Bridging the skills gap - The importance of robotics skills for social inclusion, equality and access

"Inclusive education allows students of all backgrounds to learn and grow side by side, to the benefit of all" – according to UNICEF[1]. The aspects of inclusive education include the following:

- Special needs
- Socioeconomical Status
- Cultural Diversity
- Gender

Robotics and Coding, in the shape of programmable building kits such as Lego (Boost, We Do, EV3) and Arduino, which allows you to create robots which interact with students in the form of social robots could come to be a great contribution in improving the quality of inclusive education. This type of technological tools enables teachers and educators to recognize a child's specific needs in the initial stage of education and to counteract for their diagnosed needs, disabilities and conditions. Robotics could also encourage students with special-needs, different socioeconomic and cultural backgrounds to try and experience success. Thus, acquiring technical skills which are essential in seeking employment opportunities in todays' highly technological environment[2].

E.U aspect on social inclusion and the skills gap which exists now and in the near future:

The EU Cohesion Policy encourages the social inclusion of disabled people, young and old workforce, workers with low-skills, people of ethnic minority background and migrants, people which live in underprivileged areas, and women in the workforce. It promotes the Europe 2020 Strategy, which aims to boost at least 20 million people which are close to poverty out this danger[3].

The 2016 Council Resolution on 'A New Skills Agenda for an Inclusive and Competitive Europe' reflects a mutually shared vision about the role of skills for all professions, development and competitiveness. Skills can assist in securing a job position and allows workers to thrive and fulfil up to their maximum potential. They are the key to social cohesion, they ensure access, participation and social inclusion. People need a wide-range set of skills which will allow them to reach to their potential capacity at work as well as in society. **On the other hand, European employers in the range of about 40%, have difficulty finding individuals with the skills they require in order for their businesses to grow and innovate[4]**. VET is appreciated for developing job-specific and transversal skills, enabling the change from education to employment and supporting and upgrading the workforce's skills corresponding to the needs of the sector.

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[1] UNICEF – Available at: https://www.unicef.org/education/inclusive-education
[2] Robotics in Special Needs Education – Available at: https://dl.acm.org/doi/pdf/10.1145/1463689.1463710
[3] https://ec.europa.eu/regional_policy/en/policy/themes/social-inclusion/
[4] https://ec.europa.eu/transparency/regdoc/rep/1/2016/EN/1-2016-381-EN-F1-1.PDF

The project's reflection on the parameters set by the E.U:

"Bridging the Skills Gap: Strategies for the Promotion of Digital, Coding and Robotic Skills for Social Inclusion, Equality and Access (Robot4All)" is an Erasmus+ project which was designed to introduce Robotics and Coding to schools for vocational education and training (VET-schools) as an innovative way to address deficits, social exclusion, prejudice and learning disparities.

The project consortium developed a "Complete Tool Kit" and an "Educational Pack" for developing, implementing and monitoring various inclusive strategies for promoting coding and robotics skills in VET schools. The project aimed to bridge the digital gap based on the creation of partnerships and synergies between the schools, stakeholders and the labour market (policy maker, ICT experts, providers and enterprises).

Based on the above the Robot4All project promoted the following priorities of the Erasmus+ Programme to:

Encourage:

- The acquisition and achievement of skills and competences
- Social inclusion through innovative integrated approaches
- Open and innovative methods and pedagogies

Enhance:

- The access, participation and learning performance of disadvantaged learners
- Key competences in VET
- The profiles of the teaching professions

Develop:

- Systematic approaches to, and opportunities for, the continuous professional development of VET teachers
- VET business partnerships aimed at promoting work-based learning in all its forms

Bridging the skills gap – the "hard" and "soft" skills taught in Robotics:

Robotics is believed to be the fourth "R" of learning, "Reading, wRriting and aRithmetic" which contemporary learners must comprehend to thrive in a vastly competitive, technology-driven world. Also, Robotics integrates all STEM fields - science, technology, engineering and mathematics- in way no other subject can cover. It integrates Mechanical, Electrical, Electronics, Control Engineering, Computer Science, Technology, Maths and Science as a one holistic approach.
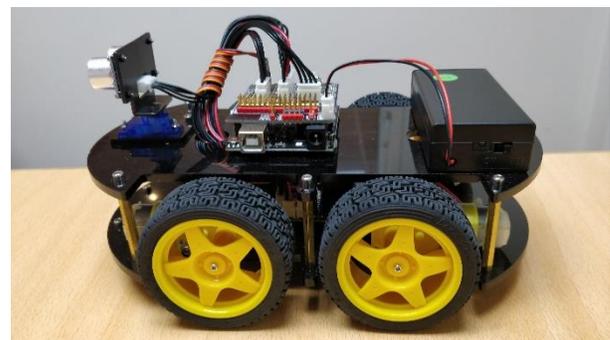

Figure 1 - The Robot4All Car Robot assembled by the students

The "Robot4All" project improved the skills of the students in the abovementioned fields significantly and offered an all-around module to what Coding is, starting from the definition of what a program is and how to construct flowcharts and algorithms.
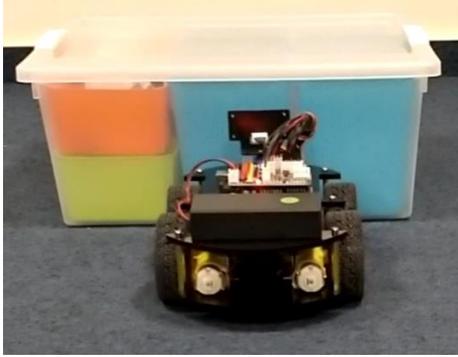
Figure 2 - Programming the Robot to stop and turn around once it detects an obstacle

This was followed by the fundamentals of coding, and concluded with advanced programming concepts. This material served as a stepping stone for the second part of this course which was the Robotics Module. For this part the students had to assemble an Arduino Car Robot and then program the robot to execute various tasks. Students learned how to instruct the robot car to move and utilize the Bluetooth and Infrared modules in activities such as controlling remotely the robot car. Moreover, the ultrasonic and colour sensor were used for the advanced tasks which students needed to complete in order to earn their badge. These advanced tasks included tasks such as following a predefined line and avoiding obstacles in order to exit a maze.

These "hard skills" although are not sufficient for the demands of today's world. Soft skills are also a crucial factor which employers often find challenging when recruiting. The "Robot4All" project improved specific soft skills of each student which participated in the pilot-testing of the course such as:

- *Communication, Team work and Collaboration* which was achieved by distributing the robotic kits to groups of 2-3 students instead of each one having an individual kit. For each student to progress through the Learning Management System (LMS) which was created for the purposes of the Robot4All project – called the *Robot4All Academy,* students had to solve (as a group) different tasks (like navigating through a maze or following a predefined path) for them to earn a *Badge*. (The concept of Open Badges was used as a methodology to **validate** and **award** the coding and robotics skills acquired).

Figure 3 - Programming the Robot to stop and turn back once it detects a black line on the floor

- *Critical Observation, Time management, Planning and Scheduling* which was accomplished by offering a set time frame on which the students had to work to solve the given task. Students divided the coding needed in sub sections and worked in parallel to achieve a solution for them to earn the specific Badge.
- *Attention to detail, Ideas Exchange and Problem Solving -* the core of coding either for physical hardware such as robots or for software solutions is to offer solutions to a given problem. Students were exposed to flowcharts and algorithmic design and learned to break-down problems and find simple step by step solutions, putting them on paper first as a diagram and then as a computer program and finally put to the test where the robot executed these instructions.
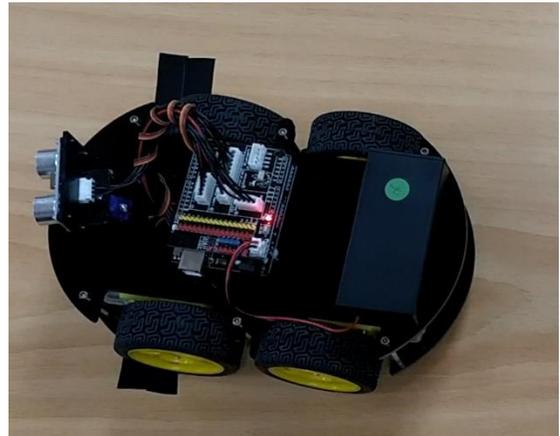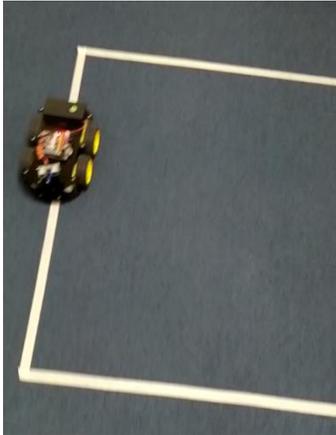
Inclusive Education in Robot4All:

Figure 4 - Programming the Robot to follow a white line on the floor

Special needs, is one of the major risk factors that can both reduce access to education in general and limit access to learning in particular areas. Although special needs students where not per say the target group of this project it is observed, mostly in countries of South Europe, for a tendency for students with learning disabilities such as speech disorder and dyslexia to choose VET schools for their studies. The content created for the purposes of this project set as goals to have limited text, numerous explanatory images and graphs, narrowing down on theoretical aspects of coding and robotics. Choosing to focus on what is essential such as hands-on experience in coding and robotics through practice in the Robot4All Labs, and concentrating on project-based tasks from real life scenarios, offered students with learning disabilities the ability to cope with the demands of the course.

Socioeconomic status can significantly influence access to STEM and Robotics education. Schools do not have equal access or funds to support students in the field of Coding and Robotics. Also, the cost of extracurricular activities and nonformal education is not something families with low socioeconomic status have the possibility to provide for their children to have these innovative learning activities. This is why the Robot4All project offered all the material in a free format where the teacher can have access to the "Complete Tool Kit" and the "Educational Pack". The academy which the students and trainers registered in order to monitor and validate the knowledge gained is also available at no additional cost. The platform chosen for coding was the C++ programming language due to its versatility and ease of use and the design environment used for coding in C++ is as well, freely available to download. The Robotics module was based on the Arduino platform which by being an open source platform meant that the equipment which the schools had to purchase was kept at a minimal cost. Additionally, the project ran in the participating countries as an afternoon activity in a non-working school time, thus, allowing to set up Robot4All Labs in school premises while ensuring access and adequate participation.

Cultural diversity - As is the situation in Europe nowadays there is cultural diversity in every aspect of the society. Schools have accepted students from first-generation migrant families which have been sometimes violently forced out of their country. The project was pilot-tested in schools and educational institutions in Cyprus, Greece and Spain as well as Germany where the migrant current is strong. The issue here had to do mostly with each ethnicity's view and somewhat religious beliefs about innovation and technology. Translation of the material in six European languages helped in situations where students had besides their mother language a basic understanding of the English language.

Gender balance is a sensitive issue where equal opportunities should be provided for all. In some countries, access to education for girls is still a problem, and involvement of girls in science is not encouraged. Most of Europe and the rest of the world there are prominent imbalances in various fields. For example, Educational Sciences have become mainly dominated by the female gender while fields of Engineering and IT have been predominantly run by the male gender. Robot4All Labs included students of both genders and strived to have equal representation which in most cases was a difficult task. The

female participants though showed as equal interest and their performance was in pair or in some cases greater than their male counterparts. One of the project's partners in the consortium was WIDE (Women in Digital Empowerment) Luxemburg an organisation which promotes inclusion of girls and women in the field of ICT. It has strong links with the industry, government and educators at national and EU level and served as a link for the inclusion of gender equal activities in the material which was created.

In conclusion, robotics can enhance inclusive education which that in turn, enables the development of teamwork and collaborative competences, helping students from an early age to obtain key skills in order to be responsible citizens in a fully equal and tolerant societies, as they grow up. Developing robotics skills can only benefit social inclusion, equality, providing them the opportunity to enhance their access to the digitalized market, advancing necessary skills and build a more open-minded and inclusive society for all individuals.

The consortium of the Robot4All project involved eight key partners which where: the VET-school 2 EK Peraia from Greece Athens, the IT Educational and Research Centre Emphasys Centre and the Cyprus Computer Society from Cyprus - Nicosia, the IT Service Centre Civic from UK - Edinburgh, the Non-governmental organisation CDIMM from Romania - Baia Mare, the Non-governmental organisation Women in Digital Initiatives WIDE from Luxembourg and the VET-school IES Maria Moliner from Spain - Segovia. Finally, the project was coordinated by the Leibniz University of Hanover in Germany.

More information about the Robot4All project and the **Robot4All Complete Toolkit and Educational Pack** can be found at: www.robot4all.eu

The free **Academy Course Portal** is also available at: www.academy.robot4all.eu