ROBOTICS AND INCLUSIVE EDUCATION

Strategies for the promotion of digital, coding and robotic skills for social inclusion

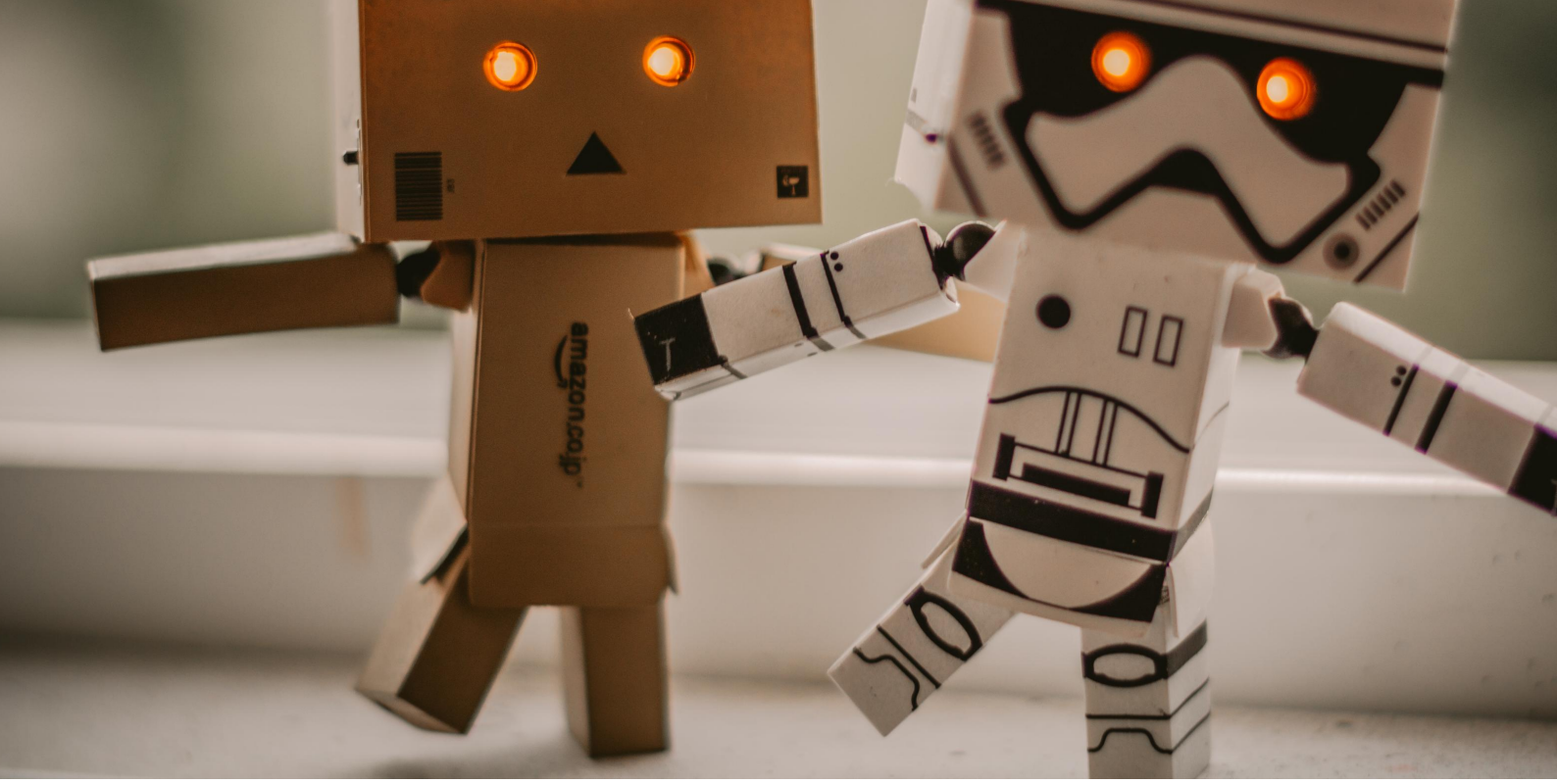
CREATED BY WIDE

ROBOT 4ALL

WIDE
WOMEN IN DIGITAL EMPOWERMENT

Erasmus+

CONTENTS



INTRODUCTION

Equipping young Europeans with the right skills has been reaffirmed by the 2016 Council Resolution on 'A New Skills Agenda for an Inclusive and Competitive' Europe which stated that skills are a pathway to employability and prosperity. However, skills gaps and mismatches are striking, 40% of employers cannot find people with the skills they need, whereas students leave E&T without being sufficiently prepared to enter the labour market. VET (Vocational Education and Training) is valued for fostering job-specific and transversal skills, facilitating the transition into employment and maintaining and updating the skills of the workforce according to sectoral, regional and local needs. Although over 13 million learners are engaged in VET each year, forecasts in several M.S. indicate that there will be a shortage of people with VET qualifications in the future.

The Robot4all Erasmus+ project has been set up as an initiative to tackle and find practical solutions in the field of robotics education, and aims to:

- Promote the acquisition and achievement of skills and competences promote social inclusion through innovative integrated approaches
- Enhance the access, participation and learning performance of disadvantaged learners further strengthen key competences in VET
- Introduce systematic approaches to, and opportunities for, the continuous professional development of VET teachers. Develop VET business partnerships aimed at promoting work-based learning in all its forms strengthen the profile(s) of the teaching professions
- Promote open and innovative methods and pedagogies

Based on the aforementioned, the following have been centered around inclusiveness as one of the main concepts to orient positive outcomes and approach potential inequities from several perspectives.

Erasmus+

ROBOT 4ALL

OUR PARTNERS

Leibniz Universität Hannover

The coordinator of the Robot4All project is the Institute of Civic Education (IDD) of the Leibniz University of Hanover. The university was founded in 1831, today it has 21,000 students and 4,700 staff members.

2 EK Peiraia

The 2nd E.K. (Laboratory Center) of Piraeus was founded in 1986. It is a Greek public Training Center for secondary vocational education, located in the industrial city of Piraeus, the largest commercial port in Greece.

Emphasys Centre

The «Emphasys Centre» began operating in 1998, as a related company to «A & A Emphasys Interactive Solutions Ltd» (due to common ownership), a successful company specialising in consultancy, software and support services in the field of ICT.

Civic Computing

Civic Computing is an award winning digital solutions provider with almost two decades of industry leading experience. They help businesses succeed through effective, usable technology by combining our expertise in user experience design, development and hosting to provide digital solutions that work.

CDIMM Maramures Foundation

CDIMM Maramures Foundation was established in the year 1994, as a non-profit, non-governmental, non-political organization. Their mission is to support the development of the private sector of small and medium sized enterprises and of other organizations at local, regional and international level.

Cyprus Computer Society

The Cyprus Computer Society (CCS) is a professional and independent not-for-profit organization, seeking to improve and promote high standards amongst informatics professionals, in recognition of the impact that informatics has on employment, business, society as well as on the quality of life of the citizen.

I.E.S. María Moliner

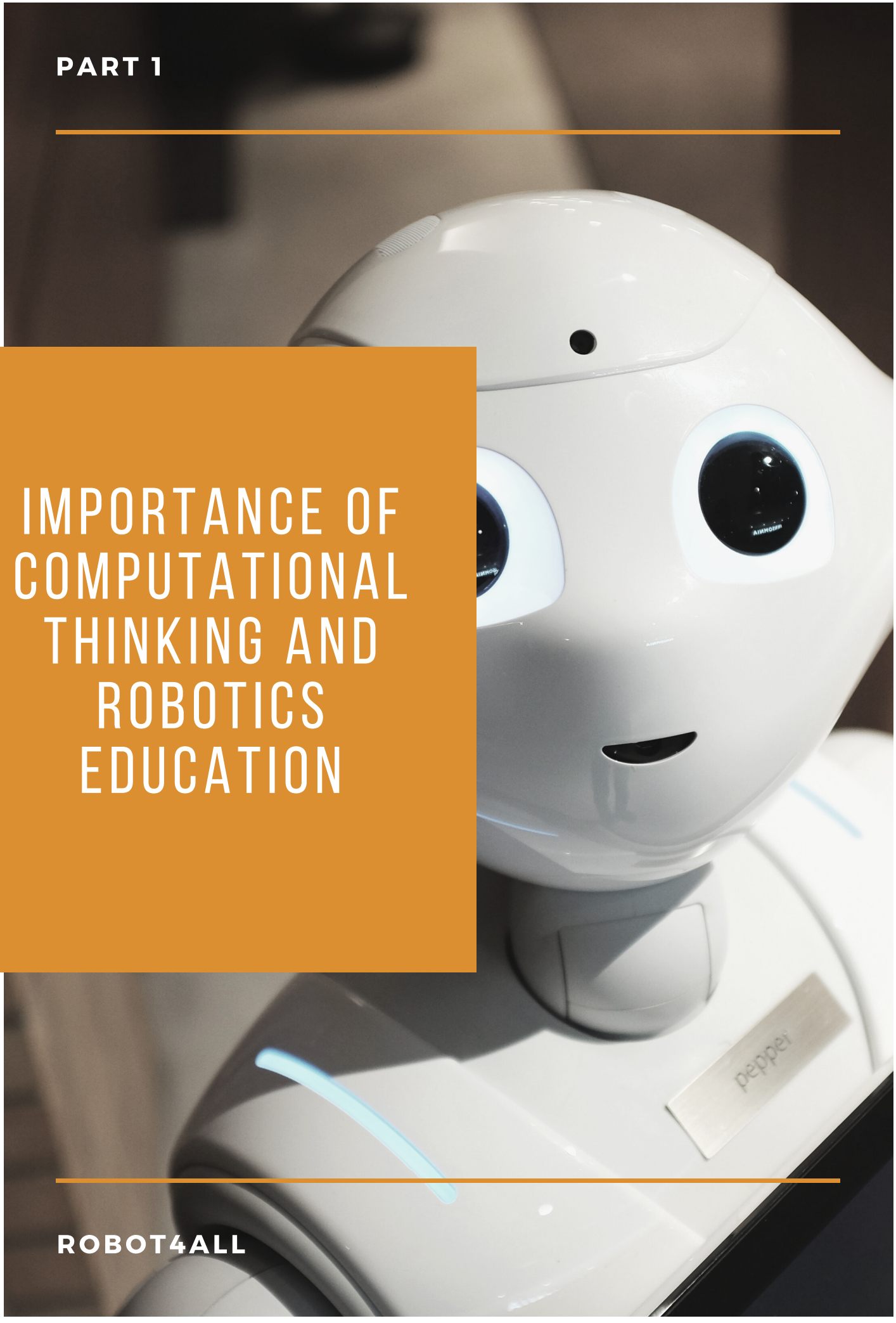
The I.E.S. María Moliner is a public high school. We have two kinds of studies: Secondary Education (compulsory education 12-16 and bachelor 16-18), and Vocational Education.

Women in Digital Empowerment

Women in Digital Initiatives Luxembourg Asbl (WIDE) is a non profit organisation initiated in Luxembourg in 2013 and officially founded in 2014. Launched as a grassroot initiative by women volunteers in 2013, WIDE has now become the leading and national reference organisation to champion inclusion of girls & women in the new technologies and digital field.

PART 1

IMPORTANCE OF COMPUTATIONAL THINKING AND ROBOTICS EDUCATION



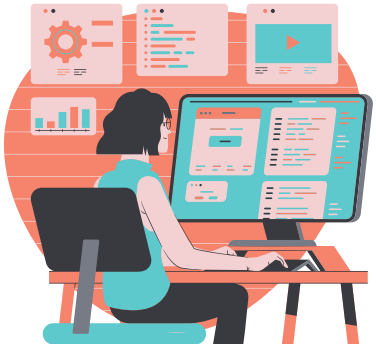
ROBOT4ALL

DEFINITION
COMPUTATIONAL THINKING

Computational thinking (CT) includes several problem-solving methods, which consist in expressing problems and solutions in ways computers do.

There are four key processes to computational thinking:

- Decomposition - decompose a complex problem into several small parts to make it easier to solve the problem
- Pattern recognition – trying to find similarities among other problems, as well as within problems
- Abstraction - Abstraction is used to facilitate the creation of algorithms. It consists in making the problem less complex by removing unnecessary parts of it.
- Algorithms - developing a solution to the problem, or the steps to follow to solve the problem



Source: https://www.bbc.co.uk/bitesize/guides/zttrcdm/revision/1

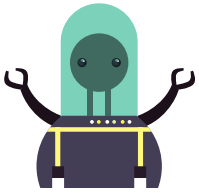
Computational thinking (CT) includes several problem-solving methods, which consist in expressing problems and solutions in ways computers do.

DEVELOP COMPUTATIONAL THINKING

thanks to robotics

A study conducted by Shuchi Grover from the University of Stanford indicates that robotics help develop computational thinking. In fact, eight middle school and two high school students accepted to participate in a robotics week in 2010, held in a school in India. The workshop and study lasted 8 hours per day and included an introduction to robotics, to logo programming, as well as work in pairs to program the final project of their choice, among other activities.

The aim was, through the different activities, to compare student's computational thinking skills before, and after the workshop. To do so, their knowledge was assessed in terms of broad CT concepts, CT principles, CT vocabulary, and procedural and operational ideas of computation.



Results

First, the study indicates that after the robotics workshop, there has been a substantial increase in terms of Computational Thinking Language. In fact, pre-workshop answers did not mention CT vocabulary, such as "abstraction", "task breakdown", "conditional logic", "error checking" or "testing" for example. It also highlights that the categories in which students improved the most were their knowledge of vocabulary linked to CT, as well as technical terms.

Even if the study was conducted with a small amount of students, it proves that robotics can help students increase their computational thinking skills. Further research and studies should be conducted to confirm these findings.

PRACTICAL **TIPS**

and steps on setting up a robotics club in an educational facility

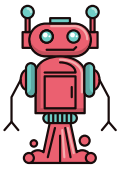
- Request the facility administration approval and seek out support
- Brainstorm ideas about the setting of the place and logistic make a list of materials needed and compare it to your budget
- Call for interested participants/students and have an overview on how many they will be and their average level of knowledge and interests in robotics
- Think and detail the logistics - when and for how long conduct research in terms of compatibility aspects with the Robot4All toolkit
- Do a list of all robotics educators who are on board as well as their time availabilities
- Think and detail the logistics - when and for how long conduct research in terms of compatibility aspects with the Robo4All toolkit

Here are some practical considerations in regards to each of the steps:

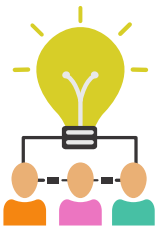
This could have a couple possible outcomes, but most administrators should be open that you want to offer students an additional opportunity to master STEM skills. If there are budgetary or location concerns, however, it might take a bit of convincing, but as robotics is crucial in helping students of all ages master key skills, the idea should be appealing to any school leader; underline specific values robotics clubs can provide, such as: teaching and applying coding, allowing students to work together, and helping them see how STEM is used in everyday life.

At this point, reflect if the meetings should be: monthly, weekly, two or three times per week; after, establish how long the meetings should be and on what days of the week; but establishing a routine will help promote consistency and allow for more students to participate continuously.

Teachers will need to figure out to what extent they will want to use the toolkit, correlated to their experience levels with robotics and coding tools and also the level of the students.



This will be useful in terms of organization and time scheduling for the club meetings.



Take into account that most school clubs start off with only a handful of members (3-5) and then grow; Also, at the beginning there are students not yet knowing they are interested in robotics or all of the things they can accomplish while using these tools and who might be interested to join later.

It is a good idea to hold an initial meeting with all parties, brainstorm ideas and do an initial assessment of level of knowledge because this influences the use of the robotic kit.

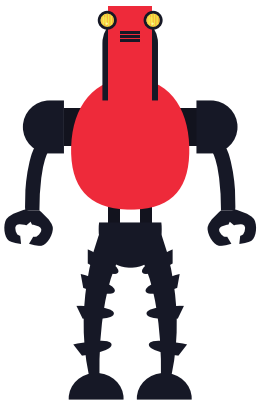
ROBOTICS **ACTIVITIES**

benefits for students

In a study conducted by Khanlari Ahmad with six robotics teachers, teachers underline that robotics classes have beneficial effects on students. For instance, according to them, robotics help students to increase their self confidence, since it learns them to use a new technology. In their opinion, this will lead them to try and to do better in other classes as well. One of the teachers explained that "Students who were not so successful in other courses, when they saw their success in robotics, believed in themselves and believed that they can succeed in other courses as well. So they tried more to succeed in other courses". Another teacher also stated that robotics help students to become more competent in STEM. Moreover, all the participants stated that robotics facilitates learning, and that it helps attracting more students in STEM subjects. This study also underlines that "Four participants out of these six participants believed that robotics created interest in students who previously did not like STEM subjects, while two other participants stated that they have no experiences to claim that robotics led their students to love STEM subjects."

However, all the participants believed that robotics promotes students' interests toward STEM subjects; indeed, they believed that "students who previously liked STEM subjects love these subjects more after taking robotics course."
Moreover, in this study, five participants believe that robotics is fun and playful, and that therefore, they learn better since they aren't under any "pressure".
Finally, all teachers agreed that robotics should be taught in class, to all grades.

*Cited from : - *Khanlari, Ahmad - Effects of educational robots on learning STEM and on students' attitude towards STEM*



EDUCATIONAL **ROBOTICS**

increase students' interest in STEM

The following study aims to check if educational robotics can increase students' interest in STEM and their skills in this field. Therefore, the study consisted in teaching STEM to two group of students, with two different teaching approaches. One group was taught STEM subjects with the help of a robotic educational approach, whereas the other group learned STEM without robotics. The activities were designed based on the "light concepts" module, which is used to:

- Understand light propagation in linear way and to all dimensions;
- Understand light interaction with different materials and sort them using the terms transparent, semi-transparent and opaque;
- Understand the light phenomena, such as reflection, diffusion and absorption.

The group of students who participated in the robotic approach, had a Lego Mindstorm NXT robot at their disposal, as an educational tool during the activities. The activities were quite diverse :

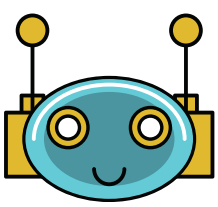
- Light sensor measurements,
- Observations/recordings,
- programming the robot
- testing the program and making conclusions.

On the other hand, students participating in the non-robotic approach performed the same experiments using their eyes to make observations. The following activities were done:

- observations,
- predictions, experimentation
- making conclusions

In total, 96 students participated in the study, and followed either the robotic approach, or the non-robotic one during a 10-hour intervention. The results of the study showed that robotics can positively impact student's attitudes towards STEM subjects, since the students who followed the robotics teaching approach had showed greater interest in STEM than those who followed the classical approach. This can result in the choice to follow a career in STEM. However, it is important to note, that according to this study, the teaching method did not influence students' preferred career choices.

**Source: Robotics as means to increase students' stem attitudes, Panayiotou, Marievie, Eteokleous, Nikleia, 2017/06/01*



IMPORTANCE OF COMPUTATIONAL THINKING

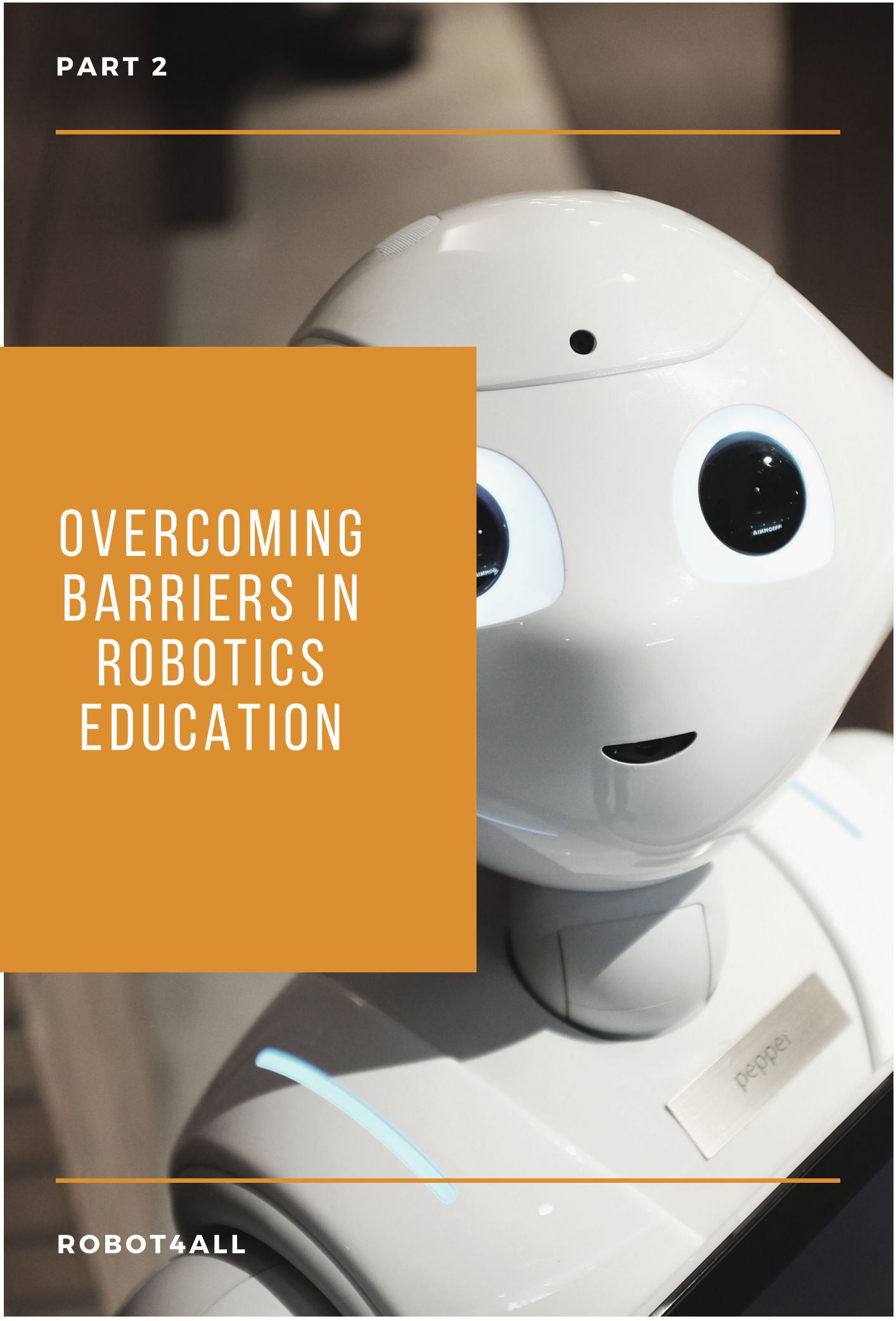
In her article “Computational thinking -- What and why?”, Jeannette M. Wing (Avanessians Director of the Data Science Institute and Professor of Computer Science at Columbia University) explains that there are several benefits to computational thinking for everyone, since it provides them with important tools such as:

- Understanding which aspects of a problem are suitable to computation
- Evaluating the correlation between computational methods and solving a problem
- Understanding both the limits and power of computational tools
- Finding a new use for a computational technique/tool
- Recognising the possibility to use computation in a new way
- Using computational strategies/tools and techniques such as “divide and conquer” in any situation/domain

Therefore, we can indicate that computational techniques can be used by everyone, in various domains.

PART 2

OVERCOMING BARRIERS IN ROBOTICS EDUCATION

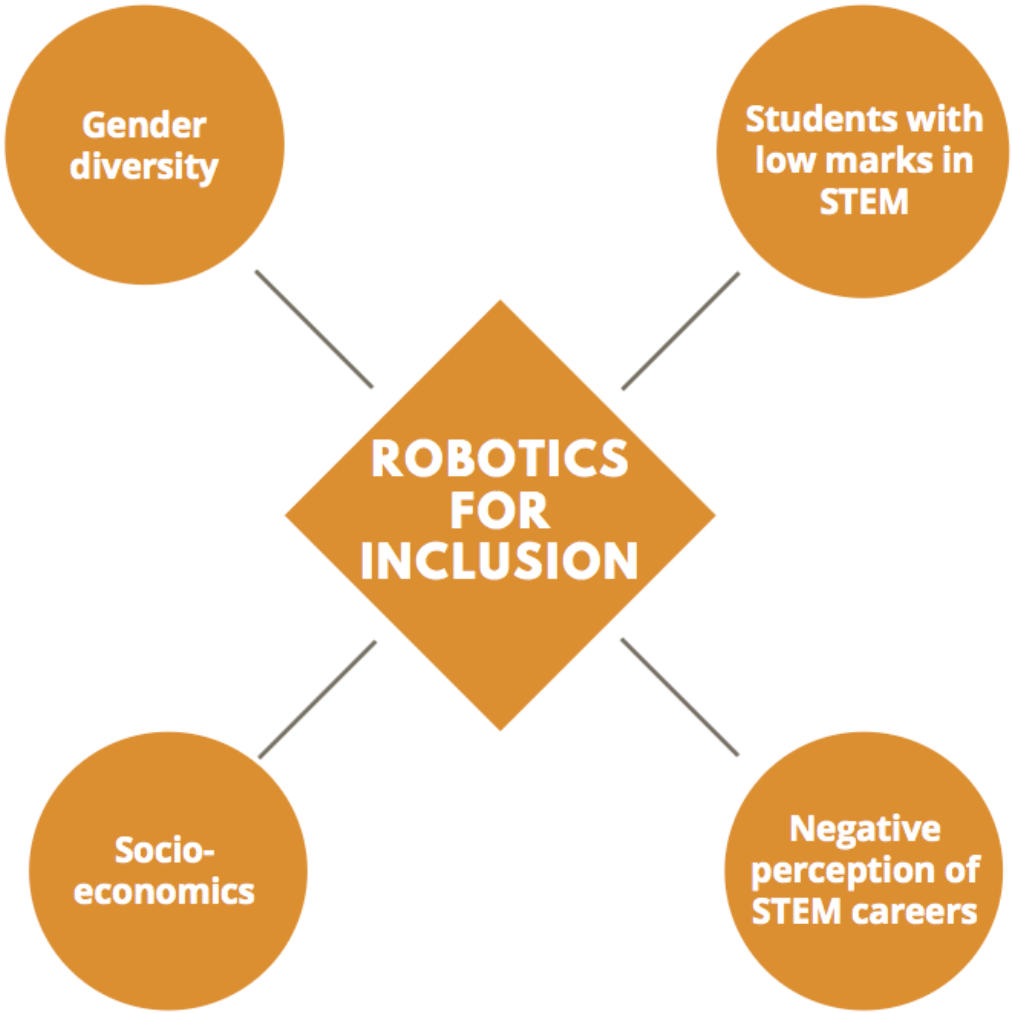


ROBOT4ALL

ROBOTICS AND **INCLUSION**

explaining scheme

The Robot4All toolkit aims to highlight in what ways robotics can be used to enhance inclusion, regarding socio-economics, gender, language acquisition and students with low marks in STEM.



IDENTIFIED **BARRIERS**

inclusiveness, benefits and potential risks

We have also identified a few potential barriers that could hinder the use of robotics in education, all the while with debating on the important advantages which a robotics toolkit can bring to educational systems, public or private. This booklet follows the argumentation that robotics can be applied as means of inclusion and positive outcomes following approached based on four associated fields:

1

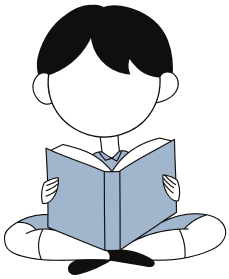
Socio-economically speaking, implementing a robotics program can be perceived as costly, and this is exactly why the tools developed via Robot4All could help by promoting alternative and easy to access resources

2

Robotics projects usually are perceived to take a lot of time and effort, so the e-platform and, the accessibility of toolkit will help overcome this

3

Students living in lower income neighbourhoods could have problems participating in robotics clubs, and this is why having online robotics material, freely accessible, would be beneficials



4

Academically, robotics could be perceived as inaccessible or requiring good grades. Students with bad results might be excluded of Robotics, so Robot4all is exactly this, a platform easy to use for all students

5

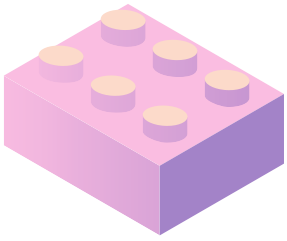
Robotics in general are associated to technical / industrial professions to pursue for the future, which might be unattractive to students, especially in terms of gender diversity in relation to STEM; given that the Robot4All toolkit is also accessible for non-ICT teachers /groups of students, it is a good solution on this perspective

a. Overcoming socio-economical barriers

Robotics are also a clever way to reduce social barriers between children. According to Allison Druin and James A. Hendler in *Robots for Kids*, robotic materials can be used in various group learning activities, since they offer an opportunity to develop social interactions. For example, the LEGO system enables students to assemble and disassemble component parts easily to illustrate or test an idea, which makes it easier for children with language deficits to communicate, since they have the possibility to show an idea rather than describing it with words. Robotics are also an opportunity for children to "practice their social collaborative skills".

According to this study, incorporating robotics in group activities is beneficial for children, since it will enable all children to participate in problem-solving tasks (thanks to Lego or the Lab View Software for example) no matter their skills. This will also prove that all students' efforts are equally important, children will recognize the contributions and work of others and feel a common sense of accomplishment as a group. This will contribute to the reduction of social barriers between them.

!! Note that close attention should be paid to the nature of the activity, as well as to the profile of each learner.



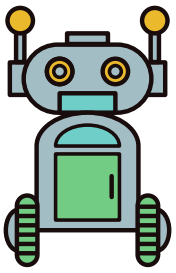
Then, regarding economical barriers, it should be noted that if robotic classes have been successfully integrated in some schools, these often have to overcome some economical barriers. In fact, as explains José L. Pons in his book *Inclusive Robotics for a better society*, robotic kits are often too expensive for schools. As a solution to this barrier, teachers could rely on other resources, such as recycled materials for example.

b. Students with learning difficulties in STEM

First, by this category we mean students who either underperform, have poor school results because either they cannot keep up with the curricula pace or are dramatically demotivated. It is not a new concept for education, although educational robotics is mostly associated with Science, Technology, Engineering, and Mathematics (STEM) in developing the understanding of mathematical concepts and principles of physics, engineering and other branches of STEM, as well as in developing knowledge in different stages of education, from preschool to higher education. Lately, new research directions have been developed where it is proved that robotics has such positive effects as: improved learning motivation improved interest in learning itself.

Robotics can help overcoming various factors that can lead to risks of :

- severe de-motivation of students that feel they can no longer cope with the learning challenges
- social marginalisation
- risks of early school leaving



Robotics can help overcoming various factors.

c. Negative perception of STEM jobs

Nowadays, innovation is mainly driven by Science, Technology, Engineering and Mathematics (STEM) disciplines. STEM skills are key to solving current challenges and taking part in today's society, propelled by new technologies, new skills and innovative jobs.

However, an important issue remains, since STEM jobs are becoming less and less attractive for people. This is related to the negative perception they have of these careers. In fact, STEM is often identified as a nerdy, male-dominated and boring field. Moreover, people, and especially girls, have no achievable image of what STEM stands for. Beyond the lack of role models, they do not know which professions, companies and working environments are part of STEM today or what opportunities these fields can offer.

This problem arises at school, when boys and girls choose their courses, which then influences their career choices. This results in a deficit of qualified workers in the STEM field. Therefore, it is essential to change people's negative perception of STEM jobs, through innovative learning tools, with a focus on the various career paths that exist nowadays.
**Source: Gender4Stem project*

d. Overcoming gender barriers

Today, robotics is still mainly considered as a domain exclusively for boys and men. This often discourages women and girls to follow STEM studies or careers. Therefore, it seems crucial to find effective solutions helping overcome gender barriers in robitics.

First, the article *Problem solving thanks to computing in class : how to increase girls' interest in computing ?* written by Lizzie Jackson (National Center for Computing Education, UK) underlines how computing can help girls to solve "real-world" problems, and how this increases their interest in computing.

The national Center for Computing Education has created a programme of study for computing, which aims to highlight why computing is an important subject that should be taught at schools : "A high-quality computing education equips pupils to use computational thinking and creativity to understand and change the world".

The article underlines that there is a useful possibility to increase students' interest in computing, which consists in making them choose a real-world problem that they would like to solve. In fact, according to the article, several research studies have identified that solving real-world problems can be highly engaging for girls, and can help to increase their interest in computing. Moreover, when computing provides pupils with the opportunity to help other people, girls are more likely to be interested

ROBOTICS & GENDER DIVERSITY

We focus on robotics as an inclusive tool, arguing that the inclusion of women and a gender balance approach should be done since the early stages of production. When speaking of women or other underrepresented groups, the reaction is to indicate their low presence in their development.

This is a worrying fact that should not go unnoticed, since if we go deeper into STEM studies, we realize the need for young people in these groups to learn technological skills, such as computer thinking competence is important.

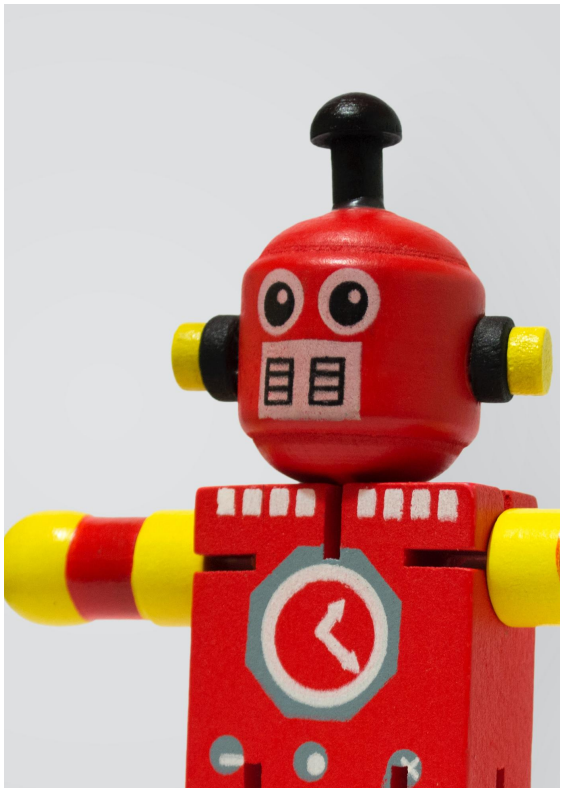
In educational robotics, gender stereotypes are often confirmed or even accentuated. Indeed, robots are usually in the shape of trucks, as robotic classes are often considered as being for boys. From an early age, toys for boys are different than those for girls: they change depending on the gender of the child. Therefore, we would advise teachers to try something new in robotic classes and to create gender-neutral robots, which can also be appealing for girls! You can for example create a dancing robot, with neutral colors.

**Cited from: Gender4STEM Erasmus+ project*

> *There is still a low presence of women in STEM.*

It should be noted that, if we want to overcome gender barriers, it is important to analyse gender stereotypes related to robotics, and to understand at what age they occur.

It seems interesting to take into account the results from the Ready for Robotics project, funded by the National Science Foundation. This project focused on creating a robotics kit for young children from four to seven years old. The purpose was to determine whether girls and boys already have some gender stereotypes regarding technology and engineering, and whether boys and girls have the same skills during their classes in Introductory Robotics and Programming concepts. During this study, children were offered several robotics activities. Boys and girls were both asked to tell who would love more to play with these kits: girls or boys? The following tools/activities were offered to both girls and boys:



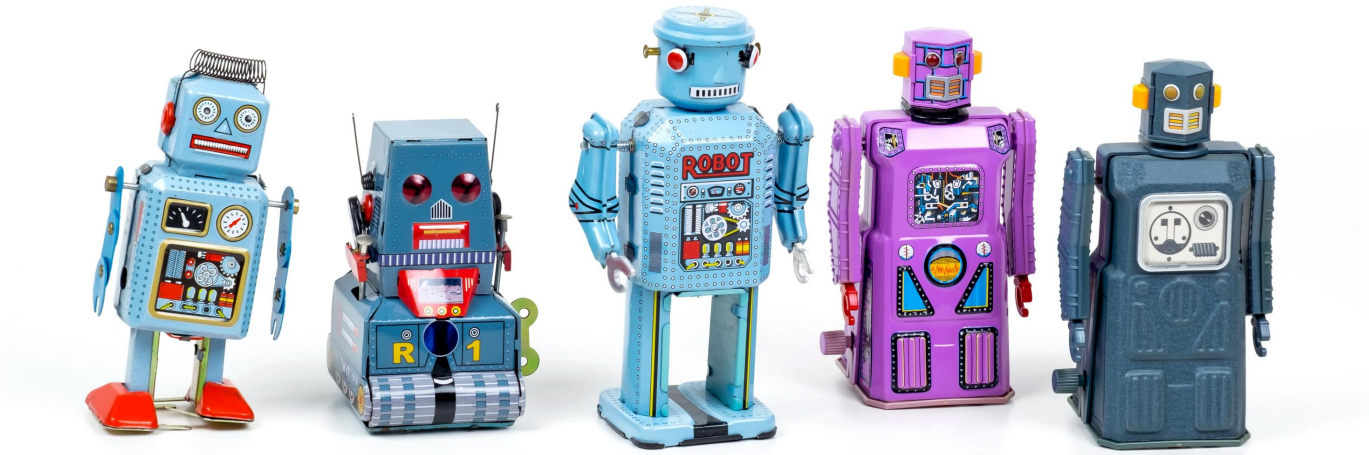
- The KIWI Robotics Kit
- Legos
- Computer

The study showed that the Legos generated the most important gender stereotypes. In fact, out of 42 children, more than half (64%) said that boys would love more to play with the Legos. The reason why the children thought boys would enjoy more to play with the Legos, were mainly the colors (yellow, red and blue). One participant even stated that Legos for girls should be pink, and other children of the group added that boys like more to build than girls. Moreover, they also commented that boys enjoy building more. Concerning the computer, more than half of the participants (62%) agreed that both boys and girls would like the computer.

However, they explained that even if boys and girls could love using the computer, they would not use it for the same reasons, they would do different activities. A girl stated for example that "boys play games like Batman. A girl computer would have girl games". Then, regarding the KIWI robot, 33% of the children believed that boys would enjoy playing with it more. Fairly the same answers emerged as for the Legos: the colors of the KIWI prototypes being blue and brown (wood color). Children explained that "There's no girls colors", "because it's a lot of blue".

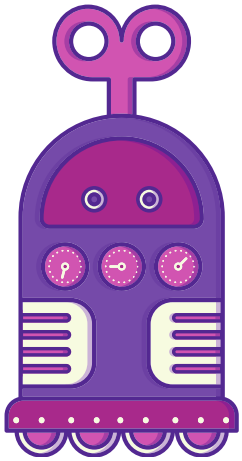
The sounds and lights of the robot were also an important theme, explaining for example that the sounds of the robot are going to bother some girls. However, more than half of the children (53%) found that both boys and girls would like KIWI. This study proves that children do already have some gender stereotypes when it comes to robotics. These are mostly linked to the use of colours, which should be taken into account when designing robotic kits.

**Cited from: Sullivan, A., & Bers, M. U. (2016). Girls, boys, and bots: Gender differences in young children's performance on robotics and programming tasks. Journal of Information Technology Education: Innovations in Practice, 15, 145- 165.*



Several studies insist on the idea that gender stereotypes are sometimes built in robots, since robot designers might be influenced by current gender norms. Thus, we find female robots, and male robots with characteristics and features that are commonly identify as being female or male. Moreover, it should be noted that female and male robots will not always be used for the same purposes, and that it can influence our expectations of the robot. In fact, as soon as we decide to embody gender within robots, stereotypes will follow. Gender can be integrated in robots through several ways :

- Voice (female or male)
- Name of the robot
- Physical appearance



Thus, some researchers argue that robots might sometimes increase social/gender stereotypes. However, in her study, PhD Londa Schieblinger underlines that robots might also be a clever way to promote social equality and to put an end to gender stereotypes, in several steps:

- By challenging persistent gender stereotypes
- Designing customisable robots, so that users can choose what the robot will look like
- Design genderless robots Design “robot specific” identities that go beyond social and stereotypes

CASE STUDY A.*

Interaction between robot gender and human gender

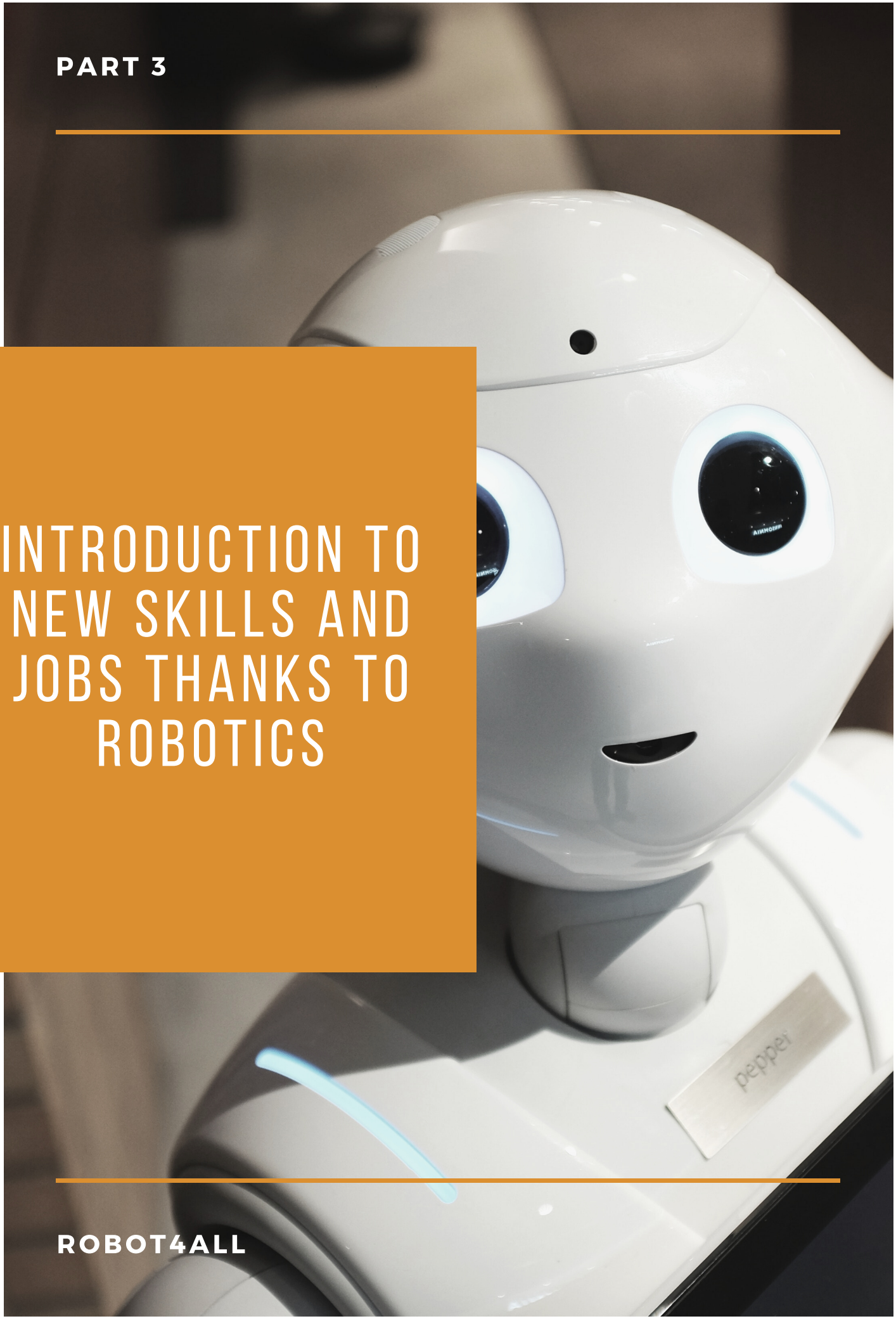
An experiment at a science museum, where a humanoid robot asked visitors (male N = 76; female N= 58) to give a donation. The robot in the experiment had a non-gendered appearance, and gender was manipulated by voice quality (pre-recorded human masculine and feminine voices). The results showed a cross-gender effect. Male participants rated the female robot as more credible and trustworthy than the male robot, while female participants rated the male robot as more credible and trustworthy than the female robot.

** cited from "Diversity and Inclusion in Engineering Education: Looking Through the Gender Question Educational Robotics for Inclusive Education"; Daniela et Lytras, Springer 2018*

By consequence, and what Case study b) demonstrates is that robotics teams need to include an equal balance of both women and men amongst the developing teams, aside those being also interdisciplinary.

PART 3

INTRODUCTION TO NEW SKILLS AND JOBS THANKS TO ROBOTICS



ROBOT4ALL

WHY TEACH **ROBOTICS?**

developing new skills such as creativity & teamwork

Today, there are several reasons that explain why teaching robotics in schools is essential.

First, robotics help both children (girls and boys) as well as adults acquire several important soft skills, such as creativity, innovation and team-work. Karolina Zawieskaand and Brian R. Duffy, in "The social construction of creativity in educational robotics" argue that one of the most considerable benefits of robotics is "its potential to inspire curiosity and creativity in students." In fact, they explain that this creativity emerges thanks to the process of building, programming and manipulating robotic platforms. Then, in "The Role of Education for the Social and Economic Uptake of Robotics", José L. Pons insists on the idea that teaching robotics to children from an early age will have a positive effect on them, since it will not only provide them with hard skills, but also with crucial soft skills. In fact, it will help them acquiring more knowledge in the fields of science and technology, but also increase their self-confidence, their creative thinking, team-work, critical thinking and problem-solving skills.

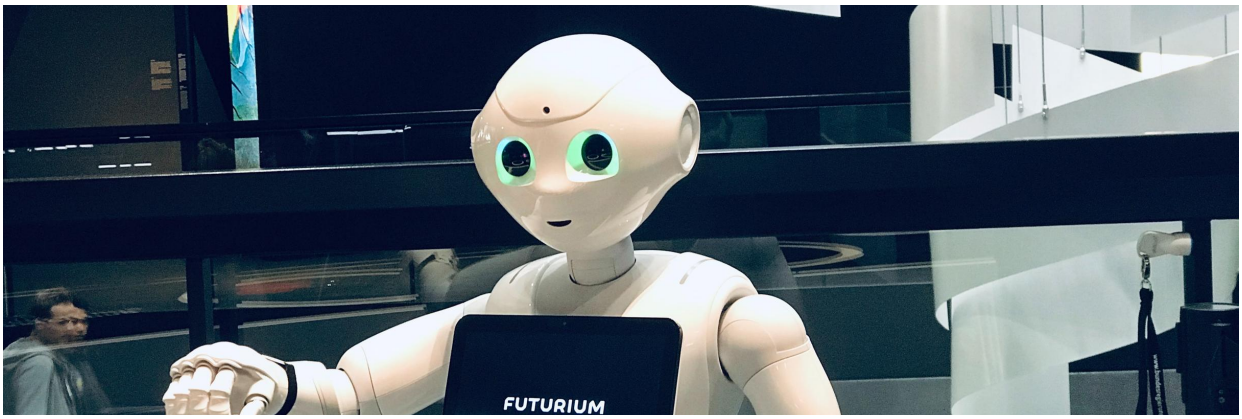
NEW JOBS

developed thanks to robotics

Although a common belief nowadays is that robots might steal jobs from humans, according to Benjamin Shestakofsky's research, robots do not steal jobs, but create more jobs for humans and create growth. He explains for example that "software automation can substitute for labour, but it also creates new human-machine complementaries". He also indicated that computer technologies have actually created new occupations in the fields of hardware, software, networking products and services.

Furthermore, he explains that new jobs emerge in various STEM fields such as biotechnology, renewable energy and mobile technologies have also emerged thanks to technological advances and robotics.

**cited from: Robotics for soft skills training, Rubinacci et al., Research on Education and Media, vol. 10, 2017*



Moreover, according to figures by the European Commission, one additional technology job creates around 5 complementary jobs. These new jobs, will need new skills, some of which are still unknown today. Professions of the future will also emerge, such as AI trainers and AI explainers (workers who interpret the outputs generated by AI).

Furthermore, new opportunities of employment will emerge for programmers or specialists in robot maintenance, for the creation of new robots for example.

**cited from: AI and Automation, European Commission*

CASE STUDY B.*

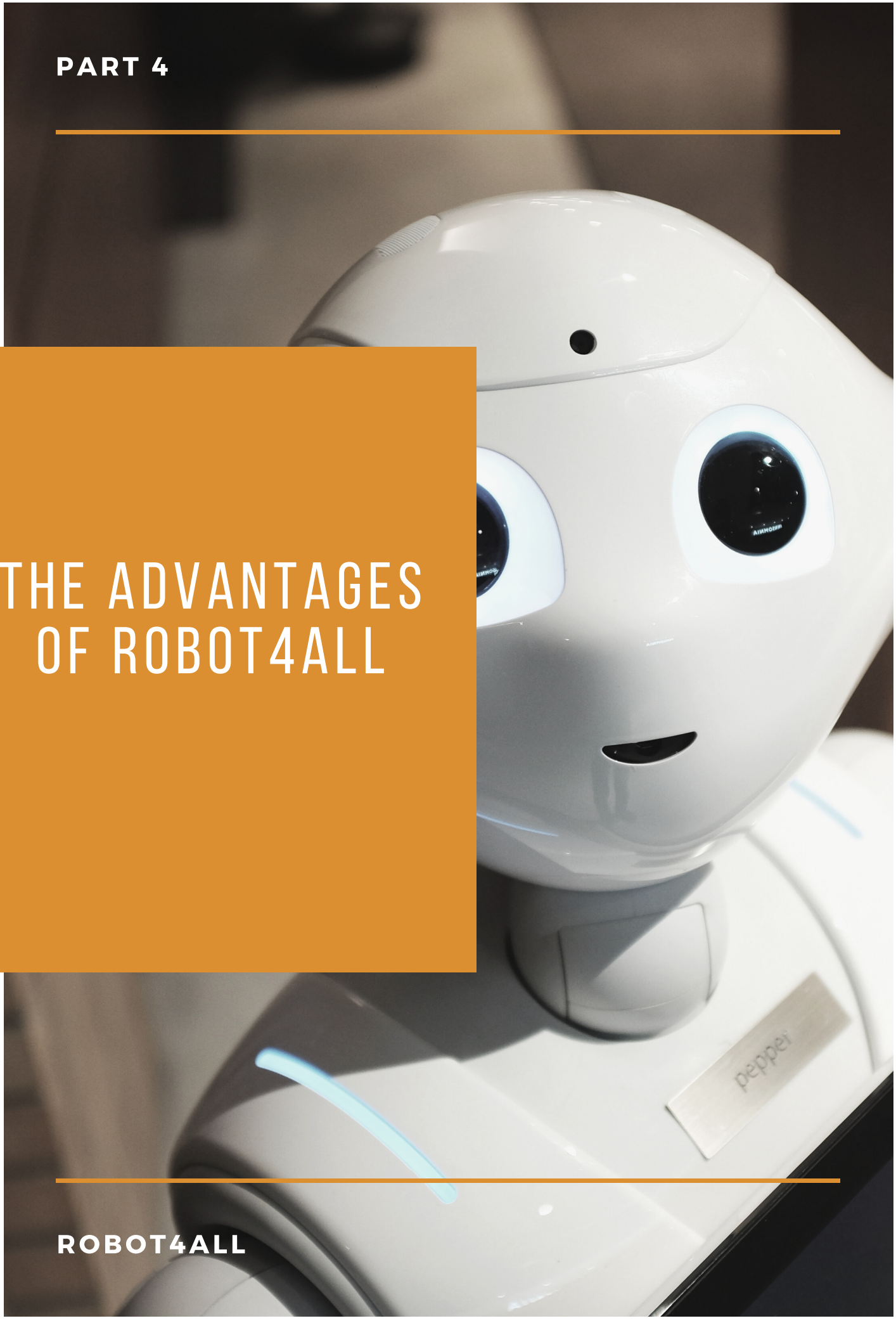
Students and teachers are confident about the effectiveness of labs in promoting soft skills. Also, the teachers agreed that it was a good chance to stimulate collaboration, group working and enhanced communication abilities in students. The feedback from the teachers has confirmed that it stimulated students' interest in STEM and coding as well as their skills in group work, mediation and negotiation, problem definition and solving.

The students evaluated the lab very positively, both about hard skills and soft skills. This lab allowed the students to start acquiring the knowledge that transforms into skills and competencies, which is crucial for their future in academic and working careers.

**cited from: Robotics for soft skills training, Rubinacci et al., Research on Education and Media, vol. 10, 2017*

PART 4

THE ADVANTAGES OF ROBOT4ALL



ROBOT4ALL

NEW SKILLS

developed thanks to robotics

Robotics based trainings and workshops can be very useful in helping adults and also young people to develop their soft skills as well as their hard skills. The most notable soft skills which according to various studies, are enahnced or devleoped in robotics are:

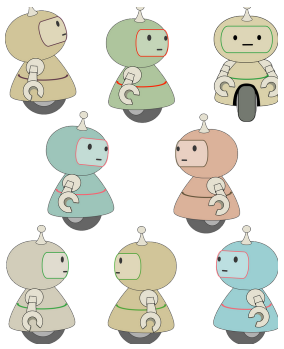
- Teamwork

- Problem solving

- Problem understanding

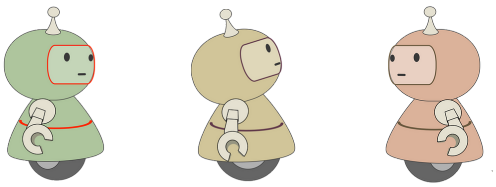
Regarding the hard-skills, in a research done in a student robotics club, the majority of answers designated the following as most relevant:

- science related skills in general, robotics, technology, mathematics, coding and robot programming



- Technical skills in general

Furthermore, according to ACER* educational robotics strengthen and support students' skills developing their knowledge through the creation, design, assembly, and operation of robots. The paper argues: "Children and young students find it funny and engaging because they feel free to interact directly with both electrical and mechanical processes and procedures. The study argues in fact that programming can be at times too difficult and boring when learned through the "traditional" abstract method. On the contrary, by having to control a physical robot and seeing what goes wrong, students learn what robots can and can't do with an immediate experience and understanding.



Potential strategies to overcome lack of interest and to reaching and engaging a broader range of learners in roboticsIn the future, If we wish to address larger target groups of learners, broader perspective projects are needed. A wider range of possible robotic applications has the potential to engage young people with a wider range of interests. Pursuing this challenge Rusk et al* (in Alimisis) argue that in order to develop innovative ways to increase the attractiveness and learning profits of robotics projects in general, four strategies for engaging a broad range of learners in robotics can be adopted.

1

Projects focusing on themes, not just challenges

2

Projects combining art and engineering

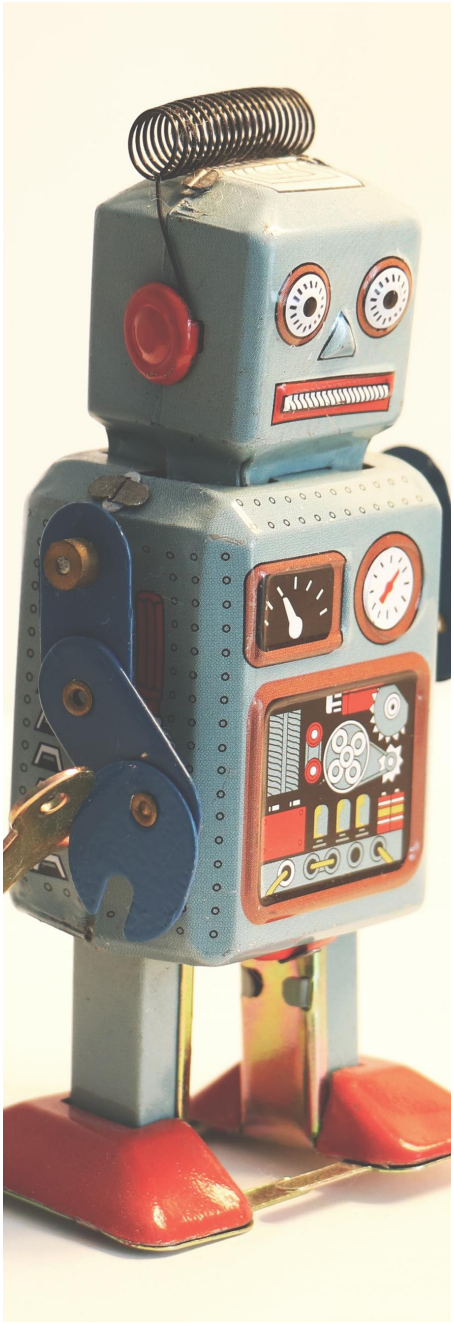
3

Projects encouraging storytelling

4

Organising exhibitions, rather than competitions

Young people who are not interested in traditional approaches to robotics become motivated when robotics activities are introduced as a way to tell a story or in connection with other disciplines and interest areas, such as music and art. Different students are attracted to different types of robotics activities; students interested in cars are likely to be motivated to create motorized vehicles, while students with interests in art or music are likely to be more motivated to make artistic robotic creations.The same authors, find embodiment as another innovative way that might be introduced in robotics activities to make them more attractive, especially for children. Embodied experiences with robotics can be realised when students physically move their own bodies and then program robots to perform a certain task. In such a case learning develops from personal embodiment to embodiment through surrogate robots Another way to facilitate learning with robotics is to make the learners embody the robotic system, for example by asking learners to follow movements of robots through gesturing.



CONCLUSION

The toolkit Robot4All provides interesting resources, such as studies, findings and study cases aiming to highlight the benefits of robotics education. These resources illustrate various positive outcomes of robotics, such as the creation of new jobs and the acquisition of new skills (e.g teamwork and creativity). Robot4All focuses on inclusion in robotics with new online tools, aiming to support VET teachers. This toolkit especially addresses four identified barriers: gender, socio-economics, students with low marks in STEM and negative perceptions regarding STEM careers. VET learners constantly need to develop new skills to adapt themselves to new jobs (of which many do not exist yet).

Robotic skills are utterly important, no one should be excluded of getting the chance to access this education. The Robot4All partnership has developed concrete and actionable tools for teachers in order to break down the identified stereotypes and create a more inclusive work and study environment.