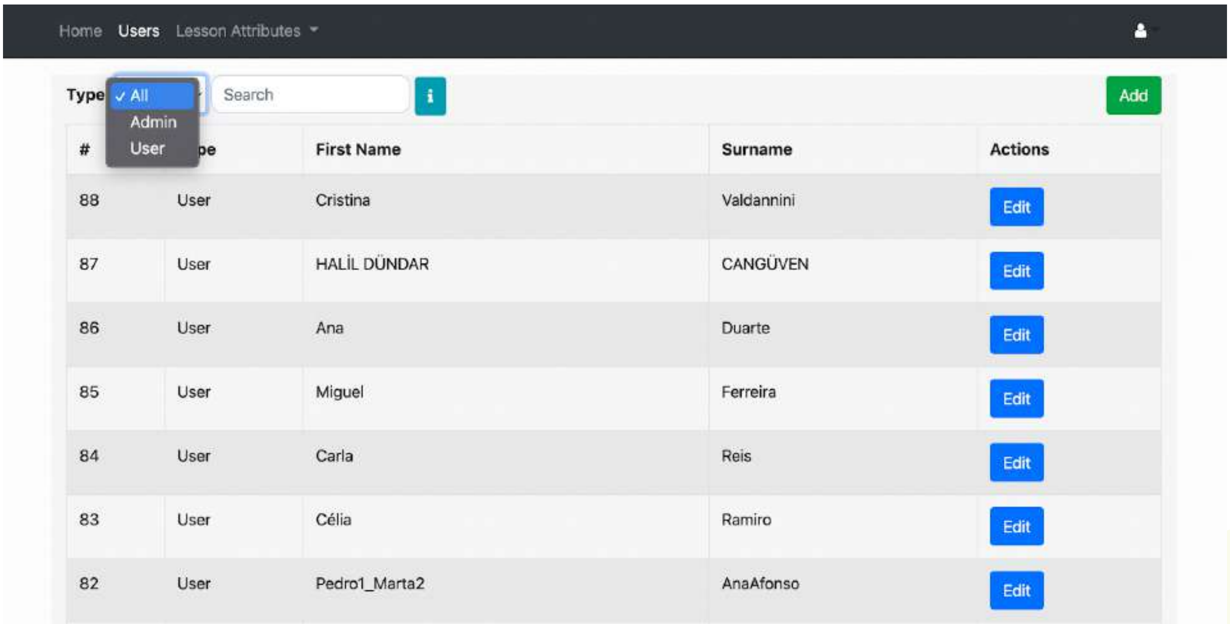
-Can see the details of the loaded e-books.



#	Title	Description	Actions
358	Geometria e Movimento	Esta atividade foi desenvolvida de acordo com o modelo de aprendizagem por investigação. O objetivo ...	Details Deactivate
357	Poluição luminosa	Esta atividade foi desenvolvida de acordo com o modelo de aprendizagem baseado em problemas. O objet...	Details Deactivate
356	DESASTRES NATURAIS	Esta atividade foi desenvolvida de acordo com o modelo de aprendizagem baseado em projetos. O objeti...	Details Deactivate
355	GEOMETRIA - COMEÇANDO A PENSAR ALGEBRARY	Bu etkinlik, proje tabanlı öğrenme modeline göre geliştirilmiştir. Etkinliğin amacı, günlük sorunlar...	Details Deactivate

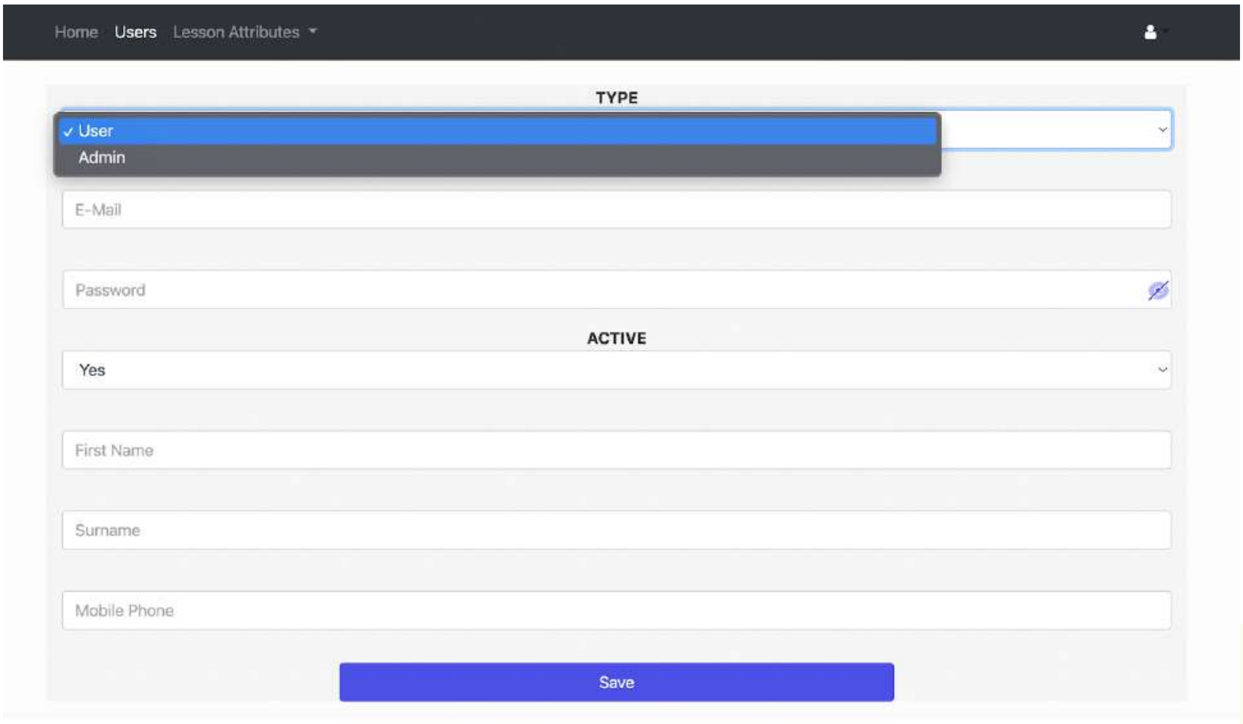
Users

-Filter can be made according to the user type with the drop-down list.
-By using the search bar, a search can be made with the information of the user.
-User can be added.
-User can be updated.



Add User Page

Admins can add admin or user registrations and assign passwords to these accounts at this page.



LESSON ATTRIBUTES

On this page:

- features can be listed.
- features can be updated.
- new features can be added.
- features can be deleted.

4.3. SAMPLE ROBOTIC SCIENCE ACTIVITES FOR 10-13 AND 14-17 AGE GROUPS

MODULE 4

5E - Inquiry-Based Learning Model

Main Theme: Sustainable Cities and Communities

Topic		Barrier-Free Life
Grade / Age Level		10-14 years
Content Standards		T.C. MoNE Science Curriculum; https://mufredat.meb.gov.tr/Dosyalar/201812312311937-FEN%20B%C4%B0L%C4%B0MLER%C4%B0%20%C3%96%C4%9ERET%C4%B0M%20PROGRAMI2018.pdf Light - Matter and Sound - Matter Interaction Sustainable Development Goals; https://www.kureselamaclar.org/en/global-goals/sustainable-cities-and-communities/
Learning outcomes		Students; • Explains the results of the interaction of matter with light and sound. • Develops a design with robotic materials. • Develops and implements creative ideas that will make life easier for people with disabilities. • Pays special attention to the needs of the disabled. • Understands and uses the contribution of technology to human life.
Key Skills		• Problem solving skill • Collaboration and working in communication • Creativity • Critical and analytical thinking • Entrepreneurship • Digital skills
Time		10 hours
Safety rules		Make sure students work with cutting tools. Beware of knocks and bumps.
PHASE		

Co-funded by the Erasmus+ Programme of the European Union

<table>
<tr>
<td>ENGAGE</td>
<td>

Activities that capture the students' attention, stimulate their thinking, and help them access prior knowledge.
Teacher creates a problem narrative /engagement scenario, video, or resource that engages students, then helps students develop questions and identify what and KWL chart.

</td>
<td>
Begin the class by discussing the importance of group work with your class. Allow students time to come up with rules for group work and to decide on group roles.
Divide students into groups.

Begin by asking students the question and discuss:

What are the problems faced by disabled people in life?

Source videos for problems discovery:
https://www.youtube.com/watch?v=YH3XWO9C4YU

https://www.youtube.com/watch?v=7teUErH5pLg

https://www.youtube.com/watch?v=xycecbwplzE

https://www.youtube.com/watch?v=4j8nyslXeP0

What difficulties do people with disabilities face, especially in traffic and at home?

What should be for disabled people for a sustainable society?
<table>
<tr><td>What do you Know?</td><td>What do you Want to learn?</td><td>What did you</td></tr>
<tr><td></td><td></td><td></td></tr>
</table>
</td>
</tr>
</table>

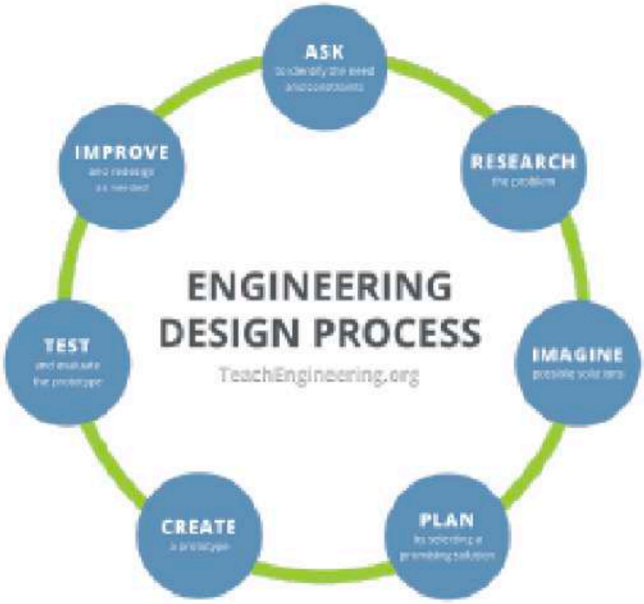
EXPLORE	• Learners may complete lab activities that help them use prior knowledge to generate new ideas, explore questions and possibilities, and design and conduct a preliminary investigation • Enable students to explore their ideas, singly and in groups, in classroom or at a distance. Provides students time to think, plan, investigate, and organize collected information.	A role-playing activity can be done with students to make it easier for people with disabilities to understand the difficulties they experience. The classroom environment is thought of as a house and divided into rooms (such as kitchen, living room, hall). Some of the students are blindfolded and given a task. The task could be as follows: You are walking down the street and you finish your shopping and return home. At home, you need to find the kitchen and leave the items on the table. After doing this task, the layout of the room is changed and he is asked to perform the same task again. It is expected to complete the task within a maximum of 15 minutes. If not, the activity is completed in the same time. The student's experience with the task is taken and they are asked to make a brief assessment. For evaluation, they are asked to answer the following questions. How did you feel when your eyes were closed? Have you ever been worried about bumping into someone or something while moving? Have you had trouble finding new places at home? Is it difficult to do something without seeing it? Would it really be difficult if there was a visually impaired person in your place? • How can we help them overcome their difficulties? • How are the needs of people with disabilities addressed in sustainable societies? • Is it possible to facilitate the lives of people with disabilities? If possible, how can you do this in the technological ways you use? • Can educational robotics materials enable you to do this?

EXPLANATION	• The explanation phase focuses students' attention on a particular aspect of their engagement and exploration experiences and provides opportunities to demonstrate their conceptual understanding, process skills, or behaviors. • This phase also provides opportunities for teachers to directly introduce a concept, process, or skill. Learners explain their understanding of the concept. • Most important, this phase allows students to express their explanations and allows the teacher to use teachable moments.	In the United Nations Declaration of the Rights of Disability, "those who cannot do the work (bodily or later) that are required to be done on their own in their personal or social life as a result of any defect" are defined as disabled (**See Annex 1**). There are many types of disability: Visual, hearing, orthopedic, mental, language and speech disability, chronic illness, injury-deviation, disability, etc. Disabled individuals may encounter certain problems in social and economic life. In particular, they experience various difficulties in the areas of transportation and home life due to the physical difficulties caused by the disability. E.g; A visually impaired individual may experience the danger of falling or colliding on a pedestrian road or pavement. In his home life, he may have problems with which furniture to place in which room or to carry out his daily work without wasting time. Failure to make adequate arrangements for the disabled in the physical environment ensures the continuation of the difficulties. People with disabilities want to take an active part in social life like other people. Going to work or shopping as a necessity of social life; Wants to do something at home. Therefore, while making arrangements in social life, the needs of individuals with disabilities should be taken into account and practices should be carried out accordingly. In addition, there are innovative applications that facilitate the life of the disabled. You can refer to the links below as a source: https://themighty.com/2015/01/10-inventions-revolutionizing-the-lives-of-people-with-disabilities/ https://onedio.com/haber/engellilerin-hayatini-kolaylastiran-10-mobilite-cozum-930929 https://webional.com/engellilerin-hayatlarini-kolaylastiracak-technological-inventions/ https://www.youtube.com/watch?v=NBVCU1hGcmg

ELABORATE	• Through related but new experiences, the students develop deeper and broader understanding, more information, and adequate skills. • Students apply or extend previously introduced concepts and experiences to new situations. Students apply their knowledge to real world applications	Materials: Tablet or laptop, Lego mindstorms EV3 kit, infrared / ultrasonic and color / light sensor, 1-2 meter stick, obstacle blocks, plastic clamp, liquid glue, colored cardboard, colored pencils and tape. Would you like to make an application for students that will make life easier for a visually impaired individual on the street and at home by using the available materials? The question is asked. Students start a brainstorm in teams and list interesting ideas. By using Infrared / Ultrasonic and / or color / light sensor, guidance is provided for visually impaired individuals to think about a system that will prevent them from falling or hitting and that will give a warning. In addition, they are informed that they can strengthen their practices with a system that provides a warning indicating the room they are in. The teams decide on the most ideal idea and start their robotic assisted design. Below are videos and guides on using the Infrared / Ultrasonic and color sensor: https://ev3lessons.com/en/ProgrammingLessons/beginner/Ultrasonic.pdf https://ev3lessons.com/en/ProgrammingLessons/beginner/Color.pdf https://ev3lessons.com/en/ProgrammingLessons/beginner/SoundBlock.pdf https://ev3lessons.com/en/ProgrammingLessons/intermediate/Infrared.pdf https://www.youtube.com/watch?v=UO4JfWcUd0E https://www.youtube.com/watch?v=ywFt5fENj68 https://www.youtube.com/watch?v=E-qSs8Bihmk https://www.youtube.com/watch?v=Xy7XTY7tHYk https://www.youtube.com/watch?v=aJToMY-3Mq4 After designing a road and a house with access, infrared / ultrasonic and color / light sensors are mounted on the device to be used by the visually impaired person. Next comes the programming phase. At this stage, the ultrasonic sensor is programmed to give a sound warning 50 cm from the object via the Lego Mindstorms EV3 software. On the other hand, the color/light sensor is programmed to give different stimuli of different colors (depending on the room). After the prototype is developed, it goes to the testing phase and is tested. See Annex 2 See Annex 3 See Annex 4 See Annex 5 See Annex 6 See Annex 7

EVALUATE	• The evaluation phase encourages students to assess their understanding and abilities and provides opportunities for teachers to evaluate student progress toward achieving the educational objectives.	The assessment phase encourages students to assess their own understanding and abilities, and provides opportunities for teachers to assess students' progress towards achieving their educational goals. Portfolio and assessment rubrics can be used to achieve this. In addition, a design rating scale can be used.

Sample-2



Engineering Design Process Model

Main theme: Life on Land and Climate Action

Class / Age Level	5 – 8 Grade / 10 – 17 ages
Subject / Title	Nature-Friendly Spraying System
Content Standards	MoNE Science Education Teaching Programme https://mufredat.meb.gov.tr/Dosyalar/201812312311937-FEN%20B%C4%B0L%C4%B0MLER%C4%B0%20%C3%96%C4%9ERET%C4%B0M%20PROGRAMI2018.pdf https://mufredat.meb.gov.tr/Dosyalar/201812103112910-orta%C3%B6%C4%9Fretim_fizik_son.pdf https://mufredat.meb.gov.tr/Dosyalar/20182215535566-Biyoloji%20d%C3%B6p.pdf Sustainable Development Goals: https://www.kureselamaclar.org/en/global-goals/life-on-land/ https://www.kureselamaclar.org/en/global-goals/climate-action/ Reducing the degradation of natural habitats. Conservation of species and prevention of extinction.

		Protecting biodiversity and ecosystems.
Time Required		8 hours
Learning Objectives	Scientific Related to mathematics Related to technology Related to engineering	Math: It calculates the cost and uses the budget in the most appropriate way. Develops a design-oriented plan and can work in accordance with this plan. Technology: Uses and programs Arduino Uno R3 and its sensors. Can use technology in solving life problems. Engineering: Develops a design using engineering skills. Can develop a prototype. It can optimize its design. Science: Designs projects for efficient use of resources and solving problems. He realizes that he can detect objects with sound waves. Questions the importance of biodiversity for natural life. Discusses the factors that threaten biodiversity according to research data. It offers suggestions for the solution of an environmental problem in its immediate surroundings or in our country. It makes inferences about environmental problems that may occur in the future as a result of human activities. Discusses the benefits and harm situations in human-environment interaction on examples. Explain the relationship between living and non-living components of the ecosystem. Evaluates the causes and possible consequences of current environmental problems. It offers solutions for the prevention of environmental pollution in the local and global context. Explain the importance of sustainability of natural resources. Suggests solutions for the protection of biological diversity.
Key Skills		• Creative problem solving skills • Communication and collaborative work • Entrepreneurship and initiative taking • Analytical thinking • Digital skills

Required Resources		Turkei MoE Science, Physics and Biology Curriculum: https://mufredat.meb.gov.tr/Dosyalar/201812312311937-FEN%20B%C4%B0L%C4%B0MLER%C4%B0%20%C3%96%C4%9ERET%C4%B0M%20PROGRAMI2018.pdf https://mufredat.meb.gov.tr/Dosyalar/201812103112910-orta%C3%B6%C4%9Fretim_fizik_son.pdf https://mufredat.meb.gov.tr/Dosyalar/20182215535566-Biyoloji%20d%C3%B6p.pdf Sustainable Development Goals: https://sdgs.un.org/goals , https://www.kureselamaclar.org/en/
Safety rules		If students are allowed to cut wood/cardboard using scissors or utility knives, warn them of the dangers and teach them how to use the tools safely.
Material List		Laptop / Tablet, Arduino Uno R3, cable, Ultrasonic sensor and Water motor, wood / cardboard block, glue, scissors or utility knife, dummy trees, colored pencil and paper.
Group		In groups of 3-4 students
Problem Scenario	In this step, the teacher has to write a problem statement. The problem statement should be: • A short, carefully thought-out sentence about what problem or challenge you are trying to solve; • General enough to be open to any solution; • Includes design requirements, criteria, and constraints.	Zeynep Bade and Aras sisters wanted to spend their summer holidays in their grandparents' vineyard house. Zeynep Bade and Aras, who were very enthusiastic, talked about the orchards and natural life in the vineyard throughout the journey. They dreamed of walking in the orchard and observing the natural life in the garden. At last they had reached the orchard house. They ran directly to the garden in the vineyard house and watched the fruit trees in the garden and the fruits of these trees for a while. At that time, his grandparents came to join them. While they were having a picnic together at the edge of the garden, they saw the fish standing lifeless on the stream passing by the edge of the garden. At first, Zeynep Bade and Aras, who considered this normal, noticed that there were more dead fish on the water while walking by the creek. They immediately returned home and shared what they had seen with their grandparents. Seeing the fish in this state made them very sad. When Zeynep Bade and Aras learn that fish deaths are due to chemicals used in spraying trees in the garden, they decide to design the pesticide that is the least harmful to nature. Also, continuing to discuss a design to suit the garden environment and

<table>
<tr>
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<td>currently used sprayers, the brothers decided to conduct several studies. But they still haven't figured out how to fix the problem. Would you like to help them with this?

The "Pesticides and the Environment" video is played and there is a discussion on the natural effects of pesticides used in agriculture.
https://www.youtube.com/watch?v=sWz7oq_I_MM
https://www.youtube.com/watch?v=bgdT4xzvL9c
In this project, the groups are requested to design agricultural pesticides with the following features that will cause the least damage to the nature:

Features of the eco-friendly pesticide application (criteria and restrictions):
• It will detect the tree
• Will be able to detect the gaps between two trees
• In a structure that can be used in orchards</td>
</tr>
<tr>
<td>Questions</td>
<td>The teacher guides students to identify and define the problem and asks critical questions to do so.</td>
<td>

What is the problem to be solved?
What do we want to design?
For whom?
What do we want to achieve?
What are the project requirements?
What are the limitations? What is our purpose?
Who does the problem affect?
What needs to be achieved?
What is the overall goal of the project?

</td>
</tr>
<tr>
<td>Investigate the Problem</td>
<td>In this step, the teacher uses the WHAT? to assess what they know about a particular topic before and after involving students in the design process. directs you to use the table/form.

Teacher; Have students fill out the form before searching for the problem and have students work in groups to investigate the problem.

Teachers guide students
• To learn everything they can about the problem.</td>
<td>Each group uses the table below to evaluate what they know about the problem.

<table>
<tr><td>What do you know about the subject?</td><td>What do you know about the subject?</td><td>What do you know about the subject?</td></tr>
<tr><td></td><td></td><td></td></tr>
</table>

Students fill out the form before searching for the problem and have students work in groups to investigate the problem.

Students use the links given below to discover information:
https://en.wikipedia.org/wiki/Pesticide
https://www.fierceelectronics.com/sensors/what-ultrasonic-sensor
https://www.maxbotix.com/articles/how-ultrasonic-sensors-work.htm</td>
</tr>
</table>

- Talking to experts and/or researching existing products or solutions.
- Examine the current status of the problem and available solutions.
- Internet, library, interviews etc. through exploring other options.

https://www.youtube.com/watch?v=6WReFkfrUIk
https://www.youtube.com/watch?v=ZejQOX69K5M
https://www.youtube.com/watch?v=FkPbwRjNjCE
https://www.youtube.com/watch?v=nL34zDTPkcs
https://www.youtube.com/results?search_query=how+to+use+arduino+ide
www.arduino.cc
https://www.arduino.cc/reference/en/

Imagine: Develop Possible Solutions

In this step, the teacher encourages teamwork and building on ideas.

The teacher leads the teams;

- Brainstorm ideas and develop as many solutions as possible;
- To express possible solutions in two or three dimensions;
- Drawing ideas with labels and arrows to describe parts and function.

Regarding the information collected from the links that each group needs;

- Brainstorm and develop as many solutions as possible.
- Consider the pros and cons of all possible solutions, considering the criteria and constraints.
- Compare different design solutions.
- Try to decide on the best solution as a group.
- Plan the best fire warning system considering the criteria and constraints.

Your group has been given a $150 budget. Keep a record of the materials you purchase.

- Record the amount of each material you purchased in the "quantity" column.
- Multiply the quantity by the unit cost to find the total cost of this material.
- Add the total cost of each material to find the total cost of your System / Model.

System / Model Material Description	Quantity Unit Price Total Price	Quantity Unit Price Total Price	Quantity Unit Price Total Price
Arduino Uno R3	1	$20	$20
ultrasonic sensor	1	$5	$5

waterpump	1	$5	$5
Juöper wiring	40	$10	$10
breadboard	1	$5	$5
Pesticides car	1	$15	$15
Wood / Cardboard block 20x20 cm			
Cardboard 50x70 cm			
Liquid glue			
toy tree			
		Total price	

Plan: Choose a promising solution	In this step, the teacher guides the students; ▯ To choose the best design; ▯ To draw the prototype.	Draw the prototype of the eco-friendly spraying system according to the chosen solution and explain in detail. See APPENDIX-1
Build: build a prototype	In this step, the teacher guides the students; ▯ To create (build) the product they designed (It is important to make a model or prototype of the design to make sure it works) *Note for teacher: A prototype is the first product made from the design that the teacher uses to analyze whether it has adequately addressed the problem.	Create an eco-friendly agricultural spray system prototype with Arduino uno R3 and its sensors. See APPENDIX-1 See APPENDIX-2
Test and evaluate the prototype	In this step, the teacher asks the students to test the solution to see how well it works by considering the following question.	Test the prototype and answer the questions given below. • Is your design working? • Is your design successful in solving the problem? • Is it necessary to review the process again?

	Does it work? Does it solve the need? Does it meet all criteria and solve the need? Does it stay within the constraints? The teacher encourages students to talk about what worked and what didn't during the test, communicating the results and getting feedback.	• Does it solve the need? • Does it meet all criteria and solve the need? • Does it stay within the constraints?
Improve: redesign as needed	In this step, the teacher: Ask students to decide whether their design is the best possible design and optimize the solution. Guide them If they don't have a perfect solution to a problem, go back to step one, redesign the non-working parts, and retest. Repeat! Engineers refine their ideas and designs many times while working on a solution.	Is your design the best pesticide system? If not, would you like to go back to step one or the next? Prepare and present a guide for the use of the design you have developed.
Evaluation	To make an assessment, the teacher asks the students questions about their design. Also, various scales are used.	To evaluate your design in terms of compliance with the criteria and limitations; • Detects the tree. • Detects spaces between trees • It is suitable for use in gardens. Quantitative evaluation is made with the Design / Model Evaluation Rubric. Also, in what other areas or problems can the design you create be used to solve? The process of transferring to other areas or developing the design can be carried out by brainstorming on the question.

	Does it work? Does it solve the need? Does it meet all criteria and solve the need? Does it stay within the constraints? The teacher encourages students to talk about what worked and what didn't during the test, communicating the results and getting feedback.	• Does it solve the need? • Does it meet all criteria and solve the need? • Does it stay within the constraints?
Improve: redesign as needed	In this step, the teacher: Ask students to decide whether their design is the best possible design and optimize the solution. Guide them If they don't have a perfect solution to a problem, go back to step one, redesign the non-working parts, and retest. Repeat! Engineers refine their ideas and designs many times while working on a solution.	Is your design the best pesticide system? If not, would you like to go back to step one or the next? Prepare and present a guide for the use of the design you have developed.
Evaluation	To make an assessment, the teacher asks the students questions about their design. Also, various scales are used.	To evaluate your design in terms of compliance with the criteria and limitations; • Detects the tree. • Detects spaces between trees • It is suitable for use in gardens. Quantitative evaluation is made with the Design / Model Evaluation Rubric. Also, in what other areas or problems can the design you create be used to solve? The process of transferring to other areas or developing the design can be carried out by brainstorming on the question.

4.4. PROJECT PARTNERS' EXPERIENCES AND PERSONAL OPINIONS ON THE E-WORKBOOK PLATFORM

MODULE 4

We are very happy to bring our Science E-Robot project to you!

You can benefit from hundreds of e-workbooks and training materials on our website, which has an interface that you can use very easily and you can contribute to the development of scientific literacy by creating your e-workbooks. Membership on our website, where you can follow our community and events, is free of charge.

4.4 PROJECT PARTNERS EXPERIENCES AND PERDONAL OPINIONS ON THE E-WORKBOOK PLATFORM

4.4.1. Hadiye Kuradacı Science and Art Center (Coordinator)

The most striking feature of the e-workbook platform is its rich content. It includes activities that make the scientific learning and teaching process different. It offers alternatives for final users as it includes classification for different categories. Thus, final users can make choices and use the platform to meet their needs. With this feature, it includes diversity. Also, having content in different languages and especially English will increase international usage. The activities designed according to different learning models that allow interdisciplinary cooperation will help to increase learning motivation for students, as well as to differentiate teaching for teachers and modernize the learning process according to different learning needs. From a structural point of view, the e-workbook platform supports the user to choose the most appropriate activity for learning and teaching by filtering according to a large number of classifications. In addition, the additional resources presented within the scope of the activities enable better understanding. On the other hand, it is thought that considering sustainable development goals as the upper theme in the scientific learning and teaching process and using digital technologies in the activities will contribute to the maturation of sustainable societies and the further development of digital skills. In this respect, integration into education and training environments with such an approach will encourage the development of digital competences from an early age, increasing awareness of problems that concern everyone in daily life.

The language option on the website and platform homepage creates a global research basis. The e-workbook, located at the entrance of the site and made available to users, enables many researchers to access it with no difficulty. When you enter the site, you encounter issues in the form of the intersection of many variables, thanks to the filtering options. This feature is very effective especially in terms of international use of the site. The achievements of countries in age, grade level and education programs vary greatly. Thanks to this platform, it can be thought that researchers from different branches can find a common denominator.

Sample applications and suggestions can be shown as an important resource especially for researchers / teachers and students looking for new ideas. Since the theme and skill options are designed in accordance with 21st century skills and analytical thinking skills, it brings together the variables and ensures the preparation of activities prepared with an interdisciplinary approach. On the other hand, it is thought to be useful to see the achievements prepared for the education programs of different countries on the platform. The activities prepared are a guide for teachers. It seems beneficial to include teaching models, methods and principles that will encourage students to have synthesis-level studies in the activities.

4.4.2.Mersin University (Project Partner)

MODULE 4

In the e-workbook prepared within the scope of the project, "Sustainable Cities and Societies", "Life on Land", "Responsible Production and Consumption", "Accessible and Clean Energy", "Health and Quality Life", "Climate Action", "Clean Water and It consists of activities covering the subjects of Sanitation", "Zero Hunger", "Accessible and Clean Energy", "Life in Water", "Quality Education", Industrial Innovation and Infrastructure" and "Smart Agriculture". The activities on the platform are for users, problem solving skills, collaboration and communication, creativity, critical and analytical thinking, entrepreneurship, digital skills, planning, initiative ability, innovation, teamwork, STEM skills, design skills, computational thinking, engineering design It provides ease of searching by classifying according to abilities such as working in groups, development of algorithms and programs, construction and technological design capabilities. Thus, it is facilitated to determine the activity according to the ability to be studied. However, it is expected that the activities that are suitable for the use of the platform and the target audience can be easily determined by the practitioners.

"Inquiry-Based Learning", "Engineering Design Process Model" in interdisciplinary science teaching such as Science, Informatics, Physics, Chemistry, Biology, Mathematics, Information Technologies, Environmental Science, ICT, Robotics, Technology and Geometry, in order to increase the knowledge skills of users, Teachers, prospective teachers and students will be able to easily access the activities in the e-workbook developed within the scope of the project, in which four different learning models, namely "Problem-Based Learning Model" and "Project-Based Learning Model" are used.

The fact that the e-workbook is in different languages (Turkish, English, Portuguese, Italian and Romanian) enables the project to be disseminated and used in different countries. It is expected that the activities to be added to the e-workbook by different countries will help teachers and teacher candidates, students and experts in different countries share information.

4.4.3. Mone Ministry of Education Generaldirectorate of Special Education and Guidance Services (Project Partner)

The scienceerobot.com platform created within the scope of the Science e-Robot Project, offers teachers, teacher candidates and students the opportunity to classify activities according to grade level, field, skills and themes in line with learning models that allow interdisciplinary work. In this way, platform users can easily access the activities they are interested in with the versatile filtering method. The platform has content that can be a resource for teachers who want to carry out studies on the field. The robotic activities on the site offer a versatile perspective as they are prepared by teachers from different countries and disciplines. In addition, the platform's service in different languages increases the diversity of users and contributes to the dissemination of the project. The prepared activities support students' skills such as problem solving, creativity, innovation, teamwork and entrepreneurship. Many robotic activities with rich content can be accessed through the platform, which is offered to the target audience involved in different processes of education.

4.4.4. Istituto Istruzione Scolastica Superiore "Carlo Alberto Dalla Chiesa" (Project Partner)

MODULE 4

The e-workbook platform for the project Science E-Robot provides a really good customer experience for the following reasons:

- The platform goal is clearly stated in the "about" section of the homepage toolbar;
- The target audience is well defined being the platform meant to be for teachers, educators and trainers;
- The website structure and design makes the platform user-friendly and able to give the user an idea of the content at the first glance, having intuitive main menu navigation.

The platform has been thought as a useful tool for teachers and educators looking for meaningful activities for their students and the search bar together with buttons for search refining (learning module, discipline, grade, skill and theme) truly help the user to find what he/she is looking for, besides every content is provided in 6 different languages.

Users have the chance to get in touch with the platform editors and leave a message by using the "contact" button in the homepage toolbar, this is particularly important because comments, suggestions, experiences and flaws in the content can be collected in order to improve the platform.

The load time is really fast, the language and graphics are effective and the content is clearly presented and easily accessible.

The platform has been especially used by IT, Biology, Physics and Building Techniques' teachers in our school but the experience we are referring to here has been conducted in the Building, Environment and Territory course while studying the effects of earthquakes on structures and the anti seismic building techniques allowed in Italy according to the different seismic areas in our country. The module, which is a problem based one and explores the theme of sustainable cities and communities, provides useful materials to let students understand the effects of earthquakes and how it can be possible to create tools evaluating and assessing the damage level after an event. Even though the module was meant for younger students (10-12 years old) it showed to be and effective way to introduce the subject to older and more advanced students.

4.4.5. Liceul National De Informatica Arad (Project Partner)

MODULE 4

A very useful tool in the implementation of activities is the project e-workbook platform. It comes with a simple and very well structured concept and design with the possibility of accessing information in the languages spoken by the project partners. Simple and drop-down menus offer the possibility of easy navigation. The site is upright, with its own sources, easy to navigate with obvious buttons. The content accessible to users offers the possibility of accessing many useful resources to teachers and students interested in the field of robotics in an elegant and well-organized format with the possibility of filtering the content according to various criteria: learning model, discipline, class, skills and theme.

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MODULE 4

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MODULE 5

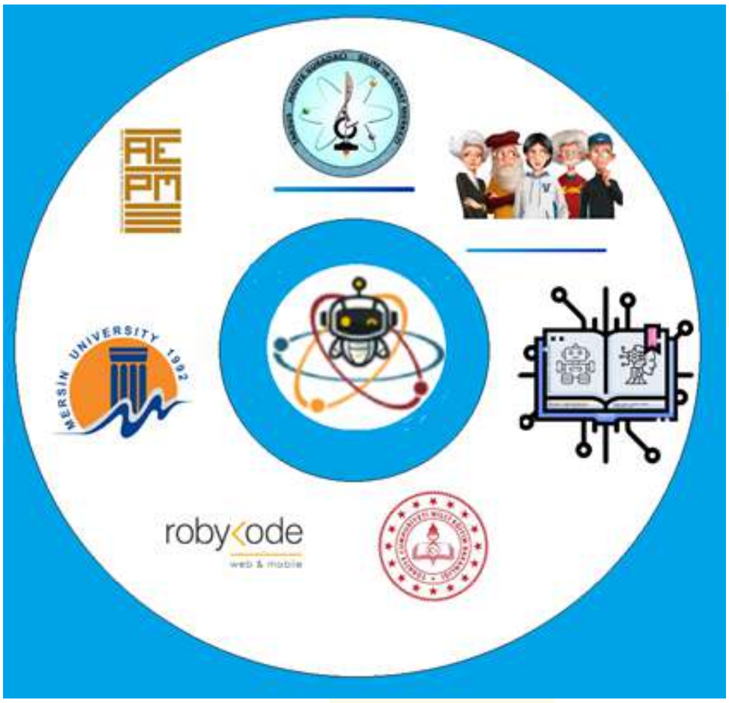
5.1. PROJECT PARTNERS' EXPERIENCES AND PERSONAL OPINIONS ON THE PROJECT

5.1.1. Hadiye Kuradacı Science And Art Center (Coordinator)

MODULE 5

The project consisted of partners from different countries and experienced in the subject area. In this regard, the organizations involved in this project shared their experiences and skills in partnership within the scope of the project. Thus, we broadened our perspective with the help of the perspectives of different countries and organizations in the scientific learning and teaching process. Each of the partners we work with has implemented project activities with a common understanding to provide students and teachers with modern tools to improve scientific learning outcomes and especially the quality of learning outcomes in the context of 21st Century skills. We have also increased our experience on how digital tools can be used effectively in the activities implemented and in the creation of project results.

With this project, we have been provided with experience sharing and integration between partners/participants in different countries regarding skill transfer in educational robotics applications with various knowledge. Particularly, mixed teams formed in concrete practices and events were among the most effective activities in terms of international knowledge transfer. The continuation of this work will be more effective in transferring scientific learning goals, coding and digital skills, which can be considered not only at the national level but also as international common goals.



It was useful to see the work of schools in different countries engaged in educational robotics studies in the context of sharing good practices. Seeing the interest and skills of trainers in different disciplines in educational robotics applications has changed our perspective on the field of educational robotics in a positive way. Practicing sample applications for the use of educational robotic materials, using different robotic materials, and examining activities adapted to different grade levels helped me develop myself. What we learned during the project process increased my motivation to integrate robotic coding into lessons.

The project activities allowed us to acquire different skills such as developing applications to enrich learning, how to use robots in education, and gain experience on how to collaborate with people from different countries, different languages and cultures. The project not only taught me new skills to use in my teaching environment, but also increased our motivation for future project plans.

5.1.2. Mersin University (Project Partner)

MODULE 5

The project aims to improve scientific literacy within the consortium by contributing to the development of basic competencies by integrating educational robotics technology into the scientific learning and teaching process.

Within the scope of the project, 3 different outputs will be developed and an innovative learning-teaching strategy compatible with the education programs of the project partner countries will be developed with the learning-teaching process in which educational robotics is integrated for the target groups in the project. In addition, it is planned to increase the knowledge skills of the personnel from the partner organizations on different teaching models, assessment and evaluation and robotic methods/techniques in interdisciplinary science teaching. In addition, different dissemination activities and 5 large-scale multiplier activities will be organized to improve the knowledge skills of at least 200 science teachers, 50 teacher candidates and 100 experts regarding the use of the intellectual outputs developed within the scope of the project. In addition, it is expected to improve the basic competence and scientific literacy of students aged 10-17 through educational robotics. During the project process, it is thought that long-term innovative cooperation between international project partners will develop.

5.1.3. Mone Ministry of Education General Directorate of Special Education and Guidance Services (Project Partner)

Teacher trainings (LTTA) and transnational project meetings (TPM) organized within the scope of the Science e-Robot Project were very effective. It is aimed to increase the quality of education by contributing to the integration of technology into the learning-teaching process via teacher trainings. Teachers had the opportunity to practically experience the examples of activities applied in different cultures through the schools involved in the project partnership. The activities prepared by the participants contributed to the integration of robotic technology into the scientific learning-teaching process and to the development of basic competencies. In addition, the prepared content is a rich source for teachers, teacher candidates and students. It was provided that the project partners came together, shared the experiences related to the project process and made plans via TPM. In general, the project steps proceed smoothly by fulfilling the responsibilities determined in line with the calendar.

5.1.4. Istituto Istruzione Scloastica Superiore ¨Carlo Alberto Dalla Chiesa¨ (Project Partner)

MODULE 5

When we, as a school, first joined the Erasmus+ Project Science E-Robot, we took it as a great opportunity to get involved in something we considered fundamental, but we had not been able to fully implement in our teaching routine and curricula: coding and computational thinking.

We soon realized that the needed expertise was not adequate, and that the tasks we were required to fulfill were set a bit above our competences, this is why we decided to start with trying new activities for our students based on someone else's experience. We consider it as the very first brick to build up a complete set of skills for both students and teachers.

Generally speaking the project has been developing according to the planned schedule quite nicely, in spite of the inevitable delays caused by the Covid 19 pandemic alla activities have been carried out successfully.

The first intellectual output dealing with teaching materials and resources about the implementation of robotics in STEM discipline modules has been published on the e-workbook platform thus all contents have been made available to the wider audience.

All the modules are of high standard quality and they fully fulfill the criteria of reproducibility in different learning environments, adaptability to different curricula and remodeling according to the students age.

The project milestones (intellectual outputs, dissemination plan, quality control plan) have been accomplished as long as the checking and replanning activities carried out during the TPM held at the IISS Carlo Alberto Dalla Chiesa (Italy) in May 2022.

Comparing the project targets with the actual accomplishment it is possible to say that there isn't any worrying gap: each partner in the project has contributed to the output production effectively and profitably. The slight delay on the programming has been rescheduled so that all planned activities will be operated within the expected timelines.

The project hasn't produced any budget issue so far and the sums of money provided for intellectual outputs, TPMs, travels and individual support is definitely enough.

Finally the general judgment on the project is completely positive for what concerns the content relevance, the relationships within the project team, the communication among the partners, collaboration and reliability.

The use of educational robots in the teaching-learning process is a more and more common way to attract future generations to technology and to a higher level of thinking and education.

Our participation in the robotics project has given us numerous educational possibilities in STEM activities to arouse students' interest and develop skills such as teamwork, algorithmic thinking. Within the project, Romania was the host of the first LTTA that took place in Arad, Romania in October 3-8, 2021 called "Robotic Learning Teaching Opportunities that Enrich Science Teaching and Acquisition of 21st Century Skills" in which activities were carried out through workshops within our school and at the university.

We also participated in the second LTTA that took place in Portugal (March 2022)and which gave us the opportunity to follow and participate in practical learning and teaching models that where proved very useful. In the activities, the collaboration between the partners was a very good one for the development of competences and the development of innovative approaches to teaching and learning. In Italy (April 2022) we were impressed with the way every partner was involved and ready to communicate.

Following the discussions and the activities we came into contact with the way we might implement digital methods in the educational system of every participant country. We believe that the partnership with the Univeristy of Mersin and MONE is a true asset because of the human and material resources they can involve.

5.1.5. Liceul National De Informatica Arad (Project Partner)

MODULE 5

The use of educational robots in the teaching-learning process is a more and more common way to attract future generations to technology and to a higher level of thinking and education.

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5.2. DATABASE LIST CREATION BY PARTNERS IN ORDER TO PROVIDE EASY ACCESS TO FREE NATIONAL AND INTERNATIONAL RESOURCES USED IN EDUCATIONAL ROBOTICS APPLICATIONS.

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https://microbit.org/teach/for-teachers/ https://lightbot.com/ https://appinventor.mit.edu/

https://education.lego.com/it-it/

https://lab.open-roberta.org/

https://github.com/OpenRoberta https://scratch.mit.edu/

https://scratch.mit.edu/educators https://snap4arduino.rocks/ https://vr.vex.com

https://education.vex.com/stemlabs/cs https:// fritzing.org

https:// circuit.io

https://mblock.makeblock.com/en-us/

https:// blinky.com

https:// all3dp.com

https://www.simulide.com/p/home.html

https:// tinkercad.com

https://www.lego.com/en-us/service/buildinginstructions/search#?search&text=31313%2520LEGO%25C2%25AE%2520MINDSTORMS%25C2%25AE%2520EV3%2520MINDSTORMS

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CONCLUSION AND RECOMMENDATIONS

Today's world requires understanding new developments to adapt to all areas of life. The rapid development of science and technology and its interdisciplinary structure differentiate the competencies and skills that individuals should have. Therefore, this study, which is presented as a holistic methodological guide in the acquisition of basic competencies is a tool that can be used in reducing failure in science, thus improving science literacy, learning by having fun and integrating technology with science education.

With this guide, a mentor resource containing innovative pedagogy and teaching methods with technology content was created to guide people who teach/will teach science to improve science teaching professionalism. This guide, in terms of developing scientific literacy, in different teaching models; comes to the fore in adapting robotics technology to science teaching in a methodological framework. Therefore, this guide aims to help increase science teaching capacity, in which educational robotics technology is integrated, as an innovative approach to increase the level of acquisition of key competencies in reducing the failure of schools in science.

Concrete applications and suggestions are presented for science teachers who want to include educational robotics technology that will lead to the development of science literacy in science classes to increase the level of acquisition of students' problem solving, critical thinking, creativity, communication and collaborative working skills. It will help science teachers better understand the relationship between basic competencies and scientific literacy and shape the teaching model.

Prepared in English and partner country's languages, the guide reflects a common science teaching perspective. It is thought that science teachers from different countries will positively affect and facilitate in-class science teaching. It can be an interactive reference source, especially in environments where there is a shortage of printed resources. The manual is in an electronic downloadable format.

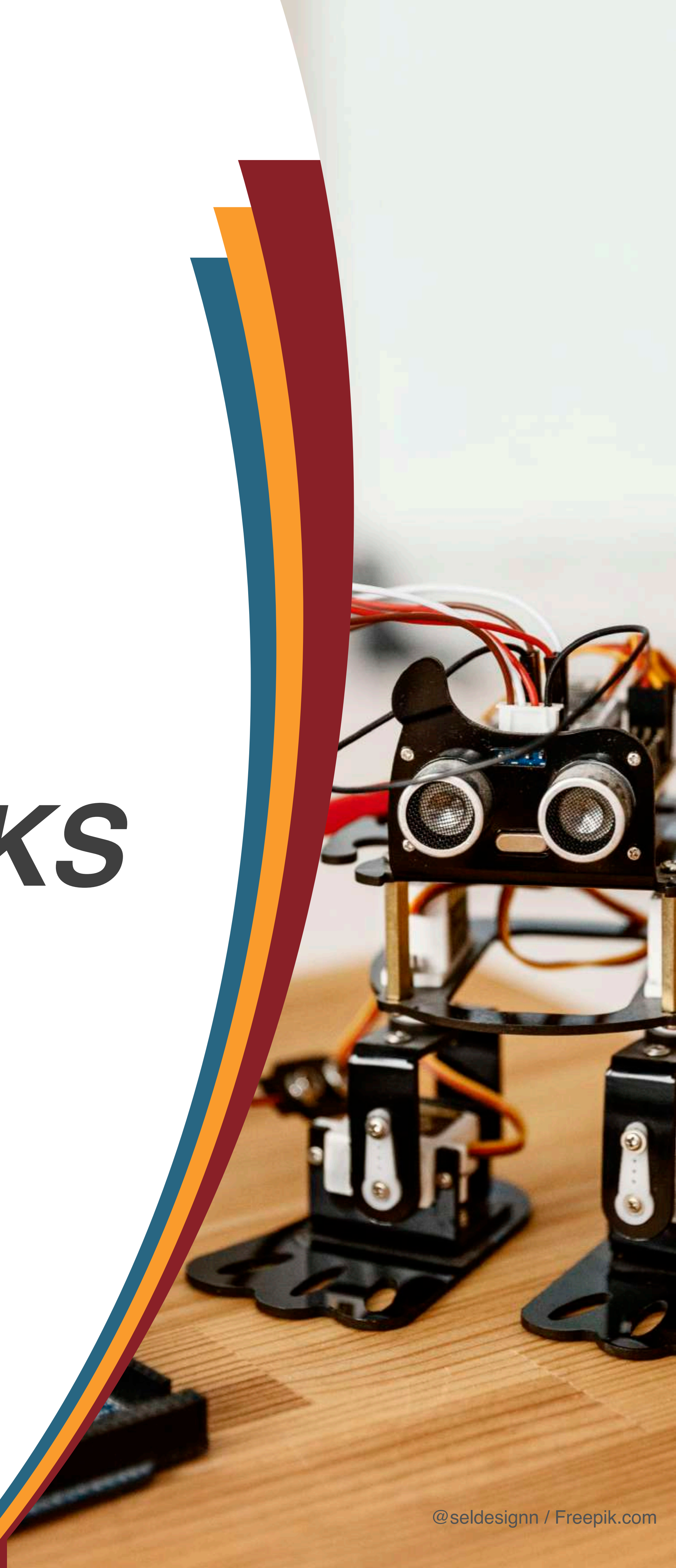
In this guide, the theoretical and practical aspects of robotic-assisted science teaching are discussed. In the theoretical part, besides revealing the relationship between science, science learning and teaching and technology, the cause-effect relationship between 21st-century basic competencies and scientific literacy is explained. Innovative teaching strategies and models include practical knowledge and applications of how robotics can be used. Technical information on the use of robotic materials such as structural, electronic and software used in the design phase of the activities were explained visually and textually. Thus, it is aimed to increase the usability of users according to their interests and abilities by presenting different robotic materials together.

In the practical part of the guide, experiential information about the innovation, advantages, limitations and use of the e-workbook open education resource, which is the other output of the project, is given. In addition, sample robotic-supported science activities for the scientific themes in the e-workbook, separated according to the 10-13 and 14-17 age group levels, are included in the guide.

There are visual, audio and textual resources related to thematic science activities in the guide presented to the use of the target audience. The guide is completed with the conclusion section, which includes the personal opinions of the project partners, their experiences in the local and within the consortium during the design and implementation of the activities, and their benefits for science teaching.

SCIENCE e-ROBOT

THANKS



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