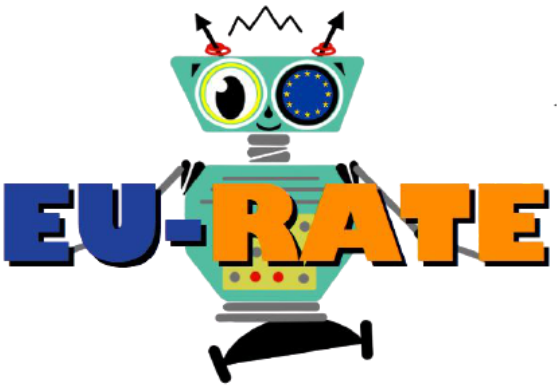


EU-RATE Robotics Access To Everybody

Diagnosis of practices and audiences & recommendations

IO1 Learning sequence design

Introduction

EU-RATE - 01/10/2020 - 31/07/2023 (34 months step by step)

In a world where digital tools are increasingly part of our daily lives, educating children and young people in their use and understanding is the responsibility of educational actors. Machines, algorithms, and artificial intelligence are all terms that are now part of everyone's vocabulary, even though we do not always know what they mean. The issues of conscious use, access for all, understanding, ethics, personal data protection, but also technical training for the professions of tomorrow are today more than ever at the heart of the debates of European societies, and the questions arise from early childhood onwards. Digital education, and education through digital technology, offers opportunities in terms of education, creativity and innovation, in addition to meeting a societal need. We are a **consortium of 6 structures, from 4 different European countries**, that share reflections and common objectives in terms of educating young people and educational actors to digital tools, and in particular to machines, in order to give the keys to citizens to become active and not passive users of the tools. Different countries, but similar uses and issues.

The education of young citizens plays a really important role and so does teacher training. The partners have come to the common analysis: we need to invest in teachers as transformers and awakeners. They can contribute to the empowerment of the new generation of citizens in using digital technology effectively and in a responsible manner. The EU-RATE project wishes also to include other educational actors (youth leaders, volunteers) as these actors are complementary to school education.

EU-RATE project has the **following goals :**

1. provide the means for teachers who wish to offer turnkey robotics activities at low cost,
2. make children and young people understand the making of information through action so that they become creative and responsible actors,
3. educate to computer science and raise awareness on algorithmic logic underlying all the tools we use, in order to take over power on machines,
4. promote the mainstreaming of digital competence provision across the curricula,
5. foster critical thinking especially through teaching technology and science in line with the priorities of school education,
6. prepare children and young people for robotics challenges such as RoboCup, which are great opportunities for learning in many fields (technology, mathematics, logic, English, project management...) and self-improvement,
7. make children and young people, especially girls, want to take an interest in engineering and digital professions.

To reach these ambitious objectives, the EU-RATE project will **target a public in a direct and indirect way :**

- **The direct public: primary and secondary school teachers,** especially those who do not have access to robotics for reasons of funding, knowledge, distance, etc. but also the educational community at large (educators, parents, animators) that will have access to the

training online; **Students of 14+** as co-developers of the project (participating in trainings, testing, experimenting, giving feedback).

- **The indirect public: youngsters from 8 to 10 and from 11 to 14 years old** that will take part in extracurricular and/or in-school activities.

These objectives will be achieved through the implementation of **3 intellectual outputs** (Robotic kit):

- IO1 learning sequences,
- IO2 hardware,
- IO3 software,

including 2 trainings for 14+ students :

- one on prototyping,
- and the other one on finalisation of prototypes and pedagogy

and 6 multiplier events.

Every production will be open source and accessible to all during and after Erasmus + funding.

The transnational approach is really important in order for the EU-RATE project to succeed. In certain countries in Europe, teaching robotics, coding and media literacy is already in the school programs. In others it is not obligatory but highly recommended. The consortium will rely on the knowledge of partners, experts and the participation of the target groups (direct and indirect) to find the best way to answer the needs identified during the application of Erasmus+ by all consortium partners, experts and national and european studies.

Dissemination will be a big part of the project. We have planned to work throughout the project and also after the Erasmus+ funding to involve more schools, associations, networks, stakeholders to test and disseminate the project results and to reach more educational actors and teachers, and through them, children and young people from all countries.

EU-RATE - First phase : October 2020 to September 2021 – Work on a publication

The consortium has the ambition to build a robotic teaching kit accessible to all (intellectual productions : learning sequence, hardware, software). It was important for the consortium to adapt our intellectual outputs as closely as we could with teachers' students needs, capacities and skills targeted, so we have decided to choose to propose the robotic kit to be used by teachers with students between 8-10 and 11-14 years old. This choice allows one to take in consideration the specific curricula of each country and recommendations from experts and educational policies on-going.

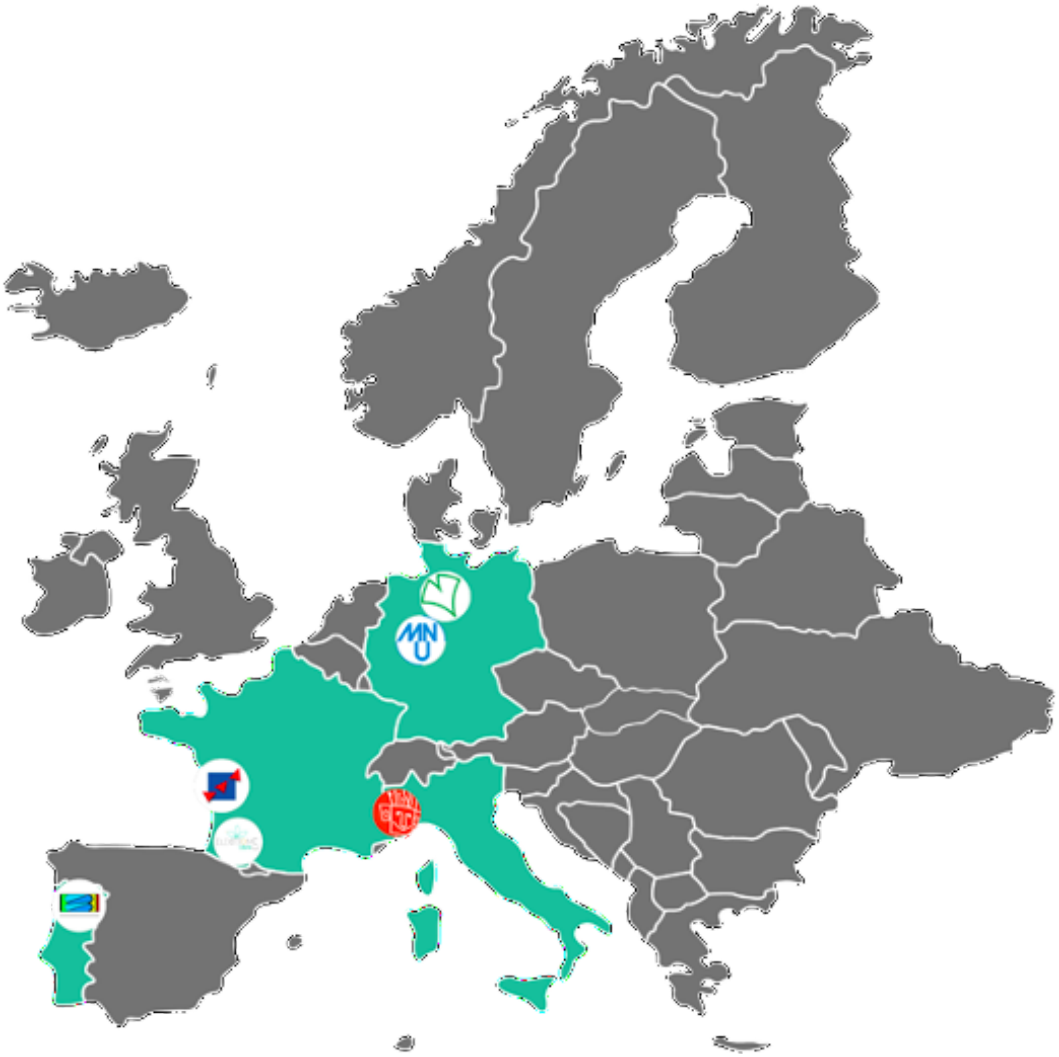
In order to contribute to this objective, we have created a **work plan for the period October 2020 to September 2021** that would give the consortium a step by step method to analyse the field, country context and policies of digital education and specifically robotic education (learning sequences, hardware and software used) in the 4 represented countries and overall at european level.

It was extremely important for partners not only to use studies and experts publications but also to survey educational actors as teachers, the direct target group of our project, but also the educational community in general as parents and stakeholders.

We also chose to interview some relevant stakeholders to bring knowledge and direct experience from different fields. Students 8-14 and 14+ were also surveyed in different ways (online survey, card game…) to bring their own ideas and learning and playing robotic experience to our analysis.

The consortium assembled all the materials and processed the information to give **recommendations and build a strategy in coherence with the SWOT** (strengths, weaknesses, opportunities and threats) of the EU-RATE project. This publication wishes to give guidelines for the building of a quality, accessible and open source robotic kit (learning sequence, hardware, software). It will evolve throughout the project duration and the feedback of experts and the testing by teachers but also by other educational actors and the children and youth involved.

The EU-RATE consortium



Ligue de l'enseignement Nouvelle-Aquitaine (Bordeaux, France)

As a regional organisation of Ligue de l'enseignement, it offers diversified actions in the field of youth, education, culture, vocational training, digital education, leisure, sustainable development and community life. Through its activities, it works to strengthen social ties and promote its secular values for a more cohesive society. Ligue de l'enseignement Nouvelle-Aquitaine represents the 12 departemental federations (3500 associations) of its territory in regional networks and public authorities.

https://liguenouvelleaquitaine.org/

Scuola Di Robotica (Genova, Italy)

Scuola di Robotica is a non-profit association founded in 2000 by a group of robotics and human science scholars. The main objective of Scuola di Robotica is the promotion of culture through education, training and dissemination of arts and sciences involved in the process of development of robotics and new technologies.

Scuola di Robotica works with teachers and students from kindergarten to university in offering design courses and also creating designs of robotics kits. They coordinate networks and events as for example the FIRST LEGO league, the Nao Challenge or the Olympics game that gathered thousands of students on the previous editions.

https://www.scuoladirobotica.it/

EleKtrons Libres (Pau, France)

EleKtrons Libres is an association that brings together young people, parents, teachers and trainers. Created in September 2019, its vocation is to facilitate access to science for all young people, boys and girls, to promote their international mobility, to strengthen their european identity, while allowing them to participate in competitions and supporting them in their professional orientation.

https://elektronslibres.fr/

Gymnasium Langenhoven & Goetheschule (Hannover, Germany)

Goetheschule is a grammar school specialised in music, languages, mathematics, natural sciences and computer science.

Participation in the Erasmus+ programme is a worthwhile addition and is perfectly in line with the values of the school. Goetheschule offers an international education with a European focus.

In computer science, students learn the basics of data processing, algorithms and robot programming. The students regularly participate successfully in RoboCup. In 2013, a group of Goetheschule students won the world championship title.

https://goetheschule.de/

Escola secundária de Barcelinhos (Barcelos, Portugal)

Escola secundária de Barcelinhos is a public school that includes courses in robotics and science and technology in the 3rd cycle curriculum.

It integrates in its different extra-curricular activities a variety of subjects such as citizenship, health and sexuality education, cyber-security or entrepreneurship and consumer education.

The Robotics Club of Escola secundária de Barcelinhos participated and won the RoboCupJunior competition in 2016.

https://esbarcelinhos.pt/

MNU (Hessen, Germany)

MNU is a German association founded in 1891 for the promotion of STEM teaching (math, biology, chemistry, physics, IT and engineering). Its main objective consists in the further training of the teachers, the optimization of teaching materials and their use in class, and the incorporation of technical and scientific progress into teaching.

MNU works with schools and universities, takes part in teacher seminars, advises regional and state education authorities.

MNU carries out publications and conferences to educate and support members. Each year, two main conferences gather 100 to 200 participants, in addition to local conferences and training courses.

https://www.mnu.de/

The project partners are very complementary to each other as they have worked on different projects and initiatives at the national and European level that match each other.

Ligue de l'Enseignement Nouvelle-Aquitaine, being at the initiative of this project, contacted the potential partners. When developing this consortium, priority was given to identifying the competencies each partner would bring to the project and to the development of the foreseen intellectual outputs as detailed in the previous answer.

Therefore, the consortium is a mix of longstanding partners of Ligue at international level (Scuola di Robotica), a member partner that had a major role in building the project framework (EleKtrons Libres) but also long term partners of EleKtrons libres and their expert teachers and the french federation of robotics (MNU, Gymnasium Goetheschule, Escola secundária de Barcelinhos).

We decided to have a leading and co-leading school/association in each IO (Intellectual Output) and, of course, each partner will contribute to all the deliverables of the project, one partner taking the lead depending on its expertise and competences.

MNU, being an association with a major network in Germany, Europe, USA and Canada ,will also focus on the wide transnational dissemination of the project and to relevant stakeholders at EU level (see dissemination part below). All partners will also support dissemination plans at the local, regional, national and international level by their networks, participating in events not covered by the project but connected to the theme (RobocupJunior as regional, national, european and international levels, congresses, teachers meetings and trainings, etc) but also by new contacts made on preparation time and during and after the project.

All partners have taken part in an EU funded project (as individuals, teachers mobility, non-formal education projects) in recent years, they all have worked on the subject at least national level and at international level).

I – Analysis of the context

Before designing the target surveys, each partner analysed the respective country contexts. The objective of this preliminary study was to, in each country :

Define general approach of robotics:

- public opinion about household robots,
- citizens' equipment,
- number of actors of the digital economy in the territory (research institutions regarding artificial intelligence and robotics, …).

Identify experts and stakeholders in educational robotics to know:

- the recommendations in terms of digital and robotics education carried out by scientific experts (in education, neuroscience, robotics, computer science) concerning the different age groups affected by the project (8-10 years and 11-14 years);
- what is considered like specificities to be taken into account according to age.

Obtain datas about robotics in education:

- pedagogical practices (project pedagogy…),
- innovative practices, practices that are becoming more democratic (criteria) in school, after school, extracurricular time,
- equipment in the classroom (computers, programs, softwares, etc.),
- facilitators and barriers,
- place for robotics and programming in the 8-10 and 11-14 school curricula (classes hourly volume or proportion of the school program, …).

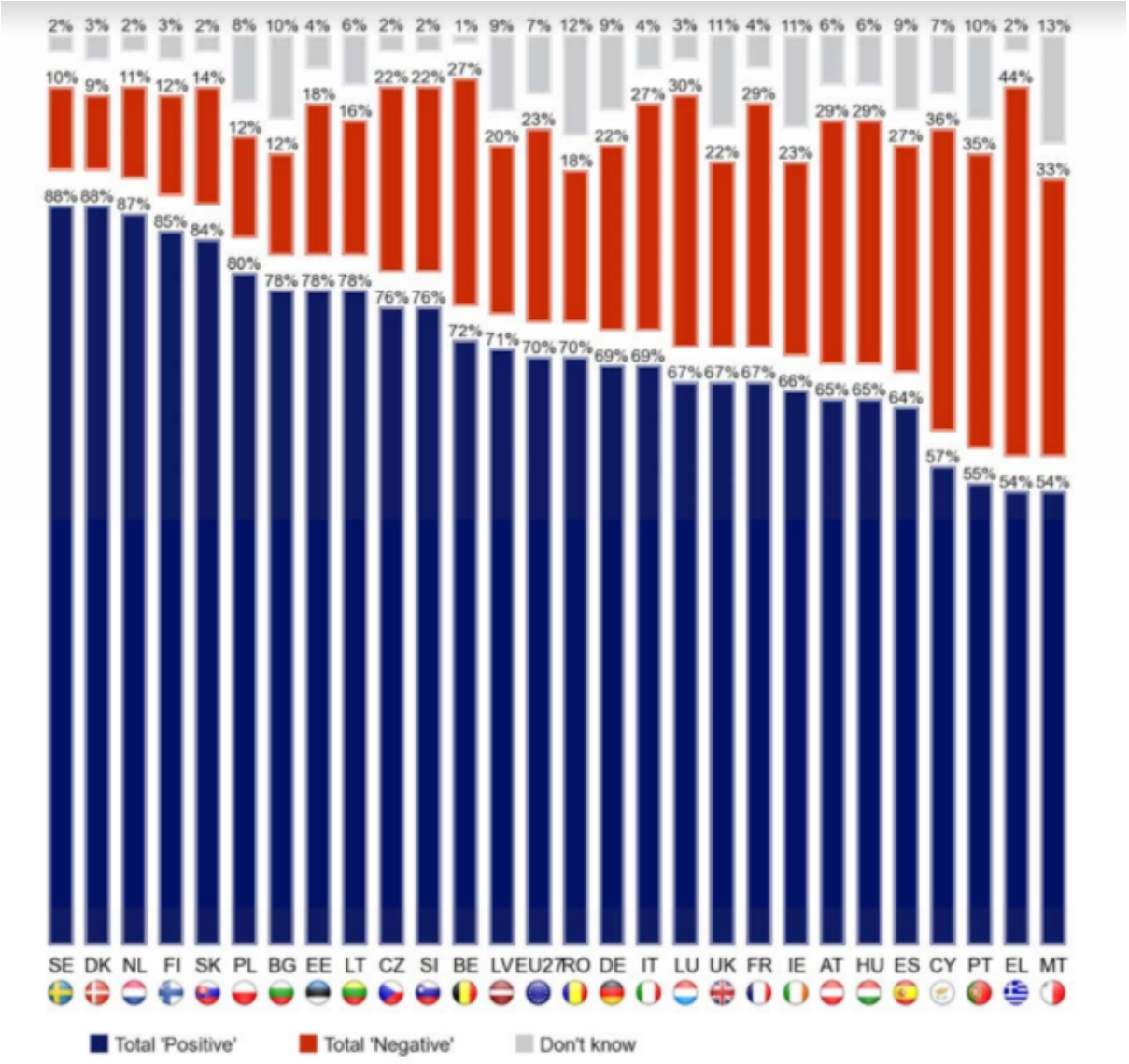
Global education context to define:

- subject areas, issues and learning objectives to be achieved,
- specificities in terms of digital literacy.

Nota bene: the context research and analysis continued as project partners wished to update information throughout the year (new studies, new data, interviews from partners and stakeholders, policies…)

A. General context

The majority of EU citizens have a positive view of robots. While there are variations between countries, the majority of EU citizens in all member States holds a positive opinion, with percentages ranging from 54% in Greece and Malta to 88% in Denmark and Sweden[1].



We note, in relation to the figures presented by the European study dating from 2017, as well as the data transmitted by the EU-RATE project consortium, that **our countries have interesting similarities regarding the opinion towards robots.**

France and Italy have the most similar results. Public opinion is rather favorable but it remains mistrustful with respect to employment - the supposed loss of jobs due to automation - as well as of the issue of care for the elderly promulgated by robots (according to eurobarometer study). Portugal is

[1] "Attitudes towards the impact of digitisation and automation on daily life" Special Eurobarometer 460 – Wave EB87.1 – TNS opinion & social – March 2017 https://ec.europa.eu/jrc/communities/sites/jrccties/files/ebs_460_en.pdf

even more worried about robots with 35% of negative opinion. Portuguese people have the highest fear in Europe about robots stealing their jobs (89%).

In contrast, in Germany, only 22% have a negative opinion : they are not especially scared about losing their job because of new technologies ; 82% of people who answered an opinion poll[2] can imagine themselves using a robot to stay longer at home when they will be older. German people think robots will be necessary in future daily life.

Also, the special barometer shows us that men are more likely to think newer digital technologies have had a positive impact on the economy (78% vs. 72% of women), or their quality of life (70% vs. 63%). Respondents aged 55+ are less likely to say the impact of newer digital technologies in these areas is positive, compared to those aged 15-54. For example, 66% of those aged 55+ say the impact on the economy is positive, compared to 79%-81% of the younger age groups.

In conclusion, public opinion on robots in our countries is generally positive, but some countries are mistrustful (the Portuguese population being the most wary). In spite of this, it can be seen that in each country, industries are using more and more robots (Germany ranked in the 3rd place for robotics in industries), specialised schools are developing and research bodies are proactive (France ranks 5th in the world in research and development; in Italy there are lot of research centers, including the Italian Institute of Technology which collaborate with MIT and Harvard). Portugal, which is the smallest country represented in the EU-RATE project consortium (1.000.000 hab), is also developing its innovations companies and counts today at least 9 robotics research institutions and labs.

[2] Forsa. Politik- und Sozialforschung GmbH (2016), "Service-Robotik: Mensch-Technik-Interaktion im Alltag". Ergebnisse einer repräsentativen Befragung. Berlin, Deutschland.
https://silo.tips/download/service-robotik-mensch-technik-interaktion-im-alltag-ergebnisse-einer-reprsentat

A. 1. Education

A.1.a. Robotics at school between 8-14 years old

Country	Integrated in curricula	Disciplinary field	Targeted skills
France	X	**Primary school (8-10 yo)** Technology, mathematics and physical sciences (mathematics and in 2 of the 4 science and technology themes) **Secondary school (11-14 yo)** ● Mathematics: geometry, algorithmics ● Physics: mechanics, electricity ● Technology: electronic circuits and components, mechanical engineering, computer science and programming.	**Primary school (8-10 years old) :** ● Design: Describe the desired robot, draw its diagram, assembly plan... ● Construction: Assembly of the robot according to the assembly plan ● Programming: Realization of the programme that will make the robot autonomous. **Secondary school (11-14 years old)** : 1. Design, innovation and creativity, ● Imagining solutions in response to needs, materialising an idea by integrating a design dimension ● Produce, in a collaborative way, the prototype of a communicating object ● Technical objects, services and the changes induced in society, ● Compare and comment on the evolution of objects and systems ● Expressing thoughts using adapted description tools 2. Modelling and simulation of technical objects and systems ● Analysing the functioning and structure of an object ● Using modelling and simulating the behaviour of an object 3. Computer science and programming, ● Understanding how a computer network works ● Writing, developing and running a programme

Italy	X	Primary school (6 to 11 yo) & Middle School (11-14 yo) : Technology	**8-5:** ● introduce the concept of programming a robot with a real human simulation; ● a relatively non-invasive method to help children understand programming; ● narrative phase, each child has to give voice commands to his classmate, who simulates a "robot"; ● phase of drawing the voice commands on paper; ● program the robot with graphic icon with simple simulation software **9-10** ● "white box" robots procedure: assembly of the robotic kit by the students ● phase of programming with visual iconic programming. **11-13 :** ● programming robot with logic solution and even with a simplified version of flowcharts. ● Programme their own kit using sensor information: introduce the concept of action-reaction ● testing the robot operation, ● rework and redesign the programs and also the assembly of the robots **14-17:** ● write algorithms by abandoning the iconic language: at this point it can be useful and interesting to use automatic code converters (such as those found on Makecode, mblock etc.), able to transform the programming contained in graphic icons into lines of code.

Germany	X (in Lower Saxony, optional for pupil)	"automated processes" and "technical realization of automated processes" (8-10 yo) 10 + Computer science	**8-10 :** ● programming of microcontroller boards ● coding of information and treatment of protocols for data transmission **12-13:** ● Java programming language ● Construction and programming of autonomous robots, programming and use of Kinect sensors, sub-zero sensors, etc. ● Programming language ● Image coding (memory requirements, colour panels, graphic formats ...) ● Structograms and trace tables.
Portugal	X optional subject or as a curricula enrichment activity	**Voluntary Schools** Since 2015 experimental studies on robotics and coding 8-10 and since 2017 11-14 ICT (Information and Communication Technologies) – Developing computational thinking is part of the basic curriculum for students between 11 and 14 years old, in the subject of ICT.Working with robots is optional[3].	● Understand and apply the fundamental principles and concepts of programming (logic, data types, variables, conditional and repetitive structures, among others); ● Analyse programs, identifying their result, errors and respective correction; ● Optimize the programming of the solution found for a given problem; ● Design programs with different levels of complexity in solving specific problems; ● Create programs to solve problems, animate stories or games using a textual programming language or block programming environment.

[3] Direção Geral da Educação - Aprendizagens Essenciais - Ensino Básico: https://www.dge.mec.pt/aprendizagens-essenciais-ensino-basico

A.1.b. Pedagogical practices

Experts in each country seem to agree on the importance of adapting the pedagogical approach according to age and language level.

Robotics training for teachers does not seem to be included in their initial training, even if « Digital Plans for Education » have been launched in each EU-RATE partner country with financing of material, resources development and training for teachers. **This dynamic is not yet truly integrated into initial training.** For France, Germany and Italy, it is often individual initiatives by some teachers who then train their colleagues, helped by the State or not (training pole action in Italy ; Canopé in France…). Teachers can also practice self-training with resources and online training provided by the ministries of education (Portugal, France…) but also by associations and other organisations. Private companies can also provide robots and training modules for teachers and students. **For our countries, robotics training seems not to be compulsory and depends rather on the teacher's will.**

8/10 years old teaching practices

The preferred methods are relatively similar in these countries: **a pedagogical approach based on problem solving, collaborative practical work in groups of 3-4 pupils, with projects lasting several days or even months, allowing the acquisition of transversal skills.**

Teacher's pedagogical posture is modified to let the pupils take the robots in hand and discover by themselves. Alves and Nova, portuguese researchers give as advice: " Strategies that respect the characteristics of each learner, provide spaces for interaction and dialogue, through communication not only between students and teachers, but also between students-students and everyone with everyone are being sought"(Alves; Nova, 2003).

Recommendations

- Teach fundamentals of machine learning
- Develop critical thinking
- Use visual programming language
- Use simple robotics kits.

11/14 years old teaching practices

We find the same preferred methods as for the 8-10 years old: a **pedagogical approach based on problem solving, collaborative practical work in groups of 3-4 pupils, with projects lasting several days or even months, allowing the acquisition of transversal skills.**

Teacher's pedagogical posture is modified to let the pupils take the robots in hand and discover for themselves. The Italians speak of « constructivists » practices, french & portuguese speak of « student centered » or « In depth activities » practices. Germans follow the Prof. Dr. Modrow[4] advises to use

[4] Eckart Modrow, Middle School Informatics, Göttingen 2007 / Eckart Modrow, "Pragmatic Constructivism and fundamental ideas as guidelines of the Curriculum", Dissertation Scheden 2002
http://ddi.cs.uni-potsdam.de/Examensarbeiten/Modrow2003.pdf

project-related approach and a high degree of autonomy for the students. Advices given by Alves and Nova (Portuguese) are also welcome for this age group (see above).

Recommendations

- Begin to write algorithms
- Create their own robots
- Collaborative practical work group
- Autonomy of the students.

A.2. Robotics in extracurricular time

Information about extracurricular time and the practice of robotics in the different countries involved seems difficult to obtain. Robotics in extracurricular time is not widespread except for robotics clubs organised in schools by volunteer teachers during after school leisure activities (example from Portugal).

Some of these clubs are aiming to participate in RoboCupJunior, especially in Germany, Portugal and France (no information about Italy- may be more engaged in FIRST LEGO League). As robotics is a rather expensive field, this may explain why it is not widely used in extracurricular time. Children can still be enrolled in robotics after school workshops/classes (as they would for a dance class – in France, this type of « after school - schools » is developing more and more) or practice on their own with kits purchased by their parents. Another possibility is for children to practice robotics in associations and leisure centers they attend, but the cost of the equipment and the training of youth leaders are real obstacles.

A.3. Material

Digital plans for education have enabled France, Italy and Portugal to equip schools on a fairly massive scale. Some areas may also benefit from equipment support from the state (digital school centres in Italy... Priority education zones in France...).

Apart from the equipment received, the material available depends on the structure in charge of the school. For example :

- In Germany, it depends on the funds of the city;
- In France, it depends on the level (in primary school, the city, in secondary school, the department, in high school, the region) ;
- In Portugal, for primary schools it's a cooperation between municipalities and the ministry of Education; for 2nd and 3rd cycle funding by the state and some external companies.

It is therefore very difficult to generalise about the level of equipment in schools in the four countries. Nevertheless, all pupils have access to computers, at least from the age of 10-11 (according to part I-B - Surveys).

A.4. General recommandations

In view of all the contextual elements mentioned here and in the documents submitted by each country referent, several recommendations can be made with regard to the pedagogical pathway and the hardware and software productions:

- To be accompanied by the research authorities for the creation of the kit, as the countries involved have many experts ;
- Encourage collaborative methods in the pedagogical pathway; propose sequences that allow students to be autonomous, while leaving the teacher pedagogical freedom;
- Propose teaching sequences not according to age but according to knowledge (the level of German pupils will be higher than pupils from other countries - they start text programming at 11 years old) ;
- Create a programming software adapted to the age and level of the student, by block and/or text ;
- Create a robot whose components are visible (transparent frame, etc.) as advised by MIT[5]
- Have the possibility to buy the robot already assembled and solid (8-10 years old) or to assemble in class (11-14 years old) ;
- Create a low-cost robot to be as accessible as possible according to the financial situation of schools, robotic clubs, associations, leisure centers;
- Target and train teachers who can train their peers ;
- Also create offline resources to use the kit.

A.5. Conclusion

Through this analysis, we can see that each country involved is very committed to the issue of robotics. The dynamic between research, industry, training and education has been created for several years now, even if public opinion remains mistrustful.

There is a general dynamic in our countries around digital learning (and critical thinking) and robotics, and this is primarily reflected in school time. Integrated or not into the school curricula, its study depends on the goodwill of teachers and their own skills, but also on the material equipment available in the school.

This analysis allows us to understand there are both similarities and discrepancies that need to be known for the development of the robotics kit and the teacher's support. There are significant differences in student levels in robotics depending on the country, for example, but the methods used are the same (student centered). The above general recommendations are deduced from the information provided throughout this document.

[5] RESNICK, Mitchel; BERG, Robbie; EISENBERG, Michael. “Beyond black boxes: Bringing transparency and aesthetics back to scientific investigation”. The Journal of the Learning Sciences, 2000, 9.1: 7-30. https://web.media.mit.edu/~mres/papers/bbb.pdf

A.6. Interactive map

This interactive map has been created to dynamically summarise the results highlighted by the general contextual analysis: https://view.genial.ly/6046097648bf6313af360d2d/interactive-image-eu-rate-map

B. Surveys

B.1. Framework note

B.1.a. Survey objectives

Through this survey, the objective is to better understand the specificities (social, economic, structural, political) inherent to each country in order to provide and carry out a project in suitability with the pedagogical and sociological contexts (knowledge, practices, uses, human means, financial means, etc.).

Overall expectations:

- Collect the general practices related to the fields of digital technology and educational robotics in all the countries involved in the project ;
- To know practices and digital uses of teachers, children, stakeholders, parents, and other educational actors in the 4 countries where the partner structures are located ;
- To know the specificities of each country (robots/software used and acquired in education, leisure activities, etc.).
- To take inventory of prior knowledge and mastery of digital and robotic tools, as well as existing equipment in each country;
- Identify the age of the public and its specificities and associated pedagogical objectives, competences to be acquired by country and audience.

In order to :

- Determine a development strategy for the project within each partner country, based on the analysis of the field (and create a complete SWOT analysis);
- Make productions (pedagogical and material) valid and relevant for all 4 countries concerned by the project ; specifically, the pedagogical pathway in line with the specificities of each country (educational content, curricula, type of teaching, equipment, expectations, needs etc.).

The questionnaires and interviews conducted with stakeholders were more strategic, with specific objectives:

- know about local policies, operating projects ;
- know good practices in educational robotics ;
- collect recommendations and opinions;
- assess the strengths and weaknesses of the EU-RATE project;
- have a strategic view on the objectives of the project and its implementation;
- add a scientific guarantee to the project.

B.1.b. Targets

In order to analyse digital and robotic practices in the countries concerned by the project, the consortium has chosen 4 targets. The goals of the number of respondents were initially :

- 100 teachers per country
- 50 parents per country
- 20 Stakeholders per country
- 200 children and young people per country

At the end of the surveys, the consortium have the opinions of :

- Teachers: 830 respondents
- Parents: 388 respondents
- Children of 8 years old and more: 485 respondents (two different approaches, with playing cards for 8-10 years old and a questionnaire for 11-14 years old)
- Stakeholders: 125 respondents (Italy, Germany, Portugal) and 21 interviewed (France).

By surveying the various parts concerned and targeted by the project, the aim is to obtain an overview for optimal implementation of the project, but also one that responds to the specific sociological contexts (structural and technical equipment, local policies, expectations and needs) inherent to each country. Concerning the 8-10 years old children, the method and goal are a little different: we chose to carry out a "personality test" in order to obtain information about the children's preferences (scenarios for workshops, robot shape for our robot...).

B.1.c. Dissemination of the questionnaires

The panel of respondents varies from country to country, **due to the way in which questionnaires are distributed to the targets.** For each target, partners worked as follows:

Teachers

France : emailing to the usual contacts and distribution lists of the French partners and academic addresses (professional addresses) of teachers throughout France, to a national professional network of Ligue de l'enseignement (via Slack).

Italy : emailing to teachers and students on a national level, so the network of teachers participating in our courses was used for dissemination. Audience was also reached through social networks, e-mails, training courses, etc.

Portugal : emailing to lists of partners and teachers, national professional network, teacher's and trainer's networks, newsletters, facebook's group, relationships, friends, …

Germany : emailing to lists of partners and teachers, national professional network, teacher's and trainer's networks, facebook's group, relationships, friends, …

Parents and 11+

France : emailing to the usual contacts and distribution lists of the French partners, and to the entourage of partners.

Italy : emailing to the network of training courses for students and courses in museums, social networks, knowledge and partner distribution lists.

Portugal : emailing to lists of teachers and trainers network, facebook's group, relationships, friends, …

Germany : emailing to lists of partners and teachers, national professional network, teacher's and trainer's networks, facebook's group, relationships, friends, …

Stakeholders

Only the stakeholders data was collected differently:

- German, Portuguese and Italian partners have digitally disseminated surveys;
- French, Portuguese and Italian partners realised semi-directive interviews. This method was privileged because they wanted to add a qualitative perspective to the quantitative data collected by the surveys. The aim was to give prominence to the words of the stakeholders, given their position, expertise and understanding of the project is important for the project continuity.

The panel of interviewees/surveyed was chosen as follows :

- Scientific experts
- Research engineers
- Educational experts
- Employees of structures dedicated to digital technology and robotics
- Educational advisors in schools
- Employees of the university research community,
- Etc.

B.2. Teachers

B.2.a. Framework

Questionnaire

32 items divided into 8 themes :

1. Teacher profile (age, gender)
2. Teaching status (length of time teaching, subject taught, number of pupils per class, weekly teaching time, duration of lessons)
3. Geographical area of the school
4. Digital and robotic practices and uses within the school:
   - Digital and robotic equipment
   - Robotics projects implemented in the school
   - What kind of robotics education is offered?
5. Views on digital and educational robotics
6. Participation in robotics projects
7. Ways of using robotic equipment
8. Expectations and needs related to educational robotics

Number of respondents

- France: 74 persons (9%)
- Germany: 111 persons (13%)
- Italy: 266 persons (32%)
- Portugal: 379 persons (46%)

For a total of **830 respondents.**

B.2.b. General remarks

Teachers experience

62% of the teachers surveyed have been teaching for 11 to 30 years :

- **21 to 30 years : 30%**
- **11 to 20 years : 32%**

And :

- 4 to 10 years : 14%
- 31 to 40 years : 17%

So, **if the majority of teachers have been involved in their profession for a long time, it means that the teachers have a real knowledge and insight into educational needs and expectations.**

Age of students

The teachers educate student from :

- 15 to 20 years old : 39%
- Under 8 years old : 19%
- 8 to 10 years old : 22%
- 11 to 14 years old : 20%

All ages and grade levels are represented, with the following tendencies:

- **Italy** has more teachers with students under 8 years of age,
- **Portugal** has a majority of teachers teaching students aged 15 to 20.

B.2.c. Technical and robotic skills

In order to be able to analyse the possibilities of developing robotics projects in schools, teachers were asked: the subject taught, the level of digital practice, the awareness and attraction to the issue of robotics. In this way, it is a question of evaluating the favourability of the field with regard to the implementation and the operationality of the EU-RATE project.

Academic subjects

The majority of the subjects taught are:

- **Sciences (Physics, biology, chemistry…) : 19%**
- **Technology : 18 %**
- **Mathematics :13%**

Then, comes the subject humanities (sociology, economics, law, marketing, etc.) : 6%, and the learning of languages : 6%. **The subjects taught with the highest percentages are those most in line with the skills required for learning robotics.**

(NB: the teaching of theology is not included in the French school curricula)

Use of digital tools

All teachers use digital tools. For **two-thirds of the teachers** (29% are basic users and 35% use digital tools without knowing programming), **their use remains basic**. So, the **last third** (36%) have an **advanced use**. But it's important to specify that this last high rate may be due to the fact that the survey was sent to teachers networks linked to the Scuola di Robotica (Italy) and the Escola Secundária de Barcelinhos (Portugal). These are structures which develop advanced digital and robotic projects (including digital and robotic programmes, computer and/or robotics clubs, participation in competitions).

Educational robotics approach

72% are familiar with the notion against 28%.

In relation to the issue of tools use, and for the reasons mentioned above, the Italian and Portuguese teachers surveyed were familiar with the notion of educational robotics.

- Italy : only **8%** are not familiar with educational robotic
- Portugal : **33%**

In Germany and France, the issue of robotics is less familiar.

- France : 42% are not familiar
- Germany : 44% are not familiar

However, it should be noted that a significant proportion of teachers in both countries are aware of the issue. **Overall, countries seem to be familiar with the issue of robotics, although Germany and France are countries where this notion is less prevalent.**

Interest in the field of robotics

Concerning the prerequisites in the fields of programming and robotics, the answers are varied:

- No prerequisites : 34%
- Basic : 24%
- Sufficient : 27%
- Advanced : 15%

But we can retain the idea that **the majority of teachers have prerequisites (basic to advanced) that can facilitate the development of robotics projects (66%).** The aim is to ensure that the 34% of teachers have basic prerequisites to allow them to understand and develop the EU-RATE project in their schools.

Then, in connection with the previous questions, **it seems logical that the majority of the teachers (62%) are interested in participating in the testing of a new educational robotics kit** (including the teaching sequence).

According to the respondents, the educational field for the implementation of EU-RATE experiments seems favourable. Indeed, the basic digital practices, coupled with the majority desire to develop a robotics project if the material and associated educational content, is provided. The expectations and needs seem to be present : this presages well for the implementation of the project.

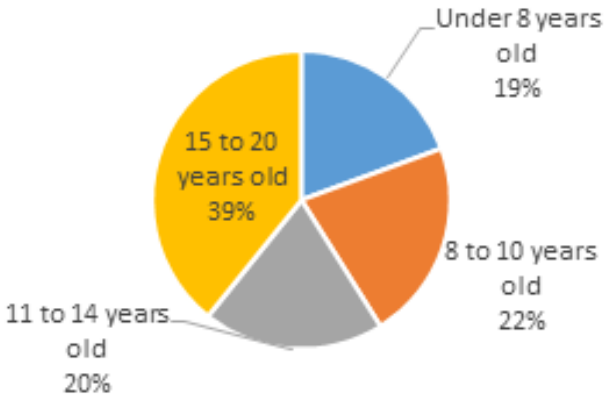
The challenge is to offer a complete robotics kit :

- **including the proposal of a pedagogical pathway accessible and readable for all participants, to fill the unequal prerequisites between teachers;**
- **not requiring any accompaniment and support for the implementation of the robot.**

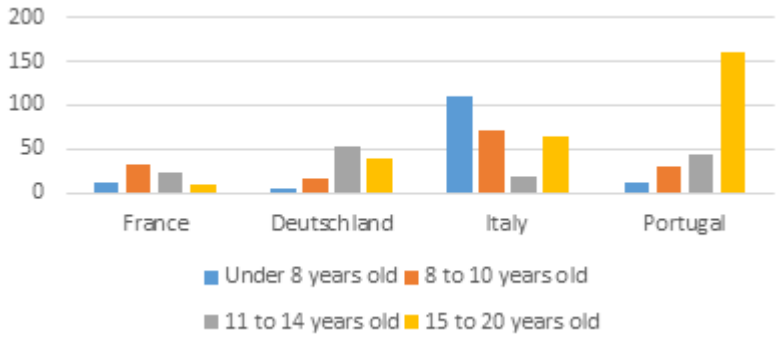
B.2.d. Pedagogical methods

As a reminder, the aim of our study is to know how to integrate digital activities, and more particularly robotics, into the education of children and young people. First of all, we need to know the pedagogical methods of the interviewed countries. We will then be able to propose a global path of pedagogical activities according to the age, the number of students per class, and the time available for each of them, and to integrate them efficiently in the proposed teachings.

In this survey, teachers as a whole address mostly 15-20 years old students (39%), followed by the 8-10 years old age group (22%).



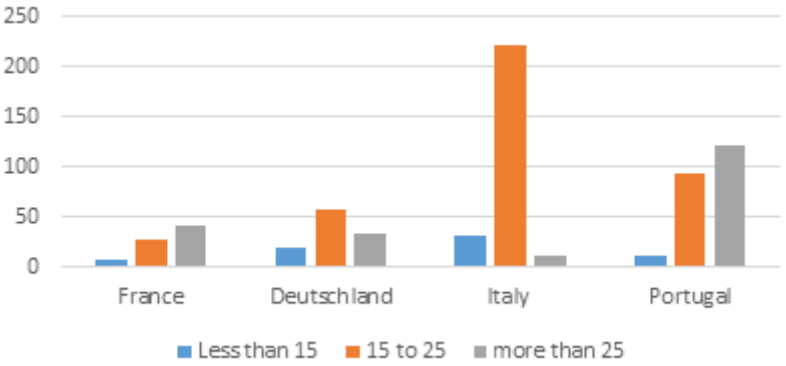
However, disparities appear between the countries surveyed : **Germany and Portugal surveyed teachers have mostly an audience of 11-20 years old, while France and Italy have a target audience of mostly 8-11 years old.**



This information is important to know for a better analysis of the results of the questionnaires. Indeed, the teachers do not all have the same point of view about educational robotics with classes of different levels (remember that school curricula differ from country to country and that robotics education is not compulsory). For our part, our age target is set at 8-10 and 11-14 years. It will be necessary to adapt the sequences according to each age group, its achievement and the educational objectives.

The teaching conditions, like the number of children per class, are rather homogeneous, despite the difference in the age of the pupils. There is a majority of classes with 15-25 pupils (59%) or even more than 25 pupils (31%) in all the countries surveyed.

For the implementation of the workshops, this homogeneity will be a positive asset to propose a workshop adapted to 15-25 students.



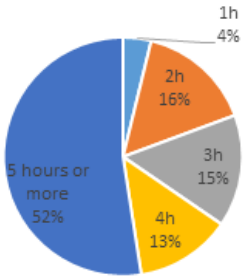
The majority of teachers are in class with their pupils for more than 5 hours in all countries (52%). As seen above, this can be explained by the fact that the teachers interviewed have students between 15 and 20 years old.

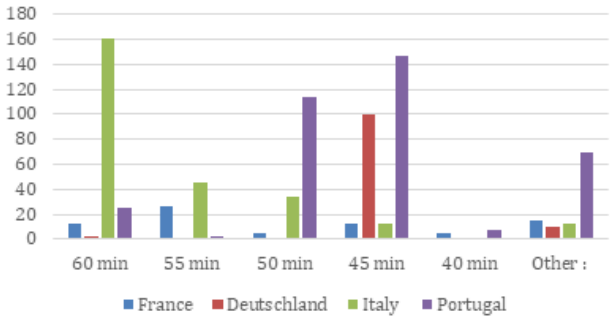
The time of a teaching sequence is mostly 45 minutes (33%), then 60 minutes (24%). For France and Italy, teachers surveyed have mostly primary school pupils (8-11 years old) and are therefore with them every day of the school week. For Germany and Portugal, where the majority of pupils of teachers surveyed are older (11-20 years old), this duration (45 minutes) is explained by the time

allowed to class, divided by subject in a class day (Moreover, the subject mostly taught by the teachers surveyed in Germany and Portugal is science and technology). Italy and France have a longer sequence of 55 to 60 minutes with younger pupils.

Being with students for more than 5 hours allows teachers to know them better, to know their knowledge level and to propose good pedagogical workshops. It also gives the possibility to do several workshops and adapt them during the week, depending on their duration.

Thus, it will be preferable to propose a basic workshop time of 45 minutes maximum to fit all situations. In addition, we might propose modules "to go further" of 15-20 minutes if teachers have extra time.



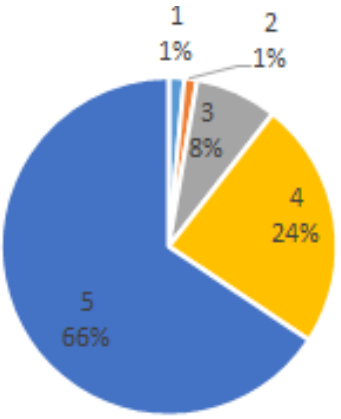


B.2.e. Robotics at school

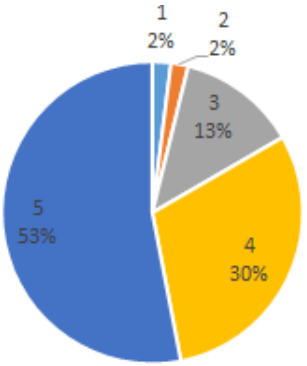
General approach

In order to determine the general opinion of teachers towards new technologies and robotics as a subject and teaching tool, our questionnaire proposed several targeted questions. Indeed, this type of information allows us to know if teachers are rather receptive to these practices or if they are reluctant to these new tools. This can challenge the methods and uses, in everyday life and in the classroom. It is important for the writing of our pedagogical pathway but also in the creation of training and support tools.

Overall, the responses indicate a generally favourable opinion. Firstly, with regard to the new technologies: 66% of teachers in the four countries thought that it was extremely important to teach them (5 out of a maximum score of 5) and 24% that it was very important (4 out of 5), i.e. 90% of the respondents spread over these two proposals.

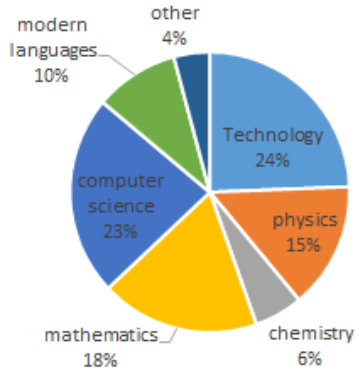


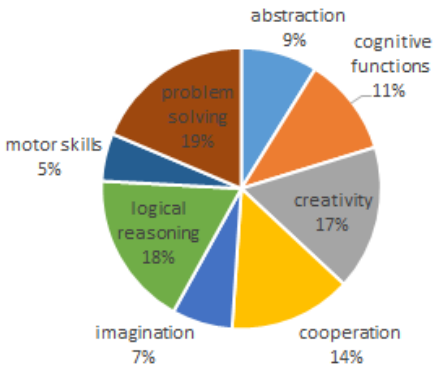
Secondly, a question was asked about the motivational leverage that robotic tools can provide for classroom learning, and the opinions were rather unanimous: **53% of the respondents said that it was an extremely important motivational leverage (5 out of a maximum score of 5), while 30% said that it was a very important motivational leverage (4 out of 5),** and 13% that it was important (3 out of 5). 96% of the respondents therefore agreed that robotic tools help to motivate students.



Regarding teaching practices, we wanted to determine the subjects in which teachers considered that robots could facilitate learning. The results show that **robotics can be useful in science subjects** (24% for technology, 23% for computer science, 18% for mathematics), but also in humanities (10% for foreign language) or other subjects (4% for "other", such as sports, native language and history, which came up several times).

If we put mathematics (18%) and foreign languages (10%) in parallel, we can see that the gap between the two answers is not so wide, while the link with mathematics is more obvious at first sight. We can therefore deduce that robotics is useful for science subjects (86%), but is not disconnected from other subjects (14%) and its use can be cross-curricular.





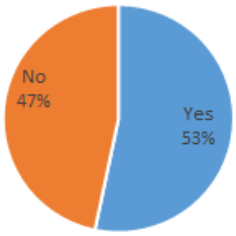
Finally, in correlation with the previous question, we wished to survey the teachers regarding the skills developed by students during robotics lessons. The teachers could tick several answers on the proposed panel: **“Problem solving" (19%) and "logical reasoning" (18%) came out on top** - the most obvious skills related to robotics - but creativity followed closely (17%), as well as cooperation (14%) and cognitive functions (11%).

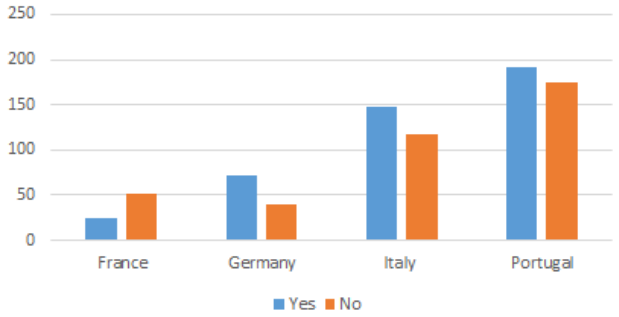
These results show that teachers see an opportunity in robotics to develop soft and hard skills in their students.

Robotics projects

In order to define the share and type of robotics activities in schools in our four countries, we proposed a number of questions. The final objective was to know the uses in order to propose adapted contents and resources. Question D15 asked the respondents to answer if their schools organised educational robotics projects. The answers obtained show that, **overall, the majority of the respondents in the four countries were in favour of robotics (53%)** and that only France had a majority of "no" respondents (67% out of all French respondents).

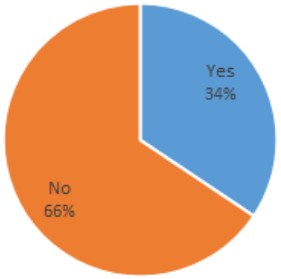
We could deduce that it will be easier to integrate German, Italian and Portuguese classes to carry out our tests and that our productions will be more used in these countries, but we must nevertheless remain cautious: these answers may be biased because the French panel is less substantial and therefore less representative, composed of many primary school teachers. In fact, there are some truly innovative approaches by teachers in France, but the lack of equipment and training can be a barrier to extending these practices. Nevertheless, surveyed french teachers responded massively that they wished to be kept informed of the progress of our project and to host tests in their schools. This proves awareness-raising, communication and dissemination will have to be carried out with greater attention in France (more time and resources).

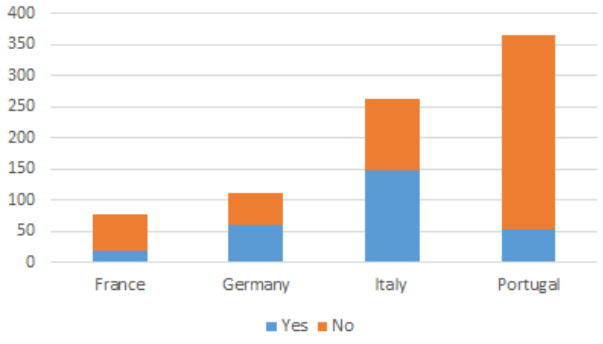




When correlated with question D23 which asks about teachers' liabilities towards robotics projects, the answers are more negative (66% of no). **Teachers may be aware of robotics projects at school but not be at the origin or involved in the project, or there may be no such activities at all.** But the striking differences between countries can skew the figures: for the Portuguese panel, only 15% of respondents ticked "yes", while in Italy it was 57%, in Germany 53% and in France 25%. **Thus, one has to be cautious on the interpretation. Even if one can deduce that more Italian and German teachers are involved in robotics projects than French and Portuguese teachers; and therefore potentially more Italians and Germans trained and comfortable with the subject.**

There is probably a correlation between the fact that teachers in Germany and Italy are part of networks connected to the partners in charge, and therefore are more advanced on robotics projects. This does not represent the whole of Italy or Germany but specific cities and regions**.**

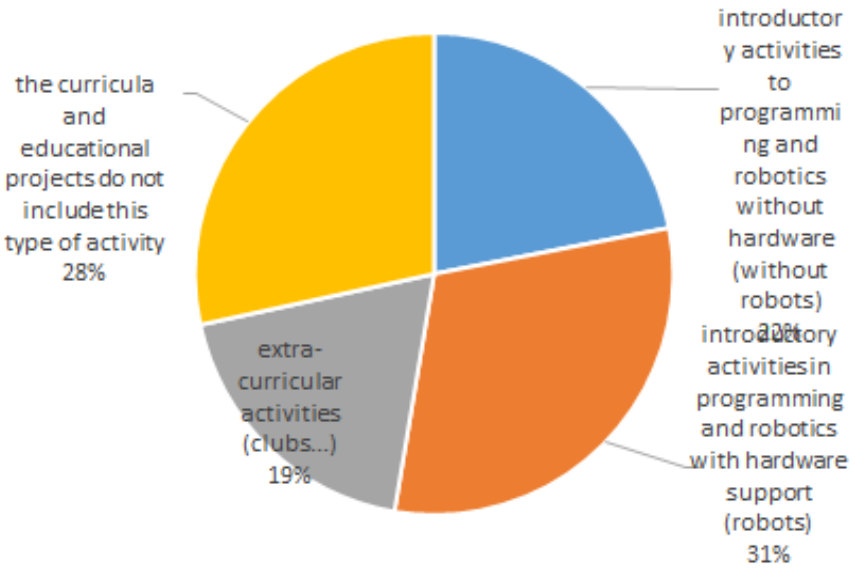




And when teachers were asked about the use of robotics kits (question D20), 55% said yes against 45% of no: this confirms the previous results.

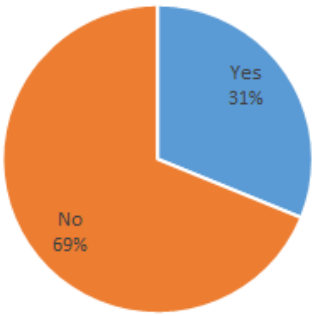
Question D16 specifies the type of robotics and programming activities proposed: 31% propose robotics activities with a robot, 22% propose programming activities without a robot, 19% propose extracurricular activities (clubs) and 28% declare not to propose this type of activity.

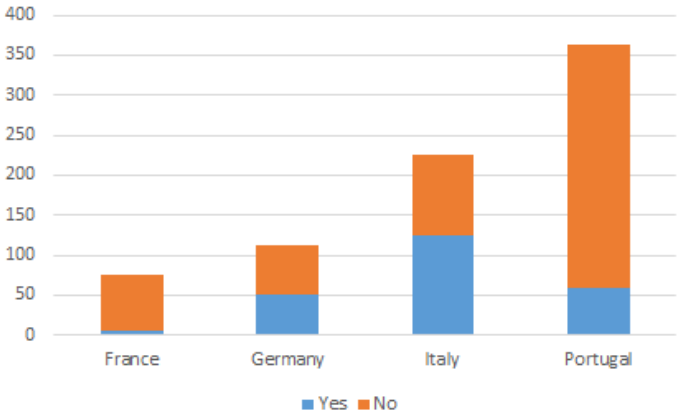
The answers reflect a majority of activities (72% offer robotics and programming activities, in school or extracurricular time). The number of respondents in the extracurricular field is interesting (19%) and invites us to propose contents adapted to school and extracurricular time.



Finally, as several organisations in our consortium are involved in the FIRST LEGO league, the RoboCupJunior or other robotics competitions, we asked teachers about the use of their robotics kits in competitions (D21). 31% of the respondents indicated they participated in competitions: in detail, only Italy had a higher number of "yes" than "no" votes (55% yes). Italy is very involved in the FIRST LEGO League during school time. Germany is more moderate, while France and Portugal have a majority "no" vote. It is worth remembering that for the past 2 years the RoboCup (international event) has been subject to cancellations and postponements due to the COVID-19 crisis, with many teachers not signing up for fear of the event being cancelled. This has had an impact on the number of responses from the Germans, Portuguese and French, who are normally very active (Portugal and Germany are organisers of the Open Europe, France of the international competition in 2023).

As competitions are often considered as motivational levers (I-B.5), it could be interesting to promote them further, maybe by facilitating the transmission of information and participation through our project. Moreover, the organisation in 2023 of the RoboCup in Bordeaux (France) is a real opportunity that will offer new perspectives to the EU-RATE project and teachers .



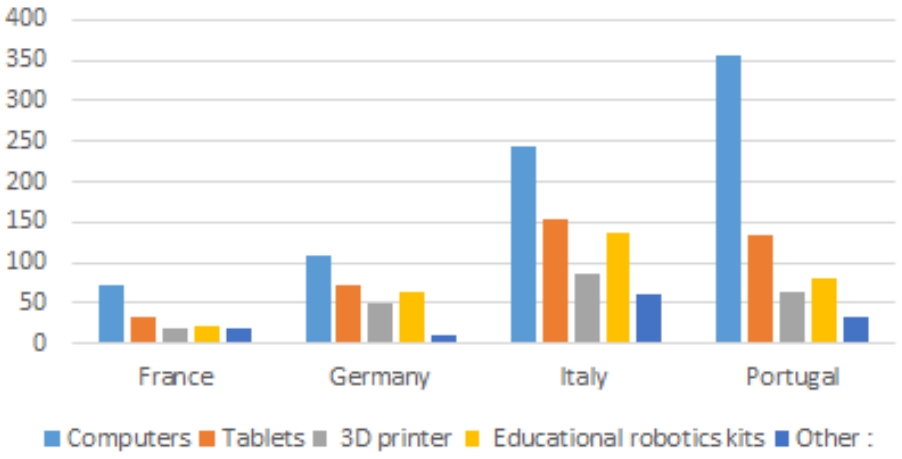


Material used and needs

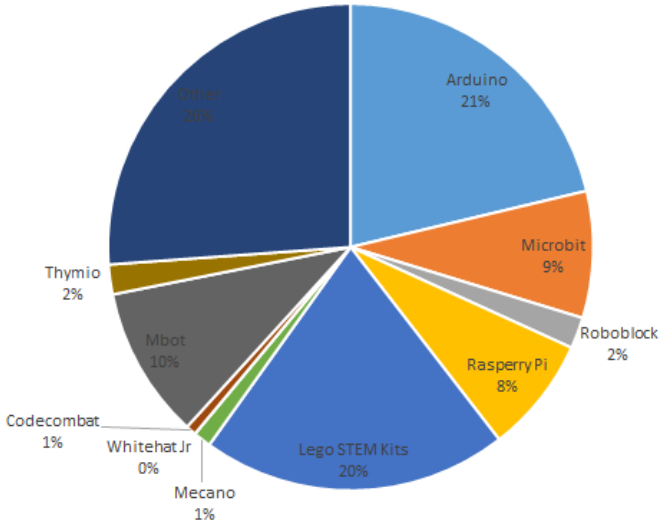
As our project aims at proposing a turnkey robotics kit, we wanted to make an assessment of the existing equipment in schools, whether it is computer or robotics, and its positive and negative aspects, and the possibilities of it.

The teachers state that the majority of schools are equipped with computers (95%), tablets (47%), robotics kits (36%) 3D printers (27%) and other tools (15%). Interactive digital boards, video projectors, etc. were not mentioned as proposals, but we can easily imagine that they are present in the majority of secondary schools. **We can also assume that the degree of equipment varies according to the school level, taking into account that 18% of our general panel teaches in primary schools.**

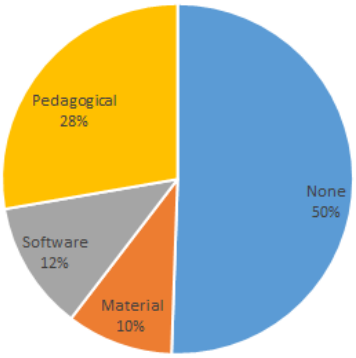
We will therefore have to favour the computer as the programming medium for our robot, as almost all schools have one.

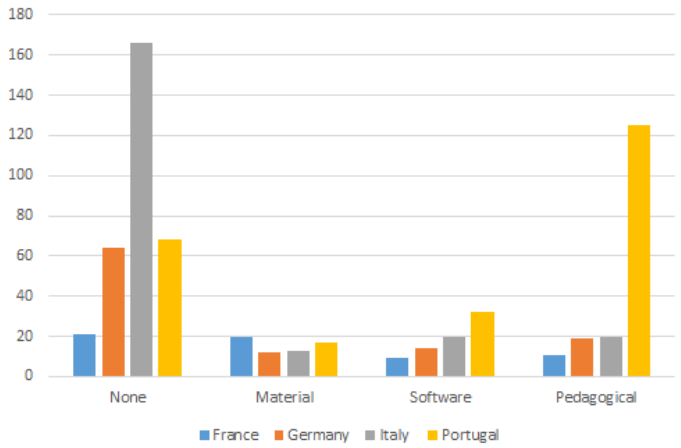


For teachers using robotics kits or offering programming, we find that **the most used interface is Arduino (21%) followed by Lego (20%), then Mbot (10%) and Microbit (9%).** Comparing the number of respondents by country, we see that the largest number of Lego users come from Italy (45% of teachers introduced to Lego) while the largest number of Arduino users come from Portugal (37% of teachers introduced to Arduino). For French teachers, the highest response rate is on Mbot. So there are definitely trends by country. The most ticked response proposal is "other" but unfortunately the open response option did not work so we have no further information.

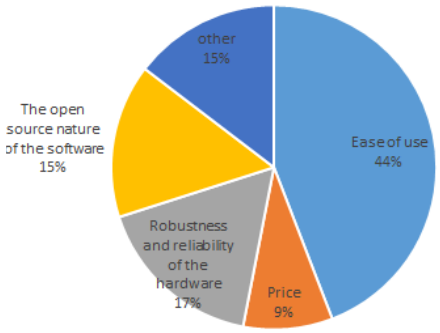


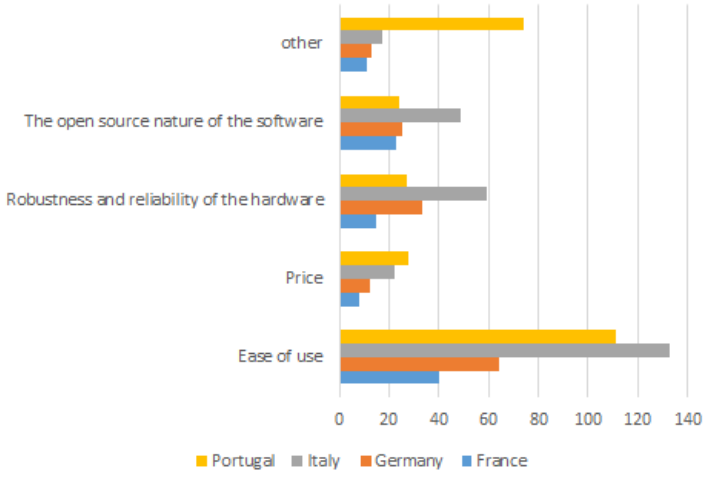
In order to limit the difficulties encountered by teachers when using our kit, we asked about the main source of difficulties encountered (question d25): 50% of the respondents indicated that they had not encountered any particular problems, 28% pedagogical problems, 12% difficulties in using the software and 10% hardware problems. However, caution should be exercised as the number of Portuguese respondents on pedagogical issues is very high. **It is therefore important to provide Portuguese teachers with turnkey pedagogical solutions as this is their priority, when pedagogical, software and hardware issues are fairly equivalent in other countries. Our solutions will have to address these 3 issues.**





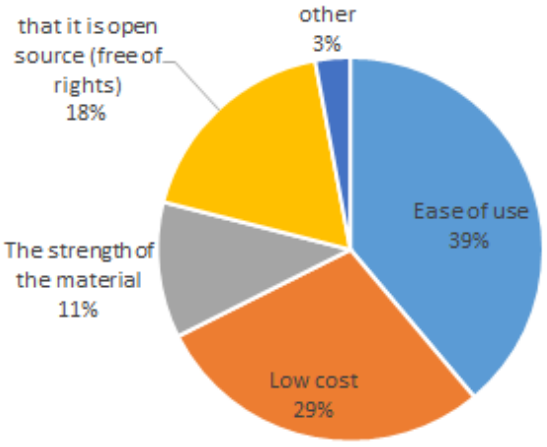
In order to highlight the facilitating aspects of the robotics kits, we asked the teachers about the positive points of the hardware and software solutions they had experimented with (question D29). **The positive aspect identified by a large majority is the ease of use (44%), followed by robustness (17%) and open source (15%)**. Price came last, indicating that the kits used are not sufficiently accessible.



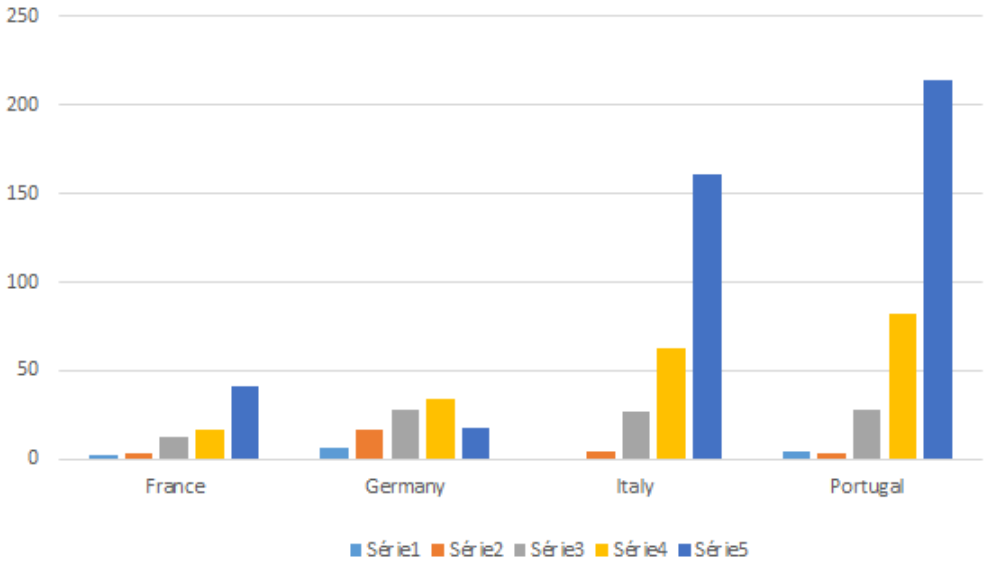


Teachers expectations

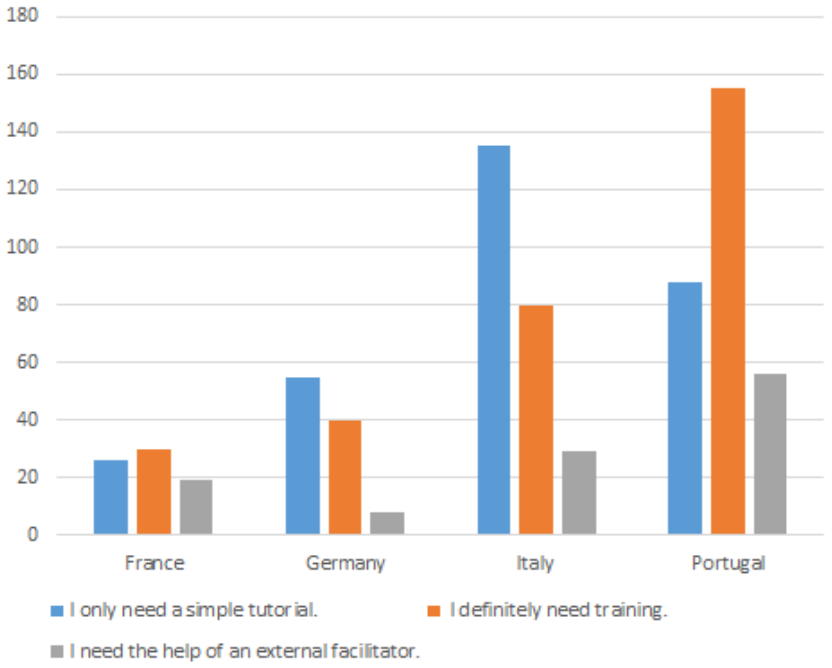
We can compare these results with those of question D30, which asked about **teachers' expectations of hardware and software solutions: ease of use comes first (39%), then low cost (29%).** This highlights the stumbling block between ease of use and affordability in the current offer and gives us the objective of meeting these two expectations together. The Open Source aspect comes in 3rd position (18%) then robustness in 4th position (11%). **This shows us that the open-source aspect is important for teachers even if it does not exceed the prerequisite of ease of use and low cost.**



Question D31 was concerned with the ethical aspect of the proposed tools (environmental, social, etc.): apart from the German respondents, the ethical aspect was very important for the Portuguese, Italian and French teachers, who gave a majority score of 5 on a maximum scale of 5. This confirms the previous results concerning Open Source (question D30), but also tells us, among other things, that **it is necessary to pay attention to the origin of the materials and, if personal data are processed, that they are secure (General Data Protection Regulation).**



In order to best support teachers in their practices, we surveyed teachers on their degree of autonomy in relation to the use of robots in the classroom. **The results are perfectly equitable between the proposal of a tutorial or training: the divergence is based on the country of origin: while the Italians and Germans need a tutorial as a priority, the Portuguese and the French rather need training**. 16% of respondents would like an external speaker. What we don't know is whether an online MOOC-type training is sufficient or whether they need face-to-face training. **In any case, our productions should meet the demand for sufficient resources (paper tutorial, video tutorial, online training, face-to-face training, etc.)**



Concluding note

Subjects taught

- The subjects taught with the highest percentages are those that best match the skills required for learning robotics, namely science, mathematics and technology.

Use of digital tools

- Two thirds are basic users (use digital tools without being aware of programming), the last third does some programming.

Approach to educational robotics

- 72% are familiar with this notion against 28% (French and German teachers surveyed are the ones less familiar)
- Concerning the prerequisites in the fields of programming and robotics, the answers are varied: 34% have no prerequisites, 24% have basic notions, 27% have sufficient notions and 15% have advanced notions.
- The majority of teachers have prerequisites (from basic to advanced) that can facilitate the development of robotics projects (66%). The objective is to ensure that the 34% of teachers that have no prerequisites achieve the basic level, to enable them to understand and develop the EU-RATE project in their schools.

Pupils

- Teachers mainly address pupils aged 15-20 (39%), followed by the 8-10 age group (22%).

For France and Italy, teachers have pupils in primary school (8-11 years) and are therefore with them every day of the school week. For Germany and Portugal, where the majority of pupils are older (11-20 years), this is due to the subject taught by the teachers, which is science and technology.

It will therefore be necessary to adapt to the maturity of the children for a good understanding of the proposed robotics workshops.

Workshop format

- The duration of a teaching sequence is mostly 45 minutes (33%), then 60 minutes (24%).
- The most suitable format for robotics workshops should be for an average of 15-25 students.

Opinion on robotics in schools

- Overall, the responses indicate a generally positive opinion. 53% of the respondents said that it was an extremely important motivational tool and 30% said that it was a very important motivational tool.
- Robotics is said to be useful in science subjects but with a big potential of transversality.
- Teachers see robotics as an opportunity to develop their students' soft skills (problem solving, thinking creatively, working on a team, active learning...)

NB: Italian and German teachers are more involved in robotics projects than French and Portuguese teachers. Italians and Germans would therefore be better trained and more comfortable with the subject.

Robotics education activities

- The responses reflect a majority of activities organised by teachers (72%) involving robotics and programming, either in school or extracurricular time. The number of respondents in the extracurricular field is interesting (19%) and invites us to propose contents adapted to school and extracurricular time.
- Participation in competitions is seen as a motivating factor. It could be interesting to further promote the competition axis by facilitating the transmission of information and participation through the EU-RATE project.

Materials used

- The teachers state that the majority of the schools in which they work are equipped with computers (95%), tablets (47%), robotics kits (36%) and 3D printers (27%).
- The most used programming interface is Arduino (21%), followed by Lego (20%), Mbot (10%) and Microbit (9%).

Expectations

- Teachers are primarily interested in turnkey educational solutions, whereas the pedagogical, software and hardware issues are fairly similar in the other countries. EU-RATE will have to respond to these 3 issues.
- Teachers' expectations of hardware and software solutions are primarily ease of use (39%), followed by low cost (29%). The open source aspect is important for teachers even if it does not go beyond the prerequisites of ease of use and low cost.
- In connection with the ethical issue, it is necessary to be careful about the origin of materials and security of personal data..

B.3. Parents

B.3.a. Framework

Questionnaire

22 items divided into 5 themes

- Profile of the respondent (age, gender, number of children, location area)
- Profession and use/practice of robotics and digital technology in the professional field
- Interest in digital and robotic fields
- Digital and robotic equipment in the home
- Type, budget and time dedicated to family activities

Number of respondents

- France: 50 persons
- Germany: 41 persons
- Italy: 116 persons
- Portugal: 181 persons

For a total of **388 respondents**

B.3.b. General remarks

As EU-RATE aims to include parents in robotics education, the aim is to evaluate their opinions and uses in order to understand their support and involvement in the project digital education of their children.

As a reminder, the EU-RATE robotics kit and manual must be **readable, usable and accessible** to all targets (teachers, parents, children), and also to the general public (anyone who would like to use it).

Profile of respondent

Respondents in each country have similar proportions of professional status: a majority of employees (47%), followed by civil servants (33%), then the self-employed (13%), and finally the other cases such as retired and unemployed (7%).

With regard to the number of children, the majority of respondents in all countries had between **one and two children (31% and 57% respectively**), which also corresponds to the European average of 1.56 children per household.

Digital skills

89% of the respondents use digital tools in their work. Given the fact that digital tools are mostly used in the professional context of parents, it can be expected that parents will support or promote educational robotics projects in the extra-curricular context.

This is confirmed by the question “How important do you think it is for your child to learn about robotics and programming at an early age?”

On a scale of 1 (not very important) to 5 (very important), the responses are:

- **40% of parents think that learning about programming and robotics is very important**
- **31% of parents think it is important.**
- The remaining third of the parents feel that it is not very important (24%) to not at all important (3%).

B.3.c. Robotics at home

Use of digital tools

To understand and adapt educational sequences linked to robotics, it is necessary to take in account the use of digital tools

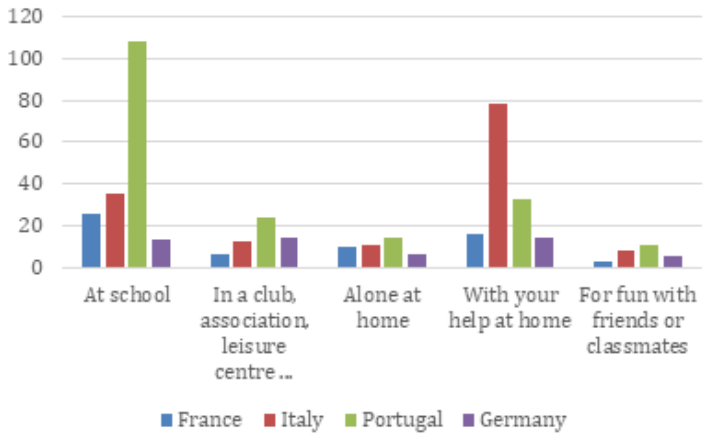
- within the family unit,
- in the school environment,
- in the extra-curricular environment.

According to the parents surveyed in all countries, the majority of children are equipped with their own computer (64%). This result is greatly enhanced by the responses from Portugal, where 90% of them are equipped, and Germany with 74%. Italy and France are only 34% equipped individually. This disparity is also due to the age of the parents surveyed children, who are much younger in these two countries (8-12 years), whereas they are between 11 and 20 years old in Portugal and Germany parents' survey.

Children are generally well equipped and robotic activities are well present in their lives in the four countries surveyed. In fact, for these two questions, equipment and robotic activities, the results are identical with 64% of personal equipment and 64% of practice. Portuguese parents surveyed are very invested in these practices.

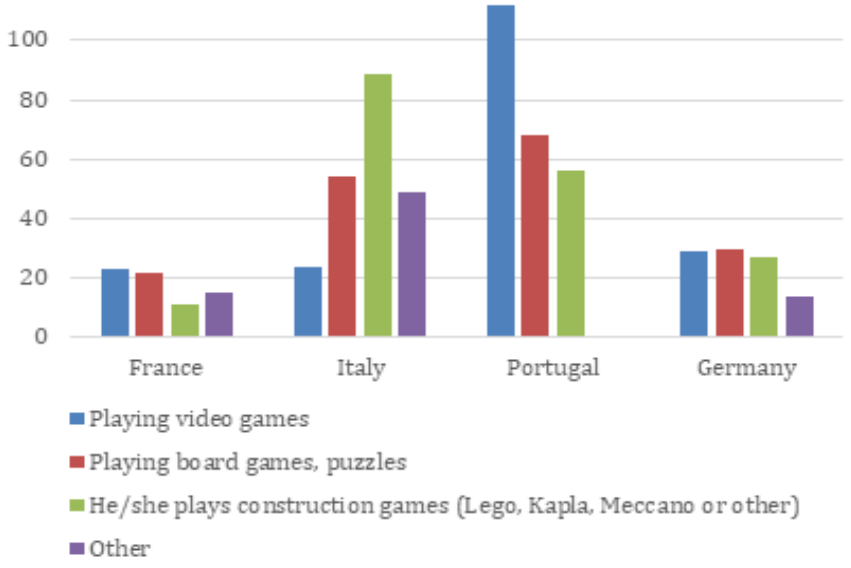
Organisations of the child's time and parents involvement

For all countries, the majority of digital education takes place at school (41%) and then at home with the help of parents (32%). Germany is noticeable for its more developed practice in associations, clubs and extracurricular activities. This difference is explained by their school rhythm, with afternoons devoted to these extra-curricular activities.



The majority of children prefer video games (30%) followed by construction games and puzzles (29%) board games (28%)

Italy stands out with a 41% preference for construction games, while the other countries tend to prefer video games. These activities are quite favourable to the interest in robotics (link with the digital tool, construction of the robot...) Furthermore, we will have to draw inspiration from this for the scenario of the activities, the methods ....

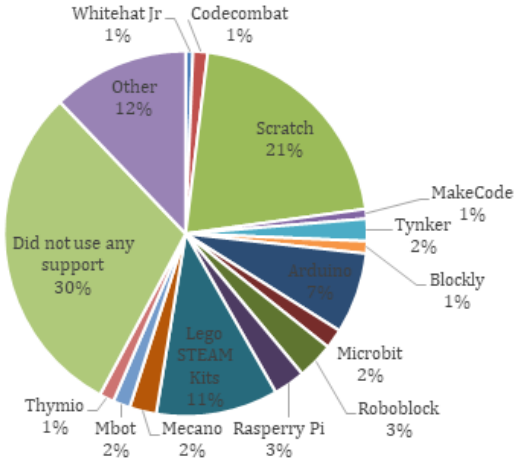


Concerning the average amount of time parents have available per week for homework help, **all countries are homogeneous, with more than 2.5 hours (43%) and between 1 and 2.5 hours (33%). They make themselves available to follow the schooling. We can then deduce that they may also have time to help their children discover or accompany them in a robotics activity.**We have observed that robotics is not currently part of the school curricula. However, it is at school that they most often do digital and robotic activities. It is therefore interesting to see how robotic sequences could be proposed in the free time of children and parents, and how to build these sequences according to their preference to be attractive and motivating.

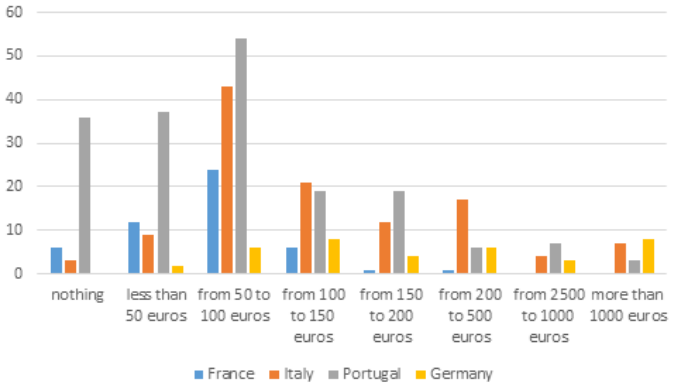
For the majority of the parents questioned, they spend more than 2.5 hours a week sharing leisure activities with their children (71%). These results are homogeneous in all the countries surveyed.

Hardware, software and parents' budget

The use of Scratch is the most common medium (21%) followed by the Lego steam kit (11%).



As with any innovative activity, there is a question of budget for the education of these technologies. The results of the survey are homogeneous for all countries. **Parents are prepared to spend an average of €50-100 per year (33%).** But a good majority are not ready to invest more than 50€ (15%).



The budget remains low for activities that are expensive, especially for the equipment that must be used.

Finally, the question below asked about the presence of robotics in the school curriculum. The majority of no's at 57% shows that parents are not necessarily aware of what is going on at school and believe that the school curriculum is not always respected, due to lack of means, time.

Still with the aim of proposing adapted sequences, it is then necessary to study the budget share for all leisure activities. **We can see that this budget breaks down equally between 200-400€/year (35%) and 400-1000€ (34%) for all countries. However, we must take into account the share of the robotics budget for teaching, which is on average between 50-100€/year (33%).**

Concluding note

Digital skills

- 89% of the respondents use digital tools in their work. As digital tools are used in the professional context of parents, it can be assumed that parents would / could support or encourage educational robotics projects in the extracurricular context.

Use of digital tools at home

- In the families surveyed, children are mostly equipped with their own computer (64%).
- Robotic activities are rather present in the lives of children in all four countries surveyed.

Dedicated budget

- Parents are prepared to spend an average of €50-100 per year (33%)

Other activities

- The amount of time dedicated to accompanying children schooling is more than 2.5 hours (43%) and between 1 and 2.5 hours (33%).
- The majority of parents surveyed spend more than 2.5 hours a week sharing leisure activities with their children (71%).
- It can thus be assumed that parents may have time to introduce or accompany their children in a robotics activity.
- The majority of children prefer video games (30%), followed by construction games, puzzles and board games (29% and 28%).

Activity budget

- The budget for activities ranges from 200-400€/year (35%) to 400-1000€ (34%) for all countries.

B.4. Young people 11+

B.4.a. Framework

Questionnaire

21 items divided into 4 themes

- Profile (age, gender, discipline favourite school subject)
- Interests and opinions on robotics and digital topics
- Knowledge and skills in computer programming
- Robotics project experience (learning styles and tools used)

Number of respondents

- France: 39
- Germany: 52
- Italy: 305
- Portugal: 89

For a total of **485 respondents**

By interviewing pupils/students aged between 11 and 20 years old, the aim is to find out the overall level of knowledge, uses and digital practices of young people. Based on the information collected, the aim will be to propose a suitable and accessible kit to all ages and levels of young people, but also respond to the desires and expectations identified.

B.4.b. General remarks

The majority of survey respondents are between 15 and 20 years old.

- 11-14 years old: 24%
- 15-20 years old: 76%

It should be noted that the high rate of the respondents of 15-20 years old is due to the high participation of young Italians in the questionnaires. **Two thirds of the respondents (66%) were young men.** This figure is consistent with the respondents for all respondent countries.

Favourite school subjects

In order to promote its learning, it is therefore important to combine it with existing school subjects. In this respect, it seemed relevant to ask young people what their favourite subjects were at school.

The subjects identified as favourites by the respondents are:

- Mathematics 21%
- Sciences 22%
- Sport 20%

Languages (12%), literature (8%), arts (7%) and other disciplines remain in the minority.

Robotics requires cognitive activity in context, related to the development of critical thinking, problem solving strategies and mathematical skills. Being able to combine school subjects with an educational robotics project can therefore be complementary.

Digital /robotic skills

As computer programming and robotics require basic construction skills, the consortium looked at the type of activities young people do. When asked if they like to play construction games, **77% responded positively**. At the same time, **76%** of the young people answered that they liked technological and construction games. More specifically, they indicated that they have the following games at home:

- Legos 35%
- Remote control cars 22%
- Drone 17%
- Puzzles 3D 12%
- Robots 9%

In addition, **48% think that robots are fascinating, and 35% find them fun.** Other answers:

- 8% who do not seem interested in the subject
- 2% say they are afraid of it.
- 9% say other (without precising specifically)

Thus, it can be deduced that the majority of respondents have the basic skills needed to learn robotic and digital programming. Their interest in building and logic games, but also the favourite subjects mentioned (such as science or maths), are important positive points for the possibility of developing a robotic education project with them.

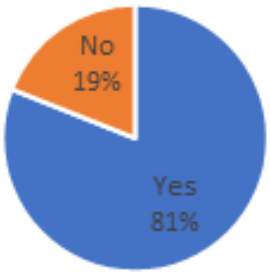
In view of the large number of young men respondents, the challenge will also be to mobilise and raise awareness among young women, who are the minority in this survey.

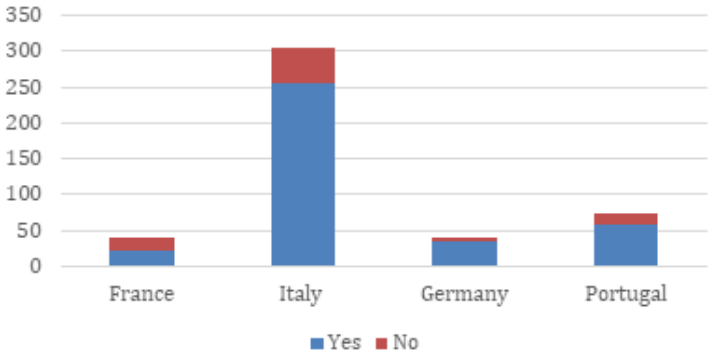
B.4.c. Robotic experience

Interest in robotics

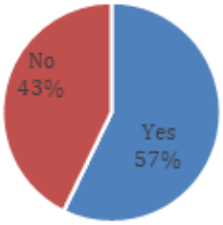
With the aim of proposing educational sequences on robotics, our study with our partners is now focused on the real experimentation of each one. It is useful to know if they have an interest in building and if so, have they already built and how.

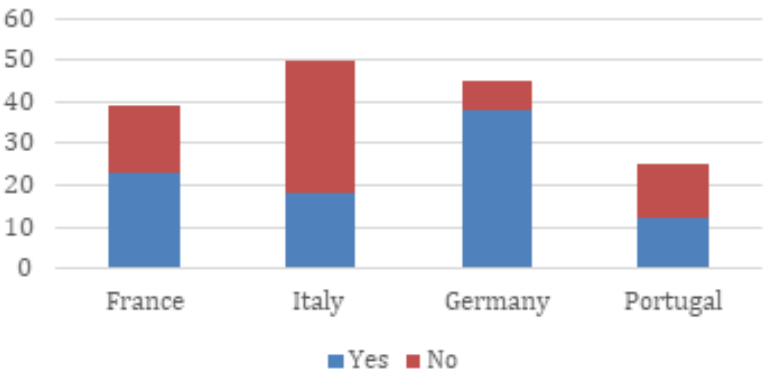
There is a strong interest in construction with 81%, even if it can be noted that France obtains a half-tone result, with as many yes as no votes.





All of the pupils questioned are curious about learning to build, with a total of 57%. On this point, Portugal is more balanced, with an equal number of yes and no answers. But we also see that Italians, despite a strong interest in construction, have no desire to learn how to build.

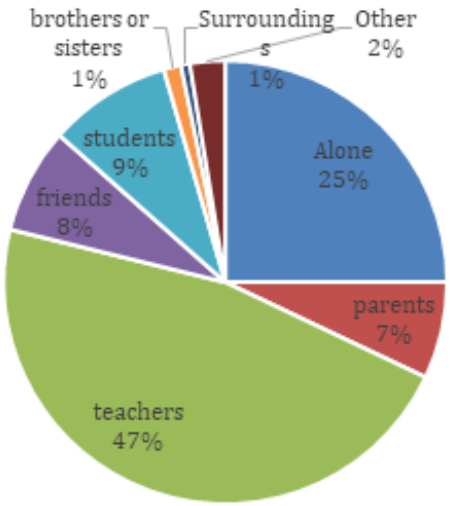


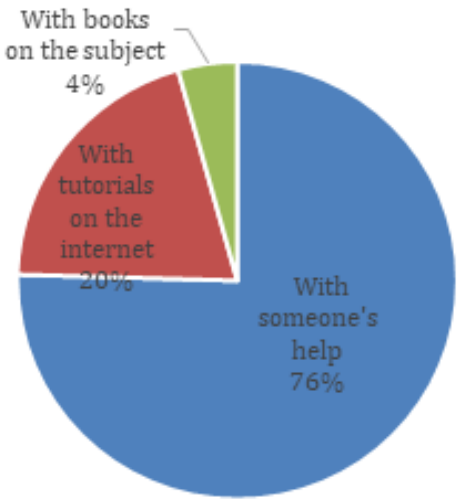


This interest in construction could correspond to the fact that most of them have not yet built a robot (68%).

Only 25% of them would like to learn on their own, the majority would like to learn in collaboration with a physical person (teachers - parents - friends - brothers/sisters...)

Face-to-face classes are therefore the ones to be prioritised in order to obtain good motivation during the proposed robotics workshops.





Robotic programming

We saw earlier that most of the young people had not yet built a robot, but that this activity was very attractive to them.

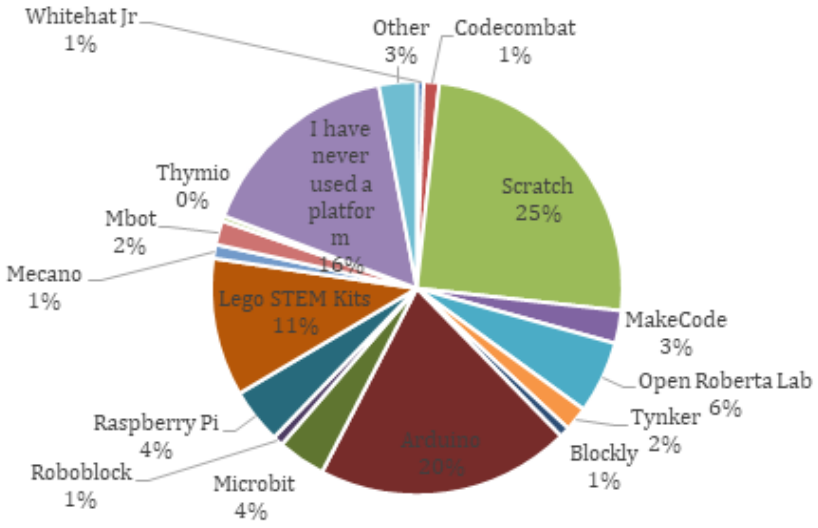
55% have not yet done any programming **but they are very interested in learning (81%) and for a majority of them with their teachers (42%).** The results of the survey are homogeneous between all countries, as is the case for robot construction.

The respondents enjoy learning with the help of a person (69%), which they consider to be the best learning tool. The results are homogeneous across all the countries covered by this study.

Specifically, we observe that the respondents prefer to learn how to build and program **with a teacher, a tutor, a trainer (52%), followed by internet tutorials and classmates (12%).**

For those who have already programmed (45%), most of them did so with block programming (36%) or with C language (Arduino, RobotC 32%))

Finally, **for those who have already tried coding, 25% have done so on the Scratch platform and 20% on Arduino**. But we can also see that 16% of them have not used any platform.



Concluding note

Profile and teaching subjects

- Two-thirds of the respondents (66%) are young men, with the age ranges split between: 11-14 (24%) and 14+ (76%)
- The subjects identified as favourites by the respondents are : mathematics (21%), science (22%), sport (20%). Languages (12%), literature (8%), arts (7%) and other subjects remain in the minority.

Digital /robotic skills

- When asked if they like to play construction games, 77% responded positively. At the same time, 76% of the young people answered that they liked technological and construction games.
- 48% of them think that robots are fascinating, and 35% find them fun.

Interest in robotics

- There is a strong interest in robot construction: 81%. This interest in construction could correspond to the fact that most of them have not yet built a robot (68%).

Notion of programming

- For 55% of them, they have not yet done any programming but they are very interested in learning (81%) and for a majority of them with their teachers (42%).
- 45% of the 11+ who have already programmed (45%) did so via block programming (36%), or C/C++ with Arduino and RobotC (32%).

Learning about robotics

- Pupils want help from someone (69%): a teacher, tutor, trainer (52%), followed by internet tutorials and help from classmates (12%).
- Students who have already tried to code have done it with the Scratch platform (25%) and Arduino IDE or Ardublock (20%).

The majority of respondents seem to have the basic skills needed to learn robotic and digital programming. Their interest in construction and logic games, but also the preferred subjects mentioned (such as science or mathematics), are important positive points for developing a robotics education project for and with them.

The preferred learning modalities for robotics are face-to-face and adult or peer support.

In view of the large number of young male respondents, the challenge will also be to motivate and offer training and professional guidance for young women, who are underrepresented in this study.

B.5. Stakeholders

Method

As indicated in the framework note, two methods were chosen for collecting the views of the stakeholders :

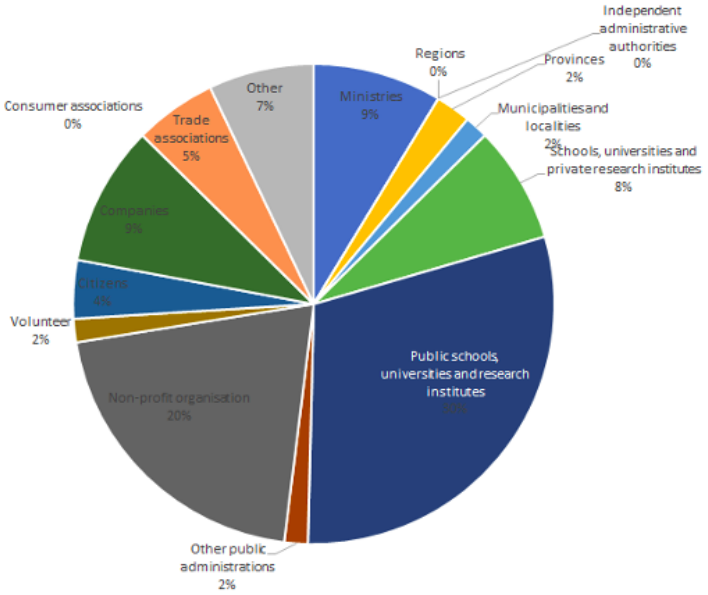
- 125 questionnaires completed
  - 17 in Germany
  - 59 in Portugal
  - 49 in Italy
- 21 stakeholders interviewed (18 in France, 2 in Italy and 1 in Portugal[6]),

The two methods complement each other in terms of analysing the figures and obtaining qualitative content.

Profile of the respondents

- **Majority aged 41-54**
- **Equal distribution of men and women**
- **majority from public schools, universities or research bodies (30%)**
- **associations (20%)**
- **ministries (9%)**
- **Companies (9%).**

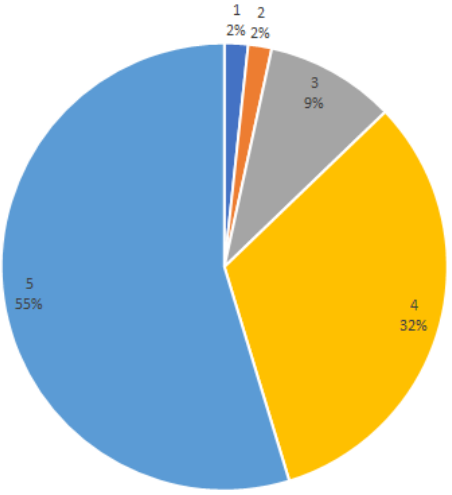
The distribution by country alerts us to the diversification of the panel surveyed: 81% of the people from public schools, universities or research bodies and 90% of the people from ministries are Portuguese, 77% of the people from associations are Italian... The distribution is not equitable in Italy and Portugal, as the questionnaires were certainly sent out through the networks of each structure. The German panel is smaller but better distributed.



[6] See the profile of the interviewees in annex

B.5.a. Facilitating robotics

The majority of the experts were unanimous about the facilitating effect that robotics can have on complex concepts (question d6): 55% gave a score of 5 out of 5, while 32% gave a score of 4 out of 5. They consider that robotics can be "stimulating", "engaging" and "innovative" (question d8). The French experts interviewed in the framework of the structured interviews were also unanimous about the facilitating and motivating lever " "*Robotics is a great learning lever for students. [...] The attractive, playful aspect of the object is a plus for me and at each session the gamble is won. It is motivating when you are a trainer or teacher. It works well with students who are having learning difficulties [...]*" (Caroline Sulek, Canopé Gironde[7]).



Robotics also allows theoretical concepts to be transposed in a concrete way, but also to manipulate:

"Pupils like to tinker with things, tinker with systems, make motors move, it's very rewarding when it works. [...] Children like to manipulate, robotics couples that with thinking, logic and planning". (Vanessa Mazzari, Generation Robots[8])

This approach of experimentation, trial and error, ultimately encourages Do It Yourself, and thus the autonomy of people with regard to everyday problems. "*It's a fight against oneself, you get angry, you get annoyed, it's the school of robotics, testing yourself in your intellectual and physical resources.*" (Stéphane Brunel, teacher-researcher at the University of Bordeaux, Co-chair RoboCupJunior[9])

[7] Canopé: Strengthening the action of the educational community in favour of student success: this is the founding mission of Réseau Canopé. As a public operator present throughout France, Réseau Canopé plays a decisive role in the refounding of schools by intervening in five key areas: pedagogy; digital education; education and citizenship; arts, culture and heritage; and documentation. The Canopé network is involved on a daily basis with education stakeholders, placing its expertise at the service of those who work every day for the success of all students.

[8] Génération Robots distributes technological equipment in the field of service robotics. Present in France and Germany, Génération Robots is today one of the major players in the distribution and consulting of service robotics in Europe.

[9] *RoboCup i*s an international scientific initiative and event with the goal to advance the state of the art of intelligent robots. *RoboCupJunior* is a project-oriented educational initiative that sponsors local, regional and international robotic events for young students.

It also reverses the teacher/pupil relationship: "*It is not the teacher who says whether it is good or not, it is the rob*ot *that does or does not do it. The fact that it is the machine, there is a neutrality in the relationship*" (Emmanuel Page, national coordinator of the TNE project[10], Canopé)

B.5.b. Subjects and cross-cutting approach

Concerning the subject in which, in the experts' opinion, robotics should be taught (question d9): science subjects are in the majority (technology 18%, science 14%, mathematics 14%, i.e. 46% of the answers alone), the general pre-primary and primary school curricula (19%) and then as part of the acquisition of practical and vocational skills (9%) or even art (7%).

In Italy, *"For the Ministry, educational robotics is very important because it is an interdisciplinary course that involves various subjects, starting with mathematics, physics and science and ending with all those activities that involve transversal skills such as group work, self-assessment, etc. For the last four years in particular, we have been promoting educational robotics."* (Anna Brancaccio, Ministry of Education, University and Research | MIUR - General Directorate for School Regulations and School Autonomy)

"Currently, educational robotics is definitely an emerging technology and its use has increased a lot in recent years and is continuing to increase not only as an extracurricular activity but also as an activity to be integrated within the curriculum." (Beatrice Miotti, Technologist, Researcher Technological Area, INDIRE[11])

"It can mediate creativity, maths, French, applied arts. It is interdisciplinary, it is an attractive tool, an innovative object." '(Caroline Sulek, Canopé Gironde)

This correlates with the results obtained via the survey submitted to the teachers, which highlighted the primacy of scientific subjects but also the cross-curricular skills worked on thanks to the practice of robotics.

Robotics should therefore definitely be approached as an interdisciplinary tool, allowing the acquisition of multiple skills: this being the case in primary school, it is logical this answer obtains 19% of the answers and comes in first position.

"*We mix things up a lot in primary school, we work across the board, and it's a shame that we don't do it as much in secondary school. Things are done to encourage synergy between subjects, but more connections would help, and it is easier to motivate by first going through robotics and digital to learn maths! [...] We also need to work on the school - extracurricular continuum, as has been done for sport, for example, because it is just as much a social issue.*" (Julie Stein, Banque des Territoires[12])

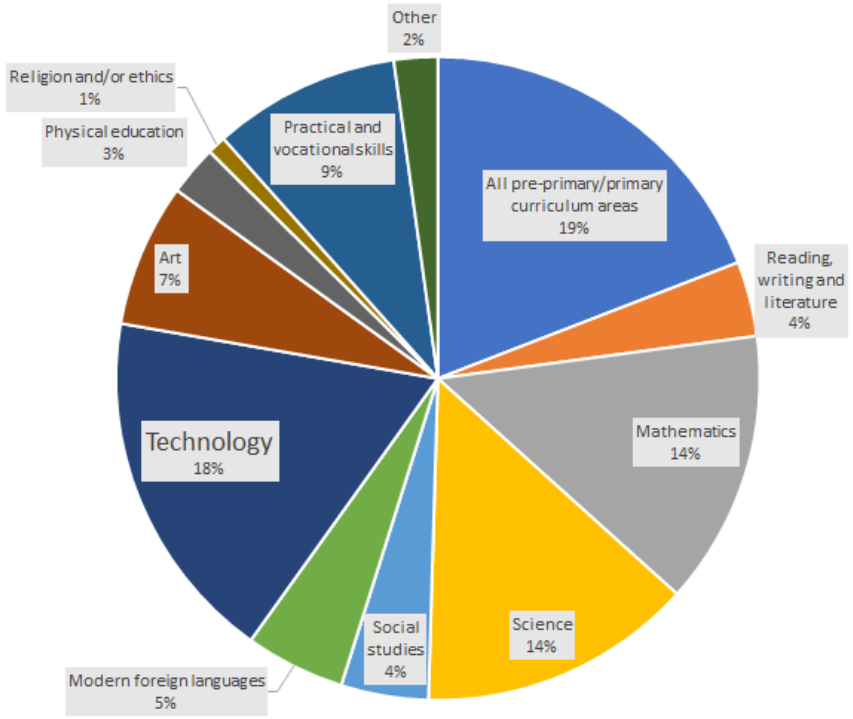
[10] The ambition of the "Digital Education Territories" is to act in a concerted and immediate manner, in an integrated approach, on all the levers of education in and through digital technology, with the provision of equipment, support, appropriate training and teaching resources.

[11] INDIRE is the National Institute for Documentation, Innovation and Educational Research. It is the Italian Ministry of Education's oldest research organisation.

[12] The Caisse des dépôts et consignations (CDC), a French public financial institution created in 1816, is under the direct control of a supervisory commission reporting to the Parliament and carries out general interest activities on behalf of the State and local authorities as well as competitive activities. The Banque des Territoires is a department of the Caisse des Dépôts et Consignation.

"*A major obstacle today is the disciplinary compartmentalisation: the idea that robotics concerns technology and maths teachers and not the others. The STEAM approach*[13] *is interesting, it's a pity that it is not more widespread in France!*" (Edwige Coureau-Falquerho, ENS Lyon[14])

One way to do this is to "*Create activities that scan programming skills and script on other subject-specific themes, like the bloodstream represented with Ozobot for example!*[15]"(Vanessa Mazzari, Génération Robots)



Moreover, it is a real issue of critical citizenship: "*robotics should not be more a technology teacher's thing than a philosophy teacher's thing*!" (Antonin Cois, Poppy Station[16] & MedNum[17]). The final objective is to train future enlightened citizens, aware of the stakes of digital technology and robotics

[13] STEAM is a multidisciplinary approach to learning that uses science, technology, engineering, art and mathematics as entry points to skill acquisition. This pedagogy aims to foster student creativity and innovation.

[14] The École normale supérieure de Lyon is a major French scientific and literary school, one of the four écoles normales supérieures. It trains for teaching and research in the field of basic and experimental sciences as well as in the humanities.

[15] Génération Robots website : https://www.generationrobots.com/blog/fr/ozobot-classroom-plateforme-pour-ozobot-dedie-aux-enseignants/

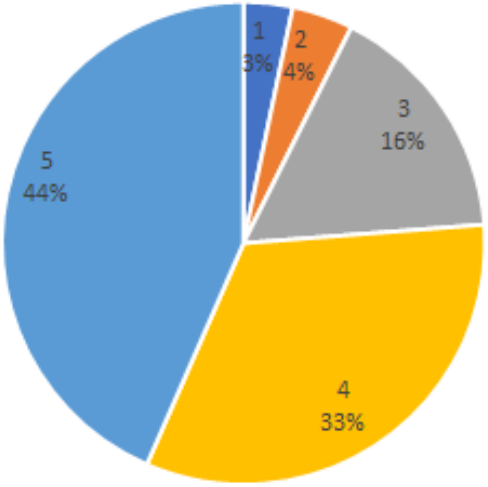
[16] Poppy Station aims to develop and preserve robotic ecosystems and associated open source or free technologies, in all areas where their use can enable this development and preservation, in a spirit of transparency and openness. The association pays particular attention to the fields of education, training, the arts and research.

[17] MedNum is a cooperative society of collective interest that creates and accelerates solutions to promote digital inclusion and mediation throughout the territory. It acts directly with the public in a situation of digital fragility and accompanies the public and private organisations that welcome, guide and train them. Its objective is to make digital technologies a factor of progress, efficiency, inclusion and empowerment for everyone, in every territory. Founded in 2017, it now has 85 members with the same ambition: to create common tools in response to shared needs, in order to change the scale of solutions for supporting digital uses.

in the present and the future: "*We need to make people who understand what we are talking about, not necessarily roboticists, but responsible people, capable of having an opinion, of discussing the subject*" (Adrien Payet, Educabot[18]). And that these notions become part of the basic knowledge "*I would like to see this become part of the common knowledge: that we all have an ethical reflection [...] I think we do not question citizens enough about what they want for their future, they do not question themselves enough and tend to suffer a little [...], especially on digital subjects. [...]. The open source aspect is important to avoid the black box effect and the reinforcement of the hegemony of the big players in this world. [...] We have to be aware, with digital tools, that there are ethical issues [...]. Critical citizenship is the most important thing*." (Yoan Mollard, Poppy Station)

B.5.c. Robotics competitions

Moreover, this transversal dynamic, in a project methodology supported by participation in competitions, tournaments, inter-school competitions, etc., seems to be a real motivating factor for the pupils from the experts' point of view (44% of the respondents gave a 5/5 mark on the importance of participating in competitions, and 33% a 4/5 mark, i.e. 77% of the panel) This opportunity seems to be known by teachers as 31% of them indicated that they participate in robotics competitions.



"*Robotics competitions are motivating: they lead to emulation, collaboration, everyone brings something to it. A team needs to do communication, mechanics... Everyone will find something to do with it, with real coherence, and everyone can bring out their skills. The methods must be different, the objectives announced: for the same project we tell the children "learn programming" or "take part in a competition" the approach will be different. [...] You should not say "you are going to do robotics" but "you are going to do maths, French, history..." using robotics to motivate young people. The starting point should not be the robot but the project!"*(Adrien Payet, Educabot)

These competitions are no longer simply class projects but real human adventures that allow students to develop cross-cutting skills and to surpass themselves:

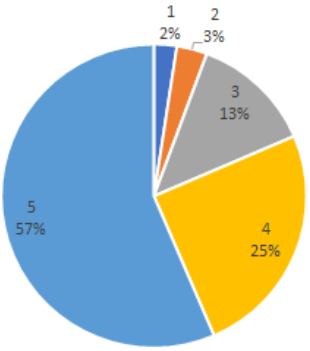
[18] The aim of the Educabot Association is to federate and promote all digital innovations in order to contribute to the awareness and development of educational robotics projects.

"*[...] It's about doing things together, the collective dynamic, sharing, cooperation: it's a fight against oneself, we get angry, we get annoyed, that's the school of robotics! Accepting to test oneself in one's intellectual and physical resources. It's a cross-disciplinary approach, being a polytechnician. A RoboCup team is like a rugby team! You have to be united, because nobody has ever found a robotic system on their own. So it's also about meeting people.*" (Stéphane Brunel, Co-chair RoboCupJunior)

The example given by Anna Brancaccio, Ministry of Education, University and Research | MIUR - General Directorate for School Regulations and School Autonomy, proof that competition is an important lever : *"For the last four years we have been promoting an Olympiad dedicated to robotics, which we coordinate and finance with the support of Scuola di Robotica. A large number of schools (over 100) participate in this contest; it is held in teams and the themes are chosen every year. The students build prototypes and then present them to a jury."*

B.5.d. Robotics and inclusiveness

The experts interviewed are unanimous on the inclusion lever that robotics can represent: 57% give a score of 5/5 and 25% a score of 4/5.



"*The digital divide is modelled on the social divide, and the most privileged groups will have more interest and more opportunities to evolve. At the same time, the divide is narrowing thanks to the integration of digital technology and robotics in schools, therefore via education and pedagogy.*" (Thibaud Desprez, PhD in computer science, author of the "Design and evaluation of pedagogical robotic kits" thesis)

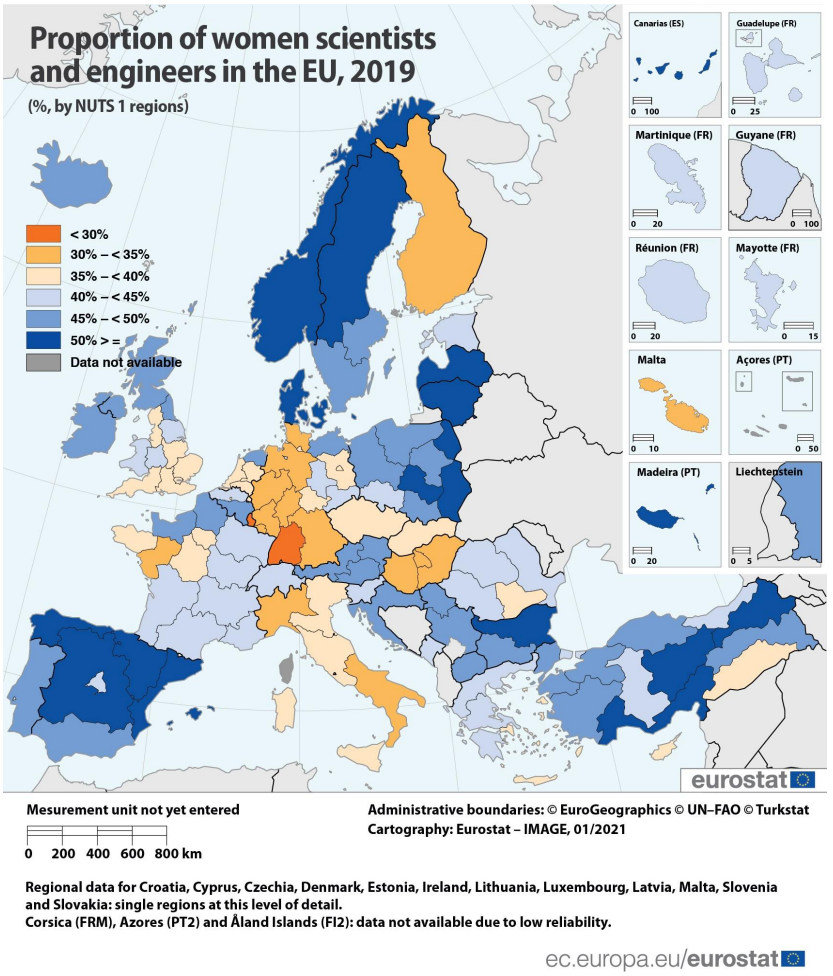
It is therefore imperative to work in this field of digital technology and robotics from a very young age to avoid this digital divide.

Moreover, robotics produces what is known as a "honeymoon effect" which can, at first, arouse a new interest in the pupil, by its innovative and playful aspect, and thus capitalise on the attention of certain pupils who are usually disinterested/demotivated.

Also, robotics, in its project-based approach, can sometimes shake up the relationship between pupils and teachers, who are no longer necessarily "knowers" but "helpers". This method can encourage pupils who need to get involved in their learning, to invest themselves.

Popularisation and demystification, on a large scale, which facilitates understanding and encourages further development, can help to reach audiences who would not have dared to take an interest in the subject. But we must not forget that robotics remains a technical discipline, even if it tends to be popularised *"If you are someone who studies maths and French well, you will create a more favourable ground for subjects such as robotic*s." (Daniele Valli, Colombbus association[19]). Indeed, robotics is still a subject that is prey to stereotypes: "robotics is for geeks" or "robotics is for boys". "*It is essential to deflate representations [...] and raise awareness as early as possible. Working on gender diversity is crucial, not only in terms of gender but also in terms of economic and social diversity. The fact that there are very few women contributes to the precariousness of women today. But I don't have the magic wand: we need to rethink science education as a whole, the gentrification of professions: these are societal issues that are not linked to digital technology but which have an impact on the digital environment."* (Julie Stein, Banque des Territoires)

This correlates with the Eurostat datas[20]: women are less present than men in scientific and engineering jobs.



[19] The Colombbus association works for education, training and professional integration thanks to computers and the internet. Through its activities, it facilitates the use and appropriation of digital tools, which then become vectors of inclusion, personal development and social ties.

[20] "Women in science and engineering", Eurostat,10/02/2021
https://ec.europa.eu/eurostat/fr/web/products-eurostat-news/-/edn-20210210-1

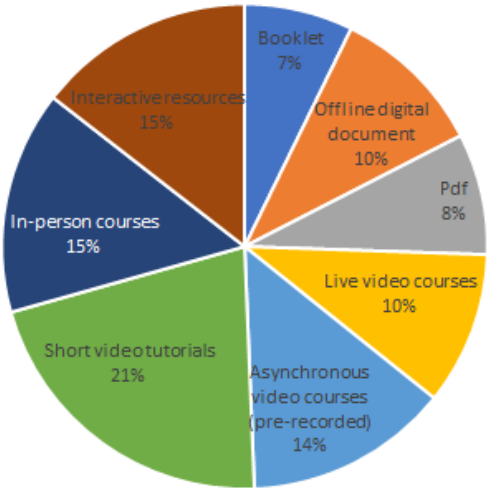
Representations that create gaps: "*Robotics creates jobs and there is a serious lack of manpower. Companies tell us that they lack engineers, mechanics... The problem is that robotics jobs are not well known! But today, little by little, specialised training courses are opening up. The problem is that we don't communicate enough about the possibilities, and where there is a lack of knowledge and ignorance, there is also sometimes mistrust.*" (Laurène Bonnesseur, Cluster Aquitaine Robotics[21])

Finally, educational robotics can also be a learning lever with students suffering from autistic disorders, attention deficit and hyperactivity disorders or dyslexia "*it can remove certain social blocks*" (Didier Roy, researcher at INRIA[22])

Robotics is therefore a tool that should be used to promote inclusion, even if today representations and social, scholar or digital divides can make it a divisive discipline.

B.5.e. Pedagogical support tool

In order to define which pedagogical support tools for educational actors would be the most relevant, we asked the experts the question: 21% recommend video tutorials, 15% face-to-face training and 15% interactive resources. Written resources that can be accessed online or printed together received 25% of the votes ("pdf", "offline digital document" an "booklet").



From the point of view of the experts interviewed, quality training and learning resources - and in their own language (in addition to the materials) - are absolutely essential. This is a hindrance to implementation when the conditions are not met: in France, the current observation is that equipment has been bought massively without any thought for the support of the educational actors (it is not always used, some experts spoke to us of "robots sleeping in the cupboards"!).Even if this is not true everywhere: there are "real territorial inequalities in equipment and training" (Vanessa Mazzari, Génération Robots) depending on the establishments, communities and local policies...

[21] The Aquitaine Robotics cluster, created in July 2013, currently has more than one hundred members, mainly companies, research and training organisations, and users. It brings together players in manufacturing and logistics robotics, service robotics, and robotics in open environments in New Aquitaine.The objectives of the Cluster are simple:To structure the regional robotics sector / To support collaborative R&D projects/Develop skills in scientific research and training.

[22] INRIA, National Institute for Research in Digital Science and Technology

"*If we don't have equipment, whether it's recycled or not, if we don't have training that allows teachers to understand the underlying concepts, and if we don't have resources that then allow us to teach, it seems complicated.*" (Emmanuel Page, TNE project director)

"*You really have to pay attention to the training support aspect: it is not enough to create content or make tools available, you also have to support and train! If you don't know how the technology works, you don't take the risk.*" (Saïda Mraihi, Ecole nationale Supérieure Art et métiers ParisTech[23])

As a first step, it can be useful to popularise robotics to allow understanding by all: "*Popularisation in a very general way: first of all, you have to make things very, very simple. Videos, the world of YouTube is very good for that. All the institutions, the programmes (C pas sorcier[24]). Even if we say to ourselves that it's a bit wrong, the key is to popularise it. The diagram is a tool; what I say is wrong but it makes it easier to understand and to develop afterwards.*" (Yoan Mollard, Poppy Station)

Also, it is important to democratize science practices. Building connections and partnerships between schools and universities can help to broaden our publics and motivate more students to integrate courses and jobs related to robotics. (José Lima, Professor in the Electrical Engineering Department of Polytechnic Institute of Bragança, Portugal, and President of the Board of Direction in Portuguese Robotics Society).

B.5.f. Face to face training

In terms of training engineering: "*the teacher must be in the act of doing. We can't be in top-down training. Successful training is training in which the teacher is an actor, active in handling the robot, discovering what it is, programming, solving a complex task. The teacher must himself argue and experiment*". Emmanuel Page, Canopé. "*They (teachers) also need to experience group work [...] with progressive challenges where they can progress at their own pace.*" (Marie Fauquembergue, Maisons pour la Science, Foundation La Main à la Pâte[25])

Concerning the content of the training courses, the technical and pedagogical aspects must be addressed, but the experts also insist on the "citizenship" and "ethics" aspects that must be mentioned, so that the teachers can then educate future citizens who are enlightened and aware of the challenges of digital technology and robotics. Also, giving the means to talk about digital technology and robotics without tools, otherwise known as "unplugged computing" as at the Maison pour les Sciences: "*We always take an active approach, we put the teachers in a situation: we have worked a lot on unplugged computing which solves the hardware problem. When we program, we use a lot of algorithms, which are not limited to robotics!*"

[23] Arts et Métiers is a major public institution of higher education and research dedicated to technology. It offers diplomas from bac+3 to bac+8 and, with its 11 sites, provides a unique territorial network for industrial development.

[24] French TV programme for the popularisation of science

[25] The mission of the Fondation La main à la pâte is to contribute to improving the quality of science and technology teaching in primary and secondary schools, the schools where equal opportunities are at stake. Its action, conducted at national and international level, is geared towards the support and professional development of science teachers. It aims to help teachers implement an investigative approach to teaching that stimulates pupils' scientific thinking, understanding of the world and ability to express themselves.

Another approach is to rely on networks, associations and existing structures, whether for training, support or even projects with pupils: *"Get closer in terms of community, talk to fablabs. Don't reinvent things, but put people who know how to do it in touch with each other."* (Didier Roy, INRIA)

B.5.g. Hardware

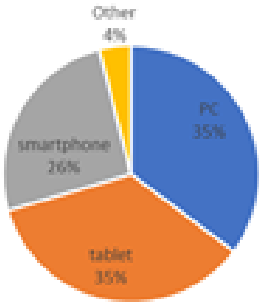
Programming device and software

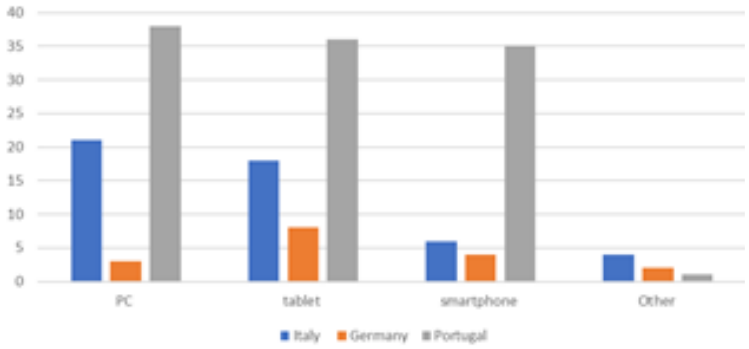
We polled the experts about the device that should be used as a programming medium for educational robots: the answers are mainly divided between the computer and the tablet (35% each). The smartphone comes in third place with 26% of the answers. If we compare with the answers obtained in the question addressed to the teachers on the tools they have in class - we see that there is a predominance of the computer as a pedagogical support and not the tablets.

It is interesting to note that the highest rate of selection of the answer "tablet" is attributable to German experts, even though German classes have more computers.

The "smartphone" response rate is also significant. The increase in the number of young people's equipment may indeed allow them to use their own tools in the educational context.

For our project, it could be useful to choose a platform that benefits from a software solution AND an application that can be downloaded from the various stores so that it can be used in as many contexts as possible. However, the use of a robot on a smartphone or tablet requires a connection via Bluetooth which generates a higher cost in relation to the purchase of the specific module. It will therefore be relevant to weigh up these two pieces of information when making our choice.

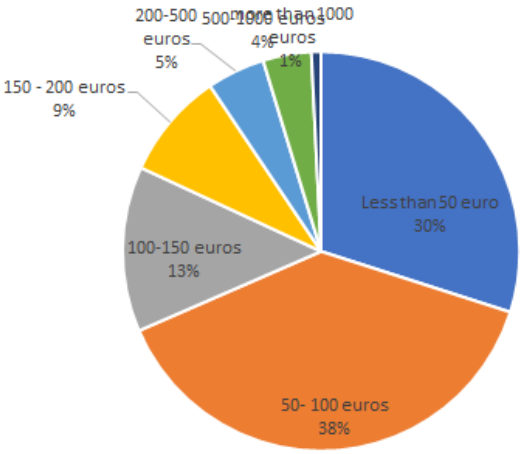




Price

The purchase price of the robot is an important factor: 38% of experts think that the price (for primary school) should be between 50 and 100 euros maximum, 30% that it should cost less than 50 euros and 13% between 100 and 150 euros.

In this sense, the choice of a "modular" robot may seem relevant, allowing the purchase of additional components as needed, in order to lower the purchase price of the basic kit. Indeed, the teachers answered in their questionnaire that price was the main problem encountered (32% - question d28).



Ergonomics / robot components

The question of the components necessary for a robot to function properly was not asked in the questionnaire sent to experts from Germany, Italy and Portugal, but some French experts were able to give us some food for thought.

"*If I take the robot out of the box and it doesn't work, we'll quickly move on to something else. If there is documentation for the handling, it means that the interface is not good. It has to be intuitive! Even if people also need to have a basic understanding and make the effort to go and find the resources.*" Jérôme Laplace, Génération Robots. The intuitive aspect is therefore essential.

But it is also necessary to go further : *"Today, we need to go further than what already exists in terms of ethics: we need to favour sustainable solutions, to favour repairable products! It is important to convey the idea to the educational community that we can repair and fight against programmed obsolescence. And work in open source to encourage the evolution of the tool and co-construction.*" (Didier Roy, INRIA)

Also, some experts spoke to us about the importance of being able to test and handle the robot, even if it means making mistakes: "*You have to be able to manipulate, to touch it, I believe a lot in learning through manipulation. Pupils need to have access to robots, to make them their own and not be afraid of them: so you need a robot that is adapted.*" (Yoan Mollard, Poppy Station)

This idea of a robotics kit designed for manipulation by pupils is in line with the speech of. Adrien Payet: "*Robotics is poorly approached: young people should be allowed to build their own robots and work in project mode. There is no perfect robot that is adapted to all contexts."*

The objective is therefore to be able to produce a robot that is easy to access (a strong demand from teachers), low cost, durable, robust, easy to handle and repair, buildable by the students - depending on the level - and adaptable to the need.

This question of handling, which is strongly recommended by the experts, can however be a barrier for the teachers: "*The facilitators are more used to going out, unpacking materials and putting them away. They are ready to have a whole staging around a workshop, which is not necessarily the case in*

a classroom. That's why robotics in schools today is often limited to programming. And with ready-made robots." (Adrien Payet, Educabot)

Another difficulty frequently mentioned is the maintenance of the tools: a robot is a tool that needs to be updated, its components can be defective, etc. As teachers and other educational actors do not always have the time or the skills to carry out this maintenance, they need to be given the tools and means to carry it out easily and choose the right components. To avoid that the acquired robots remain sleeping in the cupboards!

Since ease of access and maintenance are very much in demand for the use of the robot(s), and confirmed by the experts interviewed, the challenge will be to find the right balance for the deployment of the EU-RATE kit : "*Educational robotics is a great tool, as long as we manage to combine strong ethical requirements and an ability to model things that are easy to use and that allow us to overcome the obstacles*." (Antonin Cois, MedNum)

Concerning infrastructure and equipment, it should be noted that the accessibility of robotics has also been hampered by the pandemic context. "*The situation is different depending on the geographical location, but the pandemic caused by Covid-19 has given a boost to many educational institutions that were struggling to improve their infrastructure.*" (Beatrice Miotti, Technologist, Researcher Technological Area, INDIRE)

B.5.h. Robotics, a tool for the school, after-school and extracurricular continuum

European educational policies encourage the implementation of projects within the framework of digital education. In France but also in other countries, calls for national and regional projects on digital education are launched and cities, departments, regions associate schools, associations and enterprises to answer common and shared challenges in the digital era. Cities like La Rochelle (France) have created a digital educational scheme evaluated every 5 years in order to finance schools' digital materials (computers, …) and also give the opportunity to children in schools, after school and extracurricular activities to discover robotics. The city decided not only to buy materials but also to finance training for teachers and youth leaders. "*The digital educational scheme is an asset for the municipality of La Rochelle."* (David Berthiaud, agglomeration of La Rochelle)

Teachers, parents, public servants but also youth leaders, volunteers, civic service volunteers… The experts confirmed that all education actors could and should take up the issue of robotics for the education of children and the public. It is a great tool to work on the school, after school and extracurricular continuum because it is transversal: "*practising robotics also means practising elements related to you, your body, your health, cooperation, and citizenship issue*s". Julie Stein, Caisse des Dépôts et Consignation; "*Education in digital technology and robotics raises issues of understanding the world and ethics (e.g. autonomous drones, etc.) These are questions that affect the future of humanity...* ! " (Antonin Cois, MedNum)

This is in line with the conclusions drawn in the "subject" part developed above with regard to teachers: but adding the fact that the school is not the only one responsible for this education in digital technology and robotics, which has become a significant element of our present and our future.

With its strong attractive potential, it can also sometimes help to create or recreate links: "*My observation is that robots bring humans closer together; one might think that robots drive them apart, but in the end the pupils talk, argue and debate! And even at the level of the parent-teacher link, I always cite this example: a mother had never come to school, to any meeting dedicated to parents. She came because her daughter said "there's a robot in the classroom". As long as it is well orchestrated, robotics can strengthen interactions and social links*!" (Emmanuel Page, Canopé).

Furthermore, the questionnaires dedicated to parents show us that they understand the challenge of digital education and robotics. It is therefore necessary to create opportunities for parents in order to facilitate their appropriation, through events for example.

During extracurricular time, when children are supervised by activity leaders, workshop time is a great place to practice robotics.

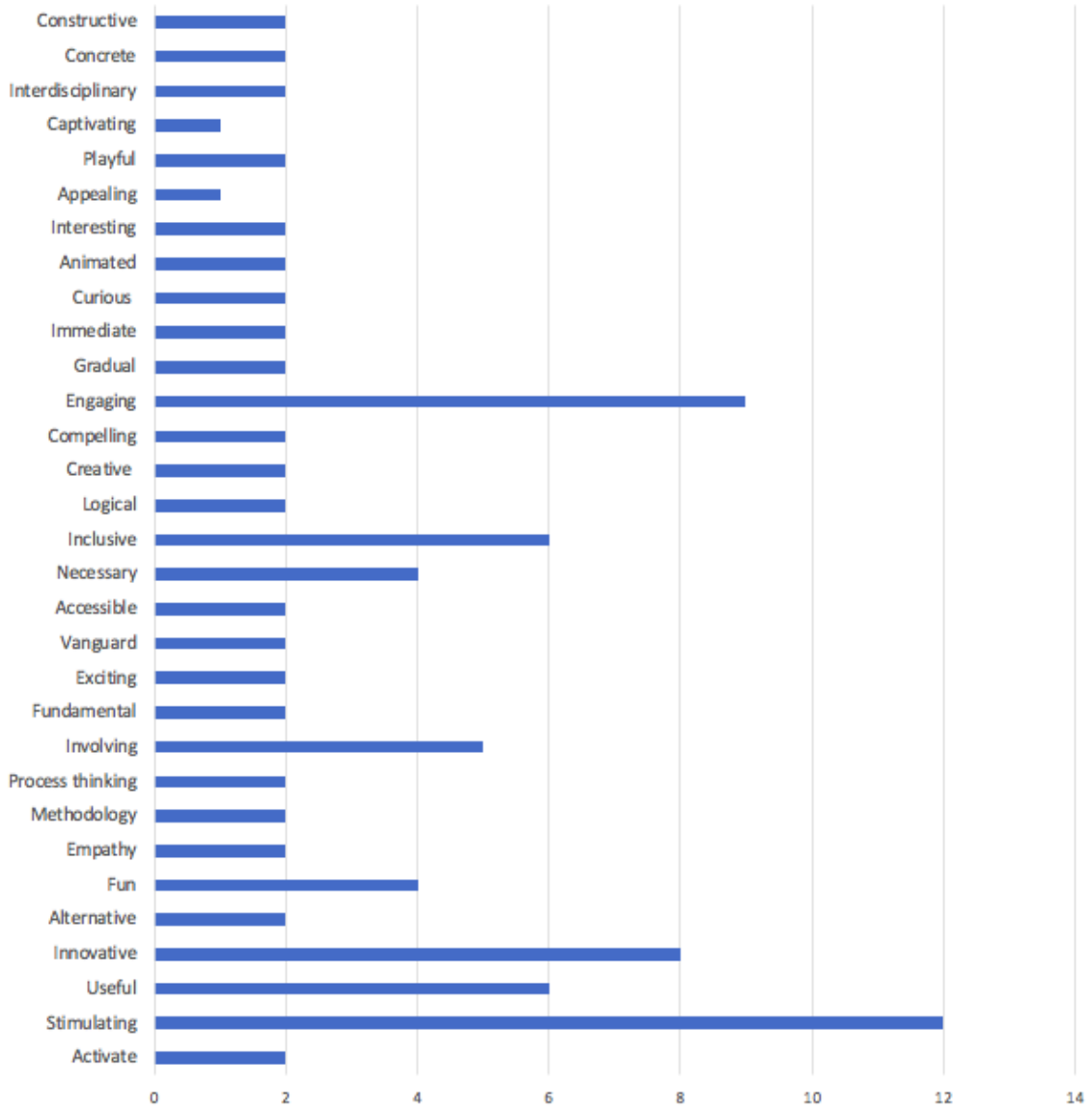
But : "*The turnover of the youth leaders does not encourage this appropriation. It's a pity because as a playful tool for appropriating the challenges of educational digital technology, robotics is one of the leaders, it is a tool that allows us to mobilise things that we don't otherwise mobilise at home. For an educational and leisure space, whether at school or at a leisure centre, educational robotics is a great tool, as long as we manage to combine strong ethical requirements and an ability to model things that are easy to use and that allow us to overcome the obstacles*." (Antonin Cois, Medmun)

Indeed, as the professions linked to after school and extracurricular leisure time are sometimes precarious (small contracts, work teams changing each year…), this can create a brake on retaining the skills required for robotics workshops in a structure. "Designing" is not something that can be taken for granted, and robotics requires overcoming the fear of manipulating and knowing the basics of electronics and programming. Solutions must therefore be found to provide the best possible support for the facilitators to facilitate the rapid appropriation of turnkey tools. This is also true for volunteers, who do not always commit themselves in the long term, or civic service volunteers who are present in the associations for short missions.

For José Lima (Professor in the Electrical Engineering Department of Polytechnic Institute of Bragança, Portugal, and President of the Board of Direction in Portuguese Robotics Society), Mediation Center for Scientific, Technical and Industrial Culture, as Centros de Ciência Viva[26] in several regions of Portugal, offer a great panel of activities on different subjects as robotics workshops for children and young people in extracurricular time.

[26] https://www.cienciaviva.pt/centroscv/rede/

Stakeholders were asked to propose an adjective to describe educational robotics. Here are their answers.



Concluding note

Facilitating robotics

- The majority of the experts were unanimous about the facilitating effect that robotics can have on complex concepts (question d6): 55% gave a score of 5 out of 5, while 32% gave a score of 4 out of 5. They consider that robotics can be "stimulating", "engaging" and "innovative".

Subjects and cross-cutting projects

- Primacy of scientific subjects but also the cross-curricular skills worked on thanks to the practice of robotics : technology 18%, science 14%, mathematics 14%, i.e. 46% of the answers alone. Then, the general pre-primary and primary school curriculum (19%) and then as part of the acquisition of practical and vocational skills (9%) or even art (7%).
- Robotics should be approached as an interdisciplinary tool, with the final objective to enlight citizens.
- Robotics and digital notions must become basic knowledge.

Robotics competitions

- Robotics competitions is motivating for young people (44% gave a score of 5/5, 33% ⅘).
- It develops cross-cutting skills and allows us to work on projects which is a change from the usual school methods.

Robotics and inclusiveness

- The experts interviewed are unanimous on the inclusion lever that robotics can represent: 57% give a score of 5/5 and 25% a score of 4/5.
- It can help to “remove social blocks” for disadvantaged groups.
- It is imperative to work on the field of digital technology from a young age to avoid digital divide and raise awareness to avoid misrepresentation and stereotyping.

Pedagogical support tool

- In order to define which pedagogical support tools for educational actors would be the most relevant, we asked the experts the question: 21% recommend video tutorials, 15% face-to-face training and 15% interactive resources. Written resources that can be accessed online or printed together received 25% of the votes ("pdf", "offline digital document" and "booklet").
- As a first step, it is useful to popularise robotics in order to remove obstacles.
- From the point of view of the experts interviewed, quality training and learning resources - and in their own language (in addition to the materials) - are absolutely essential.
- The perfect combo seems to be : material + training + resources + support.

Face to face training

- 15% of the experts think it’s important to offer face-to-face training.

- The teacher (or other educational actor) must be in the act of doing. Successful training is training in which the teacher is an actor, active in handling the robot, discovering what it is, programming, solving a complex task.

Hardware

- Programming device and software: the answers are mainly divided between the computer and the tablet (35% each). The smartphone comes in third place with 26% of the answers.It could be useful to have a software solution and an application for tablets and smartphones even if mostly teachers have computers in class.
- Price :38% of experts think that the price (for primary school) should be between 50 and 100 euros maximum, 30% that it should cost less than 50 euros and 13% between 100 and 150 euros.
- Ergonomic/ robot component : the challenge is to find the right balance between low cost, intuitive, sustainable, repairable, open source,buildable and manipulable, easy to maintain.

Robotics, a tool for the school, after-school and extracurricular continuum

- The experts confirmed that all the actors in education could and should take up the issue of robotics for the education of children and the public (teachers, parents, youth leaders, volunteers, civic service volunteers, associations, enterprises, public servants/elected people…)
- it can create a link between the different educational times of the child - between parents, teachers,..
- Extracurricular activities are perfect times for practising robotics, but there are obstacles, such as the turnover of youth leaders.

C. Hardware and software state of play in robotics field

In order to develop the robotic, it seemed necessary to have an overview of what was proposed in terms of equipment and softwares in the field of robotics. This will help us to fit the expectations defined thanks to the pedagogical analysis done.

There is a really big number of possibilities to classify the different robots.

We'll first focus on their type (how it moves : flying, wheels…) and see the advantages and disadvantages of each. Then we'll give examples of sensors and actuators with their main characteristics. We'll also list the main programming platforms and languages that can be used. Finally we'll give examples and compare ready made robots and self made robots.

C.1. Types of robots

According to the questionnaire answered by children, parents and teachers, they prefer robust, easy to use, open source and cheap robots.

- Wheel robots : most common robots. Often on 2 or 4 wheels, they are the most used for the training of young children. They're resistant and work like cars. However, the motors can be damaged if the wheels are blocked by an external element (child who prevents the robot from moving forward by holding it…)
- Chain robots : As with tanks, the usefulness of chains is to cover rough roads and cross obstacles.
- Arms (no displacement of the base) : articulated arms allow objects to be picked up and moved within the robot's range of action. This type of robot is widely used in industry. Although easy to use, these robots are often limited in terms of learning: once the student has succeeded in catching an object, he or she has mastered the robot and wants to move on.
- Drones : most popular robot among young people. Drones can fly, carry small items, take photos, and film the landscape. Nevertheless, drones are often fragile and expensive for a battery not exceeding one hour of autonomy. Thus, it is not suitable for beginners.
- Crawling robots : inspired by animals, in particular the caterpillar and the snake, these robots are very modular. They are generally made up of several cubes which are attached or detached depending on the actions to be performed. They can go to inaccessible places like under the cupboard…
- Underwater robot : Like submarines, these robots can navigate underwater. Small, they go to places inaccessible to humans and can film and take photos. Yet, this type of robot is not easy to use, there are no kits ready-made and it is not suitable for children.
- Boat robot : Like boats, they are the cars of the ocean. There exist kits ready-made but this robot requires a water point, which is not practical to learn robotics.
- Hovercraft : Robot propelled by air, it levitates a few centimeters above the surface. Thus, he can go on water as on land and overcome obstacles. However, this type of robot is not easy to use, and there are no ready-made kits. So, it's not suitable for beginners.
- Robots on legs : Humanoids or animal droids. Inspired by humans or animals, these robots make it possible to use and reproduce nature to perform specific tasks. Nevertheless, although impressive, these robots are not suitable for beginners.

C.2. Sensors and actuators

To move or to carry out a task, a robot needs actuators and sensors. If we want to design a pedagogical sequence, we need to know what the robot is able to do.

Actuators

- Motors : The main actuator used are the motors. Motors make the robot move : rotation of an arm, displacement (rotate wheels), translation (using for example an endless screw).Their speed, their torque, their supply voltage, their size, the way you command them, their precision are different characteristics we'll have to look at to choose them.
- Display : Mainly LCD displays are used to show information about the robot or to give a message.
- LEDs : Some RGB leds could help the programmer for debugging, for lightening in the dark
- Relay : to activate motors for example
- Servo Motors : some sensors for robotics arms need a servo motor to move.
- Buzzers (active or passive) : to make sound, play music or single sound.
- Joystick : to control an action, direct the robot, raise an arm, or simply turn on LEDs of a particular color.
- Remote control : to control all robot actions at the same time.
- Pushbutton : to activate an action or series of actions manually, as activate a LED, a program…

Sensors

- Line sensor : for tracking lines or detecting the borders from the playground.
- Distance sensor : to avoid obstacles, to detect other robots, or to find an exit in a maze
- Camera : for reading letters or symbols, to detect objects
- Acceleration sensors : to detect shocks, to evaluate robot position in comparaison of the earth gravity.
- Gyroscope : to have an accurate rotation motion
- Temperature sensor : to measure the ambient temperature and to detect heat sources as the human body.
- Water level sensor : to measure and know precisely the water level in real time automatically.
- Motion sensor : to detect movement within the range of action of the sensor.
- Infrared sensors : can measure temperature and movements.
- Sound sensor : to detect a particular sound and react accordingly.
- Vibration sensor : to detect sensor movement, such as a shock or earthquake.
- Light sensor (photoresistor) : to measure light density.
- Hall effect sensor (magnetic) : to measure a magnetic field.
- Pressure sensor : to measure the weight of an object or pressure.
- Gas sensor : to measure the surrounding gas density.

C.3. Programming platforms and languages

The new visual programming languages are known as block-based programming languages (BBPLs). The integrated development environments in which they are used are called block-based programming environments (BBPEs)[27]. BBPLs allow the development of a computer program by dragging, dropping and snapping program chunks that are organized into different categories. Thus, people who never encountered application development can better understand the basic concepts of programming and the creation of algorithms[28].

From an early age, children start to use mobile devices (smartphones and/or tablets) to play, make phone calls, and for entertainment. But they can do much more with the help of computer technologies. Young children can visualize their ideas through computer drawings, animations, or computer games that they develop themselves. The use of modern computer technologies by children as a learning tool is not a novelty . In the 80's, "Turtle", the computer-controlled cybernetic animal, was created at MIT[29]. This robot is controlled by a computer language LOGO, which is the first computer language appropriate for children. A study of Papert [30]can be considered as fundamental to human-computer interaction as children are no longer seen as ordinary users but as a part of the computer program development team. Thus, the development of comprehensible and intuitive programming languages has become a priority for all software engineers.

It is important that the appropriate robot or robot kit is used depending on the age involved. All this is to ensure the best possible learning of the children and youngsters.

In this regard, Micheli et al. distinguish for each age group what is the appropriate program:

- Between the ages of 5 and 8, it is necessary to approach robotics with an introduction: To introduce the concept of programming a robot, the idea is to propose a real human simulation, which does not yet use physical robots but people; a relatively non-invasive method to help children understand programming. The first phase is just narrative, each child has to give voice commands to his classmate, who simulates a "robot". The second phase is related to drawing the voice commands on paper, in this way the children create real icons that the teacher and then also themselves will have to examine to really program the physical robot. In this way, children are able to better understand what it means to program a robot with simulation software because they see their work, drawn to control the human robot, implemented on the simulator to control the robot; in this way they associate a drawing with a subsequent action of the real robot.

In this environment there is thus a customization that allows a simplification of the introduction of the standard and common language as a programming language can be. The teacher can share the children's icons on the online platform and discover those of other students, discovering the

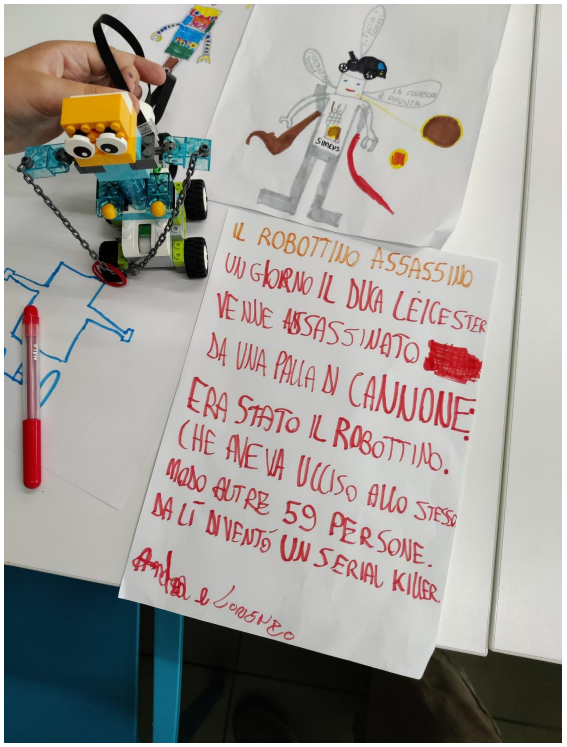
[27] KRALEVA, Radoslava; KRALEV, Velin; KOSTADINOVA, Dafina. A methodology for the analysis of block-based programming languages appropriate for children. Journal of Computing Science and Engineering, 2019, 13.1: 1-10.

[28] PANE, John Francis. A programming system for children that is designed for usability. Carnegie Mellon University, 2002. https://www.researchgate.net/publication/35247353_A_Programming_System_for_Children_that_is_Designed_for_Usability

[29] MICHELI, Emanuele; AVIDANO, Marco; OPERTO, Fiorella. Semantic and epistemological continuity in educational robots' programming languages. In: Proceedings of the TERECoP Workshop Teaching with robotics, Conference SIMPAR. 2008. p. 80-90. https://terecop.eu/downloads/simbar2008/Micheli_et_al.pdf

[30] S. Papert, Mindstorms: Children, Computers, and Powerful Ideas. London: Harvester Press, 1980. https://dl.acm.org/doi/pdf/10.5555/1095592

multiplicity of solutions of the language corresponding to a common action. At this stage, programming is confused with both verbal and graphic narration capable of describing the actions of a robot.



- Between the ages of 9 and 10, we proceed with the "white box" robots: in this phase it is necessary that teachers promote activities of assembly of the robotic kit by the students, and then move in the next phase to the programming of the same.

In this way, students will be able to customize the robots, as in the case of the European project Roberta, in which Scuola di Robotica is a partner, dedicated to the promotion of robotics among girls (in which there are customized models of robots made by girls)[31].

Still at this school level, it is recommended to use visual iconic programming.

- Between ages 11 and 13: At this stage, students have already learned and mastered programming logic, and even a simplified version of flowcharts. Now they should be invited to program their own kit using sensor information. Here the teacher can constructively introduce the concept of action-reaction, which in previous years was only hinted at, but not formalized. Students at this stage are themselves the authors of the programming. At the end of a first phase of learning the program and testing its operation, the teacher will invite students to rework and redesign the programs and also the assembly of the robots. All these first phases will be adapted obviously to the level of preparation of the class.

In the event that during these first programming and testing phases errors occur in the programming and operation of the robot, the teacher will suggest to the students to proceed by trial and error, first drawing their program on paper with flowcharts imagined by themselves to identify the error made, and only then implement the programming on their computer.

[31] European project Roberta: https://www.roberta-home.de/en

- Between the ages of 14 and 17: At this stage it is important that students begin to write algorithms by abandoning the iconic language, which is the first step towards learning program codes. At this point it can be useful and interesting to use automatic code converters (such as those found on Makecode, mblock etc.), able to transform the programming contained in graphic icons into lines of code. In this phase they will be able to make changes to the iconic programming to realize that the programming in lines of code also changes, this makes students aware of the importance of variables, parameters and conditions.

After a training phase, moving from iconic to line-of-code languages, students will be able to easily and permanently transition to actual code programming. In figure 2, we can see a summary of Radoslava Kraleva et al. with the specifications of some block programming software.

Name	Website	Age (yr)	Price	OS and other software	Language support	Science publications
Code.org	http://studio.code.org	4+	Free	All modern browsers	English, Bulgarian etc.	[23, 24]
ScratchJr	http://www.scratchjr.org	5+	Free	iOS, iPad, Android	English, Spanish	[25, 26]
Scratch	https://scratch.mit.adu	8+	Free	iOS, iPad, Android, Windows, Mac, Linux	English, Spanish, Bulgarian, etc.	[16, 24, 27, 28, 29, 30]
Tynker	https://www.tynker.com	7+	Free and payment	All modern browsers	English	[31]
Kodu Game Lab	http://www.kodugamelab.com	8+	Free	Windows	English	[15, 19, 32, 33]
GameStar Mechanic	http://gamestarmechanic.com	8+	Free and payment	All modern browsers	English	[34]
Hopscotch	https://www.gethopscotch.com	8+	Free	iOS, iPad, iPod, iPhone	English	[35]
Alice	http://www.alice.org	10+	Free	Windows	English	[27, 36, 37, 38, 39]
Snap!	http://byob.berkeley.edu	13+	Free and payment	All modern browsers	English, Bulgarian etc.	[40]

Figure 1: Specifications of some block programming software, from the paper "*A methodology for the analysis of block-based programming languages appropriate for children". Journal of Computing Science and Engineering.*

Following this distinction, it is important to understand how block programming languages are organized.

Block-based programs most often consist of stacked block elements that resemble puzzle elements. The program is run only by pressing the RUN button. The main purpose of this type of programming language is not simply to arrange program chunks; instead, as we said previously, its purpose is to let children acquire knowledge related to the logical organization of an algorithm, so that they can solve a certain task, the basics of problem solving. Objects and splines from the real world and background images are most commonly used in these programming platforms to design the computer program or game.

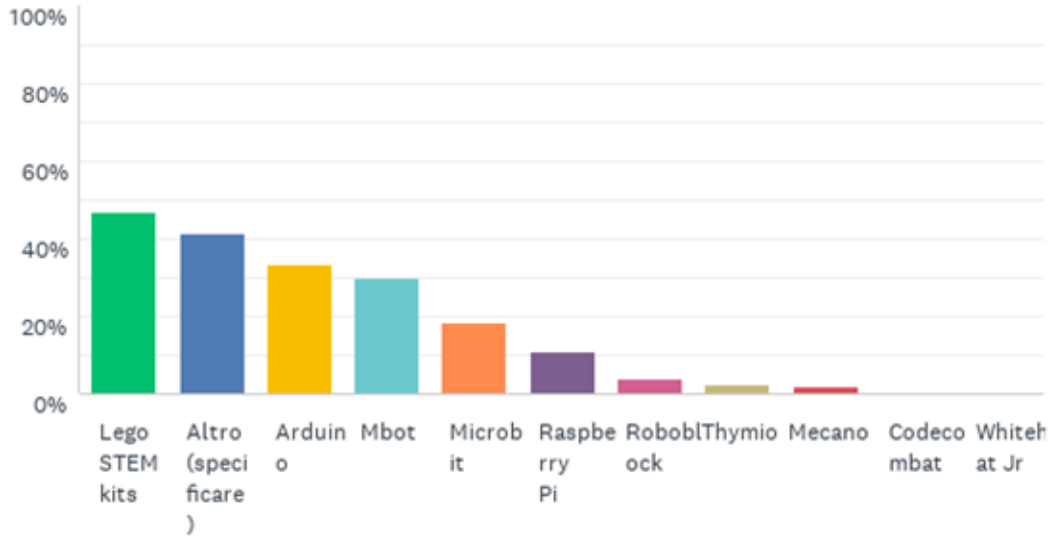


Figure 2: Answers about preferred software

From the surveys that were conducted with students, teachers, parents and stakeholders, it emerged that most users prefer to use block programming languages for ease of use. The most preferred languages are Scratch, Lego and Mbot. In addition to these languages for older students, the questionnaires showed that the use of Arduino is accepted (Figure 1).

Considering the results of the surveys and the constraints chosen by the project team, it was decided to use block programming software, user friendly and open source. The choice will most likely lead to the software Scratch. This software Scratch is open source, you can access the code and create your own modified versions and extensions. This will allow us to create our own extension for the robotic kit that you are going to produce. It will also be possible to use it on different devices and in different languages so that all the partners of the European project can benefit from it.

Languages : pros and cons

From block programming to high level language, here are some examples with their advantages and disadvantages.

Languages	Pros	Cons
Block programming	- More affordable for kids without knowing a programming language (C, Python, Javascript etc.) - Can be used with local language - For some versions, no need to reading capacities (pictures to describe the commands)	- Not easy to develop specific blocs which fit the EU-Rate Robot. - Most of them aren't open source
Python	- A lot of libraries are available and specific libraries can be easy written - Open Source - Used in most of high schools	- Syntax learning - Only in english
C	- Language close to the system and compilated : faster than Python - Simplified version for Arduino programming - A lot of libraries are available (for Arduino for example) and specific libraries can be easy written	- Syntax learning - Less affordable than Python - Only in english

C.4. Ready made VS self made robots

Most of the teacher's don't want to build their own robots, but the second more important expectation is the price. Indeed, according to the answers of European teachers to our questionnaire, about 70% want a robot that is easy to use, and 55% want a low price. We could think that a self made robot could be cheaper than a ready made robot. That's right for a beginner's robot who doesn't have a lot of features. But for robots with more features, a ready made robot could be much cheaper than a self made one.

In addition, 50% of European teachers also want the robot to be robust. The advantage of a ready-made robot is that the cables are hidden, and the mass-produced structure is generally stronger. There are exceptions, where the electronic board is too exposed. In this case the problem can be solved by 3D printing a robot guard.

The last point that the European teachers want is the open source of the robot. About 40% of them value the fact that the project is open source. This means that they can modify the robot, improve it, add sensors as they wish. Moreover, it does not require any paid particular programming software and the user manuals and websites do not require any subscription.

Thus, the wish of the European teachers would be to have an easy-to-use, low-cost and durable robot. This corresponds to a ready made robot. However, some of them also want an open source robot with possibilities of improvement. For teaching beginners, the ready made robot seems to be the right solution, while the self made robot is more for advanced students, who want to continue their discovery of robotics.

There have been some directives issued by national school authorities, for example by the Italian Ministry of Education, encouraging the development of educational robotics projects in schools, and some new school curricula are being enriched with robotics projects, educational robotics (and also other digital technologies) has not been introduced in European school curricula. Most experiments involving robotics activities are not integrated into normal classroom activities; they take place in after-school programs, weekends or summer camps.

The problems with implementing robotics as part of the normal program seem to be the time-consuming nature of robotic activities, the cost of the necessary equipment and the practical work required of teachers to manage the disorder in the classroom and to keep all the pieces in the right place in their kits.

Although exceptions have been reported by teachers who have been able to integrate robotics into mainstream teaching, teachers who have implemented robotics activities in schools demonstrate that they consider after-school courses or special classroom activities more convenient for some students only.

Some studies suggest four strategies to involve a wide range of students in robotics: projects that focus on specific topics, not just challenges; projects that combine art, engineering and medicine; projects that encourage storytelling; and the organization of exhibitions rather than competitions. Young people who are not interested in traditional approaches to robotics become motivated when robotic activities are introduced as a way to tell a story (for example, by creating a mechanical puppet show), or in connection with other disciplines and areas of interest, such as music, art, fashion and medicine.

Robotics so far is mainly addressed to humans using pre-programmed and prefabricated robots. The way in which robots are built and programmed is a "black box" for their users. Unfortunately, the same "black box" method is very often followed in educational robotic applications where the robot has been built or programmed in advance and is introduced into the learning activity as an end or passive tool. This is due to the fact that the construction and programming of a robot is thought to be a very difficult task for children.

Quite differently from this approach, constructivist methodologies require a shift to the design of transparent robots ("white box") where users can build and deconstruct objects, they can program robots from scratch, they can then actively use 'their hands', rather than just using ready-made technological products. All this has the power to generate empathy, creativity and student involvement.

D. SWOT analysis

In order to assess the development potential of the EU-RATE project, it is now necessary to highlight the various positive and negative points (internal and external environments) related to the project. Indeed, the aim of collecting all the data is to grasp, evaluate and probe the context and related parameters in order to define a strategy that meets the desired challenges, **i.e. a proposal for an ethical and relevant educational robotics solution that is in line with the specificities of the analysed fields**. The aim is also to respond to a "theory of change" that would answer the following questions:

- How will the EU-RATE project differ from existing proposals?
- What is its innovative potential?
- Will it be able to respond effectively to the expectations and challenges expressed?

Strengths and weaknesses are internal, while opportunities and threats generally focus on the external environment.

STRENGTHS	**WEAKNESSES**
- Consortium expertise, knowledge, network - Current robotics education schools programs, equipment - Uses, practices, interest prerequisite and competencies	- Consortium voluntary, communication internal (languages, culture), external (visibility, clarity and understanding of information), - Robotics education context pedagogy, heterogeneity of targets - Material cost, access, maintenance, after-sales service
OPPORTUNITIES	**THREATS**
- Robotics education learning, acquisition of transversal skills, inclusiveness - Robotics: a major challenge for the future economic and industrial stakes, european context, Covid-19 context, full-employment sector - Target audiences development of cross-cutting skills in an interdisciplinary context - STEAM approach UNESCO supports national capacities to deliver gender-responsive STEAM education - European Reference Framework DIGCOMP(Digital Competence Framework) - Competitions Competition as a motivational lever - Development of open source culture public, freely available format - Ethics and robotics reliable, responsible, traceable, reusable materials	- Education policy and education polity Digital issues not sufficiently supported or grasped by public policies / Educational policies to be developed and strengthened - Representations An unknown field : apprehensions, misconceptions - Material Expensive, Hard to use, without enough resources - Teachers and educational actors Training issues, pedagogy, transversality, multiplicity of educational solutions - Partnership multiplicity of stakeholders : a sector segmentation - Impact : communication and dissemination visibility of the project (experimentation and results) - Rapid assessment of technology

D.1. Strengths

Consortium

Expertise

Each member of the consortium has a proven expertise in the management of projects related to educational robotics.

- The French partners have been running robotics education activities in and out of school.
- The German and Portuguese schools have been organising robotics education workshops.
- The Scuola di Robotica, a recognised training center for teachers, has a proven national reputation and recognition.

This implies that these partners have a network of schools and several authorities and organisations, after-school activities and extracurricular activities, favouring the development of the EU-RATE experimentation.

Participation in competitions

In addition, it should be noted that the French, German and Portuguese structures train and accompany teams in the Robocup competition and that the Italian partner accompanies teams to the FIRST LEGO League.

Current robotics education

From the data collected from our surveys, it seems that robotics education is the subject of sequences, teaching and programs integrated within the school curricula. It is mostly linked to scientific and technical subjects and includes the acquisition of technical skills (programming, coding).

Moreover, awareness and learning starts relatively young, from the age of 8.

Some countries have specific policies and/or programmes related to digital equipment (computers, tablets, etc.) in schools. The sources of public and private funds are various. It is estimated that the majority of pupils have proven access to a computer from the age of 10-11 years.

Overall, the countries concerned are involved in robotics education, even if most of this learning is done in schools.

Uses, practices, interest

Teachers

According to the surveys, teachers are aware of and familiar with the notion of educational robotics. They see interdisciplinary bridges to be made (in connection with the learning of skills). A large majority is ready to test and experiment with a new robotic educational solution. There is a strong interest.

Pupils

Like the teachers, the pupils seem to have an interest in robotics. Moreover, the students' favourite school disciplines and their personal activities are in line with the basic skills required to learn robotics.

Digital technology seems to be anchored in practices. The level of mastery required for learning robotics is favourable.

The expertise, knowledge and network (in relation to the project targets) of the consortium are great strengths. Receptivity to the issue of educational robotics is favourable to the EU-RATE proposal and its experimentation.

D.2. Weaknesses

Consortium

Voluntary

It should be noted that part of the consortium is composed of professional teachers (Portuguese and German). Thus, the time dedicated to the development of the project, and therefore the availability of the latter to work on the EU-RATE project can be an obstacle.

Internal communication

As European Erasmus+ projects include the use of English, communication between partners with different levels of understanding and language can be a barrier. Indeed, misunderstandings and misconceptions about the content and objectives of each partner punctuate the development of the project.

Moreover, the working cultures are different: the world of work and the related habits differ according to each person. Some are animators, others technicians, others project managers. These are therefore different work rhythms, as well as different timetables or priorities.

Finally, the health context linked to the Covid-19 crisis is not helpful, not facilitating face-to-face meetings or transnational travel.

External communication

In relation to the visibility and impact of the information provided on the project by the partners, audiences differ. Thus, the accessibility of the information is likely to be unequal.

For example, schools and associations may have less visibility than a publication made by the scuola di robotica which has many followers on social networks (about 35000 on Facebook). MNU hosts and participates in annual conferences for teachers and students in Europe and around the world.

Also, as the EU-RATE project is a project related to a very specific field (in terms of vocabulary, of knowledge), the risk may be the lack of clarity, or understanding by the audience of the information related to the project.

Robotics education context

Pedagogical practices

Despite the implementation of digital programmes for education (including funding of hardware, provision of resources, and teacher training), initial teacher training does not include awareness or introduction to the issue of educational robotics.

Thus, as teacher training on this issue is not compulsory, the development of projects related to robotics remains localised initiatives that depend on the teacher's desire, as well as on the priorities and pedagogical projects carried by the schools.

The role of school directors is fundamental in promoting digital education in schools, but their training is less often and less explicitly stated in terms of objectives in current national strategies. Indeed, only one third of education systems have measures in place in this area as part of their current strategy.

Heterogeneity of targets

As expected, the surveys show different levels of teaching and learning in robotics education. In addition to the different learning levels between countries, the objectives and contents related to educational robotics actions are different.

The educational approach of teachers and the expected goals are parameters to be taken into account.

Material

Digital/robotic equipment varies according to the level of the school (primary, secondary). Also, depending on what the teachers and animators want to do with their learners, but also on the skill objectives they are seeking, the cost of the robots can be high.

At the same time**,** the question of maintenance and after-sales service of robotic equipment is an important issue to consider. Breakage, obsolescence and inoperability of equipment are common problems to be countered. The purchase of equipment is intended to be amortised over a more or less long term, its cost being high.

In addition to cultural differences in work and possible misunderstandings, the challenge is therefore to propose an educational solution:

- **Accessible to all levels and all ages,**
- **promoting relevant and useful learning,**
- **to acquire transversal and interdisciplinary skills,**
- **employing an approachable methodology,**
- **including robust materials,**
- **using an affordable approach methodology,**
- **including low costs, ethical and responsible materials**

D.3. Opportunities

Robotics education

Learning and acquisition of transversal skills

The use of robots in a pedagogical setting leads to increased motivation of students. They are training and educational tools, evolving, innovative and creative, which lead students to use digital technology in a playful and natural way to solve the problems they face.

The multidisciplinary nature of robotics also facilitates the involvement and expression of all. It opens students up to a variety of knowledge that develops their curiosity and expression.

Educational robotics includes different uses of robots with an educational intention, both in formal (school), non-formal and informal (extracurricular activities, autonomous learning) learning contexts. Pedagogical robotics activities in formal and informal learning present a great diversity on :

- cross-curricular learning objectives: from mathematics to arts, science and technology
- cross-curricular skills: from collaboration to problem solving to creativity
- the degree of linkage to the curriculum and school activities: activities carried out in relation to the curriculum, such as the use of robotics in the classroom.

Inclusiveness

In an inclusive education system, educational robotics can help provide better education for all children by interacting on four levels:

- Learning disabilities,
- Socio-economic status,
- Cultural diversity,
- Belonging to a gender[32].

Robotics: a major challenge for the future

Economic and industrial stakes

The robotisation of companies and especially industries has become a major development axis in its own right. Every year, there is a constant growth in the installation of industrial robots by industries throughout the world. Digitalisation is more than ever at the heart of the industry's challenges.Thanks to robotization, companies gain market share, competitiveness, and can hire behind..

According to IDATE DigiWorld (European think tank specialising in the digital economy, media, internet and telecommunications), the robotics market will exceed 90 billion euros by 2030[33].

European context

Europe is heavily invested in robotics. It has excellent research centres, secure digital systems and a strong position in robotics, and our manufacturing and service provision sectors are competitive, in areas as diverse as automotive, energy, healthcare and agriculture.

[32] Source : Daniela, L., Lytras, M.D. "Educational Robotics for Inclusive Education". Tech Know Learn 24, 219–225 (2019). https://doi.org/10.1007/s10758-018-9397-5

[33] Source : *"Robotics: a meteoric market which will grow to above 90 billion EUR by 2030",* Isabel Jimenez, 16 May 2019: https://en.idate.org/robotics-a-meteoric-market-which-will-grow-to-above-90-billion-eur-by-2030/

In response to the economic and industrial issues, the European Parliament voted the text "Civil law rules on robotics" in February 2017: among the decisions is the creation of a European Agency for Robotics and Artificial Intelligence, to be able to “meet the challenges opened up by the development of robotics[34]”.

In 2020, the European Commission published a white paper entitled "On Artificial Intelligence - A European approach to excellence and trust"[35] in which it presents a society centred around "the human" despite the development of new technologies. It also sets up an action plan on data. Thus, the Commission wishes to position itself as a model by building a legal regime covering the processing of personal data, fundamental rights, security and cyber security within the Union. If used properly, digital technologies will benefit citizens and businesses in many ways. Over the next five years, the Commission will focus on three key digital objectives:

- Technology for people;
- A fair and competitive economy;
- An open, democratic and sustainable society.

Europe clearly wants to position itself as a leading and trusted digital actor.

Covid-19 context

The global Covid-19 pandemic has significantly accelerated the modernisation and automation of businesses through robotics. Indeed, companies have become more aware of the need for robotics due to health restrictions and barrier actions. As a result, many countries have stepped up efforts to develop robots that can perform certain tasks while avoiding human contact.

Within industries, robotics aims to delegate tasks and make robots and humans work together. In this way, industries have been able to organise a new way of working that addresses today's health challenges.

Full-employment sector

Artificial intelligence and robots have already begun to transform the job market. New jobs are emerging and will continue to emerge, in the field of drones for example, with outlets in delivery or first aid, in health, or in waste treatment.

At the same time, the number of training opportunities related to the sector is increasing.

The International Federation of Robotics has estimated the turnover of "service" (non-industrial) robotics at 35 billion dollars, with France in second place in terms of the number of companies specialised in the sector. In education, the application scenarios of robotics are intriguing, sometimes as teaching objects for an intuitive introduction to computer programming, sometimes as remote access solutions or assistance to teachers, etc.

Robots will change the nature of work and create many new jobs in the coming years. According to a study conducted by Metra Martech (market research firm based in London) and reported by IFR (International Federation of Robotics), 1 million industrial robots currently in use are already directly responsible for the creation of 3 million jobs. The development of robotics in the coming years should

[34] European Parliament resolution of 16 February 2017 with recommendations to the Commission on Civil Law Rules on Robotics : https://www.europarl.europa.eu/doceo/document/TA-8-2017-0051_EN.html

[35] “White Paper on Artificial Intelligence: a European approach to excellence and trust 19” , European Commission, February 2020 : https://ec.europa.eu/info/sites/default/files/commission-white-paper-artificial-intelligence-feb2020_en.pdf

create another 1 million skilled jobs worldwide[36].
Robotics education is therefore an important issue in terms of career guidance.

Target audiences

Students

Robotics in the digital world can be used to combine learning cross-curricular skills through manipulation, while allowing for proximity and relationships. Learning about robotics is fun and motivating: the discipline enhances the pleasure of learning and encourages teamwork on projects. Moreover, participation in competitions is a very important motivational lever.

The challenge of professionalisation around robotics is strong. As a sector of the future, new professions and new training courses are emerging.

The notion of digital citizenship has evolved to include a range of skills, attitudes and behaviours that harness the benefits and opportunities offered by the online world while building resilience to potential harm.

Teachers

Globally, the interest and awareness of educational actors regarding the notion of educational robotics is growing. Expectations are simple: a robot that is easy to handle and not excessively expensive.

But, in addition to the desire and wish to develop robotics projects, it seems important for teachers to be able to develop cross-curricular, interdisciplinary projects (bringing together and combining different school subjects) to improve the acquisition and development of pupils' skills.

Robotics is a field that fascinates and intrigues children. The playful aspect is a driving force in instilling skills and knowledge in students throughout their school career.

STEAM approach

To respond to the challenges of gender equality and interdisciplinarity of the robotics field , the STEAM approach is a relevant one. In a world that is becoming increasingly computerised, the STEAM (Science, Technology, Arts, Engineering, Mathematics) approach has emerged in the United States in order to attract more children to science courses. It is a way of responding to the growing need for skills in these fields.

Rather than teaching the four disciplines as separate subjects, STEAM integrates them into a coherent learning paradigm that shows how knowledge gained in specific areas complements and supports each other. This multidisciplinary learning process encourages children to learn these subjects through practice and experimentation. The methodology is based on the development of projects directly related to real-life situations. The projects carried out by the children themselves make them the protagonists of their own learning experience.

The method is promoted everywhere, particularly by UNESCO, which sees it as a good way of attracting girls and women in particular to the scientific and technological branches. These are still strongly male-dominated sectors, although this is tending to change. An approach that could also

[36] Source : “Robots create jobs”, International Federation of Robotics : https://ifr.org/robots-create-jobs

appeal to young women and men in developing countries and give them tools to improve their living environment[37].

European Reference Framework : DIGCOMP (Digital Competence Framework)

While everyone agrees that the acquisition of solid "basic skills" in reading, arithmetic, science and technology is a prerequisite for individuals to better adapt to the transformation of professions, the European Union and many international organisations (UNESCO, OECD, among others) are seeking to integrate these skills into the skills that are indispensable to our digital society: communication, creativity, critical thinking, collaboration and problem-solving.

The new reference framework for digital skills, which is part of the European DIGCOMP framework[38], incorporates these dimensions. It thus provides teachers with strong pedagogical guidelines in taking into account these skills that need to be developed through classroom activities. Robotics places students in situations that favour the exercise of all these skills: they must succeed in working as a team by cooperating and/or collaborating, inventing solutions, making multiple decisions on the basis of acceptable compromises, communicating their approaches and pathways, while demonstrating empathy, curiosity, and even courage in order to succeed in meeting the challenges they face. Robotics can therefore be used to exercise these fundamental skills outside the classroom, and thus help to consolidate them. As far as the teacher is concerned, it is not impossible to think that participation in this type of initiative may lead to a renewal of his or her practices by better integrating these skills into daily life.

The competition as a motivational lever

The competitive nature of certain initiatives provides additional motivation for the participants and undoubtedly provides an event visibility considered relevant by the organisers in the same way as traditional sports meetings. In the shared opinion of experts and stakeholders, this is a strong global trend whose public success is growing in Europe, for example : the international RoboCup initiative originally created in 1997.

The preparation and participation in these meetings are still mainly done in the extracurricular context (robotics clubs at school or outside), but they are gradually tending to be integrated into school time as well, due to the investment of volunteer teachers.

Schools can find in these events a lever to rethink and update the repertoire of current practices in which classroom guidance is often considered too strong and at the expense of a real involvement of the pupils. Thus, giving or restoring a taste for science to the youngest pupils is a priority issue, as we are currently seeing a lack of interest in this field among lower and upper secondary school pupils, while the industrial sector and the world of research are being penalised by a drop in recruitment[39].

---

[37] "Girls' and women's education in science, technology, engineering and mathematics (STEM)", UNESCO - The United Nations Educational, Scientific and Cultural Organization : https://en.unesco.org/stemed

[38] "The Digital Competence Framework 2.0", EU Science Hub - The European Commission's science and knowledge service (Last update: 09/01/2019) : https://ec.europa.eu/jrc/en/digcomp/digital-competence-framework

[39] "Note de synthèse sur les enjeux des challenges robotiques en milieu scolaire" - GTnum OCEAN Mars 2019 (original text in french)
http://ife.ens-lyon.fr/ife/recherche/numerique-educatif/robotique-educative/Pdf-robotique-educative/note-de-synthese-ocean-challenges-robotique

Importance of Open Source

Free software has four main qualities: freedom to use the software, to modify it, to redistribute it, to redistribute it with modifications.

If EU-RATE productions are open source, they will be public and freely available. Under this licence format, productions can be developed collaboratively: other programmers can view, modify or use the code for their own purposes. Productions can be independently reviewed and audited by anyone qualified to do so, to check for backdoors, vulnerabilities or other security issues. This format will ensure that the software does exactly what it is supposed to do.

Source code that is available to all for review and evaluation minimises the chances of being tampered with. Open source remains a reliable and tamper-proof software format, but also the most suitable for the targets of the EU-RATE project.

Ethics and robotics

The consortium, through the EU-RATE project, wishes to respond to the current and timely question of ethics raised by the field of robotics. Indeed, robotics and robots raise new legal and ethical issues. In addition to the impact of the omnipresence of robots in everyday life, it is a question of reflecting on the ethical issues and the impact of machines on humans, understanding the machine, learning how it works and demystifying its technical aspect.

It is a question of proposing a robot with responsible, traceable and reusable materials: human ethics must guide its design, construction and use.

Robotics is a major challenge for the future. Today, it is inseparable from social, economic and industrial development strategies. European policy has also taken on board the problems linked to the potential abuses and threats that robotics can generate. Ethics, responsibility and accessibility are priorities. Its exponential development is creating jobs, and therefore a growing supply of training for new professions linked to the sector. In addition, the context of Covid-19 has accelerated digitisation and robotisation.

Teachers and young people now seem to be increasingly aware of the field. Teachers, for the stakes linked to the learning of transversal skills, young people for the playful and collaborative aspect.

STEM education is a way of understanding and applying an integrated form of learning that resembles real life. Instead of teaching disciplines separately, they can be taught together: knowledge from different fields complements and supports each other. Like STEM education, real-world jobs are interdisciplinary. Subjects do not stand alone, but are woven together in a practical and transparent way, allowing complex subjects to be designed.

D.4. Threats

Education policy

The dissemination and use of digital technologies are a major tool for developing the education system by profoundly renewing teaching methods and pedagogical organisation. These technologies are likely to improve the efficiency of learning and thus promote the success of all students. They are also important levers for adapting to the economic challenges and needs of contemporary society, particularly for training in new professions and qualifications.

However, if digital issues are supported or grasped by European public policies, their implementation at the local level remains more complicated.

A differentiated view of digital competence

Throughout Europe, digital competence is uniformly referred to as a key competence. In this respect, almost half of the European education systems refer to European definitions of key competences. 11 education systems exclusively apply their own national definition of digital competence (including Germany).

In primary education, more than half of the European education systems include digital competence as a cross-cutting theme. It is treated as a separate compulsory subject in 11 countries (including Portugal), and integrated with other compulsory subjects in ten countries (including France and Italy).

Regarding lower secondary education, the number of countries where e-skills are taught as a separate compulsory subject represents more than half of the education systems. For upper secondary education, the number of countries where it is taught as a cross-curricular subject is slightly lower than for lower secondary education, and fewer countries have it as a separate compulsory subject for all students. It should be borne in mind, however, that in upper secondary education, students can generally choose more optional subjects, including subjects related to digital competence[40].

Approaches to teaching digital skills[41]

The development of learners' digital competences is mentioned in almost all primary and secondary curricula in European education systems. However, unlike other traditional school subjects, digital competence is treated not only as a subject in its own right, but also as a transversal key competence. It can be integrated into the curriculum in three ways:

- As a cross-curricular theme: digital skills are considered cross-curricular and are therefore taught in all curriculum subjects. All teachers share responsibility for developing digital skills.
- As a separate subject: digital skills are taught as a subject in their own right, like other traditional subject-based skills.
- Integrated into other subjects: digital skills are integrated into the curriculum of other subjects or learning areas.

In Germany, the strategy "Education in the Digital World", which covers primary and lower secondary education, has been adopted as a national programme, although curricula are normally defined at Länder level.

In Portugal, due to the current curriculum reform, digital skills are taught as an interdisciplinary theme in lower primary education (first 4 grades), and as a separate compulsory subject in upper primary

[40] Source: European Commission/EACEA/Eurydice, 2019. "Digital Education at School in Europe". Eurydice Report. Luxembourg: Publications Office of the European Union
https://eacea.ec.europa.eu/national-policies/eurydice/content/digital-education-school-europe_en
[41] Ibid.

education (5th and 6th grades) and lower secondary education (7th, 8th and 9th grades). From 2018/2019, this reform is implemented in all grades from 5th to 9th.

In Italy and France, in primary education, the education systems integrate digital skills as an interdisciplinary subject. Digital skills are treated as a separate compulsory subject and are integrated into other compulsory subjects. A quarter of the education systems combine two approaches.

In lower secondary education, the situation is relatively similar as regards the interdisciplinary and integrated approach. However, the number of countries where digital skills are taught as a separate compulsory subject is increasing to more than half of the education systems. At this level, the teaching of digital skills as a specialised subject in its own right, such as computer science, is becoming more widespread.

Representations

Unknown field

The field of robotics is not well known, it must be demystified. The robotics field is seen as a "geek" field. It also seems gendered: seen as exclusively male. The "in principle male" sectors still struggle to attract women. Women do not go enough into the field.

Furthermore, the European Commission's *2nd Survey of Schools: ICT in Education* shows that pupils in general, and girls in particular, rarely participate in coding/programming activities. More attention should be given to activities aimed at strengthening pupils' coding skills or at increasing girls' interest in digital technology[42].

Apprehensions

The upheavals brought about by technical progress give rise to fears.

The robot, an automatic mechanism that can replace humans and sometimes has a human appearance, can appear beneficial or terrifying. Progress in terms of robotisation raises many questions, whether it is a question of the risks of automating jobs or of interference in other aspects of everyday life. It can be thought that eventually jobs are robotised and robots take over jobs.

According to the 2017 survey "Attitudes towards the impact of digitisation and automation on daily life", respondents are concerned about the impact of robots and artificial intelligence on employment: 74% of respondents expect that due to the use of robots and artificial intelligence, more jobs will disappear than new jobs will be created. 72% of respondents believe robots steal peoples' jobs. 44% of respondents who are currently working think their current job could at least partly be done by a robot or artificial intelligence. Overall, 88% of respondents agree robots and artificial intelligence are technologies that require careful management[43].

[42] Source : European Commission DG Communications Networks, Content & Technology by Deloitte - Ipsos. "2nd Survey of Schools: ICT in Education : final report" . Luxembourg: Publications Office of the European Union https://data.europa.eu/euodp/data/storage/f/2019-03-19T084831/FinalreportObjective1-BenchmarkprogressinICTinschools.pdf

[43] "Attitudes towards the impact of digitisation and automation on daily life" Special Eurobarometer 460 – Wave EB87.1 – TNS opinion & social – March 2017 https://ec.europa.eu/jrc/communities/sites/jrccties/files/ebs_460_en.pdf

Material

As for the educational robotics actions, the main objectives are, for teachers and educational actors, to have "ready-to-use", cheap and easy to implement proposals. However, a ready-made robot can be expensive even if it saves time. In general, it is not a scalable solution, so it can be used to work on a specific skill but will be more difficult to apply to an interdisciplinary project.

Moreover, the demand for robotics education depends on the educational projects carried out by schools. If robotics is not a specific demand, the budgets dedicated to actions will not be consequent. The buying and accessibility of equipment depends on the willingness of the institution.

Beyond the cost of the equipment, fragility (fear of breaking the equipment) and the question of maintenance are significant obstacles.

Teachers and educational actors

The way in which digital technologies are used in teaching is at least as important as the digital equipment of schools. From this point of view, teacher training should go beyond technical skills in the use of digital tools.

Training issues

For teachers, there is a lack of time, educational resources, training and support. The level of complexity of the materials can slow down the desire to develop educational projects.

The implementation of projects requires prerequisites that training and support could provide.

Moreover, robotics can be considered as time-consuming. Teaching time does not necessarily leave time for the implementation of projects. If training times are set up, they are mainly dedicated to digital technology: robotics is not addressed.

Pedagogy

Robotics is approached differently by teachers, due to several reasons (material, skills, enough space…). Young people do not always build their own robots and do not necessarily work in project mode. Programming is favoured.

Digital and robotic teaching can be limited to what young people already know how to do: the basic use of digital tablets and computers (generally for leisure).

It is necessary to make the young person an actor in his teaching, an actor in the development of a project.

Cross-curricular/transversality

Cross-curricular in an educational robotics project is difficult to implement. Disciplinary compartmentalisation remains entrenched: robotics projects are mainly carried out by technology, mathematics and science teachers. The approach must change: educational robotics projects must be carried out in an interdisciplinary manner. If this transversality is observed in primary school, it is waning in secondary education. More connections between school disciplines would help to develop robotics and digital actions.

Multiplicity of educational solutions

Today there are a lot of educational proposals related to robotics. There are many educational robots, which contributes to losing the educational actors who, in the middle of this great offer, do not know which proposal will be the most relevant, the most adapted to what they wish to develop.

Robotics learning and education devices are multiplying, but teachers do not always have the reading keys to judge their real uses and interests in the classroom (their pedagogical relevance), nor the resources at their disposal to appropriate them[44].

Partnership

There are more and more actors in the robotics field: companies, industries, mediation structures, research centres, universities, fablabs, makers, hackmakers, associations, etc. If this richness and diversity are positive, the sector remains nevertheless segmented. Not all of them have a vocation to mediate and raise awareness of their projects among the youngest. Finally, the private/public partnership remains complicated to set up, in terms of vision, reflection and common issues to be prioritised.

In addition, many actors are working on the issues of the digital divide, the development of skills and a general digital culture. These are all resources that we must be able to associate, to popularise and make accessible the field of robotics.

By relying on these actors, and by making young people aware of robotics, we can also prepare ourselves for the challenges of tomorrow's world, prepare ourselves for tomorrow's jobs, and respond to the needs for training and professional and cultural development in the future.

Impact: communication and dissemination

If the EU-RATE project aims to address a problem of educational solution, the importance of the problem and its solution are indicators of the project's impact.

Whatever the outcome of the project may be, its impact will be considerably reduced if nothing is done to communicate the outcomes to the targeted beneficiaries. This means that the practical experimentation of the project, and the results that will be derived from it, must then be communicated and disseminated in a sustained manner.

Raising awareness of the project's results is a necessity to be thought through and reflected upon if the project is to be successful, especially in a context of rapidly evolving technological advances, demands, trends and innovations.

Rapid assessment of technology

The continuous growth of digitalisation in society, as well as the evolution of technologies themselves, leads to a rapid obsolescence of strategies and policies, strategies and policies are rapidly becoming obsolete. European countries need to continuously European countries need to continuously review and develop new policies and strategic measures to meet the new demands for European countries need to continuously review and develop new policies and strategic measures in order to meet the new demands for quality digital education. As a result, almost all education systems currently have education systems currently have strategies for digital education

[44] Thibault Desprez. “Conception et évaluation de kits robotiques pédagogiques : Études écologiques et expérimentales sur l’impact de l’intégration de la robotique dans le milieu scolaire, en matière d’acceptabilité, de motivation et de connaissances”. Informatique [cs]. Université de Bordeaux (UB), France, 2019. Français. fftel-03003748f (original text in french) https://hal.archives-ouvertes.fr/tel-03003748/document

---

The challenges of the educational policies related to educational robotics do not seem to be understood, nor co-constructed with the actors in the field. It is necessary to be able to mobilise public and private actors to think of a collective and collaborative vision. Even if the sector is segmented, it seems important to bring industrial robotics or inventive robotics closer to the educational world.

In this respect, it is also important to work on deconstructing prejudices: to get past the stereotypes that the field of robotics may imply (gendered professions, robotisation of jobs, ...).

Trained educational actors, equipped with resources, and supported (humanly and materially), bypassing disciplinary compartmentalisation, will participate in raising students' awareness of a field that encourages the learning of cross-cutting skills, and will enable students to be actors in their teaching, actors in a collective project. For young people, working on motivational levers, such as participation in competitions, is a major point.

Finally, the communication and dissemination of the project experimentation will be crucial for the long-term impact of the project on the audiences targeted by the project.

II. Recommandations

A. Pedagogical

The questionnaires and interviews carried out during this part of the project diagnosis enabled us to see clear recommendations in pedagogical terms, thanks to an inventory of needs, expectations and possibilities. This part will deal with the recommendations for the pedagogical pathways created, but also with the recommendations for the support of the educational actors in the handling of this pedagogical pathway, in order to facilitate its handling.

A.1. Learning sequence design

General requirements

As a reminder, the actors of the EU-RATE project are committed to :

- Quantifying and qualifying the needs of each audience before the production, and identifying the similarities and differences in the practices and curricula of our 4 countries;
- Define the architecture of the production according to the needs;
- To create one or more turnkey pedagogical pathways that are progressive in terms of knowledge and skills acquisition, usable for the target audience, 8-10 and 11-14 year olds;
- Usable by all categories of educational actors (teachers, extracurricular activity leaders, volunteers, civic service volunteers, parents);
- Involving stakeholders, experts, teachers, youth workers and young people aged 14+ in the design of the pedagogical pathway, for a production that is as close as possible to the needs of young people;
- Providing generic and technical knowledge in robotics, but also dealing with general issues of digital citizenship for a better understanding of the world;
- Translating the pedagogical pathway into English, French, Portuguese, German and Italian.

The objective being, in the long run, to increase young people's interest and success in science, technology, engineering and mathematics, making them actors in their use and promoting innovative methods, through playful robotic teaching kits accessible to all.

Recommendations

The recommendations are proposed both in correlation with the analysis of the pedagogical practices in our countries, carried out by the partners (see part I-A.1.b), the results of the questionnaires and the interviews of the stakeholders (part I-B), as well as the results obtained by the SWOT analysis (part I-C). They aim to facilitate decision-making by the project actors and thus ensure relevant productions and easier implementation for the educational actors.

Building a complete and adaptable pedagogical pathway

In order to meet all the criteria for good appropriation by the educational actors who will be able to use it, the pedagogical pathway must be both complete and adaptable, i.e:

- Offer a general introduction presenting the different issues of the pathway and digital literacy;
- Propose at least 10 workshops of 45-minute sessions (corresponding to the average class time in our four countries, see part I-B.2.d) ready to use (presenting the sequence of events, the

material and space required, the educational objectives, the link with the school curricula in each country, the prerequisites for the session, additional resources if necessary...)[45]

- For the sessions, be aware of the constraints that a classroom can present (in terms of space and layout...)
- Have the possibility to go further for each session (if the time allocated is more than 45 minutes, propose a content according to the remaining time)
- Present a variety of approaches (e.g. alternate practical and theoretical sessions, practical application and a general issues session with a film debate, for example)
- Present additional resources in an appendix (theoretical, practical, ethical, creative ..)
- Have a strong potential for adaptability (possibility of interchanging the sessions, of drawing on resources, of making links with structures in the area - e.g. fablab, scientific centres, etc.)

Propose 2 different pedagogical pathways, one for each age group

The age groups selected for our project are fairly representative of the school cycles of the different countries involved (primary - middle or secondary school). It is therefore relevant to develop two pathways that adapt to each age group and its particularities, but also to other contexts (extracurricular time, out-of-school time).

The objectives of each pathway will have to be adapted. For example, while the activities of pathway 8-10 will focus on teaching the fundamentals of robotics, with block programming, pathway 11-14 will propose to build its own robot and start writing algorithms.

In both cases, the diagnosis made in part I-A.1.b allowed us to note that the teaching methods chosen should be based on problem solving, collaborative group work of 3-4 pupils maximum, children's autonomy, long-term projects - thus already corresponding to our pedagogical pathway approach, in several workshops - and support for participation in competitions (e.g. propose, in the appendix, the rules for participation in the RoboCupJunior and contacts, websites, etc.) since these are described as strong motivational levers by the stakeholders.

Popularising and allowing appropriation by all educational actors

As stated by some experts in part I-B, the key to democratising robotics, making it accessible to all and allowing the understanding of its issues is above all popularisation. By this, we mean proposing activities that are easy to access, simplifying the main concepts, accessible in all contexts (not only in a classroom context), allowing us to go on to more complex notions. These activities can be carried out directly with the robot(s) that will be used or in an "unplugged" format. An example of good practice is the game of the idiot robot[46], which does not require any specific equipment and can be adapted to all ages. Thus, the two courses could start with this type of workshop or find several of them along the way, depending on the new concepts presented.

[45] See the blank frame in annex

[46] In the idiot robot game, children play in pairs. One child is the programmer, the other the robot, and the programmer has to write the best possible program so that his or her "robot" gets through an obstacle course blindfolded. This introduces the first notions of sequential programming. Pixees Ressource pour les sciences numériques website : https://pixees.fr/dis-maman-ou-papa-cest-quoi-un-algorithme-dans-ce-monde-numerique-%E2%80%A8/

Encouraging interdisciplinarity and a project-based approach

The teachers and stakeholders interviewed were unanimous in their view that robotics is a formidable lever for working on cross-curricular skills, be they scientific or technical, or ethical or creative. It is necessary to encourage the acquisition of what can be called "21st century skills": cooperating, questioning the world, communicating and creating as proposed in the DIGCOMP, Digital Competence Framework[47] (see part I-C.3). The sessions should therefore not be designed to respond to the challenges of a single subject, but rather to promote cross-curricularity and thus the acquisition of both soft (life skills) and hard (know-how) skills. In the school context, this may make it possible to promote the link between subjects and teachers; in the extracurricular context, it may make it possible to promote the link with the school and third-party structures.

It is strongly recommended to use the STEAM method (Science, Technology, Engineering, Arts, Mathematics) which is gradually developing in Europe and promoted by UNESCO. It aims to place learners in a situation of real problem solving and project development in order to encourage their creativity, critical thinking and sense of analysis. This approach integrates different ways of experimenting and creating and responds to the challenges of today's and tomorrow's professions and helps to attract girls and women to technological and scientific works. (see part I-C.3).

To this end, the use of scenarios is helpful in immersing the learner in the context; they can be borrowed from other subjects (e.g. creating the blood circulation diagram with Ozobot[48]...) in order to promote interdisciplinarity and meet the challenges of several disciplines.

A.2. Support of educational actors

General requirements

The partners have come to the common analysis that we need to invest in teachers as transformers and awakeners if we want to empower the new generation of citizens in using digital technology effectively and in a responsible manner.

But other educational actors also have an important role to play in learning about digital technology and robotics. Animators, volunteers, civic service volunteers but also family members, parents and grandparents feel concerned by this issue and should, if they wish, be able to appropriate the productions made for the EU-RATE project.

In order to enable everyone to take ownership of the project, the project's actors have undertaken to :

- Create a turnkey pedagogical pathway (see part below)
- set up face-to-face training courses for educational actors in each country, to enable them to test the kit developed, with evaluation at the end of the training (1 per structure, 25 participants maximum, 2 days of training) , do an with evaluation + feedback questionnaire several month after the training

[47] "The Digital Competence Framework 2.0", EU Science Hub - The European Commission's science and knowledge service (Last update: 09/01/2019) : https://ec.europa.eu/jrc/en/digcomp/digital-competence-framework

[48] Source : "Activités de codage et de robotique en SVT", François Courel, (13.02.2017 (Original text in french) http://pedagogie.ac-limoges.fr/svt/spip.php?article414

- Create an online course on Moodle platform (example) or other existing platforms (open source and free) of at least 6 hours about robotics and media literacy and the robotic kit for teachers
- Have a transnational approach to create an online training for the teachers, youth leaders, educational actors all over Europe. We will then adapt this training to the culture and needs of each partner country thus providing a European response to a European priority.

Recommendations

Immersive and relevant face-to-face training

The education experts and training engineers who were approached during the guided interviews are formal: teachers must take an active approach: practise, handle the robot, have progressive challenges and solve complex problems - in the same way as the pupils afterwards - and work in groups (see part I-B.5.f).

The challenge is to work on the motivational levers of the teachers: it must be fun, it must not be too easy or too difficult, and the person must understand what the added value is to his or her training. It is also necessary that the training has a high potential of reusability directly in the teaching practices, without requiring a time of readjustment and resumption too important: the turnkey aspect.

The actors of the EU-RATE project will therefore have to build a relevant training program that meets all these criteria, in order to guarantee a perennial use in the practices of the trained teachers. Directly involving teachers and training engineers in the construction of the training programme is a guarantee of its viability. The evaluation at the end of the training modules will allow us to understand the positive and negative aspects and the levers for improvement for the construction of resources.

Comprehensive distance learning courses

The project's actors have also committed to building distance learning courses of at least 6 hours, via an e-learning platform such as moodle.

In order to be useful and relevant, these courses will also have to meet several challenges:

- Be adapted for each country (language, content, links and complementarity with the school curriculum);
- Offer short modules, to enable learning at one's own pace and according to one's profile - facilitator, teacher, parent, etc;
- To allow the technical handling of our developed pedagogical kit (pedagogical path + robot + software);
- Be accessible to all and therefore start from the basics, both in terms of technique but also of pedagogy and digital citizenship;
- To be transdisciplinary, to make the link between the skills developed to allow teachers to make links with other subjects than technological subjects;
- To address issues of digital citizenship and provide tools to educate future enlightened citizens;
- Suggesting activities to be carried out in the classroom, during extracurricular activities and during school time;
- To provide additional resources.

Diversified and complementary resources

Also, the learning path, face-to-face training and online training must be enhanced by other media and complementary resources to make it easier to learn.

In the questionnaires sent out to teachers (part I-B.5.e), they called for video tutorials, off-line resources (explanatory pdf files, examples of workshops, etc.), workshops accessible live via videoconferencing and other interactive resources (serious games, etc.) that not only popularise but also go into technical and theoretical aspects in greater depth. Not all of these resources will necessarily have to be created within the framework of the project, but a diagnosis of the existing resources (creative commons) in each country could allow for a pooling and translation into each language. Indeed, there are many initiatives in each of our countries but they are not always known to the general public.

Network and partnership

Furthermore, if we start from the assumption that educational robotics must be based on local know-how, developing projects locally seems complicated to implement. The educational policy is centralised and does not include a shared collective educational vision. The means for its development within schools and out-of-school structures may therefore be limited.

In order to guarantee the sustainability of the project, it will therefore be necessary to encourage networking, in partnership with associations, companies, researchers, engineers, fablabs and other makers' networks, in order to create a real community and to bring together "people who know how to do things" (Didier Roy, INRIA).

This co-constructed approach will then make it possible to create cross-cutting projects with the children and to encourage them to enter the digital and robotics professions, by overcoming stereotypes (discovery of the different professions linked to robotics, such as biomedical technologies, agricultural technologies, logistics and transport, aviation, automotive industry, industry 4.0, smart homes, or environmental technologies, etc. Meeting with roboticians and engineers women..).

Thus, as the project actors have already listed the relevant structures in these fields in their territory, it will be necessary to create a listing, in the form of a map for example, enabling the educational actors to network with the local actors (from all fields). This map could be presented during the face-to-face training and in the e-learning courses.

To develop the co-education approach

The co-education approach, i.e. the link between school, after-school activities and extracurricular activities, should be explored further in order to ensure that children can better grasp the challenges of digital technology.

Indeed, the experts strongly advise working on this issue in a cross-cutting manner (see section I-B.5.h): a good example is the practice of sport, which has become widespread in these three phases of a child's and adolescent's life thanks to pedagogy and a strong public policy in each of our countries. It would be good to initiate projects that allow everyone to get involved. Robotics competitions are also a good example, as they are often not only worked on during school time but also at home, with the help of parents.

Just as teachers' attitudes towards digital technologies and their ability to use them are key factors in how they teach their pupils, parents' attitudes and skills will help or hinder their children's development of digital skills.

A qualitative survey on young children and digital technologies showed that "parents would welcome advice on how to keep children safe online. It was found that the advice provided by schools was limited and that there was a lack of substantive communication between schools and families on technology-related issues[49]".

It will therefore be necessary to invite educational actors to communicate widely with parents, but also to participate in parent-child or parent-only workshops, in order to enable them to have a better knowledge of their children's practices and also to develop digital literacy (setting up meetings, debates, conferences, etc. Examples will be provided in the resources created.).

B. Hardware

General requirements

The project partners are committed to producing a robotic system with its experimental environment, which should be easily and cheaply reproducible, open source, extensible to different teaching practices, and, as far as possible, with components manufactured in europe.

As the hardware should be adapted to the age of the learners, the partners decided to create several versions of the robot, one for each age group, 8-10 and 11-14 years.

The choice of components (sensors, controllers, actuators...) and design should be chosen according to the age and content of the school curricula of the different countries, in order to meet the expectations of each.

Recommendations

Design & components

According to the results of the questionnaires and interviews, it appears that the most important things for teachers and experts is to have access to a robot that is :

- low cost (between 50 and 100 euros),
- intuitive,
- sustainable and repairable,
- open source,
- buildable and manipulable,
- robust,
- easy to maintain.

[49] Chaudron, S., 2015. "Young Children (0-8) and Digital Technology. A qualitative exploratory study across seven countries". Luxembourg: Publications Office of the European Union. https://op.europa.eu/en-GB/publication-detail/-/publication/1f8b73cc-d900-406a-927c-0f8c0f202ed4/language-en

It is not easy to find the right balance between these criteria, which are not always easy to combine, such as being buildable AND robust, or low cost AND easy to maintain. The challenge will be to make choices in the most judicious way possible, to evaluate the most important and least important criteria, and sometimes also to favour them according to the age group.

- For 8-10 year olds, the robust, inexpensive and intuitive aspect should be favoured,
- For 11-14 year olds, the constructible and manipulable aspect should be favoured.

The criteria that are cumulative for the two age groups are as follows: low cost, open source, easy to maintain, sustainable and repairable. The prototypes developed must therefore meet at least these criteria to be selected.

It is important to note that several experts we met[50] did not recommend developing a new robot, but rather to build on existing open source robots and modify them to meet our criteria. Indeed, the open source community is rich and it would not be smart to develop a new offer when hundreds of robots are already on the market and the technical document is freely available and editable for our needs.

For this purpose, a comparative table will have to be created, with testing and manipulation of more relevant robots, in order to establish a relevant choice with regard to the profusion of the offer.

Concerning the design, the experts did not recommend any particular design, but a study by MIT[51] showed the interest of having a transparent chassis to allow visibility of the robot's interior and thus promote understanding.

Also, concerning the components that would be needed for the robot, the results of the questionnaires show a wide use of arduino as an electronic board and programming language, which is widespread and low cost. It will therefore be relevant to use it, especially as it is the most widely used programming language with scratch, which is compatible. The actuators and sensors must be chosen according to the educational sequence and the pedagogical scenario.

To ensure its relevance, our prototype will have to be tested by educational actors several times during the project and modified if necessary ; it is already planned to organise, on two occasions, training courses bringing together young people and adults (teachers and experts) carrying out tests and giving their feedback and opinions on the outputs.

Finally, the EU-RATE consortium will have to work on how to facilitate the purchase of components by public and private sectors/structures. We are aware of the difficulty, within the frame of public order and competitive bidding to purchase specific equipment, small amounts and/or separated pieces. It will be necessary to make it possible to buy “packages” containing the necessary material for the construction of the robot or the robot already built.

Technical documentation

In order to meet the expectations of all the educational actors who will be able to use it, the technical documentation must be complete and perfectly translated (assembly guide, installation, programming, appendices with solutions to frequent problems, etc.). This technical document will be in creative commons license as “Attribution 4.0 International (CC BY 4.0)”. This allows productions to be shared

[50] Comments made by Didier Roy, Yoan Mollard, Thibault Desprez and Adrien Payet.
[51] RESNICK, Mitchel; BERG, Robbie; EISENBERG, Michael. “Beyond black boxes: Bringing transparency and aesthetics back to scientific investigation”. The Journal of the Learning Sciences, 2000, 9.1: 7-30. https://web.media.mit.edu/~mres/papers/bbb.pdf

and adapted freely (just give appropriate credit, provide a link to the license, and indicate if changes were made).

Video tutorials should be added to this written documentation, at least in English with subtitles for each language.

Maintenance support

As mentioned above, it will be essential to offer solutions to anyone who encounters a problem with their robot, during and after the EU-RATE project. For this, it will be useful, on each of our supports, to refer to existing sites, documents, forums but also to fill our technical document with examples of solutions in case of problem. Also, a mailbox will have to be proposed in case of an unsolved problem, referring to one or several partners of the EU-RATE project in charge of the material part.

C. Software

General requirements

The project partners are committed to using accessible and easy-to-use programming software at the lowest possible cost, in 2 part :

1. Propose a documentation to set up a software platform to program the robots developed. This study should correspond to the expectations of the project: use free software, to be easily modifiable and adaptable to the needs of the project, to be easily distributable and installable on free and non-free operating systems, and finally to be easy to use and user-friendly for the end user, children and teenagers.
2. Develop libraries for the chosen software platform to allow the end user to use all the functionalities of the hardware. These libraries in their presentation as well as in their use will have to be easily importable into the robot programming platform and adapted to the robot as well as to the age of the young people who will have to program them.

The whole set will be delivered in the form of packages that can be downloaded on an internet server, the content of which will remain accessible even after the Erasmus project is over. In order to keep it alive and ensure its continued development, the sources will be published on a Wiki system set up at the start of the project. The aim will also be to create an international community that will work on the development of new functionalities as well as on the improvement and optimisation of existing ones. For example, it will also be able to implement libraries to manage sensors that were not supported during the initial project. It will also be in charge of adapting the libraries to the evolutions of the initially chosen support platform.

Recommendations

As with the feedback from the experts in the hardware section, they strongly advised building on existing software platforms and not creating a new one. Indeed, there are many programming platforms, some of which fully meet our criteria and are adaptable to many educational scenarios. The challenge is to choose the best one according to our criteria and to modify or amend it if necessary (adding functionality, an interface with the chosen micro-controller, etc.)

For this purpose, the partners will create a comparative table to help them in their choice, for each age group, just like the selected hardware.

Digital device

According to the results obtained in the surveys below, the digital work tool most frequently found in the classroom and in extracurricular areas (including the family area) is the computer, followed by the tablet and smartphone.

The recommendation is to choose a software compatible with as many systems as possible (and different OSes - Linux, Microsoft, IOs, Androïd…) even if the main use will probably be on a computer.

For 8-10 years old : Scratch or other block programming platform

The results of the questionnaires showed us that a majority of children were aware of and used block programming, as the Scratch platform, which is very well adapted to this age group according to teachers and experts.

It will therefore be relevant to use this platform or an equivalent, which is a free, easy interface, internationally known and translated into all languages, for the EU-RATE project. It has the advantage of being ergonomic and adaptable to most hardware (such as Arduino boards, thanks to the Scratch for Arduino extension,). As an equivalent, it is possible to use Ardublock, a plugin that integrates with the Arduino IDE .

For 11-14 years old : Text programming or block programming

As explained in the Hardware and surveys sections, one of the most used interfaces in our 4 countries is arduino. Arduino IDE is widely used around the world, is easy to use and is open source. It is quite suitable for the age group chosen, with ardublock as a first step.

It gathers all the tools that allow to program for the arduino and in particular to create and install new libraries, files that add functions to the Arduino IDE programming language, useful when creating a new robotics kit.

It allows teachers to choose to program with blocks or a programming text language as C or Python.

Another hardware interface which is more and more used for the same reasons (easy to plug and program) is Microbit. For this platform also you can choose to program with blocks or using a text langage.

Technical documentation

The technical documentation should be directly integrated into the hardware documentation, and be as complete as possible, like the description of the part concerned (part II-B). It must explain, for example, how to integrate control modules for the actuators or sensors. Also, it will be relevant to add dedicated video tutorials. During this phase several technical tests must be carried out with the aim

of testing the software developed with different technologies and activities to ensure the compatibility of the software with as many systems as possible.

D. Communication / dissemination

General requirements

Ligue de l'enseignement Nouvelle-Aquitaine coordinates the communication activities related to the project in order to guarantee the widest and most efficient dissemination possible at European and national level of the material developed and experimentation carried out.

MNU strongly supports the dissemination plan. It's an association with a major network in Germany, Europe and also USA and Canada , focuses on the wide transnational dissemination of the project and to relevant stakeholders at EU level.

All partners must also support dissemination plans at the local, regional, national and international level by their networks, participating in events not covered by the project but connected to the theme (RobocupJunior, at regional, national, european and international level, congresses, teachers meetings and trainings, etc) but also by new contacts made on preparation time and during and after the project.

In addition, each of the participants committed to share the progress of the project (articles, photos, videos) on their websites and social networks, and contact the press during our multiplier events and meetings**.**

The project partners plan to use the following european platforms to disseminate and share the project results on:

- EPALE
- School Gateway
- Erasmus + project results platform.

The consortium decided to organise specific multiplier events of 1 day event in the countries/regions of the project partners: Italy Genova, Germany Hessen, Germany North Rhine-Westphalia, France Pau and Portugal Barcelinhos.

These events will be organised between december 2022 and january 2023 aiming at promoting a public presentation of the project outputs (prototypes of the robots, their software and the associated tutorials), involving at least per event 25 stakeholders, including teachers, educational actors, school representatives, experts and decision and policy-makers, as to obtain respective legitimacy and acceptance. During the event, the participants will be able to test the teaching materials and make returns which will be used for the final development.

Specific objectives are to encourage discussion and sharing of perspectives and experiences and offer networking opportunities to strengthen further implementation of the testing, teacher training and the use of the kit after the end of the project.

Recommendations

Structured overall coordination

In the context of project management and implementation / information on staff involved / timetable / frequency of follow-up activities the consortium has to set up a communication system to ensure intensive cooperation between partners. Virtual communication between meetings is essential.

To this end, clear communication rules (tools, frequency, reaction time to emails, etc.) have been established and monitored. Common templates ensure consistent collection of comparable data and information during research activities.

The partners know from experience gained in previous projects that fluid, efficient and transparent communication is the key to the success of a project.

Means to be retained and implemented :

- A dedicated mailing list ;
- a cooperative communication tools chosen (Telegram® for direct exchanges, which is secure, free and open-source);
- Online meetings organised using Teams®(tool already used by Ligue de l'enseignement), which allows the creation of virtual web conferencing spaces dedicated to the project;
- As lead partner, Ligue will be available to all partners to discuss any issue related to the project ;
- Specific time slots for bilateral discussions will be included in the transnational meeting agenda.

During the first consortium meeting MNU and Ligue already presented a dissemination plan that was validated by partners. This plan established the role of each partner throughout the project.

Take advantages on events

During the project there will be several opportunities to spread the word about the project as the consortium will use their events, partners' events, conferences, meetings to speak about the project, the on-going results, in order to associate more educational actors and stakeholders to the EU-RATE project achievements and challenges.

Also, considering the multiplier events in each country : the consortium has a huge network of schools, teachers, a strong contact with the ministry of Education and partners at the regional, national and international level. The consortium must associate its national partners to this event. These events may have an online alternative if the COVID-19 crisis continues to accelerate and restriction measures are settled.

The final event of the project will be organized in connection with the last partners' meeting in France. It is expected that minimum 40 participants (national and European relevant participants (trainers, teachers, learners, policy makers, stakeholders, trade unions, research centres, ICT companies, NGOs, etc.) will attend. The aim is to promote the project outcomes also at the European level and to engage stakeholders in further exploitation of these results. Partners must use their networks for inviting key organizations that can support the future implementation of the project

outcomes. Some of them will be organizations that were already involved in the previous project activities, but the aim is to also bring new organizations around the table.

Partners will encourage participants to intervene and thus will facilitate the exchange of practices and ideas. At the end of the conference participants will be invited to fill in an evaluation questionnaire that will allow the consortium to analyse the results for further integrations.

The event will be in June/July in Bordeaux, France (Ligue's office). Robocup 2023 will take place in Bordeaux and the consortium wishes to take advantage of this opportunity to disseminate in large scale the project results. The exact date of the event will be defined by the Consortium based on its availability and on the opportunity.

Rely on existing networks, policy makers and overall stakeholders

A number of organisations have already expressed their will to support the project when the consortium applied for Erasmus+ support without being identified as formal partners. Some partners have provided support letters and some of them, as COVID-19 has blocked a lot of structures, which were not able to send us a letter before the application deadline.

Following the reception of the notification of Erasmus+ support, the consortium organised presentations of the project to their networks and on events where stakeholders, teachers and students were present. Here are some examples of participation/contribution of associate partners and/or stakeholders to the project:

- participate in the project providing advice and information, depending on their field of expertise, bringing valuable input to the project activities and outputs;
- facilitate the contacts of the project partners with appropriate data sources in their country/network;
- review the outputs being produced;
- and disseminate and share the project results within their networks (formal and informal).

They will carry out these activities mostly by means of e-mail, telephone conferences, attendance to events and participation in project meetings (only if considered absolutely necessary).

We believe associated partners and/or stakeholders are the key to disseminate the project on-going, to make it evolve and to reach educational actors (public and private) that will contribute to disseminate our project results and also its sustainability. The associated partners will continue to grow throughout the project and a final list will be given with the final report.

Federation, committees, networks

- **National Network of Educational Robotics - RNRE - (Italy)** is an official public community of more than 50 public schools based mainly in the Italian Ligurian Region. It was funded three years ago and the leading member is the Nautical Institute San Giorgio of Genova. The RNRE members are public schools from kindergarten to high school. The main aim of the RNRE is to introduce innovation in the educational system using online learning, coding and educational robotics. The RNRE offers training courses for teachers to upgrade their competences.

- **French Federation of Robotic - FFROB (France)** is the french national association for the promotion of robotics and the support of robocup events (local, regional, national and international) in France.
- **RoboCup Committee of Germany,** made up of robotics and education specialists, which organizes the annual World Robotics Event.
- **Sociedade Portuguesa de Robótica - Portuguese robotics society (Portugal)** of which main goals are to foster education, scientific research, technological development and applications (industry and services) of robotic systems. Their annual event is the Portuguese Robotics Open, including robot competitions for university and high school levels, as well as a technical conference which has been co-sponsored by IEEE in the last few years.
- **NAIA.R, the New Aquitaine forum for Artificial Intelligence and Robotics (France)** is an event bringing together the entire Neo-Aquitaine AI, machine learning and robotics ecosystem in Bordeaux. Participants, speakers and partners will meet around talks, workshops and demonstration areas in order to project themselves concretely into what is already shaping up to be the biggest transformation of our companies, our institutions and our society in the years to come.

Educational resource centre

- **Canopé (France)**, National Centre for Educational Documentation, is a public administrative institution and publisher of public educational resources, under the French Ministry of Education. The Canopé network publishes trans-media educational resources (print, digital, mobile, TV), meeting the needs of the educational community.
- **Educabot (France).** The Educabot association is participating in the creation and national deployment of a technical and pedagogical reference system, in partnership with the French Ministry of Education. This reference system is associated with the contextual uses of robotic tools for active learning adapted to all the times of the child. For each tool, practice,... Educabot sets up online and face-to-face training modules for trainers.
- **Maison pour la Science en Aquitaine - House for Science in Aquitaine - (France)**. Established on the Bordeaux university campus, the Maison pour la science en Aquitaine (House for Science in Aquitaine) offers professional development actions to teachers from primary to high school throughout the Bordeaux academy. These actions are the result of a close collaboration between the university or industrial research community and the educational community.
- **Association Colombbus (France).** Since its creation in 2000, the association has been working for education, training and professional integration through computers and the internet. Through our activities, we facilitate the use and appropriation of digital tools, which then become vectors of inclusion, personal development and social ties.

Laboratories, research institutes, schools of higher education

- **The French Institute for Research in Computer Science and Automation - INRIA- (France)** is a French national research institution focusing on computer science and applied mathematics with national and international recognition for their work in educational robotics.
- **The ENSEIRB-MATMECA (France)** is a National School of Electronics, Computer Science, Telecommunications, Mathematics and Mechanics in Bordeaux, is a public engineering school of Bordeaux INP.

- **The INSPE (France)** is the National Higher Institute of Professorship and Education, that trains future teachers in Bordeaux, France.
- **Future Education Modena (Italy)** is an international centre for elevating research, quality and impact of education in society. Future Education Modena aims to increase the potential of education in society, improving the quality and impact of educational experiences through research, design and acceleration activities. Positioning itself as the main national reference in the relationship between technology and educational innovation, Future Education Modena brings together the best results of educational research with the most advanced technologies.
- **Ecole Nationale Supérieure Art et Métiers ParisTech (France) :** Arts et Métiers ParisTech has been committed to responding to constantly evolving industrial and societal challenges. Its primary mission is to train engineers specialised in sustainable technologies: engineers capable of designing environmentally friendly products and systems, but also of controlling an industrial organisation by controlling risks and costs.
- **Institut Français de l'Education - ENS Lyon (France) French Institute of Education - ENS Lyon** The French Institute of Education was born in 2011 from the reorganisation of the National Institute of Pedagogical Research and has been integrated into the École Normale Supérieure de Lyon, which is distinguished, both nationally and internationally, by a permanent interaction between training and research. The ambition of the institute, an interface structure, is to articulate research and training in order to support educational policies. For the IFÉ's inter-category teams, this means producing rigorous studies and useful resources that can be used by trainers and, more broadly, by all educational actors.
- **Università Cattolica (Italy)** The Catholic University of the Sacred Heart (UCSC) is a private Italian university of Catholic inspiration founded in 1921, with headquarters in Milan and other locations in Brescia, Cremona, Piacenza and Rome. The founder and promoter of the Università Cattolica del Sacro Cuore is the Istituto Giuseppe Toniolo di Studi Superiori.

  The university is divided into twelve faculties and seven postgraduate schools and is linked to a network of health facilities, in particular hospitals, research centers and nursing homes, including the Agostino Gemelli polyclinic, named after the founder of the university.
- **Università Degli Studi Firenze - Terza Cultura (Italy).** The University of Florence is an Italian state university located in the city of the same name and founded in 1321 as Studium Generale. It is one of the largest research and higher education organizations in Italy, with 1,800 structured faculty and researchers, about 1,600 technical and administrative staff, and over 1,600 doctoral and post-doctoral fellows.
- **Liceo Scientifico Statale Leonardo (Italy)**. Inspired by the eclectic genius of the great Renaissance artist and scientist, the Leonardo State High School in Brescia is an institute in step with the changes in society thanks to qualified teaching, state-of-the-art equipment and practical application of the knowledge acquired. The wide educational offer ranges in three different addresses:
  - Applied Sciences, which guides the student to mature the necessary skills to follow the development of scientific and technological research.
  - The Linguistic address where you reach the communicative mastery of three foreign languages and critical understanding of the historical and cultural identity of different civilizations.
  - And the Artistic course in which the student develops the ability to design and creative skills through three educational opportunities: Architecture and Environment, Figurative Arts and Graphics.

Numerous supplementary extracurricular activities, Erasmus, competitions and internships complete the educational pathways in the creative and experimental spirit of Leonardo da Vinci.

- **University of Genoa (Italy).** University of Genoa is active in the international degree course in robotics (EMARO, European Master on Advanced Robotics) that operates in collaboration with universities around the world (Nantes, Valencia, Warsaw, Shanghai, Japan and Thailand).

Centres for the popularisation of science for the general public

- **Cap Sciences (France)** is a renowned center of scientific culture in Bordeaux (Nouvelle-Aquitaine) which, among other things, organised an exhibition "Robots" during the 2019-2020 school year in connection with the Robocup 2020, which was due to take place in Bordeaux (postponed to 2021).
- **Espace Mendès-France (France)** offers scientific exhibitions throughout the year to the general public. It coordinates several major regional operations such as “La Fête de la science”, “La Science se livre” or “Images de sciences, sciences de l'image” and co-organises or assists with many events in Poitou-Charentes. It also maintains a permanent mission on the theme of science, innovation and territories, creativity and territories and develops international partnerships.

Fablabs, clusters, makers, enterprises

- **MPIS lab (France)**. The MIPS Lab is a space dedicated to creation and which will allow everyone to be able to move from the imagination of a project to its realization.
- **Cluster Aquitaine Robotics (France)** is a cluster that helps companies and researchers to bring their robotics projects to fruition. Created in July 2013, it currently has more than a hundred members, mainly companies, research and training organisations, and users. It brings together players in manufacturing and logistics robotics, service robotics and robotics in open environments in New Aquitaine.
- **Generation Robots (France).** Generation Robots has been a major player in the distribution of service robotics equipment in Europe for 12 years. It distributes equipment for the world of education, research but also for professionals. It is also a professional service robotics design office with expertise in the development of autonomous robotics solutions, in the development of robotics algorithms around ROS (mobility, gripping) but also with the capacity to carry out embedded image processing.
- **Madlab 2.0 (Italy)** is an Innovative Start Up with Social Vocation that deals with training, 3D printing, humanoid robotics and technology consulting for individuals, schools and companies.

Festivals

- **Festival della Scienza (Italy).** It is a point of reference for the popularization of science. It is a meeting point for researchers, enthusiasts, schools and families. It is one of the largest events for the dissemination of scientific culture at the international level. Intimately linked to the city of Genoa and the region of Liguria, the Festival is an event with an intrinsic international character. Meetings with important national and international guests enrich every year the days dedicated to science, giving rise to lasting collaborations with personalities and institutions from all over the world. http://www.festivalscienza.it/site/home.html

Local authorities public

- **Nouvelle-Aquitaine Region, cooperation department (France).** The Nouvelle-Aquitaine Region has set itself the objective of becoming a responsible digital territory. This exemplary approach begins with its organisation and internal processes, and is reflected in its support for businesses, citizens and local authorities in the region
- **Director of Digital Transformation, City and Agglomeration of La Rochelle (France) :** The Digital Transformation Directorate has three strategic work areas: continuous innovation and the right to experiment, participatory governance and digital inclusion, and data valorisation and privacy. A great deal of importance is given to the circulation of data as a pillar of digital transformation.

Conclusion

The consortium in charge of the EU-RATE project engaged itself in a major challenge to reach in 34 months: propose the more accessible, low cost and open source robotic kit to be used by 8-10 and 11-14 years old.

During the past 12 months a multidisciplinary team of schools and associations of 4 countries has been working online due to COVID-19. We have learned to work together, share tasks and commit to the success of this publication and overall project. Even if sanitary restrictions and unequal periods of confinement did not facilitate our work, we reached **1828** (teachers, parents, 11+ students, stakeholders) answers to our surveys, interviewed more than **21** stakeholders, presented our project to more than associate partners and/or events and worked thoroughly to understand the countries context, its curriculas and compare it with the support of experts studies on digital education, robotics. We have also worked closely to understand and compare the existing robotics learning sequences, hardware and software used in each country.

This **collective work** allowed us to identify **the strengths, weaknesses, opportunities and threats of our project and build recommendations** that will be our guidelines for next steps.

This **publication concerning the period october 2020 - September 2021** will help EU-RATE partners start a new stage of the project, the building of the pedagogical pathway, the prototyping of hardware and the identification/improvement of accessible software for 8-10 and 11-14 years old students. Our direct target public, **teachers**, and the educational community in general will be our testing field and their feedback is essential to our project. Quality test protocols and evaluation tools as to overall coordination of testing phases with specific timelines are central to the on-going EU-RATE robotic kit development. We must also highlight the EU-RATE consortium's choice of involving **14+ students as co-developers of our project**. They'll be part of the next phases by participating in 2 trainings one on prototyping and the other one on finalisation of prototypes and pedagogy testing the robots building as peer multipliers.

Next EU-RATE publication will concern the période **October 2021 - September 2022.** It will assemble the on-going results and evaluation of the EU-RATE project, new findings, analysis and recommendations to enrich further work for the improvement of the robotic kits, communication and dissemination, impact and sustainability of our work.

EU-RATE consortium common values have become shared strategies and a will to overcome a challenge to make robotics access to everyone.

Bibliography

"Attitudes towards the impact of digitisation and automation on daily life" Special Eurobarometer 460 – Wave EB87.1 – TNS opinion & social – March 2017
https://ec.europa.eu/jrc/communities/sites/jrccties/files/ebs_460_en.pdf

Direção Geral da Educação - Aprendizagens Essenciais - Ensino Básico
https://www.dge.mec.pt/aprendizagens-essenciais-ensino-basico

Forsa. Politik- und Sozialforschung GmbH (2016), "Service-Robotik: Mensch-Technik-Interaktion im Alltag". Ergebnisse einer repräsentativen Befragung. Berlin, Deutschland. https://silo.tips/download/service-robotik-mensch-technik-interaktion-im-alltag-ergebnisse-einer-reprsentat

Eckart Modrow, Middle School Informatics, Göttingen 2007 / Eckart Modrow, "Pragmatic Constructivism and fundamental ideas as guidelines of the Curriculum", Dissertation Scheden 2002
http://ddi.cs.uni-potsdam.de/Examensarbeiten/Modrow2003.pdf

RESNICK, Mitchel; BERG, Robbie; EISENBERG, Michael. "Beyond black boxes: Bringing transparency and aesthetics back to scientific investigation". The Journal of the Learning Sciences, 2000, 9.1: 7-30. https://web.media.mit.edu/~mres/papers/bbb.pdf

KRALEVA, Radoslava; KRALEV, Velin; KOSTADINOVA, Dafina. A methodology for the analysis of block-based programming languages appropriate for children. Journal of Computing Science and Engineering, 2019, 13.1: 1-10.
https://www.researchgate.net/figure/Evaluation-of-the-block-based-programming-languages-investigated-and-their-programming_fig1_332143998

PANE, John Francis. A programming system for children that is designed for usability. Carnegie Mellon University, 2002.
https://www.researchgate.net/publication/35247353_A_Programming_System_for_Children_that_is_Designed_for_Usability

MICHELI, Emanuele; AVIDANO, Marco; OPERTO, Fiorella. Semantic and epistemological continuity in educational robots' programming languages. In: Proceedings of the TERECoP Workshop Teaching with robotics, Conference SIMPAR. 2008. p. 80-90.
https://terecop.eu/downloads/simbar2008/Micheli_et_al.pdf

S. Papert, Mindstorms: Children, Computers, and Powerful Ideas. London: Harvester Press, 1980.
https://dl.acm.org/doi/pdf/10.5555/1095592

European project Roberta: https://www.roberta-home.de/en

"Primary education, teachers (% female)", UNESCO Institute for Statistics. Data as of September 2020. https://data.worldbank.org/indicator/SE.PRM.TCHR.FE.ZS

"Women in science and engineering", Eurostat,10/02/2021
https://ec.europa.eu/eurostat/fr/web/products-eurostat-news/-/edn-20210210-1

"Robotics: a meteoric market which will grow to above 90 billion EUR by 2030", Isabel Jimenez, 16 May 2019.
https://en.idate.org/robotics-a-meteoric-market-which-will-grow-to-above-90-billion-eur-by-2030/

Daniela, L., Lytras, M.D. "Educational Robotics for Inclusive Education". Tech Know Learn 24, 219–225 (2019). https://doi.org/10.1007/s10758-018-9397-5

European Parliament resolution of 16 February 2017 with recommendations to the Commission on Civil Law Rules on Robotics.
https://www.europarl.europa.eu/doceo/document/TA-8-2017-0051_EN.html

"White Paper on Artificial Intelligence: a European approach to excellence and trust 19" , European Commission, February 2020.
https://ec.europa.eu/info/sites/default/files/commission-white-paper-artificial-intelligence-feb2020_en.pdf

"Robots Create Jobs" International Federation of Robotics website : https://ifr.org/robots-create-jobs

"Girls' and women's education in science, technology, engineering and mathematics (STEM)", UNESCO - The United Nations Educational, Scientific and Cultural Organization : https://en.unesco.org/stemed

"The Digital Competence Framework 2.0", EU Science Hub - The European Commission's science and knowledge service (Last update: 09/01/2019).
https://ec.europa.eu/jrc/en/digcomp/digital-competence-framework

"Activités de codage et de robotique en SVT", François Courel, (13.02.2017 (Original text in french)
http://pedagogie.ac-limoges.fr/svt/spip.php?article414

"Note de synthèse sur les enjeux des challenges robotiques en milieu scolaire" - GTnum OCEAN, Mars 2019 (original text in french).
http://ife.ens-lyon.fr/ife/recherche/numerique-educatif/robotique-educative/Pdf-robotique-educative/note-de-synthese-ocean-challenges-robotique

European Commission/EACEA/Eurydice, 2019. "Digital Education at School in Europe". Eurydice Report. Luxembourg: Publications Office of the European Union.
https://op.europa.eu/en/publication-detail/-/publication/d7834ad0-ddac-11e9-9c4e-01aa75ed71a1/language-en/format-PDF/source-105790537

European Commission DG Communications Networks, Content & Technology by Deloitte - Ipsos. "2nd Survey of Schools: ICT in Education : final report" . Luxembourg: Publications Office of the European Union.
https://data.europa.eu/euodp/data/storage/f/2019-03-19T084831/FinalreportObjective1-BenchmarkprogressinICTinschools.pdf

Thibault Desprez. “Conception et évaluation de kits robotiques pédagogiques : Études écologiques et expérimentales sur l’impact de l’intégration de la robotique dans le milieu scolaire, en matière d’acceptabilité, de motivation et de connaissances”. Informatique [cs]. Université de Bordeaux (UB), France, 2019. Français. fftel-03003748f (original text in french)
https://hal.archives-ouvertes.fr/tel-03003748/document

Chaudron, S., 2015. “Young Children (0-8) and Digital Technology. A qualitative exploratory study across seven countries”. Luxembourg: Publications Office of the European Union.
https://op.europa.eu/en-GB/publication-detail/-/publication/1f8b73cc-d900-406a-927c-0f8c0f202ed4/language-en

Annexes

1. Questionnaires

Teachers

D1 Country

D3 Age Group

under 30 years old

31 to 35 years old

36 to 45 years old

46 to 55 years old

over 55 years old

D4 Gender

Male

Female

Non Binary

Other

I prefer not to say

D5 Not counting the year 2020-2021, how long have you been teaching?

Less than a year

1 to 3 years

4 to 10 years

11 to 20 years

21 to 30 years

31 to 40 years

Over 40 years old

D6 What subject do you teach? It is possible that the exact title of your subject does not appear in the list. In this case, please tick the category that you think best fits

All subjects (primary school teaching)

Humanities (French, Philosophy, Literature, FLE, ...)

Mathematics

Technology

Modern languages

Sciences (Physics, Chemistry, Biology, Environment, Agriculture....)

Humanities (history, geography, economic and social sciences, economics, sociology, law, management, marketing...)

Arts (plastic arts, music, theatre, photography, visual arts...)

Physical and sports education

Religion (religion, history of religions, religious cultures...)

Professional education (in all fields)

Other

D7 How would you rate your level of use of new technologies?

Basic user

Advanced (cannot program)

Advanced (can program in at least one language)

D8 Your establishment is rather located in an

urban area

suburban area

rural area

D9 How old are your students?

Under 8 years old

8 to 10 years old

11 to 14 years old

15 to 20 years old

D10 How many students/pupils are in this class?

Less than 15

15 to 25

more than 25

D11 How many hours per week do you teach this class?

1h

2h

3h

4h

5 hours or more

D12 How long does a lesson last in your institution?

60 min

55 min

50 min

45 min

40 min

Other :

D13 Tick the (technological) equipment available to you in your school from the list below:

Computers

Tablets

3D printer

Educational robotics kits

Other :

D14 Are you familiar with educational robotics?

Yes

No

D15 Are there any educational robotic projects in your school?

Yes

No

D16 What activities related to robotics and programming does your school offer to the pupils you teach?

introductory activities to programming and robotics without hardware (without robots)

introductory activities in programming and robotics with hardware support (robots)

extra-curricular activities (clubs...)

the curricula and educational projects do not include this type of activity

D17 How important do you think it is that new technologies are taught? (on a scale of 1 - not at all important - to 5 - very important)

1

2

3

4

5

D18 Do you consider that educational robots can be motivating learning tools (on a scale of 1 - not at all important - to 5 - very important)

1

2

3

4

5

D19 In your opinion, robotics can play an important role in the development of: (tick the three most important)

abstraction

cognitive functions

creativity

cooperation

imagination

logical reasoning

motor skills

problem solving

D20 Have you ever worked with robotics kits?

Yes

No

D21 Do you use this equipment for competitions?

Yes

No

D22 In your opinion, in which subject(s) could robots be used as a teaching aid?

Technology

physics

chemistry

mathematics

computer science

modern languages

other

D23 Have you ever run a robotics project or participated in a robotics club in your school?

Yes

No

D24 The media you have already used with your students in the list below:

Arduino

Microbit

Roboblock

Rasperry Pi

Lego STEM Kits

Mecano

Whitehat Jr

Codecombat

Mbot

Thymio

Other

D25 Have you encountered any difficulties in using these materials?

None

Material

Software

Pedagogical

D26 How much autonomy do you think you have in using robots in the classroom?

I only need a simple tutorial.

I definitely need training.

I need the help of an external facilitator.

D27 How do you rate your prerequisites in the fields of programming and robotics?

No prerequisites

Basic

Sufficient for further training

Advanced (self-study ability)

D28 What type(s) of difficulty(s) did you encounter when implementing these materials?

Difficulties of use

The price

Hardware problems

Software that is not free of rights (Open Source)

Other

D29 What positive aspect(s) would you like to highlight about the hardware and/or software you were able to use?

Ease of use

Price

Robustness and reliability of the hardware

The open source nature of the software

Other

D30 What would you expect from a new robotics kit (both software and hardware)?

Ease of use

Low cost

The strength of the material

That it is open source (free of rights)

Other

D31 How important to you is the "ethical" (environmentally friendly, locally produced, fair) nature of the tools you could use to teach robotics? (on a scale of 1 - not at all important - to 5 - very important)

1

2

3

4

5

D32 Would you be interested in participating in the testing of a new educational robotics kit (including the teaching sequence)

Yes

No

Parents

D1 Age group

Under 30 years old

From 31 to 40 years old

From 41 to 54 years old

More than 55 years old

D2. Gender

Male

Female

Non-binary

Other

I prefer not to comment

D3. Number of survey respondents per country

D5 You live in a

urban area

peri-urban area

rural area

Other

D6. Job category

employed

self-employed

civil servant

Other

D7 Number of children

1

2

3

4

more than 4

D8. How important do you think it is for your child to learn about robotics and programming at an early age? (on a scale of 1 - not at all important - to 5 - very important)

1

2

3

4

5

D9 Do you use computers and new technologies at work?

Yes

No

D10 How old is your child?

Less than 8 years old

8 to 10 years old

11 to 14 years old

15 to 20 years old

D11 Does your child have his/her own laptop?

Yes

No

D12 Has your child ever participated in activities related to robotics and programming?

Yes

No

D13 In what setting?

At school

In a club, association, leisure centre ...

Alone at home

With your help at home

For fun with friends or classmates

D14 In which medium(s) has your child participated in robotics and programming activities?

Whitehat Jr

Codecombat

Scratch

MakeCode

Tynker

Blockly

Arduino

Microbit

Roboblock

Rasperry Pi

Lego STEAM Kits

Mecano

Mbot

Thymio

Did not use any support

Other

D15 How much would you be willing to pay per year to keep your child's education up to date with the latest technology?

nothing

less than 50 euros

from 50 to 100 euros

from 100 to 150 euros

from 150 to 200 euros

from 200 to 500 euros

from 2500 to 1000 euros

more than 1000 euros

16 In your country/region, are robotics and programming part of the school curriculum?

Yes

No

D17 How much time do you spend per week with your child to help with homework?

30 minutes to 1 hour

from 1 to 2.5 hours

more than 2.5 hours

D18 How much time do you spend per week with your child on leisure activities?

30 minutes to 1 hour

from 1 to 2.5 hours

more than 2.5 hours

only the WE

D19 In their free time at home, what indoor activities does your child do?

Playing video games

Playing board games, puzzles

He/she plays construction games (Lego, Kapla, Meccano or other)

Other

D20 Where do you take your child for the weekend?

To parks

Amusement parks

Exhibitions, museums, aquariums...

Gymnasium

Outdoor activities

Other playgrounds

Other

D21 How often do you go on holiday with your child?

once a year

2 times a year

Very regularly

Rarely

D22 How much do you pay each year for your child's activities (all types)?

between 100 and 200 euros

between 200 and 400 euros

between 400 and 1000 euros

more than 1000 euros

Children 11+

D1 Age

Under 8 years old

8-10 years old

11-14 years old

15-20 years old

Over 20 years old

D2 Gender

Female

Male

Non-binary

Other gender

Do not wish to comment

D3 favourite activities / subjects

Mathematics

Science

Literature

Languages

Sports

Arts

Other

D4 Do you have any construction or technology games?

3D puzzles

Drone

Legos

Remote control cars

Robots

Other

D5 Do you like building your games?
(Scale from 1 - I have never tried - to 5 - A lot)

1

2

3

4

5

D6 Do you like technological constructions? Scale from 1 - I have never tried it - to 5 - a lot)

1

2

3

4

5

D7 What do you think about robots?

It's funny!

I am afraid of robots

They are not for me

I don't care about them

It's fascinating

Other

D8 Have you ever built a robot?

Yes

No

D9 How did you learn to build a robot?

With the help of someone

With tutorials on the internet

From books on the subject

Other

D10 Who did you learn from?

Alone

parents

teachers

friends

students

brothers or sisters

Surroundings

Other

D11 Would you like to build one?

Yes

No

D12 Which tool would you prefer to use to learn how to build a robot?

With someone's help

With tutorials on the internet

With books on the subject

D13 Would you like to learn how to build one?

Yes

No

D14 Have you ever programmed a robot?

Yes

No

D15 How did you program?

Block programming (e.g. Scratch, Lego Mindstorms, Open Roberta Lab, Make Block)

C/C++ (e.g. Arduino, RobotC)

Visualg / Pascal

HTML

PHP

Python

Other

D16 Which tool would you prefer to use to learn how to program a robot?

With the help of someone

With tutorials on the internet

With books on the subject

Other

D17 Would you like to learn how to program one?

Yes

No

D18 Which tool would you prefer to use to learn how to program a robot?

With the help of someone

With tutorials on the internet

With books on the subject

D19 If yes, with whom did you learn?

Alone

With my parents

Teachers

friends

Students

Brothers or sisters

Surroundings

Other

D20 What kind of platforms have you tried to learn robotics and coding?

Whitehat Jr

Codecombat

Scratch

MakeCode

Open Roberta Lab

Tynker

Blockly

Arduino

Microbit

Roboblock

Raspberry Pi

Lego STEM Kits

Mecano

Mbot

Thymio

I have never used a platform

Other

D21 What do you think is the best way to learn how to build and program a robot?

Follow a tutorial

Participate in a workshop

Participate in a webinar

Online school lessons

Youtube video

Written tutorial in PDF

With a teacher or tutor

With your friends/classmates during free time

Other

Stakeholders (Germany, Italy, Portugal)

D1 Age group

Less than 30

31-40

41-54

More than 55

D2 Gender

Female

Male

Non-binary

Other gender

I prefer not to specify

D3 Country

D5 Which of the following categories do you belong to?

Ministries

Independent administrative authorities

Regions

Provinces

Municipalities and localities

Schools, universities and private research institutes

Public schools, universities and research institutes

Other public administrations

Non-profit organisation

Volunteer

Citizens

Companies

Consumer associations

Trade associations

Other

D6 Do you think that robotics kits can help students understand difficult and in some cases boring school concepts?
(Scale from 1 - not important - to 5 - very important)

1

2

3

4

5

D7 Have you ever experimented with educational robotics activities?

Yes

No

D8 Describe 'Educational robotics' with an adjective

D9 In which subjects do you consider educational robotics important?

All pre-primary/primary curriculum areas

Reading, writing and literature

Mathematics

Science

Social studies

Modern foreign languages

Technology

Art

Physical education

Religion and/or ethics

Practical and vocational skills

Other

D10 Are you interested in learning about educational robotics?

Yes

No

D11 If yes, why are you interested in the world of educational robotics?

School (if headmaster or administrative)

University

Department of education

Educational portal

Ministry of Education

Educational games

importance of education

Education Council

distance education

Department of Education

Hobbies

Non-profit organisation

business ideas

business insider

business plan

Business news

online business

Other

D12 In which area do you think educational robotics is most effective?

Primary school

Secondary school

High school

University

Extracurricular time

Leisure time

Other

D13 What kind of educational material do you think is necessary to combine with a robotics kit for an organisation?

pedagogical pathway

Offline digital document

Pdf

Live video courses

Asynchronous video courses (pre-recorded)

Short video tutorials

In-person courses

Interactive resources

D14 What do you think is the best price for a robotics kit for primary school?

Less than 50 euros

50- 100 euros

100-150 euros

150 - 200 euros

200-500 euros

500-1000 euros

more than 1000 euros

D15 Which devices do you think should be compatible with a school robotics kit?

PC

tablet

smartphone

Other

D16 Do you consider educational robotics a tool for inclusion?
(Scale from 1 - not important - to 5 - very important)

1

2

3

4

5

D17 In your country, how much do you consider educational robotics used in schools?
(Scale from 1 - not important - to 5 - very important)

1

2

3

4

5

D18 Do you consider robotics competitions important both for the promotion of the kit and for the promotion of educational robotics at school?
(Scale from 1 - not important - to 5 - very important)

1

2

3

4

5

D19 What do you think about robotics in our society?

An innovative field, offering solutions

I do not agree with robotics because I am afraid of the place robots will take in the future

I prefer not to express myself

Irrelevant opinion

Other

2. List of the stakeholders interviewed

1. Adrien Payet, founder and president, Educabot association

The aim of the Educabot Association is to federate and promote all digital innovations in order to contribute to the awareness and development of educational robotics projects.In particular, the association is developing a whole resource section, with the loan of robots and support in setting up educational projects.

Adrien Payet has been working for 30 years in the field of robotics. In particular, he created a robotics resource centre which he managed for several years.

https://www.educabot.fr/

2. Daniele Valli, Manager of the Education and Social Link Department, Colombbus association

Since its creation in 2000, the association has been working for education, training and professional integration through computers and the internet. Through the activities, they facilitate the use and appropriation of digital tools, which then become vectors of inclusion, personal development and social ties.

Daniele Valli studied electronic engineering in Italy and has experience in various projects as an operational manager, particularly in the United States. He also had the opportunity to manage an ERASMUS + robotics project, e-media.

https://all-digital.org/projects/emedia/

http://www.colombbus.org

3. Didier Roy, INRIA and EPFL researcher (associated with LEARN)

PhD in Cognitive Computing, researcher in the Flowers Inria team (National Institute for Research in Digital Science and Technology), and associate researcher in the LEARN Center EPFL (Polytechnic school of Lausanne, Swiss), his work focuses on the optimisation and personalisation of learning using digital technologies (intelligent tutorial systems, machine learning, educational robotics).

https://flowers.inria.fr/

https://www.epfl.ch/education/educational-initiatives/center-learn/

4. Laurène Bonnesseur, Project Manager, Aquitaine Robotics Cluster

Aquitaine Robotics is a cluster that helps companies and researchers to bring their robotics projects to fruition. Created in July 2013, it currently has more than a hundred members, mainly companies, research and training organisations, and users. It brings together players in manufacturing and logistics robotics, service robotics and robotics in open environments in New Aquitaine.

The objectives of the Cluster are to structure the regional robotics sector, to support collaborative R&D projects and to develop skills in scientific research and training.

The Aquitaine Robotics Cluster is also particularly committed to the setting up of RoboCup events in France.

https://www.aquitaine-robotics.com/

5. Caroline Sulek, Mediator and trainer in digital education, robotics project manager, Canopé Gironde

Canopé is a public establishment placed under the supervision of the Ministry of National Education. Its mission is to provide actors (teachers, supervisory staff) and partners in education (parents, local authorities, associations) with educational and teaching resources adapted to their needs. It offers support for projects: advice, training, digital workshops, etc.

Previously, Caroline worked as a documentalist teacher and then became a trainer in digital education, for teachers and educational actors.

https://www.reseau-canope.fr/academie-de-bordeaux/atelier-canope-33-merignac

6. Julie Stein, Project manager PIA "Territories of digital pedagogical innovation" · Banque des territoires, Groupe Caisse des Dépôts

The Caisse des dépôts et consignations is a public financial institution under the direct control of a supervisory commission reporting to Parliament. It carries out general interest activities on behalf of the State and local authorities as well as competitive activities. “Territories innovation” is an action of the “Grand Plan d'Investissement” (Major Investment Plan), backed by the third wave of the Programme d'investissements d'avenir - PIA - (Future investment programme). The aim of this action is to bring to light the territories of the future and new models of territorial development in France. Innovative, replicable and exemplary, these new models will promote the emergence of ecosystems conducive to sustainable economic development and the improvement of living conditions for the population, while enabling local economic players to shine.

Previously, Julie worked as a digital education project manager at departmental and national level.

https://www.banquedesterritoires.fr/territoires-dinnovation

7. Yoan Mollard, Research engineer in robotics, Bordeaux INP Enseirb - Matmeca, consultant, entrepreneur in digital art

The ENSEIRB-MATMECA, National School of Electronics, Computer Science, Telecommunications, Mathematics and Mechanics in Bordeaux, is a public engineering school of Bordeaux INP. It trains in 3 years engineers ready to meet the major challenges of the digital world.

Yoan is also a trainer and researcher for the Poppy Station association.

https://enseirb-matmeca.bordeaux-inp.fr/fr

8. Thibault Desprez, PhD in Computer Science & independent trainer in Educational Robotics

Author of the thesis "Design and evaluation of educational robotic kits. Ecological and experimental studies on the impact of the integration of robotics in the school environment, in terms of acceptability, motivation and knowledge", he is one of the co-constructors of the Poppy ErgoJr educational robotics kit and has also developed others through the Perséverons and Poppy-Education projects, as part of his research at the Flowers laboratory - Inria.

https://thibaultdesprez.com/

9. Marie Fauquembergue, Training engineer, Maison pour la Science en Aquitaine (House for Science in Aquitaine)

Established since 2014 on the Bordeaux university campus, the Maison pour la science en Aquitaine (House for Science in Aquitaine) offers professional development actions to teachers from primary to high school throughout the Bordeaux academy. These actions are the result of a close collaboration between the university or industrial research community and the educational community.

Former school teacher (8-10) Marie is now a training engineer at the Maison pour la Science where she works with teachers..

https://www.maisons-pour-la-science.org/aquitaine

10. Emmanuel Page, National coordinator of the TNE (Digital Educational Territory) program , Canopé

Canopé, formerly the National Centre for Educational Documentation, is a public administrative institution and publisher of public educational resources, under the French Ministry of Education. The Canopé network publishes trans-media educational resources (print, digital, mobile, TV), meeting the needs of the educational community.

The TNE national project, directed by the Ministry of National Education, aims to :

- train all teachers in hybrid teaching and learning
- train volunteer parents in the challenges of digital education
- provide teachers with a range of online services and resources via a platform
- ensure a minimum level of digital equipment for elementary schools (2 700 classes)
- equip each class (primary and secondary) with a hybrid teaching kit (15 000 classes)
- enable pupils in elementary classes with a digital divide to be equipped on loan (15 000 pupils)
- equip new teachers in primary and secondary education (1 000 new teachers)
- evaluate the system, measuring its relevance and efficiency.

https://www.reseau-canope.fr/

https://www.education.gouv.fr/les-territoires-numeriques-educatifs-306176

11. Edwige Coureau-Falquerho, Project Manager, Institut Français de l'Education - ENS Lyon (French Institute of Education)

The French Institute of Education was born in 2011 from the reorganisation of the National Institute of Pedagogical Research and has been integrated into the École normale supérieure de Lyon, which is distinguished, both nationally and internationally, by a permanent interaction between training and research. The ambition of the institute, an interface structure, is to articulate research and training in order to support educational policies. For the IFÉ's inter-category teams, this means producing rigorous studies and useful resources that can be used by trainers and, more broadly, by all educational actors.

Edwige organised between 2016 and 2020 4 editions of the national meetings of educational robotics - RNRE - which addressed researchers, communities and educational actors. She also organised in 2018 a meeting of experts (6 European countries who had sent representatives - 2 days robotics and steam education / How robotic artefacts feed the mechanics of education) - Finally, she is also a founding member of the association Poppy Station.

http://ife.ens-lyon.fr/ife

12. David Berthiaud, Director of Digital Transformation, City and Agglomeration of La Rochelle

The Digital Transformation Directorate has three strategic work areas: continuous innovation and the right to experiment, participatory governance and digital inclusion, and data valorisation and privacy. A great deal of importance is given to the circulation of data as a pillar of digital transformation.

La Rochelle has been coordinating (with its partners) an educational digital master plan since 2004. It plans over 5 years the investment in computer equipment and the actions to be carried out (training, tools, etc.) in the kindergarten and primary schools of the town.

https://www.agglo-larochelle.fr/vie-pratique/numerique?article=strategie-de-transition-numerique

13. Saïda Mraihi, Manager for the digital education department, Ecole Nationale Supérieure Art et Métiers ParisTech

Arts et Métiers ParisTech has been committed to responding to constantly evolving industrial and societal challenges. Its primary mission is to train engineers specialised in sustainable technologies: engineers capable of designing environmentally friendly products and systems, but also of controlling an industrial organisation by controlling risks and costs.

Saïda is mainly involved in supporting and training teachers in higher education.

https://artsetmetiers.fr/

14. Thierry Pasquier, Manager of communication and publishing, Espace Mendès France

The Espace Mendès France is a center for scientific, technical and industrial culture created in 1989 and located in Poitiers. It owes its origins to researchers from the University of Poitiers and popular education activists who went out to meet citizens to discuss scientific subjects and demonstrate that science could be accessible. This regional centre for scientific, technical and industrial culture has three missions: to popularise research and scientific careers, to educate people about science and technology, and to encourage citizens to debate social and cultural issues.

Thierry has been setting up scientific activities since the 1970s and is specialized in robotics.

https://emf.fr/

15. Antonin Cois, Expert in digital education and educational robotics

Antonin is the founding President of the Poppy Station association, for the development of open source robotic ecosystems in education (with INRIA, IFE-ENS Lyon, HESAM, EPFL). He is also an executive member of MEDNUM (Cooperative society for digital mediation in which the State is a shareholder). He carried of numerous projects for the development of education in and through digital technology in France and Europe, including the PIA D-Clics numériques (Ligue de l'enseignement with Canopé, the Francas, the Cemea, the CNOUS, Animafac, the CRI - Université Paris Diderot-), or a Magistere course co-created with the DNE, Canopé and Class'Code.

https://www.inria.fr/fr/poppy-station-la-robotique-open-source-pour-leducation-la-recherche-et-la-culture
https://lamednum.coop/

16. Stéphane Brunel, lecturer / associate professor - INSPE (National Institute for Teacher Training and Education), Bordeaux

He is attached to the IMS (Integration of Materials and Systems) research laboratory at the University of Bordeaux, and his research theme is the didactics of digital uses.

He is also President of the Ligue de l'Enseignement de la Gironde, Vice-President of the Ligue de l'Enseignement Nouvelle-Aquitaine, Vice-President of the Fédération Française de Robotique, in charge of junior teams, President of the Poppy Station Consortium and member of the RoboCup France committee.

https://www.reseau-inspe.fr/la-recherche/chercheurs-education/stephane-brunel/

https://brunel.tech

https://www.ims-bordeaux.fr/fr/

17. Jérôme Laplace, founder and director of Generation Robots

Generation Robots has been a major player in the distribution of service robotics equipment in Europe for 12 years. It distributes equipment for the world of education, research but also for professionals. It is also a professional service robotics design office with expertise in the development of autonomous robotics solutions, in the development of robotics algorithms around ROS (mobility, gripping) but also with the capacity to carry out embedded image processing.

He is a member of the scientific committee of NAIA.R, the New Aquitaine forum for Artificial Intelligence and Robotics. He is a member of the RoboCup France committee.

https://www.generationrobots.com/fr/

https://www.humarobotics.com/

https://www.naia.io/presentation/

18. Vanessa Mazzari, Marketing and Webmarketing Manager, Génération Robots

During 1 year, she had the mission to democratize the cozmo robot for education in France and was able to meet multiple audiences throughout France. She supervised all the pedagogical parts of the structure (creation and research of resources and documentation...) She also realized a big study on the use of robotics in class.

https://blog.generationrobots.com/fr/grande-etude-sur-lutilisation-de-la-robotique-en-classe-annee-2018/

19. José Lima, Professor in the Electrical Engineering Department of Polytechnic Institute of Bragança, Portugal, and President of the Board of Direction in Portuguese Robotics Society

Received the M.Ss. and PhD in Electrical and Computer Engineering on Faculty Engineering of University of Porto, Portugal in 2001 and 2009. He joined the Polytechnic Institute of Bragança in 2002, and currently he is a professor in the Electrical Engineering Department of that school. He is also a senior researcher in the Centre for Robotics in Industry and Intelligent Systems group of the INESC-TEC (Institute for Systems and Computer Engineering of Porto, Portugal). He has published more than 30 papers in international scientific journals and conference proceedings.

http://www.sprobotica.pt/

20. Anna Brancaccio, Ministry of Education, University and Research | MIUR - General Directorate for School Regulations and School Autonomy

School headmaster, currently assigned to the Ministry of Education at the Directorate General for school regulations, evaluation and internationalisation of the national education system. She is particularly involved in the whole mathematical-scientific-technological sector to promote curricular and extra-curricular innovations and in particular in the field of education.

https://www.miur.gov.it/

21. Beatrice Miotti, Technologist, Researcher Technological Area, INDIRE (National Institute for Documentation, Innovation and Educational Research)

Graduated in Computer Engineering in 2007, she obtained her PhD in Artificial Intelligence in 2010 and the qualification to teach Computer Science through TFA in 2012. She works at Indire since 2012 and isin charge of software development.

She is currently involved in the research project related to School Building (project referent L.Tosi). She has produced a study and comparative research on the different school building systems adopted in various countries around the world, for the mission unit dealing with the redevelopment of school buildings of the Presidency of the Council.

https://www.indire.it/

Workshop blank frame

Session n°	**Duration**
	Age of students
Title *Summary*	
Educational goals	**Knowledge required by children to approach the session**
	Elements of assessment of children's achievements
Course of the session (steps, timeline…)	
Layout and specific material required	**Toolkits: resources**
To go further, other resources	**Facilitator/teacher skills required**