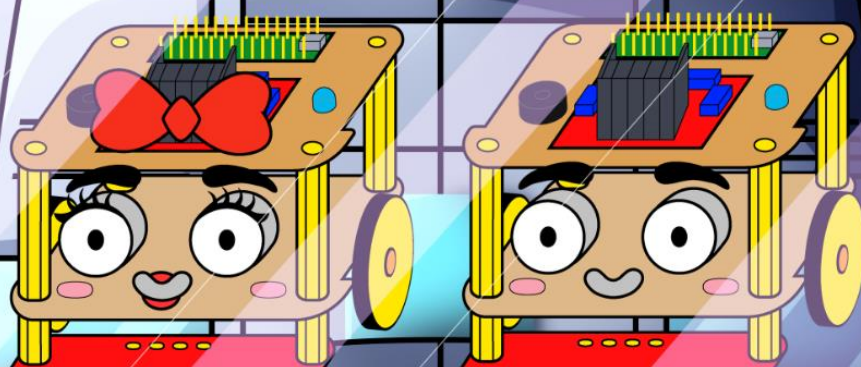


1

A NEW ADVENTURE FROM 'ROBOTS FOR STEM'

STEMIE & STEMIA'S

FANTASTIC JOURNEY THROUGH SPACE



TEACHER'S eBook



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



Stemie & Stemia's
fantastic journey through space

Teacher's eBook

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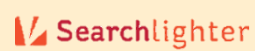
PROJECT COORDINATOR



OUTPUT LEADING ORGANIZATION



PARTICIPANT ORGANIZATIONS



Conventional signs

Throughout this book, especially in the Lesson plans chapter, you will find some conventional signs and symbols that represent various features or subjects.

Whenever you find one or several of the following signs:



science



technologies



engineering



maths

you know that a specific exercise is related to that specific subject.

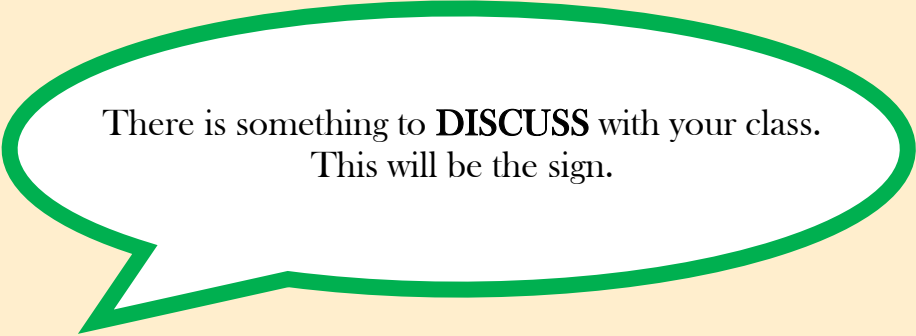
NOTES on each chapter will be marked with this frame.

If there is additional **INFO**, you will see it inside this frame.

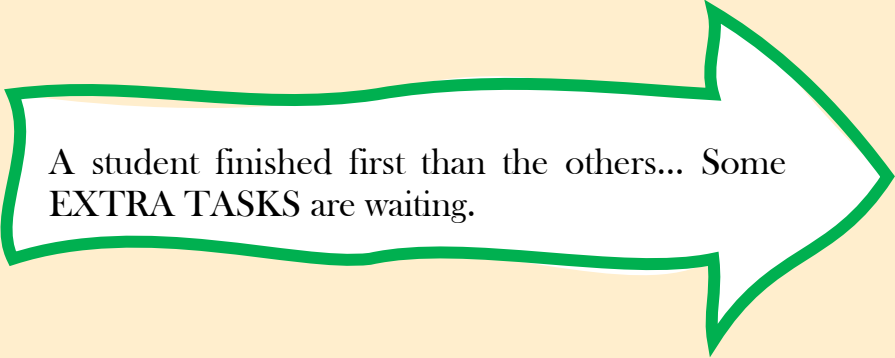


The **GOAL** of each challenge will be written in this format.

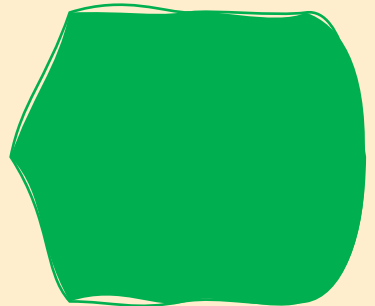
Whenever you have a part of the **STORY** to read, it will be signalled with this frame.



There is something to **DISCUSS** with your class.
This will be the sign.



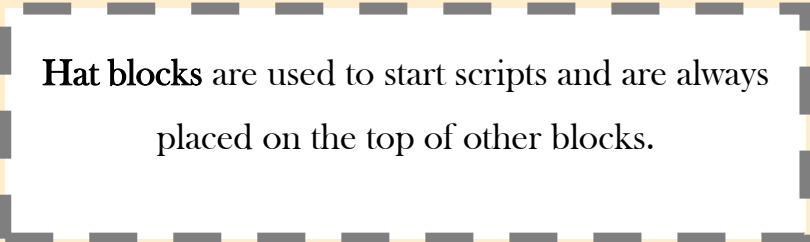
A student finished first than the others... Some
EXTRA TASKS are waiting.



Also, while reading code written in **mBlock**, there are some basics that you need to remember your students:



Arduino Program



Hat blocks are used to start scripts and are always placed on the top of other blocks.



A Stack block is a rectangular block with slots on the top and bottom that allow to fit above or below other blocks.



A **reporter block** allows you to store data and contains a value that can be a numerical value or character string.

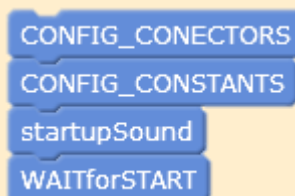


A **boolean block** contains a condition that can be either "true" or "false" and is typically used inside condition blocks like IF.



A **Cap block** is used to a script or project and therefore it can be put only under all blocks. Don't forget that in your project you should have only one forever block.

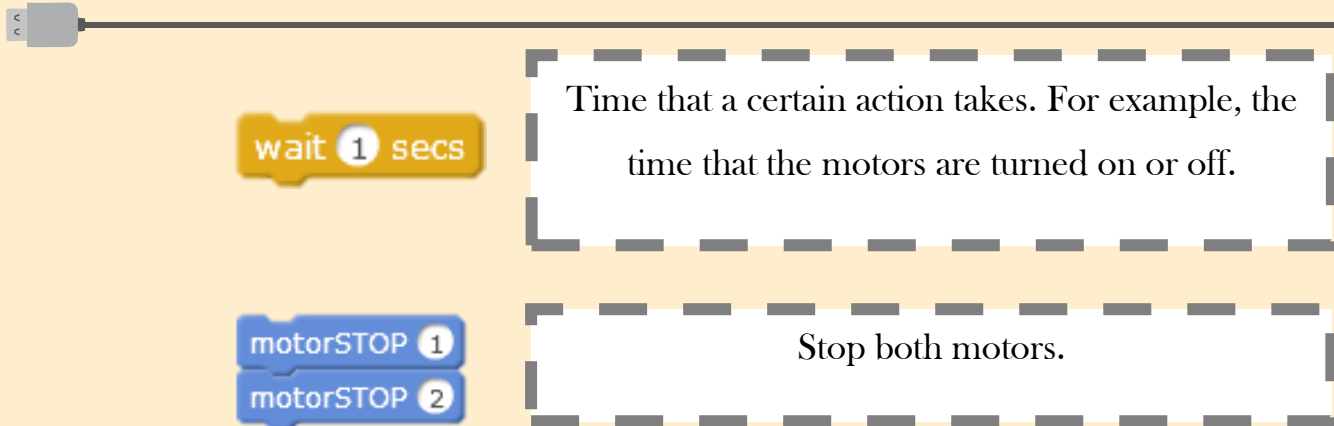
Notice that there are no slots in the bottom of the block.



Connectors, constants, startup sound **Procedures**. These blocks must **ALWAYS** be the first in your code.



Blocks that Turn on motors. In this example, Forward (motor 1, right side) and backwards (motor 2, left side).



Other things that are useful for you and your students to know:

The robots don't have any loose wires. If you find one, it should be disconnected from somewhere;

The colour of the wires doesn't matter. Just the type and length so that they connect to where they are supposed to;

Vcc is always connected to the positive (+) pole of current while GND is connected to the negative (-) pole.

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Introduction

This teacher's eBook is one of the Intellectual Outputs developed by the Erasmus+ project "Robots for STEM".

The team of teachers involved in the processing of this outcome have led a study and an action-research activity intending to create a useful guide/manual to help teachers to implement innovative pedagogical practices using Mobile Robotic in educational scenarios and to develop the motivation and involvement of students in the field of science and technology using coding and robotics so that they can understand its significance and its impact on learning in general.

To ensure readability for a wide range of users, even for those who approach this matter for the first time, the eBook is articulated through paths (step-by-step directions) presented in simple training "pills" accompanied by methodological proposals and tools that will be able to reinforce the development of teachers' competences and will be able to introduce STEM approaches.

The eBook will allow, at first, the teachers involved, and later, every teacher interested in the project to get knowledge on tasks to perform with students from 10 to 13 years. Being an eBook, it allows every teacher interested in the project to start reading it almost immediately. It also contains internet links to relevant and related websites, audio, video and animations. Once the validity of this methodological-didactic tool has been verified (tested through teachers' innovative practices), the same can be used by all teachers interested in the

Digital Toolkit for teachers and the Activity Kit (eBook students) for students, also developed by the project's consortium.

The experimentation can take place through the setting up of "laboratory environments" that each school would "stage". The aim of the educational scenario that this eBook offers is the one related to "Space": Stemie, the robot protagonist of the different challenges, will make to live immersive experiences among stars and planets. But this is only one of the many teaching proposals that can be set up in the laboratory spaces, at the discretion of the experimenters.

In the long term, this eBook could be a valid "stimulus" aimed at organizing "STEM" Days in each partner country, with the involvement of other schools, teachers, educators, parents and stakeholders, who will share their experiences related to the project activities and the promotion of the learning benefits of the STEM in the secondary school.

And not only that! This continuous experience in Robotics and the development of skills like Computational Thinking and Problem Solving will allow them to take part in games, school competitions, and events to promote healthy competition.

Finally, the proposed intervention strategies that the teacher-experimenter would implement, will be a tool to support all those who want to counteract gender stereotypes, in educational and career choices using innovative approaches through a common support framework for all students and young students to bring them closer to the STEM disciplines.



1. The importance of STEM in the learning process and key competencies of long-life learning

The increasing and pervasive diffusion of technologies has produced in recent years a continuous and abrupt change in European society and education systems that have had to question the time, space and mode of learning.

At the same time, the acronym STEM - "Science, Technology, Engineering and Mathematics" - has entered the world of education in a big way by promoting active teaching approaches, laboratories and innovative learning environments at all levels of school.

Why? The global and complex society (defined by Zygmunt Bauman, as "liquid", precisely to emphasise its frenetic nature in all its aspects) requires a wide range of key skills to be able to adapt flexibly to a constantly changing world. Already in 2006, the Recommendation of the European Parliament and of the Council of 23rd April 2008 identified eight key competencies that each citizen should master for his or her personal development, social inclusion, active citizenship, employment and lifelong learning, including digital competence, i.e. the ability to use information technologies critically and consciously.

The transversal European key competencies that students should acquire at the end of their education were as follows:

1. Communication in the mother tongue
2. Communication in foreign languages
3. Mathematical competence and basic skills in science and technology

4. Digital competence
5. Learning to learn
6. Social and civic competencies
7. Initiative and entrepreneurship
8. Cultural awareness and expression ¹

From the European Key Competencies, the European Qualifications Framework was also developed, which already contained the following definitions:

- **Knowledge:** they indicate the result of the assimilation of information through learning. Knowledge is the set of facts, principles, theories and practices relating to a field of study or work; knowledge is described as theoretical and/or practical;
- **Skills:** indicate the ability to apply knowledge and use know-how to accomplish tasks and solve problems; skills are described as cognitive (use of logical, intuitive and creative thinking) and practical (involving manual skill and the use of methods, materials, tools);
- **Competencies:** means the proven ability to use personal, social and/or methodological knowledge, skills and abilities in work or study situations and professional and/or personal development; competencies are described in terms of responsibility and autonomy." ²

¹ Proposal for a Recommendation of the European Parliament and of the Council of 7 September 2006 - Official Journal of the European Union - L394/10 - 30.12.2006

<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32018H0604%2801%29>

² The European Qualifications Framework (<https://europa.eu/europass/en/european-qualifications-framework-eqf>)

It is important to mention that in the European reference framework, the role of "computational thinking" is also recognized: that is another aspect of learning required of students in all areas of knowledge. The first to use the term "computational thinking" was Seymour Papert in a text from 1996. This term has also evolved over the years, but we will deal with it in the following pages.

*„As social, cultural and economic scenarios change, as a result of systematic international surveys of student learning outcomes at the end of their education system, the Council of the European Union reviewed the European key competencies of 2006, elaborating the DigComp "that defines and outlines the digital competencies that allow the European citizen to fully exercise digital citizenship" and to adapt to global change“.*³

In 2018, the Council of the European Parliament issues a new Recommendation adopting a new European Reference framework which not only reaffirms the 8 key competencies but also proposes to promote those in the scientific fields with an emphasis on digital and entrepreneurial competencies.

³ Wikipedia, the free encyclopedia

The scenario, therefore, changes with clarifications and changes, in the following way:

	KEY COMPETENCIES 2006	KEY COMPETENCIES 2018
1	Communication in the mother tongue	Functional alphabetical competence
2	Communication in foreign languages	Multilingualism
3	Mathematical competence and basic skills in science and technology	Mathematical competence and competence in science, technology and engineering
4	Digital competence	Digital competence
5	Learn to learn	Personal, social and learning to learn skills
6	Social and civic competencies	Powers in the field of citizenship
7	Spirit of initiative and entrepreneurship	Entrepreneurial competence
8	Cultural awareness and expression	Competence in cultural awareness and expression

Given the purpose of our eBook, special attention should be given to Digital Competencies.

The official text cites:

"Digital competence presupposes an interest in digital technologies and their use with familiarity and a critical and responsible spirit to learn, work and participate in society. It includes computer and digital literacy, communication and collaboration, media literacy, digital content creation (including programming), security (including being comfortable in the digital world and possessing cybersecurity skills), intellectual property issues, problem-solving and critical thinking."

Knowledge, skills and essential attitudes related to digital competencies

People should understand how digital technologies can help communication, creativity and innovation while being aware of the opportunities, limitations, effects and risks involved. They should understand the general principles, mechanisms and logic underpinning evolving digital technologies, as well as know the basic operation and use of different devices, software and networks. People should take a critical approach to validity, the reliability and impact of the information and data made available by digital tools and be aware of the ethical and legal principles involved with the use of digital technologies".⁴

People should be able to use digital technologies as an aid to active citizenship and social inclusion, collaboration with others and creativity in achieving personal, social or commercial goals. Skills include the

⁴ 4.6.2018 IT Official Journal of the European Union C 189/9 <https://eur-lex.europa.eu/oj/direct-access.html?locale=en>

ability to use, access, filter, evaluate, create, program, and share digital content. People should be able to manage and protect information, content, data and digital identities, as well as recognize software, devices, artificial intelligence or robots and interact effectively with them. Interacting with digital technologies and content presupposes a reflective and critical attitude, but also based on curiosity, open and interest in the future of their evolution. It also imposes an ethical, safe and responsible approach to the use of such tools".⁵

"DigComp 2.1 is the evolution of the DigCom 2.0 framework for citizens' digital skills. Starting from the reference conceptual model published with DigComp 2.0, the next version 2.1 illustrates eight levels of mastery and examples of use applied to the field of education and work".⁶

Another framework is "DigCompEdu", addressed to teachers..." which aims to define the digital skills necessary for teaching, then the digital skills that teachers should have".

DigCompEdu (Digital Competence Framework for Educators) is the framework developed by the European Commission that defines in six areas the digital skills that a teacher, but also more generally who works in education and education, should possess, articulating them in 22 sub-skills.

The framework aims to guide the teacher to the acquisition of the necessary digital skills, which appear among the eight key competencies for lifelong learning, as identified and defined in the Recommendation of the European

⁵ Key competencies Recommendation 2018

<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32018H0604%2801%29>

⁶ Wikipedia, the free encyclopedia

Parliament and the Council in 2006 and subsequently updated in 2018. For the same reason, the framework also represents a path to follow for the proposal of ad hoc training courses for teachers.

By answering the questions of a self-assessment questionnaire of the competencies related to the six areas of the DigCompEdu, the teacher assigns a level of competence between A1 (novice) and C2 (pioneer); there are six levels of competence and they are called by letters and numbers, exactly corresponding to those already used in the Common European Framework of Reference for Languages" ⁷

The latest evolution of the previous reference documents is that of the DigComp 2.2 competence framework "which identifies the key components of digital competence in 5 areas that can be summarized as follows:

Information and data literacy: to articulate information needs, to identify and retrieve data, information and digital content. Judge the relevance of the source and its content. To store, manage and organize data, information and digital content;

Communication and collaboration: interact, communicate and collaborate through digital technologies while being aware of cultural and generational diversity. Participate in society through public and private digital services and participatory citizenship. To manage your digital identity and reputation;

Digital content creation: Create and edit digital content to enhance and integrate information and content into an existing body of knowledge,

⁷ Pierfranco Ravotto - Educazione alla cittadinanza digitale, all'uso della rete e dei social network

while understanding how to apply copyright and licensing. Knowing how to give understandable instructions for a computer system;

Security: To protect devices, content, personal data, and privacy in digital environments. To protect physical and psychological health and to be aware of digital technologies for social welfare and social inclusion. Be aware of the environmental impact of digital technologies and their use;

Problem-Solving: Identify needs and problems and solve conceptual problems and problem situations in digital environments. Use digital tools to innovate processes and products. Stay up to date on digital evolution.

The 8 levels of competence and examples are described in **DigComp 2.1:**

"The digital competence framework for citizens with eight levels of competence and use examples".⁸

Between the publication of DigComp 2.1 and DigComp 2.2 (published on 22 March 2022 by the Joint Research Center) the European Union proposes a policy initiative called the Digital Education Action Plan (2021-2027) to support the education and training systems of its Member States in the Digital Age.

"The action plan for digital education:

- provides a long-term strategic vision for high-quality, inclusive and accessible European digital education

⁸ Official Website of the European Commission
<https://publications.jrc.ec.europa.eu/repository/handle/JRC106281>

- addresses the challenges and opportunities caused by COVID-19 which led to an unprecedented use of technology for education and training
- aims to strengthen cooperation at the EU level on digital education and stresses the importance of working together in all areas to integrate education in the digital age
- presents opportunities, including better quality and more teaching in digital technologies, support for the digitisation of teaching methods and pedagogies and the provision of the necessary infrastructure for inclusive and resilient distance learning.

To achieve these objectives, the action plan defines two priority areas:

1. promote the development of a highly efficient digital education ecosystem

This sector comprises the following aspects:

- infrastructure, connectivity and digital equipment;
- effective planning and development of digital skills, including up-to-date organisational skills;
- teachers and staff involved in education and training who are familiar with and competent in digital technologies;
- high-quality learning content, easy-to-use tools and secure platforms that comply with e-privacy rules and ethical standards.

2. Improving digital skills and abilities for digital transformation

This requires:

- basic digital skills and competencies from childhood;
- digital literacy, including the fight against disinformation;

- computer science teaching;
- good knowledge and understanding of data-intensive technologies, such as artificial intelligence (AI);
- advanced digital skills, to have more digital specialists;
- ensure that girls and young women are equally represented in digital studies and careers.⁹

In the long term, the strategic vision of the Action Plan provides high-quality, inclusive and accessible digital education for European countries. It also refers to the pandemic situation in Europe and other countries around the world, which has highlighted the need for a digital education and training system.

In short, the European Action Plan for Digital Education poses future challenges that recall the skills required of the new generations, who will have to learn to make the most of the opportunities and deal with the issues of a globalised, rapidly changing and interconnected world.

Of course, to do this, it is not only important to understand the role and weight of "digital competence" in schools of all levels, starting with kindergarten, but also STEM in general, together with "two perspectives":

- the investigation of sciences that involves the formulation of a question that can be answered through research;
- the technological or engineering design that involves the formulation of a problem, which can be solved with the construction/manipulation, and the evaluation after the design realization, then the redefinition.

⁹ Official Website of the European Commission
<https://education.ec.europa.eu/focus-topics/digital-education/about/digital-education-action-plan>

One of the stated aims of this education perspective is to increase the culture of citizens in these areas that are considered fundamental for the 21st century" ¹⁰

This makes STEM have a global influence not only from a cultural but also from an economic point of view. It is no coincidence that in all education systems, there is a push for the realization of school curricula based on science and technology disciplines.

It is important to mention that, in addition to STEM, STEAM (Science, Technology, Engineering, Art, and Mathematics) pathways are also being strongly introduced in schools in recent years, reinforcing the integration of science subjects with humanities and arts disciplines that can contribute to the development of European economies, as shown by the recent Opinion of the European Committee of the Regions, June 2019. ¹¹

STEM also becomes a "tool of citizenship" when it is possible to enhance the contribution offered by scientific subjects for the future citizen of the world, the one who will be able to read and understand the functioning of the society in which he lives. Acquiring fundamental skills in the present time, through the development of logical and computational thinking, will be able to solve more or less complex problems with a critical and creative eye.

In this scenario, another world, that is robotics, which we will deal with in the following paragraphs, enters powerfully into society and education in general.

¹⁰ Bybee 2013

¹¹ Official Journal of the European Union - C79/54 del 10.03.2020

<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ%3AC%3A2020%3A079%3ATOC>



2. From European key competencies to learning environments

The introduction of the new DigComp2.2 Framework, recently published (March 2022), and the innovative paths that are being traced in schools, imply the setting up of renovated physical spaces, flexible training settings, and environments of digital learning, through the use of platforms, apps and software.

Renovated physical spaces

Technologies and platforms in the network or digital sites are not enough to develop the professional competence of a teacher or school and for the life of a student.

To ensure lifelong learning also in the digital sector, the physical space, the tools and material resources are fundamental, in addition to the technological infrastructure available, in which the knowledge, know how to do and know how to be of the student come hand in hand "acted".

The educational setting is considered by the professionals of the sector the "third educator" because of the importance that is recognized. It is one of the essential elements for the realization of effective educational paths. It is no coincidence that the innovation of teaching is increasingly attentive to physical spaces, their revisiting, flexibility and usability.

But to have an innovative educational setting schools don't need to be equipped with high technology. There is no doubt that it would be appropriate to have PCs, tablets, Lim, etc. to deepen their knowledge, broaden their gaze and remain always connected with the world, but it is equally true that if the

traditional space, without state-of-the-art technological equipment, was revisited and made flexible, modifiable according to needs, organized by thematic areas, perhaps including "angles" of creativity, reflection, research and individual or group experimentation, would certainly turn into a valid and effective educational setting not only for all students but also for their teachers.

Some tips that we feel we can give as a research group and that we have experienced firsthand with our students are also linked to simple tricks to use in the classroom:

- Moving the **teacher's desk**, from the centre where it is usually placed, to a lateral position, for example, may seem trivial, but it is not at all. In the new position, it becomes a facilitator of learning processes and not a "delimiter" of spaces reserved for the teacher and separated from the rest. The desk may not even be present in the classroom where we want to do our work.
- The **desks**, instead of being arranged, as usual, one after the other and by file, could be organized into "islands", to allow the formation of small groups of students, promoting forms of inclusion, collaboration and sharing between equals.
- The **walls**, instead of being naked and anonymous, could be coloured or simply adorned with images, billboards, meaningful slogans and consistent with the space "acted", also made by the students themselves who, in this way, would feel valued, involved and builders of their learning path.
- In schools equipped with **technological infrastructure**, technology could be brought into classrooms and other spaces and not relegated to

computer labs available only at certain times of the week, thus allowing the use of the devices by all students at any time of the school day.

The physical environment, in our view, can be of two types: or already prepared with analogue and digital instruments consistent with the experimental activity to be carried out or, even, set up gradually even by the students themselves, placing at the moment furniture, chairs, tables, objects, artefacts, murals, their works, etc.

Flexible training settings

When we talk about "learning environments" we are first led to think about the physical space, objects and furnishings that inhabit them. It is important, however, to understand that learning environment means, in addition to material space, above all the **formative setting**, that is, **the environment within which the educational, social, and collaborative relationship takes place and in which the teaching-learning through diversification of adaptive and inclusive methodologies and pedagogical approaches.**

Laboratory learning environments

The most suitable learning environment for a **STEM** scenario, and not only, is the **laboratory**, but is also, the one that allows you to "**learn by doing**", the one that allows you to learn through practical activities accompanied by reflection on the actions that are carried out. **A constructive and active learning environment** in which it is in the **relationship** and **collaboration** with each other that you find the full well-being and enthusiasm to learn new things.

Collaborative learning environments

The laboratory and constructive approach leads to **collaborative learning**.

Working in small project groups encourages active learning. Social and relational skills are activated and developed in collaboration with each other and all this has a great educational and formative value for life because it accustoms to confrontation, to opinions different from one's own and respect for the other, all permanent social skills that are developed in the school but are valid for a lifetime. In small work groups, the students help each other and they all feel jointly responsible for the path they are taking. The collaborative setting also provides for a renewed educational relationship between the teacher and the student in which the teacher plans and organizes the main activities and materials but with a new role: that of **facilitator of student learning paths** and no longer transmitter of knowledge. The relationship between peers and between students and teachers will be positively affected.

Observation, investigation and discovery environments

One of the fundamental key skills of our school is **learning to learn**, both individually and in groups. Given what is already widely argued in the preamble to this eBook about the sudden changes in our society, the exercise of learning to learn will allow our students to become those future citizens of a world that do not offer an "instruction booklet" for living and working in a "fluid" society. One of the ways that seem to us more suitable and practicable, to develop the aforementioned competence, is certainly the ability, as educators, to foster in students the **spirit of observation**, to make them

experiment, try, make mistakes, repeat, discover, try again, redefine to build your knowledge. The procedure that we recommend, therefore, favours a training setting based on **investigation and discovery, on research**, which poses itself as a challenging task, as a goal to be achieved.

Learning environments for Problem-Solving

The competence of learning to learn implies a training setting model based on **Problem-Solving**. A problem that to us educators may seem very simple, for children and young people, depending on their age, can become an insurmountable obstacle and can put them in difficulty. If the teacher poses the task to the students as a challenge, they are led to find a solution, even if they are wrong, and are induced to live an **effective experience**. It is the **practical** experience, whether it is **cognitive, emotional or sensory**, to favour the learning process that, in this way, is realized through the experimentation of situations, tasks, and roles of each individual or group. It is through this type of experience that the student becomes an **active protagonist**, putting in place their resources, attitudes and skills aimed at achieving a set goal, while improving, at the same time, its weaknesses. This allows him to deal with situations of uncertainty by also developing adaptive behaviours. This type of activity is a typical element of "problem-solving" and of the management of the error in the positive and constructive key of which however we will treat later.

Experiential learning environments

John Dewey spoke about the importance of practical experience at the University of Chicago in 1902 when he contrasted the traditional educational

approach, based on the transmission of theoretical knowledge, with the new approach based on experience as an educational method. Even the great philosopher and pedagogue proposed, in fact, an approach in which the student's activity had to be put in the foreground and concretized through **experience and discovery**. The skills of the student, thus, become a tool to achieve a significant milestone for the subject itself. Observation and action, experience and theory are the pillars of meaningful learning.

Below we indicate those that we believe are most useful for our purposes, that is the promotion of STEM, not only, in school and for life.

a) JRC Learning corner learning environment – europa.eu

Learning Corner is a site managed by the European Community - Communications Sector - through which the teacher can support his students in "learning by playing" through challenges, playful activities, interactive books, and participation in competitions. On this site, you can find teaching materials for all age groups, as well as ideas for lessons and opportunities to create networks with other schools and teachers across Europe. The issues addressed are those promoted by the EU and the objectives of the 2030 Agenda that foster the development of skills reported in European frameworks, including digital and citizenship to learn while having fun. ¹²

b) Facebook's GetDigital learning environment

FbGetDigital is a learning environment accessible to all and consistent with the changes in our society. The platform offers 5 areas that are configured as 5 pillars of well-being and digital citizenship:

¹² https://learning-corner.learning.europa.eu/learning-corner_en

- 1) Information and data literacy
- 2) Collaboration and communication
- 3) Creation of digital content
- 4) Safety
- 5) Solving Problems

The activities proposed are led by experts and designed to strengthen and increase the digital skills learned at school or home by addressing them with gradual levels of

difficulty. There are also resources designed for parents and guardians, facilitating the generational gap, and for teachers, to address the theme of digital citizenship with the program "Enter the digital world".¹³

c) Google Learning Environment

In Google Learning Environment you can acquire practical digital skills necessary for the jobs of today and tomorrow thanks to several free video lessons. The platform, free and flexible, promotes the development of skills for school, work and life by teaching the 4 C: communication, collaboration, creativity and critical thinking.

The resources are aimed at:

primary, and secondary school teachers, instructors, educators, librarians
students using digital skills with their teachers

¹³ <https://www.facebook.com/fbgetdigital>

persons seeking employment or wanting to train themselves

parents and guardians using digital skills outside the classroom¹⁴

d) Code.org learning environment

Code.org is a digital platform that offers resources for students, parents and teachers, including videos, fun tutorials and projects for all age groups. Very intuitive, and has 4 areas:

- a community for teachers where teachers can ask questions about the curriculum, share ideas for lessons and get help from other teachers
- an area of professional learning to improve your curriculum through lesson plans, tools and resources with tips to improve teaching practices that are always available for free for teachers and students
- a CS Adventures area - Computer Science - that invites and helps students to create connections with the real world, with what they are learning, allowing them to continue their adventures with these resources
- an area "Lesson Plans and Resources" - "Information about curriculum standards alignment for Code.org courses"

According to Barradas, Lencastre, Soares & Valente¹⁵ (2021), Code.org is a handy tool to use in introductory coding classes. The fact that

¹⁴ <https://applieddigitalskills.withgoogle.com/s/en-uk/home?fbclid=IwAR1Bkw-hqG3k5SaDW3XzrcgzUyNDnEeSwarl-RlgHaUWW5MY0jP2Q6s-8K0>

¹⁵ Barradas, R., Lencastre, J.A., Soares, S., & Valente, A. (2021). The Code.org Platform in the Developing of Computational Thinking with Elementary School Students. In: H.Chad Lane et al. (eds), Communications in Computer and Information Science, vol 1473 (pp. 118-145). Springer, Cham.

The original publication is available at: https://doi.org/10.1007/978-3-030-86439-2_7



students have to solve different types of unfamiliar problems in creative and innovative ways makes them ask meaningful questions that clarify various points of view and lead to better solutions. The use of gamification strategies like narratives, trophies, and instant feedback, works as an engagement factor for students. Also, the fact that some exercises have clues that help children understand them, the possibility of partially solving the exercises and being able to return to complete them at a later time, makes code.org a very flexible and appropriate tool for developing computational thinking in early ages.

Of course, there are many other digital platforms that we could mention, but in this eBook, we simply limit to making a selection by reporting only those that the research group considers most significant and consistent with the purpose we set ourselves.

3. Computational thinking, coding and educational robotics

Concerning the theories of **Constructionism** and **Constructivism** and their main exponents **Jean Piaget** and **George Kelly**, according to which knowledge should not be transmitted but constructed through **direct experience**, we refer back to the very brief mention made in the previous chapter to elaborate on the concept of '**computational thinking**' first introduced by Seymour Papert in a 1996 text, which has evolved over the years.

We are going to examine this area of didactics while also trying to clarify the difference between '**computational thinking**' and '**coding**', as the educational community often tends to confuse the two terms.

Computational Thinking

In 2006, the American researcher Jeannett **Wing** stated that computational thinking is an indispensable skill that must be taught to all individuals along with those of reading, writing and calculating, which are the three basic skills, itself becoming the fourth basic skill.

It would therefore be important to initiate all students into computational thinking from an early age.

This means initiating students into logical-creative thinking through which they deploy a cognitive process that allows them to solve progressively more complex problems through a procedure of breaking down the problem into simpler parts that, when tackled and solved one at a time, allow the initial

problem to be solved thanks to a strategy devised and reasoned out by the student himself.

Intended as such, computational thinking is not to be regarded as a simple programming procedure, as 'coding' can be, but as a real basic conceptual skill, a real cognitive process that becomes metacognitive when the pupil stops to reflect on possible errors due to wrong choices or unforeseen events and returns to redefine the procedural steps to improve the result.

With this meaning, computational thinking becomes 'logical' and the main element of computer science. Logical computational thinking, however, is not only related to this area but becomes part of a new construct within digital competence, a broader and more transversal concept, useful for Problem-Solving not only in the field of computer programming but in everyday life and that is why it is important to promote it within the school. It becomes, in fact, a cultural tool for citizenship because it is linked to every area of knowledge and appropriate for the development of other key competencies such as learning to learn, planning skills and Problem-Solving.

Computational thinking thus becomes 'for everyone', in every place, in every circumstance: it can be applied to any situation, not only computer-related.

Logical computational thinking is a construct that can be experienced as early as kindergarten through activities that do not necessarily require the use of computers, but that are 'analogue educational paths' based on the basic concepts of programming and computer science that involve the body and motor skills, that use the visual rather than the written code and that have a motivating and engaging playful background.

In this case, we are talking about various **unplugged activities** that support young learners in educational paths that initiate them into logical computational thinking and deal with 'hidden' and gradually more complex computer concepts such as algorithms, binary numbers, pixels, etc., an important innovation in teaching, content and method.

Through such paths, the teacher induces students to reason, to understand and to analyse a problem and, with a playful-motor approach, to stimulate them to what will later become a 'flowchart', a typical concept in computer programming.

Through cyclic repetition, the child will be accustomed to recognising and correcting errors (**bugs**) and will be able to redefine and organize programming structures (**debugging**).

To better understand the above, the '**Learning Goals and Computational Thinking Processes**', declined into 'Competence Targets', 'Skills' and 'Knowledge', are given below.¹⁶

COMPETENCIES TARGETS
Breaking down a problem or process into several elementary parts
Analyzing, representing and solving problem situations
Constructing algorithms, sequences, of instructions to solve problems
Recognising errors in an algorithm and identifying appropriate solutions

¹⁶ Table taken from 'Officina del Coding' - Pathways to Computational Thinking and Coding - P.Mello
- M.Pagliaro - A.Russo - K.Buccelli - Ed.Raffaello Scuola

SKILLS
Understanding a problem situation adequately
Knowing how to subdivide a complex problem into a set of sub-problems whose resolution contributes to solving the given problem
Understanding and being able to reproduce the structure of the algorithm and its function in the representation of an operational sequence
Knowing how to make changes to your project to overcome errors
Creatively transforming error by paving the way for new design paths
Strengthening one's ability to communicate

KNOWLEDGE
Acquiring the logic of programming languages
Stimulating creativity
Developing mathematical logical thinking
Finding solutions to problems

After this brief discussion of activities aimed at young children and what can be done to initiate them into logical computational thinking, it is only right to return to its connection with computer science.

Computational thinking makes it possible to exploit the potential of machines as fast and accurate tools if they are well programmed. The individual interacts with 'objects' through mathematical and rigorous language, activating logical thinking.

Precisely because it has been recognised over the years as a '**cultural tool for citizenship**', computational thinking has been included by the European Commission in the **Digital Education Action Plan**, as a competence that needs to be developed in education in an interdisciplinary way because it encompasses the logical aspects and the more subtle structure of all the disciplinary activities that take place at school.

"It does not need technology because it comes before technology: it is a transversal skill, a Problem-Solving process useful in any context".¹⁷

It follows that:

- Programming is a powerful thinking tool
- Learning to programme can be a powerful tool for personal expression
- Programming can be a tool for personal growth
- Programming can become a possible career.

Coding

Computational thinking finds a wide range of areas of development in coding and thus in writing languages for a machine. The machine will only perform a task through a series of instructions and to do so, the language used must be specific and rigorous. In this way, programming makes the concepts of computational thinking concrete and becomes a learning tool.

¹⁷ <https://it.pearson.com/docenti/primaria/classe-dinamica/che-cosa-pensiero-computazionale.html>

Coding, in simpler terms, means feeding our commands to the computer in a language the computer understands, so that the computer can carry out the said command, and perform the task.

Coding is now firmly established in the common vocabulary, particularly in pedagogical circles, where it represents a teaching methodology based on Problem-Solving, the primary objective of which is to develop logic, creativity and imagination in children. CODING, therefore, represents the 'way', the 'tool' to enhance the skill of computational thinking.

According to the pedagogical-educational theory developed by Papert, Constructivism is the natural result of an experience of ideational creation, direct observation, experimentation, verification of the results of their actions and sharing. All this promotes a highly motivating environment that allows for an exponential 'evolution' of students' learning possibilities.

The students, experimenting and planning, do not always manage to complete their work correctly on the first attempt. They must correct the 'bugs', the possible errors that are made and that, only if researched and eliminated, can allow the programme to function.

It is also because of this process that the student puts into action that coding is considered, by Papert and his supporters, an approach with great educational potential: it is not the computer that is at the centre but the student's mind. In this way, the computer becomes only a 'mediator' while the main role is assigned to the student and his or her decision-making and choice-making ability.

By now, many European countries have realized the importance of introducing coding into education, and legislation has moved to ensure that

this methodology is compulsorily applied across the board in teaching activities.

Coding, therefore, does not mean knowing how to use a PC or becoming a computer scientist.

Coding means conceiving, designing, creating, and finding solutions, in short, it means developing a set of skills that will come in handy throughout life, in all sectors and areas, not only in the technological-scientific one.

We borrow the words of the 'father' of Scratch, Mitchel Resnick, to better understand the value of coding. In an interview with a well-known newspaper some time ago Resnick says: "What we learn today, including programming languages, will be obsolete tomorrow. To live in the future, without falling victim to it, we need to be able to think creatively: one of the few skills that enable us to tackle and solve new problems that have never arisen before".¹⁸

Educational robotics

Coding does not only apply to making a programme for a smartphone or a computer, but also to circuit boards and robots. This is how educational robotics came onto the scene several years ago.

The approach does not change: the robot has a 'brain' that is nothing more than a computer that has to be programmed. This can be done in two ways, with textual or visual language, but the concepts and practices exercised are always related to computational thinking, albeit with added value: the

¹⁸ La Repubblica - interview with Mitchel Resnick - 30 Jan 2019
<https://ricerca.repubblica.it/repubblica/archivio/repubblica/2019/01/30/scratch-e-nato-come-un-gioco42.html>

possibility of having a tangible 'object' to manipulate, with which to programme, make mistakes, correct, redefine and try again in the immediate future.

"Educational robotics: the history - The name has literary origins and goes back to Isaac Asimov (Petroviči, 1920 - New York, 1992), a Russian writer and biochemist, whose works are considered fundamental, both in the development of science fiction and in that of popularising science.

Isaac Asimov, the 'prophet' of robotics, was the first to talk about it in a science fiction short story, 'Vicious Circle', published in 1942 in the American magazine *Astounding Science Fiction*. Asimov is considered the father of positronic robots, imaginary creatures that have a humanoid form and, unlike Mary Shelley's *Frankenstein*, do not rebel against their creator but, on the contrary, are happy to serve him.

Positronic robots are self-taught and capable of making their own decisions. The only limitation on their freedom is the three laws of robotics, rules of conduct that are modelled on the ethical codes of humans.¹⁹

Educational robotics, like coding, promotes logical and problem-solving skills together with the development of practical-operational skills related to the construction of the robot itself and its subsequent use, thus promoting learning as the product of research, laboratory experimentation and play.

¹⁹

https://www.academia.edu/37210857/Robotica_educativa_la_storia#:~:text=Robotica%20educativa%3A%20la%20storia%20II,in%20quello%20della%20divulgazione%20scientifica

The aim is to foster the acquisition of knowledge supported by workshop practice, which will certainly result in greater student involvement.

Coding and educational robotics, therefore, become elements of an innovative yet fun approach. The result is a greater educational and training impact than traditional didactics.

The learning setting becomes three-dimensional: the learning experience through coding and robotics involves 'space', 'time' and 'reality'.

But while coding is developed in a dual mode, through one's body in space with unplugged activities and a screen with digital learning paths, robotics is developed through programming a robot. Both provide a new, innovative, playful experience with high educational potential, unique in its kind: one learns by doing, improving performance in informal contexts but, above all, in formal ones, offering alternative tools and approaches to traditional and transversal educational paths. Think of exercises familiar to students such as analysing a story or a poem, then breaking it down into parts; think of data analysis, when it is used to process or analyze facts or events; think of algorithms, when they perform calculations or mathematical problems or simply when they have to decide on a course of action to take in dangerous, difficult or generally complex situations; think of when they want to understand an event with maps or simulations, thus through abstract representations.

Thanks to educational robotics and the type of teaching approach applied to it, students can develop important skills, such as:

- Computational thinking
- Problem-Solving

- observing micro events to put them in a broader context
- critical thinking
- the ability to analyze cause-effect relationships
- creativity
- teamwork and collaborative skills
- the ability to read and write (literacy)
- numeracy (numeracy)
- the ability to narrate or argue (storytelling)
- the ability to make art, music, etc.

Robots used in Education

Since their first use in schools and general STEM education, educational robotics kits have emerged from a variety of companies and universities worldwide. Either in the form of generic kits for several activities, or kits more specifically developed for specific tasks or competitions, educational robotics has grown as a field ever since thanks to those initiatives. In this chapter, we list some of the most used and relevant to this work.

Edumouse is a project for an autonomous robot specifically designed to enter the Micromouse competition. Edumouse was designed by Juing-Huei Su and Chen Chao-Wei for educational and experimental purposes. By using observer-based sensor fusion algorithms to improve the encoder resolutions, this robot is capable of navigating through a maze and autonomously finding the best path to reach the centre. Currently, it continues to be used in project-

oriented courses at Lunghwa University of Science and Technology in Taiwan.

Robotino® is a mobile robotics platform developed by a company named Festo Didactic in Germany: the platform is designed for research and training in education (Festo Didactic, 2020; Crnokić et al. 2017). With an adaptable design and a modular structure, Robotino® can perform and be used to teach predesigned projects, although it is also possible for teachers to develop their applications should they need to facilitate a more-engaged learning experience (Prsic et al. 2018).

Lego Mindstorms EV3 (Lego Group, 2018) and **LEGO WeDo** (Lego Group, 2009) are two of the most complex educational mobile robot systems from the Danish company, LEGO. LEGO provides educational robotic kits targeted at all levels of education with online support, offering interactive ways to learn robotics through tuition in the principles of programming, physical science, and mathematics. LEGO is the founder and sponsor of two international mobile robotics events; **FIRST® LEGO League** and **World Robot Olympiad**. The events are targeted at developing knowledge, teaching life skills, and increasing self-confidence. In real-life scenarios, participants experience how to work like real scientists and engineers in mobile robotics, developing their problem-solving skills.

Darwin-OP2 (Dynamic Anthropomorphic Robot with Intelligence–Open Platform) is an anthropomorphic mobile robot developed by the Korean company **ROBOTIS**. launched in late-2017, Darwin-OP2 is intended to be used in education and research activities (Robotis, 2020). It is a miniature humanoid robot platform with advanced computational power, sophisticated sensors, high payload capacity and dynamic motion ability to enable research,



education and other activities. It was designed as a collaborative research and development project between Robotis, the National Science Foundation, Virginia Polytechnic Institute and State University, Purdue University and Penn School of Engineering.

4. Handbook's aim for teachers and impact on students and the academic community

This section lists the main aims of this Handbook for Teachers. Essentially, they identify with those relating to the application of educational robotics in schools and with what teachers should be able to promote in their students in this field.

In short, educational robotics aims to develop the following **objectives**:

- solving problems
- making decisions
- developing the creativity
- increasing the critical sense
- promoting self-awareness
- increasing Interpersonal Skills
- developing effective communication
- managing the emotions

To promote the goals listed, many teachers, especially those with little experience in the field, wonder how to develop them with the support of robotics and how to start educational robotics activities.

The answer is quite simple: by making a robot from scratch! That's what we're going to propose in this handbook.

The right and most engaging path could be to take the first steps together with students, in a path of discovery, investigation, and research, starting from the assembly of a robot and then arriving at its physical realization and programming through specific languages.

You could continue by having the robot do missions to solve a given problem, to stimulate students to make individual or small group decisions, encouraging cooperation and collaboration and including all the ideas, all the proposals to try, wrong, try again, redefine, test and, finally, solve.

In this way, the mistake is seen as an opportunity to learn, an invitation to try again, overcoming the fear of making mistakes. The teacher proposes models, demonstration examples, and stimulating questions and the students, even the most reluctant ones, try the paths and activate strategies to achieve the goal.

The teacher, attentive observer and guide, sends continuous feedback; the latter can also come from companions or, even, from the robot itself, from its behaviours: does it work or not?

During the tests the teacher invites students to repeat the paths already activated, to recheck the commands sent through the written code and to reflect. This metacognitive activity on what has been put in place, on what could have been wrong or on what has been successful, (accompanied by an oral explanation by the student), helps everyone to better reflect on the strategies adopted and what is still possible to do, improves their performance and promotes a greater sense of self-efficacy and involvement in what is being implemented.



In light of the above, the **OBJECTIVES** of this handbook are listed below:

- integrate **STEM** teaching into the classroom and in curricular teaching plans;
- conduct practical exercises in classes, integrating **STEM** methodologies and techniques;
- reorganize the classroom, in terms of the number of students, resources, time, and spaces, working on the direct, experiential learning;
- promote students' motivation to take personal and creative paths in robotics;
- foster girls' involvement in **STEM** and better manage gender perspectives in current teaching practice;
- use, through the **INSTRUCTIONS** provided, the programming languages **m-Block** and **ARDUINO**, the software **SKETCHUP** and apply them also in **SCENARIOS** different from those proposed.

Each **ACTIVITY PLAN** includes the following activities:

- reading the theoretical and narrative parts of the recommended methodologies;
- reflection, with the help of explanatory videos and/or images;
- a digital toolkit for teachers containing a list of activities to address to students.

The Working and Research Group hopes for a positive **IMPACT** of this methodological-didactic proposal:

a) on the **TEACHERS** who will receive it:

thanks to their professionalism and competence, teachers will have to take action so that effective actions can be implemented with results and positive effects on the learning and development of specific and transversal skills of their students. The application of these proposals in the operational field requires both an increase in knowledge in the field of robotics and **STEM** in general, and a change of minds, a rethinking of their way of working in the field of teaching and methodology with their students, also creating scenarios and innovative learning environments.

The **EXPECTED RESULTS** that specifically concern the didactic-educational action of the teachers will be in summary:

- spontaneously encouraging coding and computational logic thinking;
- encouraging teamwork, making shared decisions and working together to achieve a shared goal;
- promoting the inclusion of all students through challenging tasks that, entrusted to boys and girls, enhance self-esteem, and improve relationships and social skills;
- stimulating the ability to schematize, describe "problems", and use synthetic and shared codes;
- promoting an active attitude based on observation and discovery and oriented towards reflection, awareness and self-assessment of their learning processes;

- fostering innovative evaluation practices that promote the development of specific knowledge, skills and competencies in addition to the integral development of the person.

b) on the **STUDENTS** who will have this opportunity:

at the individual level and as a class group, the activity will stimulate the development of computational thinking to strengthen the ability to analyze and solve problems in learning any discipline. Students will thus develop skills related to computer science (but applicable to any field of knowledge) promoting the growth of scientific-technological culture through the basic programming in blocks of a robot.

The **EXPECTED RESULTS** that specifically concern students will be in summary:

- developing logical-mathematical, technological-scientific skills, and computational thinking;
- increasing self-esteem by defusing error, reconsidered simply as one of the moments of learning;
- working individually and in groups by promoting peer-to-peer dialogue;
- making a personal contribution by organising and using the information to carry out the tasks assigned, acting independently and responsibly, respecting the rules and the point of view of others;
- increasing one's decision-making skills and sense of responsibility by understanding that everyone is different and can be an important resource.

c) on the **EDUCATIONAL COMMUNITY** involved:

The teaching approach that this handbook offers is no longer that of traditional teaching, but a more innovative and experiential proposal. STEM disciplines and concepts are increasingly applicable to the context and our daily lives. Students are invited to discover, experiment and experience firsthand. All this requires educational policies and good practices in their school context, reconnaissance of equipment, tools, and STEM laboratories but also innovative learning scenarios. Each school institution is required to define with a certain autonomy both the teaching programmes and its management organization. In recent years, STEM initiatives in Europe have also multiplied to raise awareness among young people and, in particular girls, to the study of scientific disciplines to make them involved in the construction of scientific knowledge technology, beyond gender differences, thus promoting equal opportunities in the world of work. However, the use of robotics and all the activities to which a brief reference has been made are still limited to the will of individual teachers or carried out as part of extracurricular projects or ad hoc events and are not widely spread in all educational institutions. Through good dissemination practices, teachers and students directly involved in the experimentation will be able to positively influence teachers and students of other classes to involve the entire school community.

In this regard, the **EXPECTED RESULTS** that specifically concern the educational communities that will decide to activate similar paths will be:

- increased attention to digital transformation and new European regulatory guidelines: "educational robotics and electronics, logic and

computational thinking, handbook and digital artefacts, serious play and storytelling";

- development of three different areas of robotics: robotics as a learning object, robotics as a learning tool and robotics as learning support;
- promotion of a laboratory approach involving the construction and programming of small robots for educational purposes, often in collaborative problem-solving situations;
- encouragement to the real protagonism of students through their learning process, through the creation and manipulation of tangible artefacts;
- development of highly inclusive educational processes by promoting "feeling part of...";
- decrease in the level of early school leaving: reduction in the percentage of students leaving school and increase in the percentage of those admitted to the next class through the stimuli and involvement of the actors involved;
- increase in the percentage of students entering the labour market with specific technological and computer skills;
- promotion of Digital Citizenship by encouraging the exercise of active and conscious citizenship, including digital citizenship;
- increasing opportunities for socialisation by improving social skills outside the school context;
- possibility for teachers to become "relational educators", that can activate paths aimed at bringing out and/or developing the potential

of the individual through collaboration, the ability to listen to others, empathy, a relationship of help, etc.

In conclusion, this proposal aims to have a significant **IMPACT**:

- on how students are learning, changing as well as their interests;
- on the communicative modalities that, besides being a social task, considered the relational value of the proposed activities, are also a cognitive task related to understanding, learning, reading, writing, completing the assigned work and helping the companions to do the same;
- on collaborative modalities, a fundamental prerequisite for future citizens of the world to enter the field of work.



5. Innovative methodologies for STEM learning

Innovative teaching proposals require innovative methodologies and that's why in this part of the handbook for teachers, we will describe some of the best innovative methodologies for STEM learning.

One often wonders how to arouse students' interest in scientific disciplines: which methodologies to use? Which techniques, scenarios and tools? How, then, do we 'encourage' learning?

Certainly, the learning environments, already discussed in the previous chapters, play their part. If they are stimulating and innovative, they certainly encourage students and prompt them to new knowledge.

It is equally true, however, that the methodologies applied in education, especially in science, play a fundamental role.

It is for this reason that we have chosen not to speak in this handbook about teaching methodologies in general but to go into the specifics, to try to present, among the innumerable applications in the school field, those that seemed most suitable and appropriate to the context being presented.

We will therefore deal with a few methodological approaches, but significant and functional for the purpose, namely:

- Gamification
- Game-based learning
- Robotics education
- Project-based learning
- Digital storytelling

- Flipped classroom flipped learning
- Explore first
- Co-creation
- Problem-Solving
- Cooperative learning
- Learning by doing

Gamification

Recently, to improve the forms of learning, a technique used in marketing is making its way into the field of education: gamification. The term (in Italian gamification) was first used by Pelling in 2002, but it was not until 2010 that the term gained popularity thanks to Jesse Schell, an American video game creator.

Already Plato said: 'Educate children with play, thus you will better discover the natural inclination', and this is what gamification pursues in education.

Gamification at school falls under the concept of smart education and can therefore be linked to educational robotics and coding.

Exactly like educational robotics, gamification has also made a strong entry into schools that intend to propose innovative models and good practices of integrated digital education, which were also tested during the epidemiological emergency throughout Europe. Such models can produce a significant impact on the learning of digital competencies, encouraging the production of digital educational content and the active participation of students in their learning.

Today, gamification is understood as a 'set of processes and practices whereby through the use of playful dynamics, mechanics and strategies, an attempt is made to motivate, activate and involve people to act in a non-playful context'²⁰.

Its main objective is involvement as it bases its action on motivation and the pleasure of learning with the will to modify, direct and manage behaviour.

Gamification is applied in many fields: training, human resources management, health education, environmental protection, promotion of social causes, tourism, culture, and entertainment. The fundamentals of gamification are the mechanics, i.e. the basic elements on which the game is built, and the dynamics, which are the needs and desires that the student fulfils during the activity.

What is gamification and how does it fit into the school environment?

Gamification is defined as 'the use of typical videogame dynamics in a non-game context to encourage user involvement, make them perform certain actions and motivate them through game mechanics such as rankings, points, rewards, levels to be passed'²¹.

The **eight key principles** (core-drives) of gamification

1. **epic sense:** the desire to participate in something bigger, to be chosen, to be called upon to fulfil a mission is the best way to attribute meaning to the everyday life of man, through epic storytelling;

²⁰ Nesti, Romina, (n.d.), Gamification in educazione: nuove strade per apprendere, retrieved in from https://platform.europeanmoocs.eu/course_gamification_in_educazione_nuo

²¹ Tassoni, M. (2021). Gamification a scuola: cos'è e come applicarla in classe. TD Blog. <https://www.tdblog.it/gamification-a-scuola-cos-e-e-come-applicarla-in-classe>

2. **progress:** man perpetually seeks the challenge, which is gradually becoming more difficult and complex to satisfy;
3. **self-expression:** man's innate tendency to creative self-expression and need for recognition from others;
4. **possession:** the natural desire to possess something leads man to have an innate instinct of belonging to it and wanting to accumulate more and more of it;
5. **relationality:** it is the mechanism at the core of all cooperative and collaborative dynamics operating within a social system;
6. **scarcity:** it is the impulse to want something that cannot be obtained at that moment, in fact, the scarcer a resource is the more valuable it is and the more people do to get it;
7. **unpredictability:** when one does not know what is going to happen, the brain is busy wondering all the time and unfortunately this principle is the primary factor in gambling addiction or ludo pathy;
8. **loss:** it is the impulse to take all actions to avoid losing.

Gamification interventions require, like any other educational strategy, to be properly designed. According to Deterding²², a gamification action must have three elements:

Meaning: gamification must be linked to something that has meaning for the student;

²² Deterding, S., et al. (2011). Gamification: Toward a Definition. C. Gamification Workshop Proceedings, Vancouver, BC, 7-12 May 2011, 1-4.

Mastery: the skills required by the action must be possessed at least in part by the student;

Autonomy: the constraints and limitations (the system of rules) must be constructed in such a way as to allow the student to feel free and autonomous to explore and act.

Through gamification, the student is involved in a stimulating experience underpinned by the pleasure and fun of learning that appeals to natural needs such as competition, status recognition, identity, and belonging to a group. All resources are focused on problem-solving and overcoming obstacles by achieving a state of eustress, i.e. a form of positive and constructive stress because through play the student exercises, learns and controls reality.

Gamification means knowing the game and its rules well; it becomes an educational technique that feeds on the game and must be thought out, designed and well-organized.

The ramified (gamified) approach in education highlights how the limitations of learning processes are due, not so much to the subjects involved in the processes themselves, but to the methodologies used in teaching that do not stimulate adequate interest and participation in students. Gamification fosters learning because students learn by doing and enables the development of skills such as teamwork, communication, collaboration, and Problem-Solving by promoting competition, and involvement by monitoring progress and efforts.

The use of gamification - like any other tool - also has its pitfalls related to sloppy planning, insufficient knowledge of the world of play, insufficient extrinsic motivation, superficial and not shared by the participants, predictable, repetitive or too complex or too boring required actions (in which

case frustration arises), excessive level of competition, little cooperation with others.

The benefits of gamification in schools

Gamification in the school environment promotes socialization with other students and enables students to develop greater empathy. Through gamification, creativity, Problem-Solving, concentration and memory are improved. Students adopt the learning-by-doing approach through trial and error and learn to collaborate with other students.

Gamification keeps the students' attention level high, making them more involved in the lesson. They become the protagonists of the lesson itself and learn in a direct way concepts that in a classic frontal lesson would be particularly complex.

This method makes it possible to memorize acquired notions more quickly and effectively (in the long term) and also, through this, the pupil can see his progress, re-evaluating the mistake no longer as a failure, but as a stimulus to move forward.

Through gamification, teachers can modulate school planning according to the needs of the class and the individual pupil, thus personalizing the learning experience.

Applying gamification in schools

When applying gamification at school, it is important to keep in mind the basic concepts of the game, such as:

- establishing levels and awarding scores

- giving feedback and tracking progress
- rewarding according to the difficulty of the goal achieved.

It is also important to give increasing difficulty to the tasks and the path that students will have to follow. But what examples will be useful to the teacher in introducing gamification in the classroom when it comes to robotics?

This will be addressed practically in the next few pages of the eBook by offering the reader some lesson plans indicating the most suitable methodologies in specific cases, including gamification.

Game-based learning

Alongside Gamification, another approach to learning emerges that sees the game as the protagonist, albeit with substantial differences that need to be defined and explained to favour a more conscious, incisive and meaningful teaching action: this is **Game Based Learning**.

In the scholastic world, there is a tendency to consider these two terms almost synonymous, confusing them with each other.

The very fact that there are two different terminologies should make one reflect and understand that they are not the same concept, even though they both refer to a similar field.

The two methodologies are used in the educational field to activate active, motivating, and engaging teaching through play in a non-game context, but they have substantial differences.

Game-Based Learning, also known as **GBL**, is a very useful teaching strategy for teachers who want to teach a specific content or want to achieve a specific learning outcome and decide to do so using games. Through play, the pupil acquires knowledge and enriches his or her knowledge by consolidating what he or she has already learned in other contexts or at school. By playing, the pupil learns the knowledge that is the subject of the game. Concretely, the teacher uses the game to provoke immediate learning: he bases the game on the subject content of interest and makes it challenging, fun, and engaging.

In summary, the **GBL**:

- has a short duration, from a few minutes to an hour;
- has a simple structure;
- is limited to single activities;
- can be analogue or digital;
- it helps to acquire knowledge and skills mainly of a disciplinary nature;
- can be linked to any discipline, using specific topics;
- promotes learning through play;
- always has a winner who, in Digital **GBL**, is often single;
- is competitive, challenging, and fun;
- it can be used by everyone.

GBL, when integrated with digital, is called **Digital Game-Based Learning**.

Digital Game-Based Learning, offers teachers the possibility of building games, through digital apps, that can be played by students individually or in

groups and that, using various types of devices, can also allow them to use games created by others and shared in their communities.

Compared to Gamification, GBL is less challenging and structured, thus suitable for younger students who are not yet able to use elaborate strategies. With Gamification, young students have an authentic experience, an adventure working in cooperative groups in which the members have different roles and powers. Young students use game strategies to perform meaningful tasks and to achieve a fairly complex goal. Unlike Gamification, which uses strategies and mechanisms typical of video games, GBL has a shorter duration precisely because it addresses less complex tasks than the former and is suitable for younger students. With Gamification, as we have already said, the contents and the relative didactic activities foreseen in the gamified course are often diluted, developed and resumed during the game using levels, progress badges, rewards, and experience points that, in the gamified activity replace grades.

In light of the above, it is clear that the two methodologies, although presenting some different elements, are both oriented towards a similar aim: that of making learning more engaging, fun and competitive.

For teachers, readers and users of this eBook, it will be important to get involved and experiment with new ways of learning and understanding the mechanisms that help generate learning. It will be fundamental to apply these methodologies to the robotics course that will be presented in the following chapters with the awareness that methodologies based on "play" provoke in students a different perception of the school in general, of their peers and teachers, increasing the pleasure of learning and being together and improving the climate of the learning environment.

Educational robotics

Another method of teaching robotics is educational robotics, also known as micro-robotics. It allows students to learn, starting from scratch, through the construction of an educational robot, its programming, its development, going through all the stages of the process.

Educational robotics promotes students' creativity and their ability to communicate, cooperate and work in teams, developing their interest in all related disciplines such as mathematics, physics, etc.

Its name goes back to Isaac Asimov, a Russian writer and biochemist, famous for the development of science fiction and the popularization of science. Isaac Asimov was the first to talk about 'robotics' in a science fiction short story, 'Vicious Circle', published in 1942 in the American magazine *Astounding Science Fiction*.

For several years now, educational robotics has been making great strides in the school field because it is understood as a basic methodology for conscious learning, which means that the training of the pupil in basic school must have as its ultimate goal the formation of a citizen who knows how to get used to the change of a society in which technological development is so fast and innovative as to make obsolete all or almost all the methods used until yesterday. As Rossini says, the school's objective is the 'formation of a man capable of leading himself by the hand in the global society of knowledge' or as Edgar Morin puts it, the 'formation of a man with a head that is 'well made' and not 'well filled'.

Educational robotics, therefore, is part of that series of innovative methodologies that promote 'meaningful' learning, that 'acted' knowledge that

students bring into play when they consciously relate elements of knowledge coming from outside with those already existing, promoting a considerable increase in knowledge, information, skills, motivation, in favour of the development of a cognitive structure capable of processing, in its interaction with the external environment, the information it receives.

Fundamental is the figure of the teacher who promotes this type of learning and identifies and selects ad hoc materials and tools, who 'whets' curiosity by asking questions, engaging the student's mental faculties, and provoking the anxiety of research.

With this in mind, educational robotics is accepted as a suitable tool for training students in a broad sense. Moreover, thanks to certain added values that educational robotics brings, it offers the possibility to strongly increase motivation to learn, it allows experiencing error not as a source of frustration, but as an opportunity for growth, it promotes confrontation with others by negotiating points of view and, last but not least, it is an opportunity to express creativity.

Robotic competitions

In recent years, one hears more and more about 'robotics competitions' in schools and elsewhere. Competitions are events capable of releasing a strong motivational effect that fosters the development of skills such as tinkering, asking questions, experimenting and playing, helping students to increase their STEM culture.

Motivation may come from different factors, competition being one of its key sources. Identifiable achievements contribute to a student's independence and

leadership skills and helps promote a positive educational process (Bazylev, Margun, Zimenko, Kremlev & Rukujzha, 2014)²³

In this context, Robotic competitions are one of the most promising ways to attract students to the field of robotics, since winning an award at a competition not only gives students a sense of accomplishment but also gives pride and visibility to their schools (Silva, Soares, Valente, Barradas & Bartolomeu, 2015)²⁴. Trying their hand at an educational robotics competition prepares students to become future innovators, with 95% of participants reporting an increased interest in STEM subject areas and STEM-related careers.

Robotics competitions also encourage students to apply their knowledge to real-world problems and motivate them to learn new concepts on their own (Pack, Avanzato, Ahlgren & Verner, 2004)²⁵. Participating in such a contest is a way of developing computational thinking and problem-solving skills.

The added value of robotics competitions is that they are a great way to expose students to valuable soft skills such as communication), collaboration and time management in a fun and authentic way.

In conclusion, educational robotics promotes both the development of disciplinary skills (such as orienting oneself in lived and represented space, orienting oneself in the temporal dimension) and transversal skills (such as

²³ Bazylev, D., Margun, A., Zimenko, K., Kremlev, A., & Rukujzha, E., (2014). Participation in Robotics Competition as Motivation for Learning. *Procedia - Social and Behavioral Sciences*, 152, 835-840.

²⁴ Silva, S., Soares, S., Valente, A., Barradas, R. & Bartolomeu, P. (2015). "Enhancing stem courses through a robotic innovative project", in *Proceedings of the 3rd International Conference on Technological Ecosystems for Enhancing Multiculturality*, pp. 571-577, 2015

²⁵ Pack, D., Avanzato, R., Ahlgren, D., and Verner, I., 2004. Fire-fighting mobile robotics and interdisciplinary design-comparative perspectives, *IEEE Transactions on education*, vol. 47, pp. 369-376, 2004.

communicating, learning to learn, problem-solving), as well as personal skills (such as managing one's emotions, knowing one's abilities, committing oneself to a task) and social skills (such as relating positively to others, collaborating in a group to achieve a common goal).

Project-based learning

Project-based learning is a pedagogical model that fosters students to explore a subject, developing research-specific skills. In contrast to traditional teaching approaches, which start with theories and progress to applications of those theories, the open-ended nature of project-based learning mirrors the way knowledge is acquired in real-world scenarios.

However, having entirely open-ended projects without guidance is pedagogically unwise. Moreover, it will likely result in student confusion, frustration, and demotivation. A dilemma faced by teachers, especially in the early stages of project-based learning approaches, is how to provide students with the assistance and support they need without imposing the educator's own opinions since many students tend to treat some comments or suggestions from their teachers as directions they must follow.

This activity uses peers and external experts as alternative sources of advice and feedback on project ideas presented by students in the form of entrepreneurial pitches, with a virtual world used to permit synchronous (real-time) interaction between participants irrespective of their location.

Peer feedback strategies, in which students support one another mutually, have several advantages over instructor-supplied feedback, including offering opportunities for deep learning by both the giver and receiver of the feedback,

the ability for the input to be delivered in a timelier manner, and potential reductions in the instructor's workload.

In addition, soliciting input from external experts benefits students by introducing them to even more thriving and diverse perspectives beyond the walls of the classroom, giving them practice conveying their ideas to both experts and lay people, and providing them with networking opportunities and industry exposure to prepare them for their future careers.

The virtual event is followed by a face-to-face component where students, after having had the opportunity to develop and improve their initial ideas in the light of peer and expert feedback received, present more developed proposals to the lecturer in a formal setting. This is a hurdle they must clear to gain approval to proceed with their projects. As such, it acts as an additional scaffolding mechanism that maximises the likelihood of their projects' success. It also serves as an exercise for students in planning and delivering presentations.

The activity strives to cultivate in students creativity, entrepreneurship, and innovation skills that are in high demand in the job market today.

A secondary aim is for students to learn experientially how to collaborate and communicate in both face-to-face and online environments, developing awareness of the differences in modalities and adapting as needed when moving between them, as they will increasingly need to do in the workplace and 21st-century society.

The project-based learning process is closer to the real world. It, therefore, requires a more extended period to be assimilated by the student compared to traditional tasks or problem-based educational activities.

Furthermore, project-based learning requires applying knowledge from other core subjects and requires stronger self-learning. Therefore, students need to commit to the overall management of time and resources.

Project-based learning linked to the real world is necessary for progress in education. Students can be given simple real-life problems that they would try to solve on their own under the supervision of a teacher. In case of clarification, students would interact with real professionals who would guide them towards the solution. In this way, the student would become familiar with the professional culture and get practical insight into the problems. Moreover, the students would also be aware of the actual professional practices, which would ultimately help them grow as professionals. For example, mechanical manipulation in industry, though taught as a subject in schools or universities, is something to experience. How a large and heavy component is moved from one place to another and assembled with another is a practical situation that is impossible to appreciate in classroom teaching. Dealing with real-life situations also creates enthusiasm among the students towards positive learning.

Providing hands-on media and technology-based support (through workshops, consultations, one-to-one support, in-class instruction sessions, online resources, digital storytelling, photo and video production, 3D printing and scanning, and data visualisation) is one of the essential components of project-based learning.

Teachers can let their students explore subject content through project-based learning without needing to personally become experts in the software or equipment required to bring these projects to life. Learning spaces foster critical thinking, creation and collaboration, encouraging all students and

teachers to engage with innovative ideas and technology in an accessible and inclusive environment.

Project-based learning requires faculty to share their knowledge with their students and other local community partners. Although faculty research does not provide a template for student projects, it is the basis of a common bond that turns the classroom into a laboratory for producing a quality product for the community partner. In addition, students who present their projects to other local community partners gain invaluable real-world experience. Such partnerships are essential.

Faculty versed in project-based learning is leading the effort to infuse real-world professional situations into the curriculum. This initiative documents the evolution of project-based learning and marks the generation that will envision and build the future.

A teacher, when designing a project-based learning approach, expects that :

1. Students will acquire technical skills through interactive and creative activities.
2. Students will activate meta-awareness of their socio-cultural and linguistic line histories and environments and their cognitive processes as students.
3. Students will correlate different literacies (e.g., reading, writing, speaking, visual, auditory) and other interdisciplinary knowledge to narrate themselves and their identity through creative project-based learning.

Example of specific learning outcomes

1. Students will create a three-minute digital video that combines images, a voiceover narration and musical accompaniment using an open-access video editor.
2. Students will master a concept or concepts from a content area course by explaining that concept (or concepts) to their own life experiences.
3. Students will formulate a script with a complete beginning (i.e., oriented to the content of the video), middle (i.e., answer the questions and reflect on themselves and the experience), and end (i.e., summarize their experience/story and give a final reflection or reflection).
4. Students will self-monitor their spoken English in the video narration, paying specific attention to improving elements such as pronunciation, word stress, volume, rhythm and vocal features that have previously been identified for them in the speech diagnostic tasks.
5. Students will be able to judge images and music in their videos in terms of clarity and according to the message's overall meaning and emotional tone.

Digital storytelling

Digital storytelling is the practice of combining personal narrative with multimedia (images, audio and text) to produce a 3/4-minute video (Lencastre, Bento, & Magalhães, 2016). Every day we hear other people about their experiences in the form of stories. Storytelling is essentially a human experience, whether it is telling stories about yourself, others, or the world (McDrury & Alterio, 2003). The stories can be real or fictitious. Storytelling is

widely used in education to enrich the learning experience. Storytelling is a natural method of human communication and prevails in all aspects of human social interaction. People tend to understand complex ideas, concepts, or information better when they occur through storytelling (Chung, 2006). Mello (2001) and Sadik (2008) say that storytelling can be used to enhance the trainee's higher-order thinking and literacy skills, thereby improving collaborative learning. Today, with the rapid development of technology, a new version of storytelling is emerging: digital storytelling. Digital storytelling integrated with technology can be a useful tool to enhance teaching and learning. The educational application of digital storytelling is attracting the attention of many adult trainers.

Digital stories are grounded in the seven storytelling elements (Lambert, 2002):

- Point of View;
- Emotional Content;
- Dramatic Question;
- Soundtrack;
- Gift of Your Voice;
- Economy;
- Pacing.

Digital stories follow the established attributes of the personal narrative genre:

focuses on a single incident;

has a clear purpose, the significance of which is clear to the reader;

- is written in the first person;
- has many relevant sensory details;
- includes the author's feelings and thoughts;
- often includes dialogue.

An additional property of digital stories is a maximum length of three to four minutes (Lencastre et al., 2016).

The University of Houston (2009) Instructional Technology Department suggests the following procedures for digital storytelling:

First, the student defines the parameters of the story. The student should select a topic for the digital story. Next, he should search for image resources for the story (pictures, drawings, photographs), audio resources (music, speeches, interviews, sound effects), and informational content (from web sites, word documents, or PowerPoint slides). When the student has gathered all of his resources, he should begin thinking about the purpose of the story. Is the goal to inform, convince, provoke, or question?

In the second step, the student organises and selects specific audio, images, text, and other content for the story. He should import the photos and audio into Photo Story. In this stage, the storyteller can modify the number of images and image order, if necessary.

In the third stage, the student creates, records, and finalises the story. He should decide on the purpose and point of view of the story and write a script that will be used as narration. He can record the story with a computer microphone and import the narrative into a video editor. Finally, the digital story is finalized by saving it as a Media Video file.

Lastly, the student presents the story and receives feedback. He can show the story to his colleagues and gather feedback about how the story could be improved. If well-received, he can teach colleagues how to create their own digital stories.

Digital storytelling has the potential to facilitate teaching and learning processes. Consequently, many adult trainers intend to utilize technology in training. Digital storytelling, when it is integrated into the training set, can be a compelling learning method to gain and hold trainees' attention. At the same time, it provides a creative and open-ended environment (Sadik, 2008), and this can promote students' active participation and emphasise the active role of trainees. Therefore, it encourages student-centred learning.

Flipped learning

Flipped learning assumes the recognition that nowadays, one learns anywhere and anytime through access to online information and that the trainee develops skills related to critical thinking, working individually and in groups (Sharples et al. 2014).

Flipped learning is a pedagogical approach that moves the training process into the student's space. At home or during individual study time, the apprentice interacts with content: video, audio, software, eBooks or other online resources. The mobile environment can significantly contribute to this process by facilitating quick access to other users (tutors, colleagues, friends, and family) anytime, anywhere. Sharing content, knowledge, and experience(s) can promote what Wenger (2006) calls communities of practice. This allows laboratory time to be spent on activities that exercise critical thinking, with the

instructor guiding apprentices in creatively exploring the topics they are studying. The Flipped Learning Network (2002-2015) states that for this to happen, four requirements are needed:

1. Flexible Environment. The trainer must physically rearrange the learning spaces to support group and individual work, creating flexible spaces so the trainee can choose when and where they learn, according to their learning style. In addition, the teacher is also adjustable on deadlines for learning because not all trainees learn at the same pace. In assessing the teaching, they promote allowing trainees to demonstrate their knowledge differently.

2. Learning Culture. In the traditional model of teacher-centred teaching, the teacher is the primary source of information. In the flipped learning model, the process is student-centred, and class time is dedicated to exploring themes in greater depth. As a result, trainees are actively involved in building knowledge and evaluating their learning in a personally meaningful manner.

3. Intentional Content. The trainer should always consider using the flipped learning model to help the trainee develop conceptual understanding and dominate procedures. The trainer determines what they need to teach and what materials the student should explore. The trainer intentionally uses content to maximize classroom time and adopts student-centred methods and active learning strategies, taking into account the level of education and the subjects to be addressed.

4. Professional Educator. In the flipped learning model, the role of the trainer in the classroom is even more critical and often more demanding than in the traditional transmissive model. During class, the teacher should

constantly observe their trainees, provide them with relevant feedback, and evaluate their work. In addition, the trainer should articulate with other teachers to improve their pedagogical practice, accept constructive criticism, and tolerate controlled "chaos" in the classroom. Despite assuming a less prominent role in the classroom, the teacher is crucial in allowing learning.

Many teachers can "flip the classroom", prompting trainees to read at home, watch videos or solve problems, but without actual learning. The value of this flipped learning model is in the redefinition of classroom time, which becomes a dynamic space where the trainee can test himself in the application of knowledge and interact with other colleagues in meaningful, practical activities. During the sessions, the teacher can act as an advisor and consultant, encouraging trainees both from an individual point of view and a collaborative effort.

Explore first

The discussion about teaching today is increasingly permeated by emphasising the learning process, distinguishing between passive and active learning. A student can become immersed in the online space in the new information environment. Therefore, practices that only transfer content from the source of information (teacher or textual material) to the student are losing their meaning because they only incorporate passive learning.

In this current educational environment, active learning initiatives focusing less on information dissemination and more on student learning are gaining credibility.

While it is evident that there are many forms of learning, at their extremes, the two main approaches to education are teacher-centred teaching and models that rely on active student learning or student self-learning. Lectures and other forms of dissemination of information characterize the first. The latter places the responsibility for learning in the hands of the student.

There are several challenges to the possibility of education with the student-centred approach. First, with responsibility for learning in the hands of students, we need to question whether or not these students will have a good knowledge base to work effectively with the resources they are discovering.

In particular, it has to be seen that critical thinking skills only work well when they are grounded in a solid foundation of knowledge. So, it is unclear whether students will quickly adapt to a “guide on the side” educational approach. Many, if not most, students are unsure as they make their way through the subject of their education and expect their teachers to help them make the journey. Also, some subjects seem highly resistant to student-directed learning, particularly the maths and sciences, which require considerable factual knowledge before the method can be employed effectively (Carpenter & Tait, 2001).

The new information age, on the one hand, has made access to information more accessible, and the traditional method of teaching is, to a large extent, based on a time when the educated elite owned the knowledge and passed it on to a select few. Active learning and student-centred methods appear to be the best option. On the other hand, making students fully responsible for their

learning creates problems deriving from their need for knowledge and their uncertainty about the method as they make their way through an unfamiliar subject.

Explore First is a pedagogical model that strives to make the student the leading actor in their learning in scenarios where digital action is merged with face-to-face activity. So, exploring first can be done in the classroom, online, or a mixture of the two.

The purpose is for students, working in small groups, first explore a topic using their prior knowledge to consider possible solutions. By struggling, the students gain a deeper understanding of the structure of the problem and its elements (Sharples, 2019). Then, students explain the best answer.

Students sometimes reach a block (or impasse) when trying to solve a problem. If they work alone, they may try to find a way round the impasse by coming to the wrong solution. Therefore, students need to work and collaborate.

Often they will fail, but that failure may cause them to explore the problem more profoundly. For example, they may go back to basic principles, or they may be creative and look for alternatives to the solution.

After this process, the teacher gives the essential concepts and methods of the solution, helping the students to firm up their knowledge by comparing correct and incorrect answers. Students may feel unconfident initially, but this experience can help them become more creative and resilient. To implement explore first, teachers will need a deep understanding of the topic and may need to make fundamental changes to how they teach.

The teachers' role is:

- To create opportunities for students to learn collaboratively.
- To promote exploration of materials, content, and student confidence in their abilities.
- To encourage the student to explore the content and be proactive no matter in making mistakes or failing.

Students must be encouraged to take risks in their learning and not be afraid of making mistakes.

The student's role is:

- To explore available resources.
- To reflect on the information.
- To clarify doubts with classmates instead of the teacher.

Benefits

Convenience: the student learns through access to information available online.

Personalization: the student explores the available resources at his own pace.

Reflection: the student reflects on the contents presented.

Collaboration: the student can collaborate with colleagues to solve the problem.

Explore first can be used with problem-solving lessons in two stages. The first stage encourages students to explore a problem and generate solutions. The

second stage teaches the essential concepts and helps students to build these into a correct answer.

It is vital that they initially explore the topic in breadth and depth, testing various hypotheses and theories. Also important is for the teacher to choose a good topic to explore; it has to be understandable by the students, have many solutions, build on students' existing knowledge of the issue, and not be so easy that the answer can be found by a quick search online and not so complex that the student doesn't know where to start.

Co-creation

Student engagement in learning can range from low (e.g. attendance at lectures) to high (e.g. students are represented in their institution and their influence on policy and governance). Having students work as partners in the educational experience enables their engagement on a more profound level, as they are more involved and have more excellent agency through the co-creation of curricula and materials alongside their teachers.

Co-creation is a relatively recent innovation that can lead to more significant empowerment of students and more profitable relationships between teachers and students and also between students themselves.

Co-creation is when students work alongside teachers as pedagogical co-designers and developers to create new teaching and learning experiences or amend existing ones, occasionally based on student feedback. Depending on the circumstances, students can have more elevated or inferior levels of participation in this process. In practice, much co-creation occurs when students have some control. As students participate in co-creation activities,

they negotiate with others (teachers and peers) and form and evolve their identities. All members share the resources available, and they also share goals for teaching and learning.

The theoretical basis of co-creation is 'communities of practice' (Wenger, 1991). Communities of practice are groups of individuals bound by a common interest who come together regularly to find ways to improve their practice. Thus, the community is established through building relationships and regular interactions with other members. They share case study stories, best practices, and what works and what doesn't as an effective way to exchange knowledge during these ongoing interactions, building a valuable repertoire of shared practices. In co-creation, students and teachers working as a community of practice can experience a more peer-based working relationship, leading to more meaningful student empowerment and reducing the hierarchy between teachers and students.

Some teachers aim to involve students in planning or at least inform the initial development of learning activities, materials and tools. These professors want students to use their voices to assist the professor in making evidence-based decisions and producing engaging learning and teaching experiences.

Involving students more deeply in the teaching and learning process is advantageous for several reasons, but it is not cost-free. Students may need specific skills or knowledge to be fully involved, and they may not possess them or claim they do, only for the co-creation team to discover that they are not as well developed as needed. Student involvement can change the direction of content creation from what was initially planned, leading to time and cost issues. Some teachers may resist this approach and feel threatened or consider that students do not have the necessary skills to co-create teaching

and learning. Furthermore, while student involvement may be very high, participation is likely only for the small number chosen or able to get involved. The process can further exclude those who already feel excluded. In other words, those who benefit may be already very engaged, and, likely, entire classes of students will only be able to get involved differently.

In conclusion, co-creating teaching and learning increase students' engagement as they participate in these activities. This participation can facilitate the construction of the student's identity. In addition, students build community involvement and develop relationships with teachers and peers while discussing and negotiating. Teachers and students share resources, goals, interests and practices in these communities. However, this pedagogy has challenges regarding more significant student commitment, resource overload for content production teams, teachers' reluctance to employ this method, and the limited number of students who benefit from it. These factors need to be considered for further improvement and effective use of this approach.

Problem-Solving

Problem-solving is a pedagogical model widely used by teachers. The reason is that it is relatively easy to create problem-situations or class-problems as most people are involved in Problem-Solving every day. It occurs automatically for many of the small decisions that need to be made daily. And students accept this very well.

People who can define problems, consider options, make choices, and implement a plan have all the basic skills needed for effective problem-solving. Sometimes following a step-by-step procedure for defining problems,

generating solutions, and implementing them can make the troubleshooting process seem less complicated.

The 'Problem-Solving' process consists of a sequence of steps that fit together depending on the problem. These steps are:

- Problem definition;
- Problem analysis;
- Generating possible solutions;
- Analyzing the solutions;
- Selecting the best solution(s);
- Implement and follow up on the solution (Next Steps).

The process is only a guide for problem-solving. It is helpful to have a structure to follow to ensure that everything is noticed. Nothing here is likely to be brand new to anyone, but the pure acknowledgement and reminder of the process can help the problems to be solved.

1. Problem definition

The usual process for solving a problem will initially involve defining the problem to be solved. People often keep the problem in their heads as a vague idea and can get so lost in what they are trying to solve that no solution seems to fit. Simply writing down the problem forces you to think about what you are trying to solve and how much you want to achieve. The first part of the process involves writing down the problem to be solved. It's a verification step to make sure you don't just solve the part of the problem that's easier to solve.

People often need to verify that the problem is the right one to solve before using the most immediate solution to the first problem definition.

2. Problem analysis

The second step is to examine the current situation and what is involved in making it a problem. For example, understanding where the problem comes from, how it fits into recent developments and what the current environment is is crucial in determining whether a solution will work. Likewise, having a set of criteria to evaluate any new key or whether the idea is viable. This section of the troubleshooting process ensures time is spent stepping back and assessing the current situation and what needs to be changed. After this investigation, it is often good to confirm that your problem definition is still valid. This is because, upon investigation, people often discover that the problem they want to answer is very different from their original interpretation.

3. Generating possible solutions

After figuring out the problem to be solved, the next step is to generate several possible explanations. In this phase, many solutions must be generated and only evaluated after a period. Often an idea, which would have been dismissed, can be developed into a superb solution when adequately assessed.

4. Analyzing the solutions

This step in the troubleshooting process is where you investigate the various factors behind each potential solution. It's good to write down the good and

bad points and other things relevant to each solution. After that, work on developing the idea to make it work.

5. Selection of the best solution(s)

This is the section where you examine the various influencing factors for each possible solution and decide which ones to keep and ignore. Finally, it analyzes the solution and uses its judgment to decide whether or not to use it. Sometimes pure facts and figures determine which ideas will work and which won't. In other situations, it will be purely feelings and intuition that will decide. Then increase the depth of analysis for each idea and refine it further. If you don't get answers that work, you'll need to repeat the solution generation section to discover more potential solutions. Alternatively, you may have to reassess the problem.

6. Implement and track the solution (next steps).

This process section is where you write down what to do next. Now that you have a potential solution, you need to decide how to make the solution happen. This will involve people doing various things at various times in the future and then confirming that they were carried out as planned. This stage ensures that the valuable thinking used to solve the problem becomes a reality.

Cooperative Learning

Student learning objectives can be structured to promote cooperative, competitive, or individualistic efforts. In all classrooms, activities proposals

aim to achieve goals and are conducted under a goal framework. A learning objective is a desired future state of demonstrating competence or proficiency in the studied subject. The framework specifies how students interact with each other and the teacher during the session. Each goal structure has its place. In the ideal classroom, all students would learn to work cooperatively with others, compete for fun, and work autonomously. The teacher decides which goal structure to implement in each lesson. The essential goal framework, and the one that should be used most often in learning situations, is cooperation.

Cooperation is working together to achieve a goal. Cooperative Learning is a teaching model in which students work in pairs or small groups to achieve a common learning goal with teacher guidance (Johnson & Johnson, 1989). In cooperative situations, students share work to maximize their learning and that of others, seeking beneficial outcomes for themselves and all other group members. It can be contrasted with competitive work (students work against each other to achieve an academic goal) and individualistic (students work alone to achieve learning goals). In cooperative learning, the teacher evaluates the students' efforts based on referenced criteria. Although they exist limitations on when and where the teacher can use competitive and individual knowledge appropriately, you can structure any learning task in any subject area with any curriculum cooperatively.

The Cooperative Learning strategies are designed to meet four principles: (1) Positive Interdependence, (2) Individual Responsibility, (3) Equal Participation and (4) Simultaneous Interaction.

Positive Interdependence

In general, we speak of positive interdependence when in pairs, the gain of one benefits the other, or in a group, the members feel like a team and are working towards the same goal. To ensure a positive interdependence when working with cooperative learning, two requirements must be satisfied: (i) students must feel that they are working for the same side and (ii) the task of each group element must require similar work.

Individual Responsibility

In the cooperative classroom, students work together as a team to create and learn, but each student is ultimately responsible for a part of the work to be done and, thus, for his performance. It is precisely to fulfil positive interdependence and individual responsibility that students are given time to think/work alone and interact with peers in all cooperative learning strategies. In this way, students' autonomy and cooperation are improved.

Equal Participation

Pair and group work is often very well received by students, but the problem is that it is difficult to verify that students are working equally. Instead, cooperative learning strategies ensure that all students in each team or pair contribute equally to the ultimate achievement. They are designed to make students interact and make everyone complete a specific task at each stage of the activity.

Simultaneous Interaction

In individual interaction, when only one student is involved, the teacher talks twice as much as one student does. And when the teacher is the most active participant in the classroom, students are uninterested (and probably bored). On the other hand, cooperative learning strategies are designed to produce simultaneous interaction to involve as many students as possible simultaneously.

When working with cooperative learning strategies, teachers notice that working together will allow students to get to know their peers better. It also helps create a better community and, therefore, a warmer atmosphere in the classroom.

Cooperative learning, by reducing student disengagement and favouring students' natural need for social interaction rather than opposing it, also helps to minimize classroom management issues.

In addition, cooperative learning strategies often give students a break from class while also allowing them to move around in the classroom.

Learning by doing

"What we have to learn to do, we learn by doing". This quotation from Aristotle (Aristotle was an Ancient Greek philosopher and polymath) is rigorously what learning by doing is all about.

Teachers are increasingly adopting 'learning by doing', a more action-oriented methodology for training. It is based on the practice of the work carried out to

stimulate the activity, motivation and participation of the students, sharing ideas in work groups and developing a fair self-assessment.

The school is changing: online training is gaining ground over face-to-face training, digital media over traditional communication, and practice over theory. In this scenario of constant changes, learning by doing has emerged as a trend in training. For teachers who seek to improve their students' learning, this pedagogical model is becoming increasingly popular for its ability to develop essential skills such as decision-making, teamwork and leadership.

Kolb (1970) defined the four steps of the learning-by-doing model:

Concrete experience. Immersing people in the activities and tasks they perform gives rise to observation.

Thoughtful observation. People think about what they observe and develop hypotheses with that information and its possible meaning.

Abstract conceptualization. Based on these hypotheses, people generate abstract concepts that must be interpreted and assimilated.

Active experimentation. People experience and put the concepts into practice in other contexts, which allows them to improve.

In the case of schools, the simulation of certain situations experienced in an organization enables the development of skills and attitudes highly valued in the current context due to their strategic characters, such as creativity, critical thinking, self-assessment, analytical capacity, teamwork, problem-solving and decision-making. In addition, ideas are shared that often turn into innovative solutions that lead to improvements in productivity.

However, learning by doing cannot be improvised – it needs to be perfectly planned and structured.

This chapter concludes the general part on methodologies without going into their constituent phases. Each method includes certain constituent steps and specific peculiarities and it is assumed that teachers, as professionals, already know these in depth.

Otherwise, for any in-depth study, the literature on the subject offers a wide range of articles and resources that can help to get to know them in a more specific and detailed manner.

Problem-Solving, Learning by doing and Cooperative learning, interconnected methodological strategies

Educational robotics is studied and applied, not only to learn how to build robots but also to acquire a method of reasoning and experimentation, based on the concepts of Problem-Solving, Learning by doing and Cooperative learning.

Among the methodologies useful for promoting the development of cognitive skills, involvement and motivation in students is Problem-Solving, which is closely related to the processes underlying educational robotics. Confucius' maxim "if I listen I forget if I see I remember, if I do I understand" is perhaps the most emblematic to better understand this concept.

Bringing educational robotics into the classroom promotes students' ability to develop computational thinking, as already mentioned, the ability to solve complex problems. The student learns to 'chunk' a general, difficult problem into simple parts, to which he or she slowly manages to find a solution. Through educational robotics, the student carries out this process through a series of algorithmic and procedural sequences (coding).



This type of methodology, which can be applied to everyday activities and not necessarily with technological tools, is fully developed in laboratory activities, using 'workshop didactics' and 'active play didactics', based on the Learning by doing methodology. Laboratory activities where the laboratory is not necessarily a well-equipped space, but a place where students can think, design, tinker, build, compare, reflect on error, change and redefine their project, collaborate and cooperate.

Workshop activities allow teachers to apply Cooperative Learning: students can work in small groups, collaborate, compare notes, and learn together, also promoting peer-to-peer and peer tutoring. In this way, the abilities of each individual can be enhanced, even those of students with difficulties of various kinds. All resources can be enhanced and therefore all students, even those with difficulties, have the opportunity to make their contribution and take on a role in building their knowledge.

Robotics is, in fact, an effective teaching tool that can support and flank traditional lessons by making them interactive, fun and inclusive, so that students learn by doing and playing, gradually putting into play more and more complex skills aimed at developing problem-solving abilities.

One of the fundamental aspects of Problem-Solving is the ability of students to autonomously realize the error (in programming bugs) during the course set out and to try to correct it themselves.

In traditional teaching, it is the teacher who detects the error and points it out to his or her students and not only that, corrects it as if the students were not capable of doing so. In this type of activity, on the other hand, students do 'problem finding' and then 'Problem-Solving'.



In addition, Cooperative learning, applied to the other methodological approaches mentioned above, is a methodology that requires logistically arranged learning environments that are different from the classical ones, no longer with desks one behind the other divided by rows, but composed of learning islands. This fosters cooperation between students, the promotion of helping relationships, and the definition of roles, even interchangeable ones, which allow everyone to express and recognise their own and others' resources.

Cooperative learning encourages the application of the motto 'first ask three and then me', i.e. first ask three of your peers and then turn to the teacher when you have difficulties. In this way, peer-to-peer helping relationships are encouraged, and tutor and mentor roles are activated, which are fundamental for increasing self-esteem, positive self-image or metacognitive activities that promote the recognition of one's resources and abilities, so as not to give up on the first difficulties.

6. Assembling Stemie, the Robot

In the student's book edition of Stemie & Stemia's fantastic journey through space, Students face some challenges to help their robot friends complete their journey... but, everything starts when...

Stemie and **Stemia**, along with their assistant **At**, decided to travel to our solar system.



(...)

The journey was going very well until, somewhere between the orbits of the planets Jupiter and Mars, their spaceship suffered from gravitational perturbations and was hit in the asteroid belt.

After that accident, the friendly Robots come to Earth in pieces and the students' first Challenge is to help them get back in shape.

CHALLENGE

0 Gathering the parts

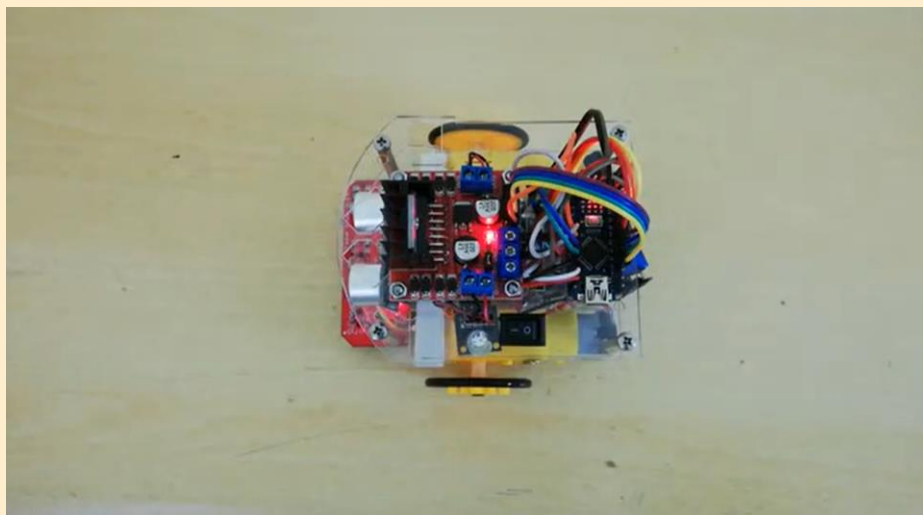
GOALS: I can assemble the robot and by using the checkup program, examine if the robot works.

At the beginning of every Challenge, students are presented with a Goal.

The instructions of assembling the robot are [HERE](#) . Click or scan the QR code.



At the end of the Assembly, the robot should look like this next video:



7. mBlock

mBlock 3, based on Scratch 2, is a software designed to support STEM education and the software chosen to be used with Stemie, in this books.

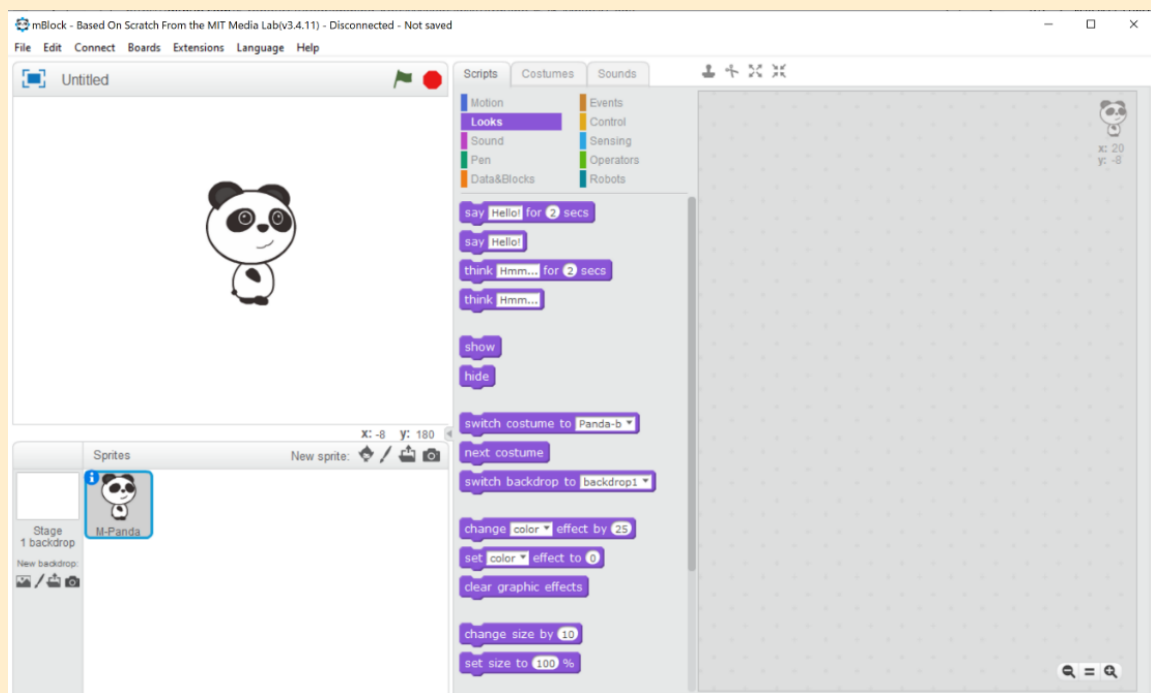
By supporting block-based programming, mBlock allows both new and expert programmers to freely create games and animations, and to program Arduino-based robots.

Before starting to program your robot, you need to install mBlock on your Windows or Mac computer.

You can download mBlock for Windows from [this](#) link.

The Mac version can be obtained [here](#).

After installing you should have a programming interface like the one in the picture below.



Block Shapes

To make programming easier, Scratch programming blocks were designed in different shapes, that can be connected vertically, to create algorithms or scripts, a series of connected blocks.

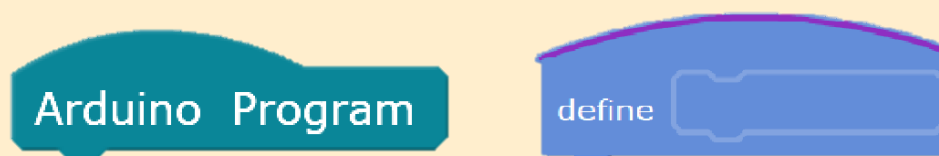
Each block type has its shape and a slot that defines how they can connect.

There are five shapes of blocks [2]: Hat blocks, Stack blocks, Reporter blocks, Boolean blocks and Cap blocks

Hat blocks

Hat blocks are used to start scripts and are always placed on top of other blocks.

The following picture shows the general shape of a Hat Block.



Every script that you build for your robot must have one Arduino Program block and may have several define blocks that allow you to execute scripts at different time points in your code.

Stack blocks

A stack block is a rectangular block with slots on the top and bottom that allows them to fit above or below other blocks.

A typical Stack Block may look like this:



Stack blocks are used to execute the main commands, and therefore are the ones that you will find most in your scripts.

Reporter blocks

A reporter block allows you to store data and contains a value that can be a numerical value or character string.

The following is the general shape of a Reporter Block.



A reporter block can be used in any script that requires data but cannot be used independently so you will need to fit it into another block.

Boolean Blocks

A boolean block contains a condition, which can be either "true" or "false" and typically is used inside condition blocks like IF.

A boolean Block is an elongated hexagon as shown in the following picture:



A boolean block must be put into the hexagonal slot of another block, and therefore cannot be used independently.

Cap blocks

A cap block is used for a script or project and therefore it can be put only under all blocks. Don't forget that in your project you should have only one forever block.

The following is the general shape of a cap block. Notice that there are no slots at the bottom of the block.

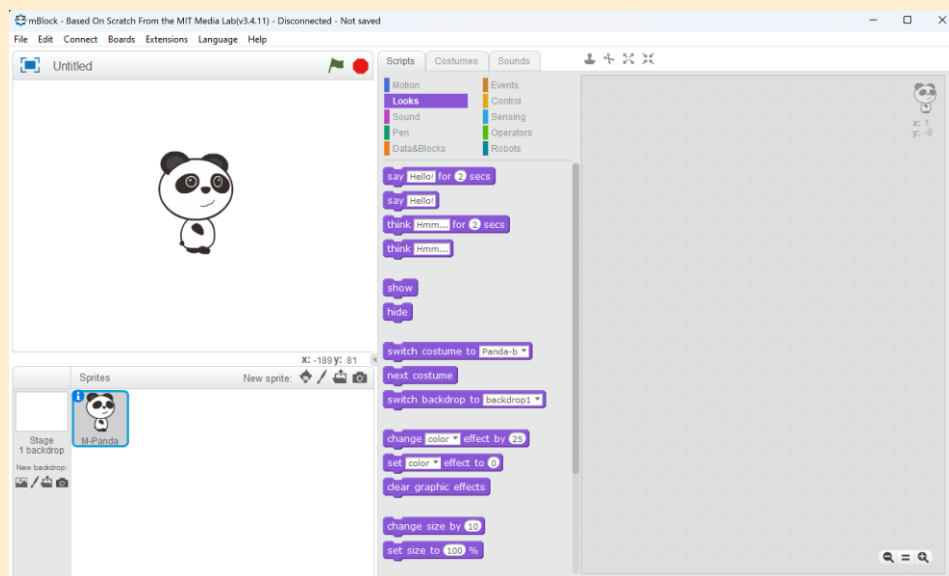


The Buzzer Extension

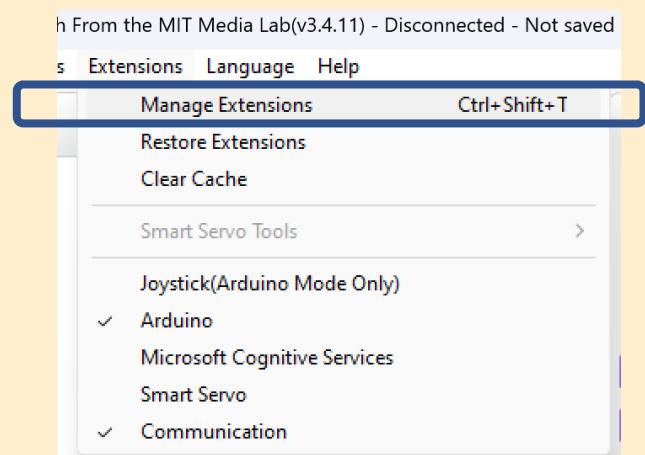
Before starting to program the robots, you need to prepare the computer to do it. The first step was to install mBlock. The next step is to install a mBlock Extension that will allow them to play musical notes.

You can download the Buzzer mBlock Extension from this [GitHub link](#) and install it by executing the following instructions:

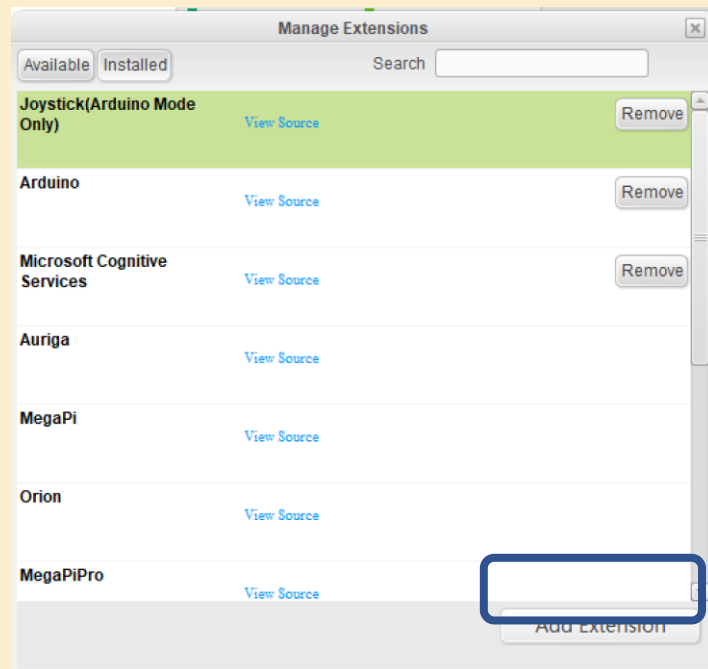
Open mBlock



Go to *Extensions* and choose the option *Manage Extensions*

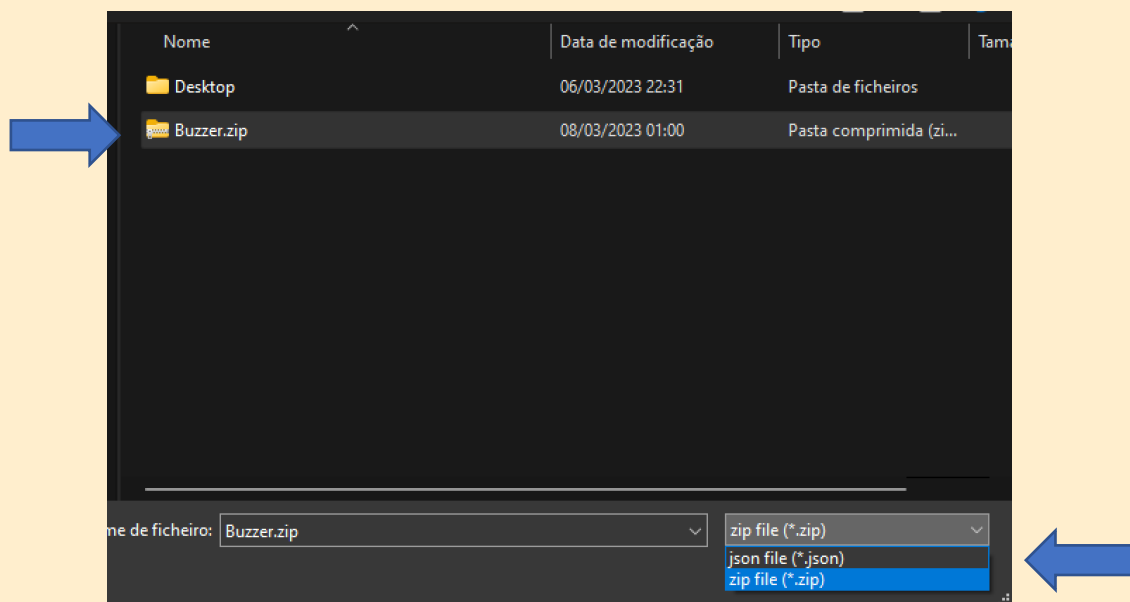


Now, click on the button
Add Extension

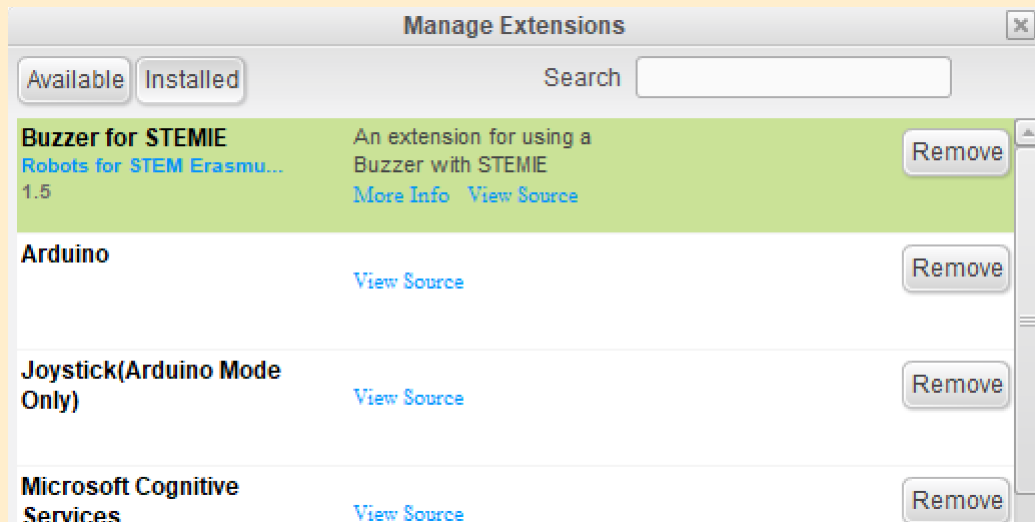


And choose the zip file that you previously downloaded (Buzzer.zip) with a double click or by selecting and pressing *Open*.

Don't forget to change the file type to *zip file (*.zip)*



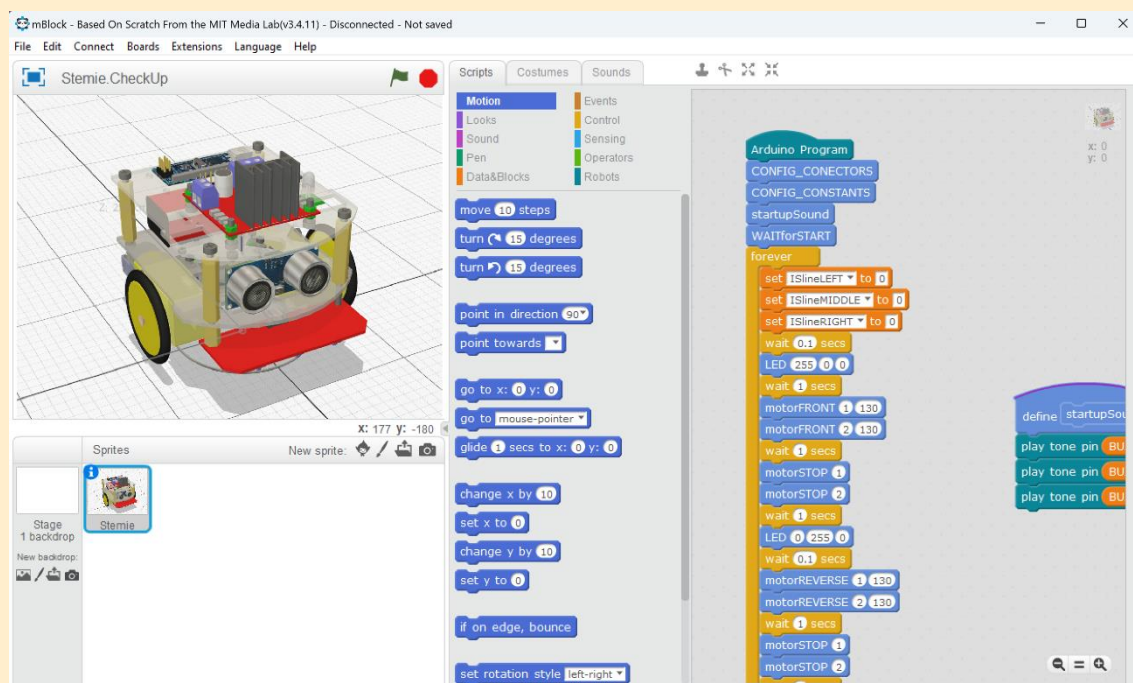
After that procedure, you can check if the extension is installed by looking at the Manage Extensions window.



The Checkup project

Created to allow you to check every connection on your robot, the Checkup project tests every sensor and actuator that is present in your assembled robot.

You can download the project from this [GitHub link](#) And then open it with mBlock.



Uploading a script to Stemie

After having a script programmed in mBlock, you need to upload your script to your robot. This is done by using the Arduino mode in mBlock.

Check the video on the next page to understand the process of uploading. This process is very important because every change that you make in your program will need to be uploaded again.

ROBOTS FOR STEM

UPLOADING A PROJECT TO STEMIE

After uploading the Checkup to your robot, you can disconnect the Arduino from your computer and turn your robot on.

The expected behaviour of your Robot, after uploading the Check-Up program and, if every wire connection is made correctly would be the following:

Both the red Led on the Arduino and the Motor Controller will light red;

The Arduino L led will start blinking, waiting for you to pass your hand in front of the Ultrasonic Sensor;

After passing your hand in front of the Ultrasonic Sensor, the following will occur:

The robot will start moving forward with the RGB Led turning RED;

The robot will start moving backwards with the RGB Led turning GREEN;

The robot will start moving forward with the RGB Led turning BLUE;

And then it will stop moving.

At this point of the program, you have already checked the connections of the Ultrasonic Sensor, the motors and the RGB LED. You still have to check the connections of the Line Sensor.

To do so, you need to pick the robot in your hands and place one finger under each of the sensors, one at a time.

When putting the hand under the:

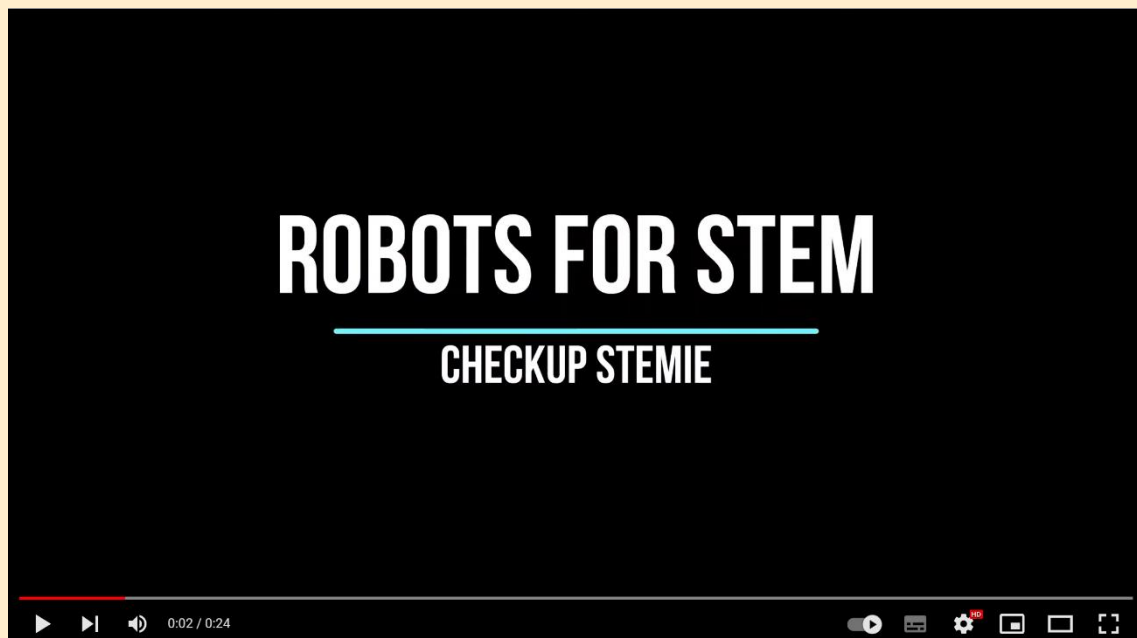
Left sensor -> Red led will light;

Middle sensor -> Green led will light;

Right sensor -> Blue led will light.

After this procedure, the robot will restart the Check-up procedure.

Check the following video and compare it with what your robot does.

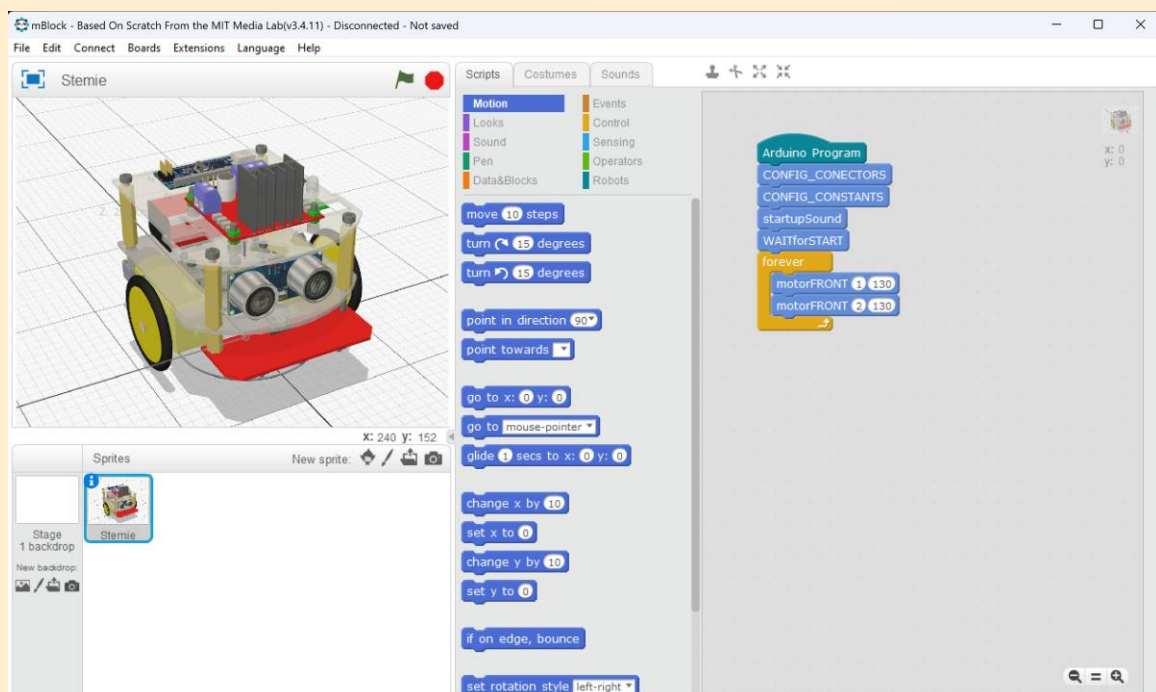


The Stemie project

The Stemie project is the basis of all the Student's work.

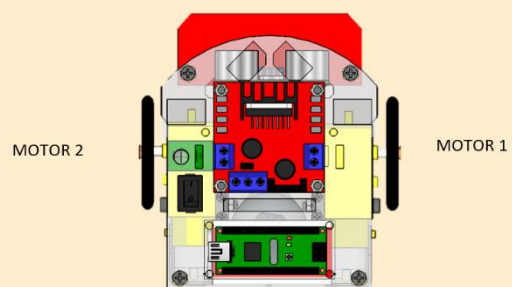
It contains the programming Framework developed to make it simpler for students to program the Robot.

You can download the project from this [GitHub link](#) And then open it with mBlock.



To better understand this chapter, there is the basic information you first need to know.

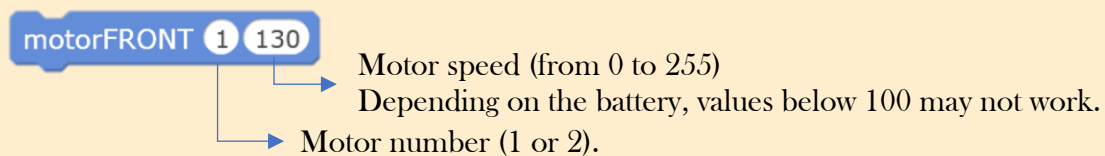
In the making of the programming framework, it was agreed that the robot's motors were to be called by numbers, as depicted. This information is also present in the student's book.



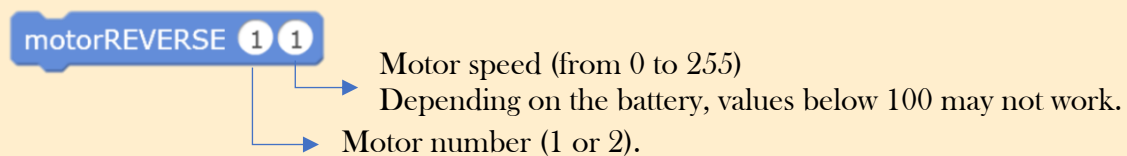
The developed Framework has some foundation blocks that, as a teacher, you need to remember:

To work with motors, to make the robot move, three basic blocks are used.

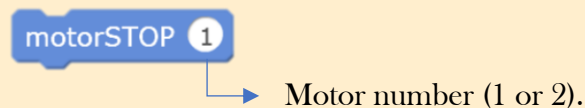
- Block that makes one of the motors move **Forwards**



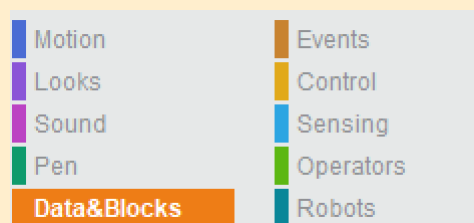
- Block that makes one of the motors move **Backwards**



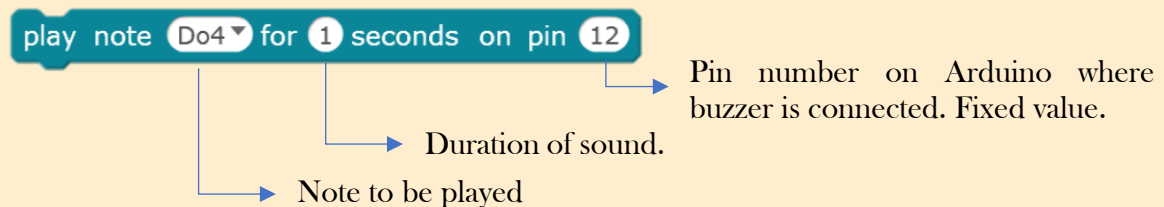
- Block that makes one of the motors **Stop**



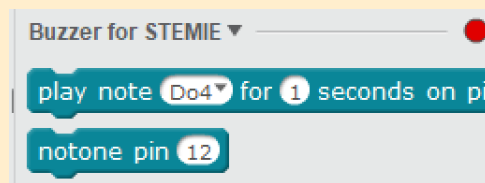
These blocks can be found at the bottom of the **Data & Blocks** group of commands:



To work with **Buzzer**, to make sound, one basic block is used. To use this block, the Buzzer Extension must be installed:

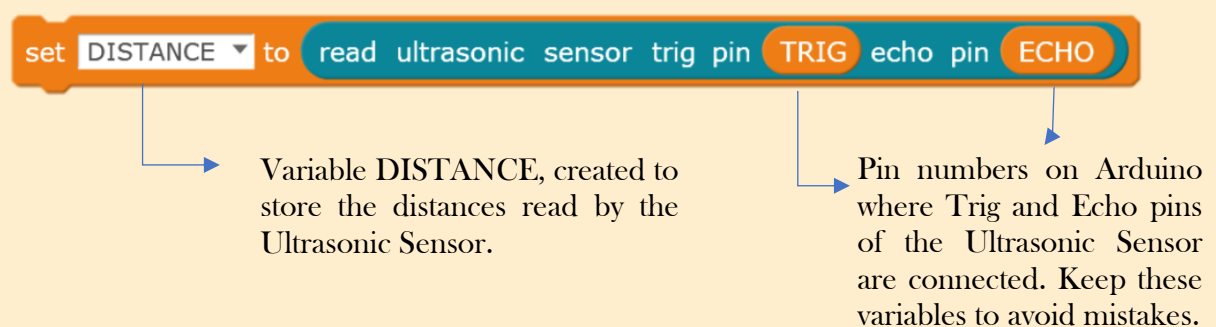


This block can be found in **Robots**, under **Buzzer** for Stemie.



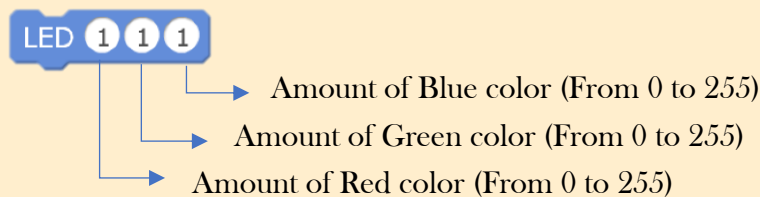
For example, the custom block **startupSound** makes use of the previous blocks to make a sound sequence whenever the robot powers on.

To work with the **Ultrasonic Sensor**, one basic combination of blocks should be used:



For example, the **WAITforSTART** custom block uses the previous block to make the robot stand still until a hand is passed in front of the sensor, after powering it on.

To work with the **RGB Led**, one custom block is used:



With the combination of these three standard colours, every light visible colour can be shown by the robot's **RGB Led**.

To turn off the **LED**, you must put all values to 0.

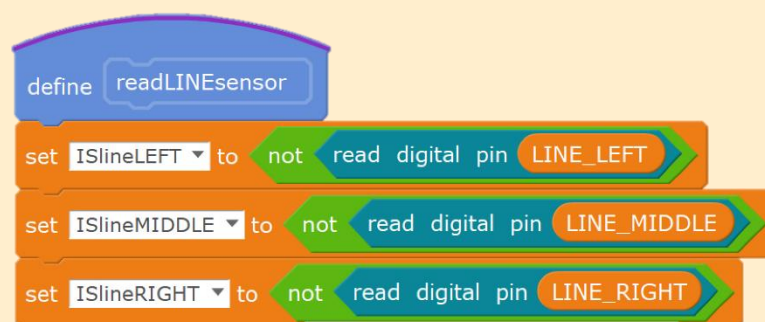


To work with the **Infrared Line Sensor**, one custom block is used:



Within this custom block, infrared sensors are read and values are stored in a variable for each one of the three sensors installed in the module. These variables will allow you to build your custom program to follow the lines.

If there is a line under the left sensor, the **ISlineLEFT** variable will have the 1 value. If there is no line under the left sensor, the variable will have the value 0, after using the **readLINEsensor** block.



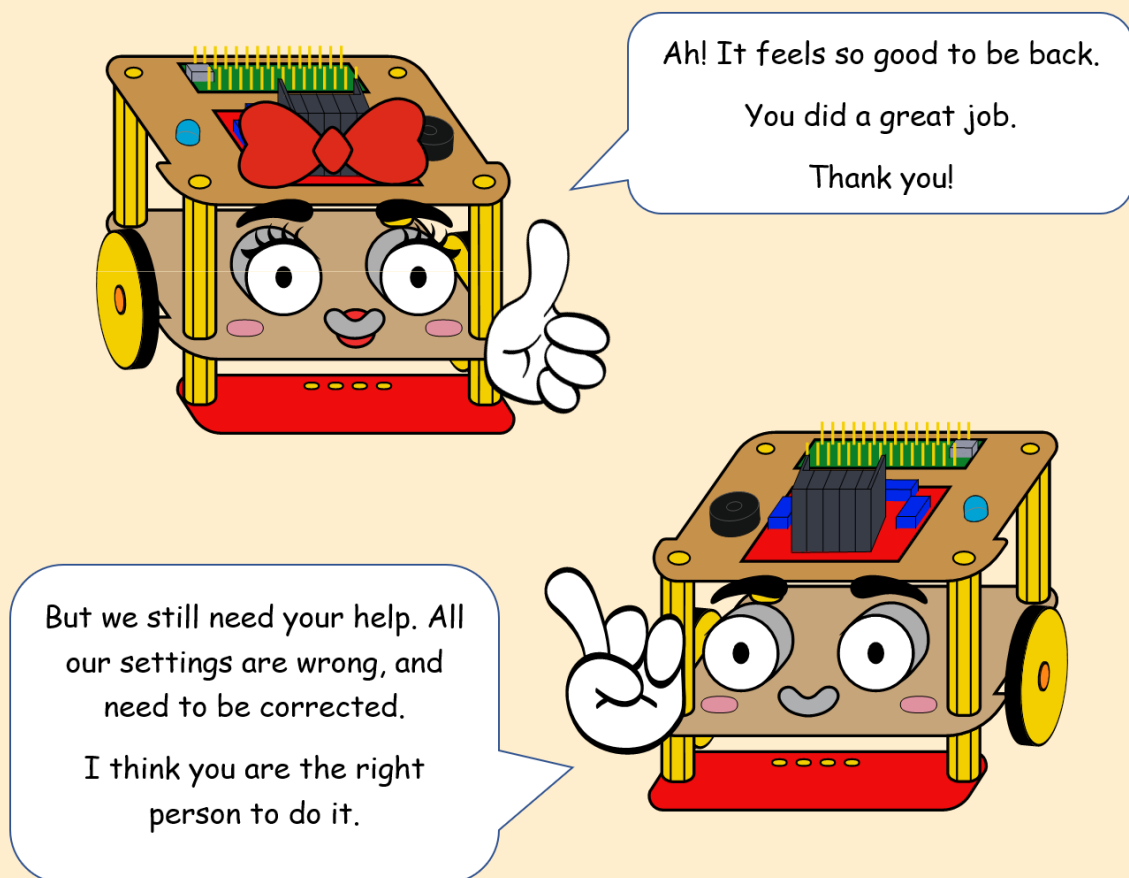
8. Lesson Plans

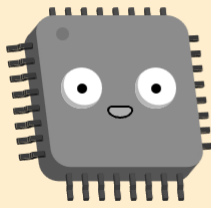
In this section, we will detail every Challenge in the Student's book.

As previously mentioned, each Lesson/Challenge has a specific objective or Goal.

To maintain the structure between the two books, some details of the Challenges will be depicted in this book, exactly as they appear in the Student's Book.

Before the next Challenge, students have already been introduced to Stemie, Stemia and their assistant At.



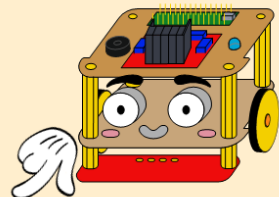


Hi! My name is **At**. It's a nickname that comes from the ATmega328 processor, that Stemie and Stemia are equipped with. I am your assistant in this book.

CHALLENGE



Learning to drive



Please charge my batteries regularly so I can work at my best.

GOALS: I can name different measurements and program the robot to go straight.

The first challenge begins with a bit of technical advice from the teacher: first of all students need to regularly change Stemie's batteries so that it can work to the best of its functionality.

Learning scenario

"Stemie and Stemia's greatest wish is to visit as many planets as possible because their eyes are always turned to the sky and the stars simply enchant them..."

As they are already assembled, they start to review their original plans and decide to visit the Moon first. To do this, they must prepare their spaceship at the mechanic store, so they decide to go there. “

AT assistant advises students that in this challenge there is a disciplinary connection with Science.



EUROPEAN KEY COMPETENCIES FOR LIFELONG LEARNING

Mathematical, science and technology and engineering competence

Digital competence

Personal, social and learning to learn competence

PREREQUISITES

Assembled and previously checked robot.

mBlock 3 installed

Stemie.sb2 project

A. CONTENTS:

the scale of units of length and time

light-year and astronomical unit

solar system

B. PROGRAMMING LANGUAGE

mBlock programming language

AIMS

A.1 name the different measures of length and time

A.2 apply prior knowledge in practical exercises

B.1 program the robot to go straight

SPECIFIC VOCABULARY

Measurement units: mm, dm, cm, m, dam, hm, km, mile, light year, the astronomical unit

Solar System: planet names

mBlock Programming language: motorFRONT/motorSTOP/Repeat loop

METHODOLOGIES:

- Problem-Solving ⓘ
- Learning by doing ⓘ
- Project-Based Learning (PBL) ⓘ

EXPECTED TIME: 45 min.

TARGET LEARNERS: 10-13 years old students

RESOURCES AND TOOLS

- Pc, STEMIE
- Squared notebook, pens, pencils, erasers
- Ruler they will have to construct
- Tables provided by the teacher
- QR-codes and links provided by the teacher

INTERDISCIPLINARY LINKS: Science, Maths, Technologies, Engineering

PROPAEDEUTIC ACTIVITY



WHAT DOES THE TEACHER DO?

The teacher:

- invites students to read the stimulus questions posed by Stemie and Stemia in the comic strip graphic (Figure 1)

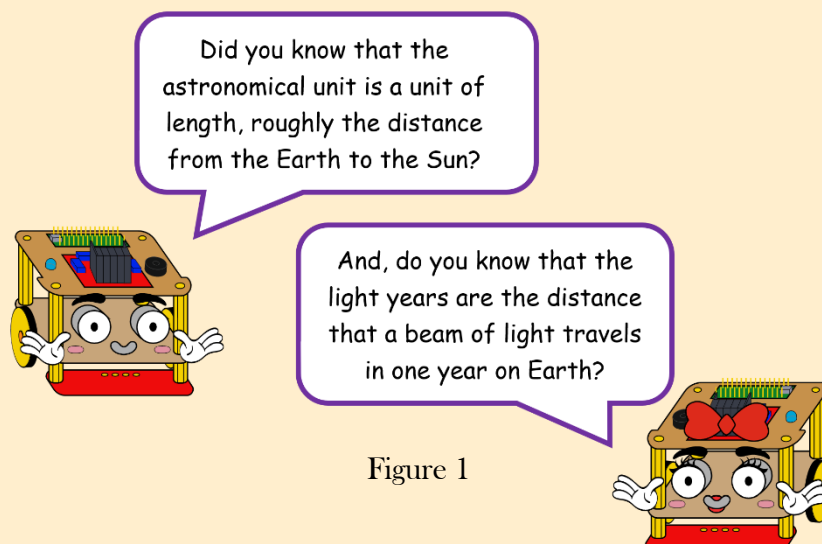


Figure 1

- encourages students to repeat the scale of length units

- provides the table below (figure 2) and reminds students that units can be very large but also very small:

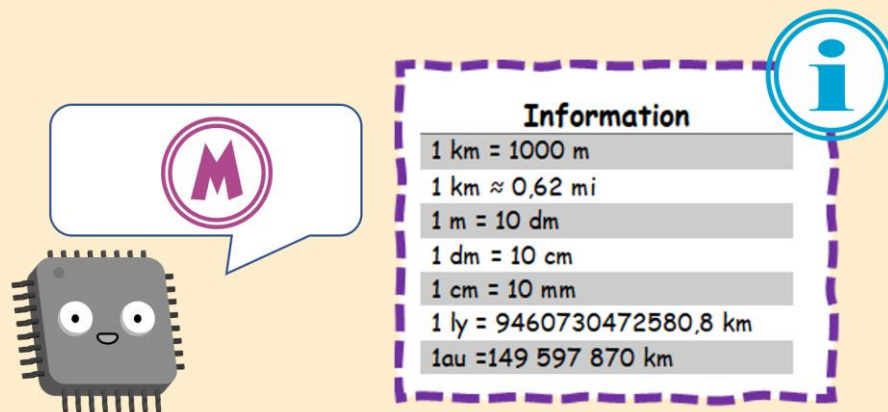


Figure 2

1. Arrange these units in ascending order

The task that students will have to perform is to arrange in ascending order the units of measurement proposed.

WHAT DOES THE TEACHER DO?

To encourage the inclusion and active participation of all students, the teacher proposes different activities with videos and games.

The teacher:

- first, proposes watching the following video to better understand what is a light year:

For better understanding what is THE LIGHT YEAR scan the QR code or click [HERE](#)



- second, invites students to complete an exercise using the LearningApps digital app.

The exercise requires the following length measurements to be entered in ascending order:

cm, km, mm, m, dm, mile, the light year, the astronomical unit

Access to LearningApps can be done in two ways: the teacher can provide the QR-Code to be scanned by a reader on a mobile phone or, if using a PC or tablet, the link to be copied/pasted into the browser's address bar.

Just scan the QR code or click [HERE](#)



WHAT DO THE STUDENTS DO?

The students:

- read and acquire the information provided by the teacher through the table handed out carefully
- remind the scale of units of length, consolidating their prior knowledge
- watch the video provided by the teacher to better understand what a light-year is
- scan the QR-Code provided by the teacher using the reader
- alternatively, copy/paste the link provided by the teacher onto the address bar
- complete the exercise using the game provided
- receive feedback on the results achieved

After the proposed preparatory activity, the teacher promotes a brief peer-to-peer discussion to obtain initial feedback from the students.

This evaluation process allows:

- the teacher, to redefine the course according to the outcomes;
- the students to reflect on their learning styles.

After the first activity, we move on to the second mission.

2. Write a program to drive the robot straight

In this task, students will have to write a simple program to guide the robot while realizing that the robot motors run at 120 power and Stemie and Stemia run for 1 second.



WHAT DOES THE TEACHER DO?

The teacher introduces the second mission by making a premise: everyone knows that the shortest path between two points is a straight line. If that is the case, the students have to help Stemie and Stemia to go straight so that they can reach the Moon faster. However, students should consider that, due to the accident they had in the asteroid field, Stemie and Stemia's navigational system was damaged and so they have some difficulties moving straight.

To support students in this challenge, the teacher provides them with an in-depth study:

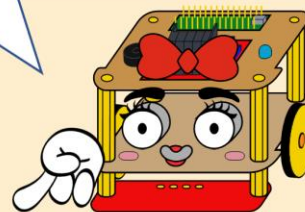
“if the robot rotates more to one side, the engine power of that side opposite side can be changed, eg: 125. Don't forget that usually values are set between 100 and 255”.

The teacher asks students to:

- write a programme to drive the robot straight
- gives them an example in which the robot's motors run at a power of 120 and Stemie and Stemia run for one second



Take a look at the video on next page to understand how to send a program to your robot.



To understand how to send a program to the robot, the teacher invites students to watch the following video.



After watching the video, the teacher suggests modifying the motor power of the opposite side if the robot rotates more to one side.

WHAT DO THE STUDENTS DO?

The students:

- analyse the result and reflect on how to proceed

Then, using mBlock, the students:

- write the code following the example provided by the teacher and insert:
 - ✓ the **motorFRONT** block for the first motor by setting its power to 120
 - ✓ the **motorFRONT** block for the second motor by setting its power to 120
 - ✓ a wait of 1 second (**the time the motors will turn**)
 - ✓ the **motorSTOP** block for the first motor
 - ✓ the **motorSTOP** block for the second motor
 - ✓ the code is written inside a **REPEAT CYCLE**

Then:

- make the robot run the programme and check its operation
- if the programme does not work and the robot rotates more to one side, they change the motor power of the opposite side
- if the programme works, they have completed the task.

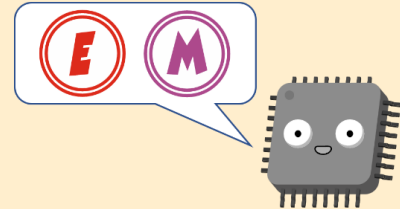
At the end of exercise no. 2, the teacher promotes a peer discussion based on the questions:

"What has happened?" "What difficulties have you faced?"

The students compare notes with each other and reflect on the results.

At the end of the discussion, move on to mission No. 3 of the first challenge.

3. Change the robot program to run 2s, 3s, 4s... and measure the distance Stemie or Stemia has covered



The teacher informs the students that to carry out this mission they will need a ruler, which they will construct themselves. They will use a maths exercise book in which 2 squares correspond to 1 cm.

WHAT DOES THE TEACHER DO?

The teacher asks students to:

- build the ruler and provides the following information: 2 squares on a math sheet correspond to 1 cm (urges students to remember how many cm make up a meter).
- invites to change the robot programme to perform a movement in 2s, 3s, 4s...
- asks to measure with the ruler the distance travelled by Stemie or Stemia each time
- provides a table in which to note the answers in cm and m

Click [HERE](#) to download the file with auxiliary grids, or read the QR-code.



The power of both engines of the robot is 120		
Time travelled, s	Distance travelled, cm	Distance travelled, m
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Figure 3

WHAT DO THE STUDENTS DO?

The students:

- reflect on the request received
- construct the ruler following the teacher's instructions: 2 squares on a maths sheet correspond to 1 cm, remembering how many cm make up a metre
- change the robot's programme to perform a movement in 2s, 3s, 4s...
- measure with the ruler the distance travelled by Stemie or Stemia
- note down the answers in cm and m in the table provided: Figure 3

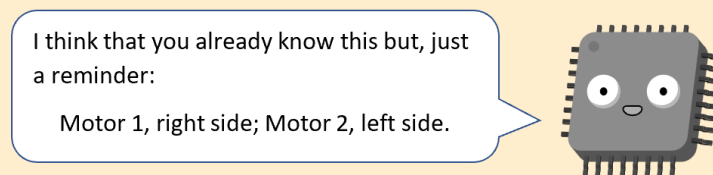
For those who finish the activity early, the teacher promotes in-depth and consolidation activities by assigning extra tasks: he asks the students to

program the robot to go 25 cm and 4 dm. Students who have finished the activity devote themselves to carrying out this extra assignment.



Extra info for teachers: For this extra task, the blocks used are the same as provided in the previous example. The only change will be the time that the robot moves. As in other challenges, there is no single solution because it depends on several factors like, for example, the battery level of power.

Finally, the teacher provides students with a pro-memory:



The tasks of this first challenge end here. The teacher, before proceeding with the next challenge, must ensure that there has been full and active participation by the students and that the experience has been positively received by the students also thanks to the forms of collaboration they will have been able to put in place in the small group. The teacher will take care to highlight any mistakes if any students have made them.

SELF-ASSESSMENT

At the end of the whole activity, the teacher proposes to the students to evaluate the experience and how they have passed the first challenge.

WHAT DOES THE TEACHER DO?

The teacher:

- urges students to engage in a metacognitive process by asking them to self-assess themselves
- provides a 'form' and asks them to fill it in

Click [HERE](#) to download the file with self-assessment forms, or read the QR-code.



- stimulates them to reflect on the path they have followed and on what they have learnt
- asks them to attribute a meaning to the experience they have had by promoting reflection on how it could be spent in real life
- gives feedback to each individual or group useful for improving their subsequent performance

WHAT DO THE STUDENTS DO?

The students complete the entries in the 'form' indicating:

- what knowledge have they gained, in this case, “Name different measurements” and “Program the robot to go straight”
- how they tried out the experience;
- what they experienced and what the outcome of the operations performed was;



- the meaning they attached to the experience carried out by explaining its value in real life

I can:	NOT YET	MORE OR LESS	YES, COMPLETELY
Name different measurements			
Program the robot to go straight			
Where can these ideas be applied in real word?			

CHALLENGE



Moving backwards

GOALS: I can draw parallel lines and program the robot to go backwards.

Learning scenario

The teacher explains to the students that Stemie and Stemia, having succeeded in moving in a straight line, need to fine-tune all the systems. As they do so, they discover that the gearbox does not work properly. They try to move backwards, but something seems to be wrong. It is very important to have all the gears working properly because they might need to divert from satellites and other obstacles they may encounter on their way to the moon.

The teacher asks the students if they think they can help them fix that problem.

EUROPEAN KEY COMPETENCIES FOR LIFELONG LEARNING

Mathematical, science and technology and engineering competence

Digital competence

Personal, social and learning to learn competence



PREREQUISITES

A. CONTENTS

lines: open, closed, straight...

parallel lines

B. PROGRAMMING LANGUAGE

mBlock programming language

AIMS

A.1 Draw parallel lines using appropriately and accurately appropriate tools (ruler, square).

B.1 Program the robot to go backwards using simple instructions.

SPECIFIC VOCABULARY

Contents: Open, closed, straight, parallel lines, ...

mBlock Programming language: motorFRONT, motorSTOP, motorREVERSE

METHODOLOGIES:

- Problem-Solving ⓘ
- Learning by doing ⓘ
- Project-Based Learning (PBL) ⓘ

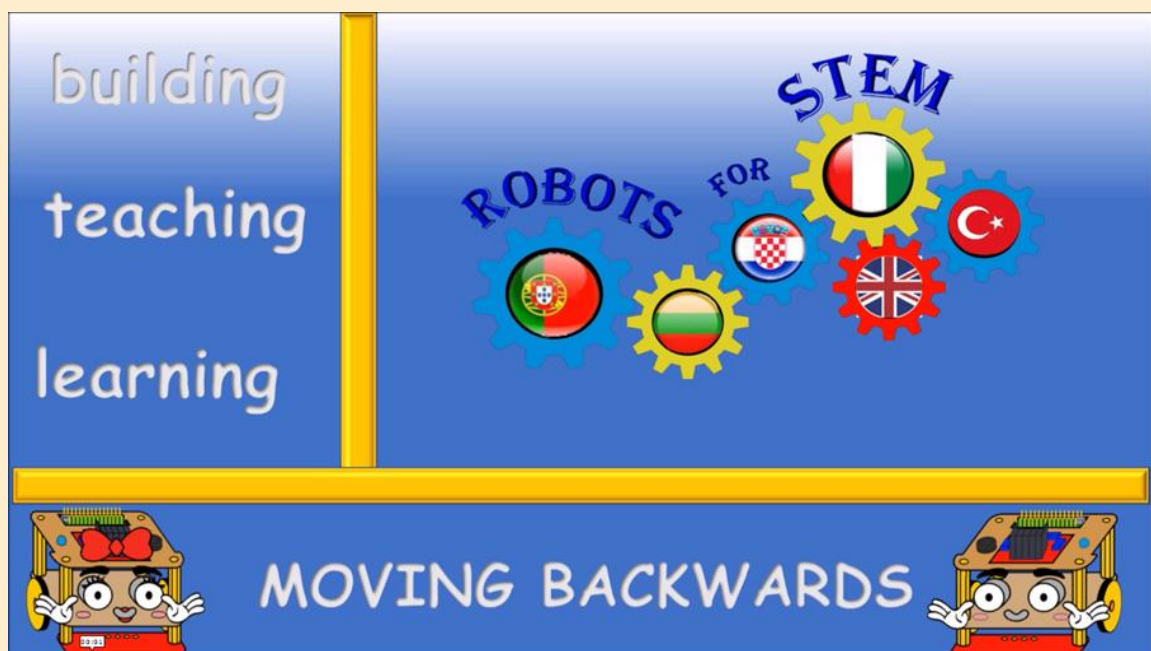
EXPECTED TIME: 45 min.

TARGET LEARNERS: 10-13 years old students

RESOURCES AND TOOLS:

- PC/Tablet/STEMIE
- Notebook
- White A4 sheets
- Scissors, pens, pencils, erasers, transparent tape...

INTERDISCIPLINARY LINKS: Science, Maths, Engineering

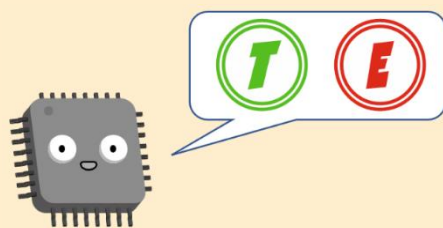


WHAT DOES THE TEACHER DO?

The teacher begins the lesson by asking the students some stimulus questions to remind them of the salient passages of the first challenge. He dwells on the mBlock programming used to make the robot move forward and explains that

in this second challenge, the two friends will have to travel in the opposite direction. Students will have to programme Stemie and Stemia using new blocks to make them move backwards within a space bounded by parallel straight lines.

The teacher assigns the students the first exercise, inviting them to program the robot to go backwards at a speed of 120 for 1s.

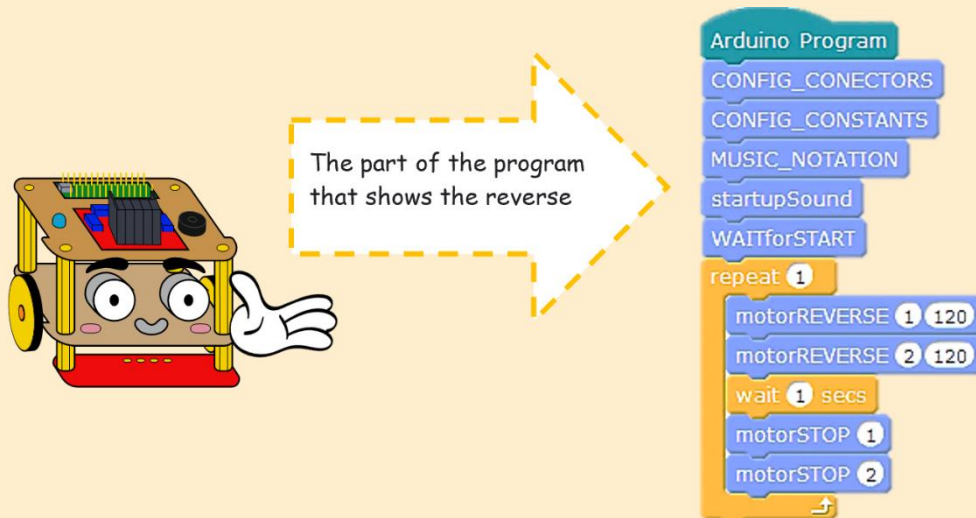


1. Write the program according to the provided example.

WHAT DOES THE TEACHER DO?

The teacher:

- provides students with sample block code



- invites the students to follow the example and write the program for the robot to go backwards
- highlights in the block code the part of the programme that makes the robot go backwards



WHAT DO THE STUDENTS DO?

The students:

- listen carefully to the teacher's request
- observe the example given
- reflect on how to proceed
- use the programming blocks `mBlock motorREVERSE` and `motorSTOP`
- set the motor speed to 120
- set wait time of 1 sec, after which the robot stops
- test the code

Completed the exercise, discussion begins.

WHAT DOES THE TEACHER DO?

The teacher:

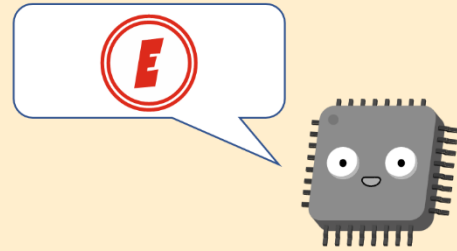
- asks the students if they have succeeded and if the robot is going backwards
- invites the students to try again if the robot does not perform as requested.

WHAT DO THE STUDENTS DO?

The students move on to the next exercise if the programme works correctly, otherwise:

- review the route
- identify the error
- rewrite the code.

2. Write the program for the robot to move forwards for 2 seconds and then backwards for 2 seconds



WHAT DOES THE TEACHER DO?

The teacher:

- invites the students to write the programme to advance the robot for 2 seconds and turn it back for 2 seconds, at a speed of 130, using the following blocks:



WHAT DO THE STUDENTS DO?

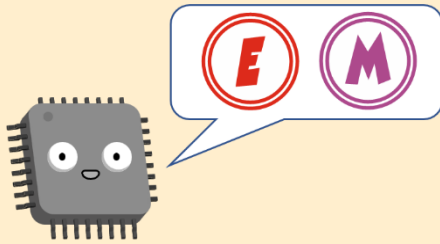
The students:

- follow the example given
- use the mBlock programming blocks motorFRONT and motorREVERSE
- set the speed of the motors to 120 for both paths
- verify the accuracy of the programming.

WHAT DOES THE TEACHER DO?

The teacher:

- asks the students whether Stemie or Stemia have returned to the same place. If not, he suggests repeating the procedure.



3. Do you know (remember) what are parallel lines?

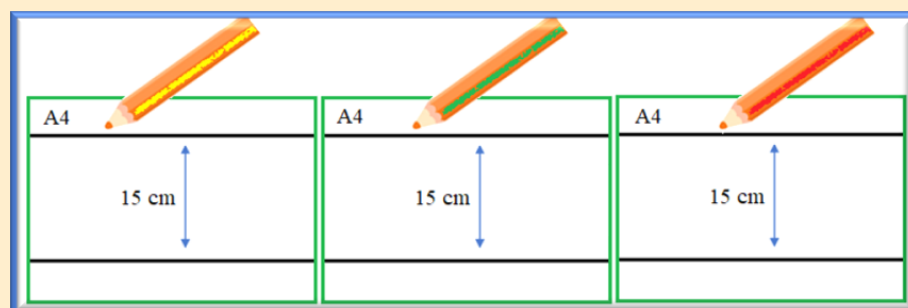
WHAT DOES THE TEACHER DO?

The teacher presents the third exercise by proposing a brainstorming activity on the word **LINE**, to focus the students' attention on the topic and stimulate them to retrieve previous knowledge. The teacher focuses on straight lines, particularly parallel lines.

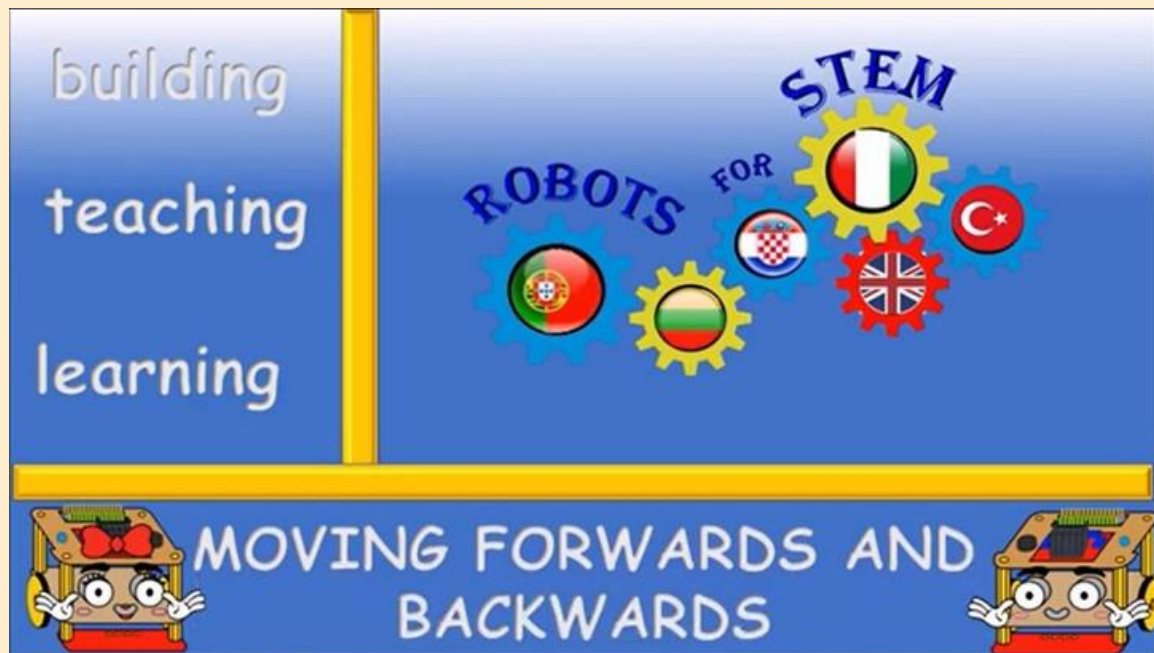
The teacher invites students to:

- take 3 white A4 sheets
- draw on them two parallel lines 15 cm apart
- place the sheets next to each other and fix them with tape
- have Stemie and Stemia compete together

and gives them this image to follow to proceed with the activity.



Before doing the exercise, the teacher suggests that students watch this video:



WHAT DO THE STUDENTS DO?

The students:

- watch the video proposed by the teacher
- take the material
- follow the image provided by the teacher
- perform what is required precisely

WHAT DOES THE TEACHER DO?

The teacher:

- points out to the students that it will be a challenge
- invites the students to let Stemie and Stemia compete together
- reminds them that the robots must go back and forth in the space between the two drawn lines and not run on the line.

WHAT DO THE STUDENTS DO?

The students:

- place the path created with the A4 sheets on a horizontal surface (floor)
- place Stemie and Stemia on the sheets
- make the two robots compete against each other by checking the correctness of the programming.

SELF-ASSESSMENT

At the end of the whole activity, the teacher proposes to the students to evaluate the experience and how they passed the second challenge.

WHAT DOES THE TEACHER DO?

The teacher:

- urges students to engage in a metacognitive process by asking them to self-assess themselves
- provides a “form” and asks them to fill it in

If you haven't done it previously, click [HERE](#) to download the file with self-assessment forms, or read the QR-code.



- stimulates them to reflect on the path they have followed and on what they have learnt
- asks them to attribute a meaning to the experience they have had by promoting reflection on how it could be spent in real life
- gives feedback to each individual or group useful for improving their subsequent performance

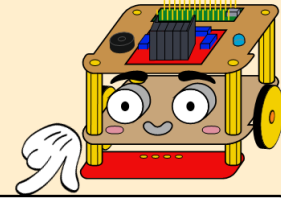


WHAT DO THE STUDENTS DO?

The students complete the entries in the “form” indicating:

- what knowledge they have learnt;
- how they tried out the experience;
- what they experienced and what the outcome of the operations performed was;
- the meaning they attach to the experience carried out by explaining its value in real life

I can:	NOT YET	MORE OR LESS	YES, COMPLETELY
Draw parallel lines			
Program the robot to go backwards			
Where can these ideas be applied in a real word?			

CHALLENGE**No time to go slow**

Please charge my batteries regularly
so I can work at my best.

GOALS: I can calculate the speed of the robot
and program it to go forwards and backwards.

Learning scenario

For the third challenge, to engage the students' interest, the teacher presents a new scenario in which Stemie will be on a mission to Mars. The teacher explains to the students that, given their journey to the Moon, Stemie and Stemia have discovered that they need a lot of energy to travel and when they are there they might have to travel at the highest speed or not so fast. This time, the mission assigned to students is to help Stemie and Stemia find out how fast they can go. Will the students rise to the challenge?

The teacher starts the challenge by inviting students to reflect on some questions. There are concepts they need to think about. Stemie helps students with a comic to read. Do Stemie and Stemia know their speed? What does the speed depend on and what does the size of engine power need to be modified to change their speed?

The teacher specifies that to calculate **the speed** they need to know the **distance** travelled and the **time** to walk it.

EUROPEAN KEY COMPETENCIES FOR LIFELONG LEARNING

Mathematical, science and technology and engineering competence

Digital competence

Personal, social and learning to learn competence

PREREQUISITES

A. CONTENTS

concept of speed, distance, time

speed formula

B. PROGRAMMING LANGUAGE

mBlock programming language

AIMS

A.1 consolidate the concept of speed, distance and time

A.2 calculate the robot's speed

B.1 programme the robot to go back and forth by formulating elementary

instructions “motorFRONT” and “motorREVERSE”

SPECIFIC VOCABULARY

Content: Power, distance, time, speed

mBlock Programming language: motorFRONT/ motorSTOP,
motorREVERSE

METHODOLOGIES:

- Problem-Solving ⓘ
- Learning by doing ⓘ
- Project-Based Learning (PBL) ⓘ

EXPECTED TIME: 45 min.

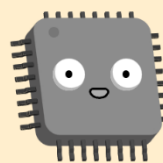
TARGET LEARNERS: 10-13 years old

RESOURCES AND TOOLS

- PC, STEMIE
- squared notebook, pens, pencils, rubber, rulers, erasers

INTERDISCIPLINARY LINKS: Science, Engineering, Maths,

**1. Write down the results in a table,
as Stemie and Stemia may need on
their journey to the Solar System.**

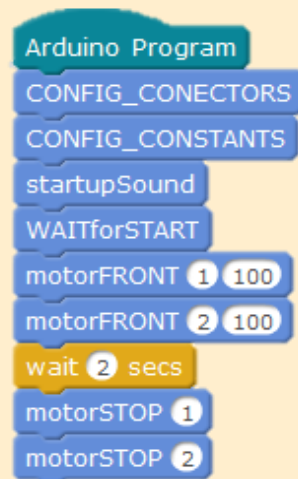


WHAT DOES THE TEACHER DO?

The teacher assigns the first task to the students and gives the following instructions:

- write the programme to make Stemie or Stemia move at a speed of 100 for 2s;

The block of code is:



WHAT DO THE STUDENTS DO?

The students reflect on the teacher's request and the indications received to hypothesise how to proceed.

With the use of mBlock, the students:

- formulate hypotheses for the solution to the problem
- use constructs typical of mBlock programming: motorFRONT / motorSTOP set the motor speed to 100 and enter a wait of 2 seconds after which the motor must stop. To do this, use the motorSTOP block
- test the code and see what happens
- if the programme does not perform its operations correctly, they must be able to find the 'bug', the error and must therefore "debug"
- reformulate the instruction sequence by rewriting the code to test it again

- if on their own, they cannot make it work, they can ask their classmates or the teacher for help
- if the programme performs the operations correctly, they move on to the next request.

WHAT DOES THE TEACHER DO?

The teacher, suggesting the use of a ruler, asks students to measure the distance travelled by the robot and note it down in the notebook.

WHAT DO THE STUDENTS DO?

The students measure the distance travelled by the robot and note it down in the notebook.

WHAT DOES THE TEACHER DO?

The teacher provides the students with a table "Stemie and Stemia are moving on", explaining to them that it contains four items concerning: **engine power**, the **distance** of the road travelled, the **time** taken expressed in seconds and the speed achieved expressed in cm travelled per second.

If you haven't done it yet, click [HERE](#) to download the file with auxiliary grids, or read the QR-code.



The first and third columns of the table are already pre-filled: the first column, indicating the engine power, starts at a value of 100, changes and increases

each time by 10 until it reaches 220; the third column shows a time of 2 seconds. Other columns are to be completed by the students. But how?

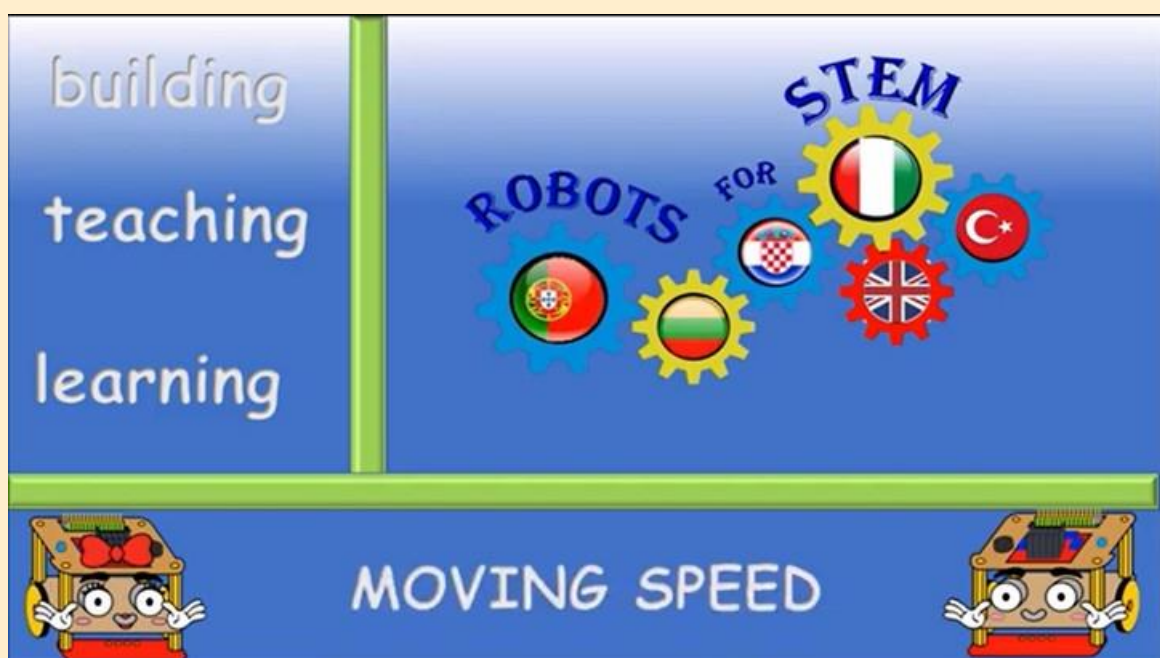
The teacher asks the students to:

- fill in a table to calculate the speed, as Stemie and Stemia may need it on their journey to the Solar System;
- proposes to change the robot's motor power to that specified in the table, repeating the experiment several times according to the parameters provided.

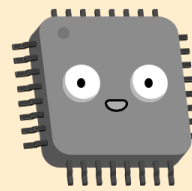
If the students need suggestions, the teacher, the 'facilitator' of the learning process, specifies that speed is obtained by dividing the distance travelled by time, applying the formula:

$$\text{The formula: } v = \frac{s}{t}$$

Another useful tool can be the video that the teacher invites to watch:



WHAT DO THE STUDENTS DO?



The students:

- calculate the speed by dividing the distance travelled by the time by applying the formula $V = S/T$ and report it in the table.

With the use of mBlock the students:

- change the power according to that specified in the table and repeat the experiment several times;
- depending on the parameters provided by the teacher in the table, each time the teacher changes the motor power, the students experiment with the robot;
- calculate the distance travelled and record it in a table;
- calculate the speed and report the results in the table each time until the task is completed.

Stemie or Stemia is moving forwards			
The motor's power	Distance travelled, cm	Time, s	Speed, cm/s
100		2	
110			
120			
130			
140			
150			
160			
170			
180			
190			
200			
210			
220			

WHAT DOES THE TEACHER DO?

To complete the table, the teacher:

- proposes another task to be solved by encouraging reflection on what has already been done: “Is Stemie’s speed when it goes forwards the same as when it goes backwards?”.

The question creates a 'bridge' between the exercise just completed and the next proposal in the form of a 'challenging' task to stimulate and intrigue students. The aim is to have students test whether Stemie, going 'forwards' or 'backwards' crosses an identical path at the same speed, suggesting that it might be a little slower when reversed.

Then, the teacher asks the students to:

- try changing the block to be used and check whether the speed of Stemie or Stemia is also changing;
- measure and calculate the inverse speed of Stemie or Stemia remembering the students the blocks they learned in previous challenges. At this point, students should be able to write the simple program with a different block. The block needed is 'motorREVERSE';
- If this is not the case, the teacher encourages them first to try again and then to collaborate with peers to be helped to overcome any obstacles.



WHAT DOES THE TEACHER DO?

The teacher assigns the second task to the students. As in the previous exercise, provides them with a table: "Stemie or Stemia is going backwards".

The teacher invites students to:

- 2. write the results in the table.

If you haven't done it yet, click [HERE](#) to download the file with auxiliary grids, or read the QR-code.



The table is identical to the one provided for the previous activity. What changes in the engines are taken into consideration? This time the robot will have to go backwards.

The teacher asks students to:

- do the same operations as in the previous exercise
- record the results obtained in the provided table

WHAT DO THE STUDENTS DO?

The students calculate the speed by dividing the distance travelled by the time by applying the formula $V = S/T$ and writing it in the table.

With the use of mBlock the students:

- change the power according to that specified in the table and repeat the experiment several times;

- provide in the table by the teacher depending on the parameters: each time the teacher changes the motor power, the students experiment with the robot;
- calculate the distance travelled and record it in a table;
- calculate the speed and report the results in the table each time until the task is completed.

Stemie or Stemia is moving backwards			
The motor's power	Distance travelled, cm	Time, s	Speed, cm/s
100		2	
110			
120			
130			
140			
150			
160			
170			
180			
190			
200			
210			
220			

The teacher builds on the teaching proposal just presented to enrich the students' knowledge by exploring the concept of **speed**, which is, of course, different between a machine, a land animal, a sea animal, etc.

The teacher then provides the exact measurement of '**cosmic speed**' proceeding with several examples and specifying that:



You know that the car can go at different speeds. Its speed on the highway, depending on the country, can be 120 km/h or 130 km/h, and in the city 50 km/h. The fastest animal - a cheetah can run at 120km/h. The fastest fish is black marlin, which can sail at a speed of 132 km / h and even surpass a submarine. And one of the slowest animals, the sloght, can only travel at 0,186 m/h, and the turtle at 2,7 m/h. The cosmic speed required for the machine to rise from the ground and rotate around it is 7.9 km/s.

SELF-ASSESSMENT

At the end of the whole activity, the teacher proposes to the students to evaluate the experience and how they passed the third challenge.

WHAT DOES THE TEACHER DO?

The teacher:

- urges students to engage in a metacognitive process by asking them to self-assess themselves
- provides a 'form' and asks them to fill it in

If you haven't done it previously, click [HERE](#) to download the file with self-assessment forms, or read the QR-code.



- stimulates them to reflect on the path they have followed and on what they have learnt

- asks them to attribute a meaning to the experience they have had by promoting reflection on how it could be spent in real life
- gives feedback to each individual or group useful for improving their subsequent performance

WHAT DO THE STUDENTS DO?

The students complete the entries in the 'form' indicating:

- what knowledge they have learnt, in this case, “Calculate the speed of the robot” and “Program the robot to go forwards and backwards”
- how they tried out the experience;
- what they experienced and what the outcome of the operations performed was;
- the meaning they attach to the experience carried out by explaining its value in real life.

I can:	NOT YET	MORE OR LESS	YES, COMPLETELY
Calculate the speed of the robot			
Program the robot to go forwards and backwards			
Where can these ideas be applied in real word?			

CHALLENGE

4 Moving in orbits

GOALS: I can list the planets according to the distance from the Sun, size and program the robot to go in a circle and a shape of an athletic track.

Humans have always observed and studied the immensity of the sky to understand what are the Sun, the Moon, the visible points of light in the night, and the planets of the Solar System and to understand what position the Earth occupies inside...

LEARNING SCENARIO

The activity begins with a question posed as a stimulus to introduce the topic.

What do students already know about Space and the Solar System?

Do they know the distance of the planets from the Sun?

Stemie and Stemia's greatest dream is to travel through the Solar System; to do so, they must know the names of the eight planets that make it up and order them according to their distance from the Sun.



EUROPEAN KEY COMPETENCIES FOR LIFELONG LEARNING

Mathematical, science and technology and engineering competence

Digital competence

Personal, social and learning to learn competence

PREREQUISITES

A. CONTENTS:

The Solar System, planets and their dimensions

B. PROGRAMMING LANGUAGE

mBlock programming language

AIMS

A.1 name the planets

A.2 list the planets according to their distance from the Sun

A.3 know the dimensions of the planets

B.1 programming the robot to traverse a circle and the shape of an athletic track by formulating typical programming constructs

METHODOLOGIES

- Problem-Solving ⓘ
- Learning by doing ⓘ
- Project-Based Learning (PBL) ⓘ

EXPECTED TIME: 45 min.

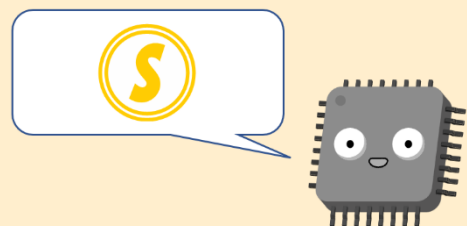
TARGET LEARNERS: 10-13 years old

RESOURCES AND TOOLS

- Pc, STEMIE
- Ruler
- Notebook
- Pens, pencils, erasers
- The table provided by the teacher
- Mobile phone

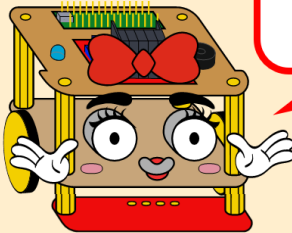
INTERDISCIPLINARY LINKS: Science, Maths, Engineering

1. To line up the planets in the order of the Sun's distance



The teacher starts the first topic of the challenge n.4 showing a comic book in which Stemia reflects and finds a way to remember the names of the three planets at the end of the list. She transforms the English name SUN (Sun) into an acronym that stands for S = Saturn, U = Uranus and N = Neptune. A way to stimulate students' visual and cognitive memory.

I know how to remember the order of the planets: Mercury, Venus, Earth, Mars, Jupiter and *SUN*.



SUN is Saturn, Uranus and Neptune. A great way to remember more easily.

This is how challenge no.4 starts.

WHAT DOES THE TEACHER DO?

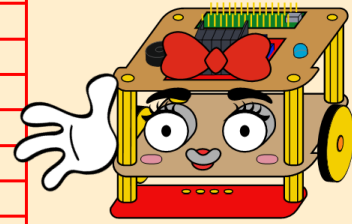
The teacher assigns the first task to the students. The teacher:

- asks the students to line up the planets Jupiter, Mars, Mercury, Neptune, Saturn, Uranus, Venus and the Earth neatly according to their distance from the Sun;
- provides the table to follow (fig.no.1)
- asks the students to fill it

Click [HERE](#) to download the file with auxiliary grids, or read the QR code.



SUN	
1	
2	
3	
4	
5	
6	
7	
8	
9	



The biggest distance										The smallest distance
----------------------------	--	--	--	--	--	--	--	--	--	-----------------------------

WHAT DO THE STUDENTS DO?

The students reflect on the teacher's request and the indications received to hypothesise how to proceed. They can digitally complete the form.

The students, with the use of the exercise book:

- draw on their previous knowledge of the names of the eight planets in the Solar System
- name them and try to order them according to their distance from the Sun
- if they are in doubt about certain answers, they discuss them in the small group and make decisions based on their choice
- fill in the table provided by the teacher according to what seems to be correct

The students, with the use of a mobile phone/PC:

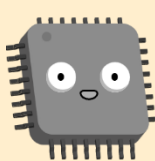
- can frame the QrCode or can click on “Here” to access LearningApps

Just scan the QR code or click [HERE](#)



- perform the required exercise

At the end of this first step, the teacher encourages an exchange of information between the students by promoting purposeful peer communication. How many managed to carry out the exercise correctly? How many did not? Why? What mistakes were made? Should they learn more about the planets and the Solar System? This encourages them to study the subject more to improve their subsequent performance. The students are led to reflect on how the experience went.



2. To know which is the biggest planet in the Solar System and line the planets from the biggest to the smallest.

WHAT DOES THE TEACHER DO?

The teacher:

- proceeds, facilitating the task for those who did not succeed in the previous exercise, by asking them if they know which is the biggest planet;

- suggests that if they know the biggest, they can line them up from the biggest to the smallest one;
- asks the students to place the planets from biggest to smallest in the correct order providing the table to follow;
- asks the students to fill it in an online exercise.

As in the previous exercise, the teacher:

- asks students to scan the QR code or click [HERE](#)



WHAT DO THE STUDENTS DO?

The students reflect on the teacher's request and the indications received to hypothesise how to proceed. Again, they can fill out the form in a digital way.

The students with the use of the exercise book:

- make use of their previous knowledge of the size of the eight planets in the Solar System and reflect on which planet is the biggest and which is the smallest
- name them and try to order them according to their size.

If they are in doubt about certain answers, the students discuss them in the small group and make decisions based on their choice.

The students, with the use of a mobile phone/PC:

- can frame the QrCode or can click on “Here” to access LearningApps
- perform the required exercise.

At this point of the challenge, the teacher tells students that Stemie and Stemia are always curious about the world around them and they love learning new things. To prepare for this journey, they studied astronomy, learning how planets orbit stars.

Now they know it takes a whole year for the Earth to rotate around its Sun. They also know that the orbits of the planets around the stars have the shape of an ellipse, which is almost a circle, with the star at the centre of the orbit. The same shape happens when a moon orbits a planet.

The invitation is to help Stemie and Stemia practice a circle so that they can rotate around the Moon.

The teacher concludes this topic by encouraging a moment of discussion within the small groups and then with the whole class. Students exchange information and verify the correct answers, reflecting on any mistakes made and why to improve their learning.

3. To write a program to make the robot move in circles.



At this point, Stemie and Stemia know that the planets orbit the Sun. The time it takes the Earth to complete one full revolution around the Sun is one year. Planetary orbits are ellipses with the Sun at the centre. Can Stemie and Stemia make one revolution around it?

WHAT DOES THE TEACHER DO?

The teacher, starting with the stimulus questions asks the students to write a programme to make the robot move circularly by helping the students. The blocks to be used are as follows:



WHAT DO THE STUDENTS DO?

The students reflect on the teacher's request.

With the use of mBlock, the students:

- write the suggested code using typical mBlock programming constructs "motorFRONT 1" and "motorFRONT 2" setting the speed of the first motor to 200 and the second motor to 120;
- check what happens by testing it;
- record the results in the notebook ;
- compare with peers.

WHAT DOES THE TEACHER DO?

The teacher asks to check what happens if the parameters are changed in the following way:



WHAT DO THE STUDENTS DO?

The students reflect on the teacher's request.

With the use of mBlock:

- change the parameters in the way indicated by the teacher;
- use constructs typical of mBlock programming: "motorFRONT 1" and "motorFRONT 2" setting the speed of the first motor to 120 and the second motor to 200;
- test the code and check what happens;
- record the results in the notebook;
- compare with peers.

4. To move the robot in a straight line and then in a circle, as in an athletic track.



Now the challenges become more and more complex!

The teacher proposes a new challenge to the students: can the robot rotate by riding in a straight line and a circle, like an athletic track?

WHAT DOES THE TEACHER DO?

The teacher:

- asks the students if the robot can rotate by making an ellipse;
- provides them with a diagram to help them move the robot in a straight and circular line;

The suggestion is to use the diagram provided because it can be a useful aid.

Stemie and Stemia are on the track!



The resulting code would be something similar to the following:

```
motorFRONT 1 120
motorFRONT 2 120
wait 4 secs
motorFRONT 1 120
motorFRONT 2 200
wait 2 secs
motorFRONT 1 120
motorFRONT 2 120
wait 4 secs
motorFRONT 1 120
motorFRONT 2 200
wait 2 secs
```



WHAT DO THE STUDENTS DO?

With the use of the scheme as a reference, the students:

- reflect on the teacher's request and indications received to hypothesise how to proceed;
- draw on their prior knowledge of the concept of 'circle' and 'the athletic track'.

With the use of mBlock, the students:

- formulate hypotheses for solving the problem;
- use constructs typical of mBlock programming;
- test the code and see what happens;
- if the programme does not carry out the operations correctly, they must be able to find the "bug", the error, and then "debug" it;
- reformulate the sequence of instructions by rewriting the code to test it again;
- if on their own, they cannot get it to work, they can ask their classmates or the teacher for help;
- if the programme carries out the operations correctly, they move on to the next request;

SELF-ASSESSMENT

At the end of the whole activity, the teacher proposes to the students to evaluate the experience and how they passed the fourth challenge.

WHAT DOES THE TEACHER DO?

The teacher:

- urges students to engage in a metacognitive process by asking them to self-assess themselves
- provides a 'form' and asks them to fill it in

If you haven't done it previously, click [HERE](#) to download the file with self-assessment forms, or read the QR code.



- stimulates them to reflect on the path they have followed and on what they have learnt
- asks them to attribute a meaning to the experience they have had by promoting reflection on how it could be spent in real life
- gives feedback to each individual or group useful for improving their subsequent performance

WHAT DO THE STUDENTS DO?

The students complete the entries in the 'form' indicating:

- what knowledge they have learnt;
- how they tried out the experience;
- what they experienced and what the outcome of the operations performed was;
- the meaning they attach to the experience carried out by explaining its value in real life

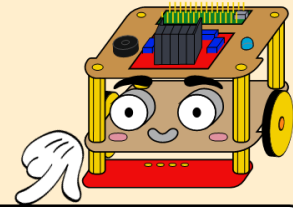


I can:	NOT YET	MORE OR LESS	YES, COMPLETELY
List the planets according to the distance from the Sun			
List the planets according to the size from the Sun			
Program the robot to go in a circle			
Program the robot to go in shape like an athletic track			
Where can these ideas be applied in real word?			

CHALLENGE



Making sounds



Please charge my batteries regularly
so I can work at my best.

GOALS: I can name what is needed to make a sound,
program the robot to play the music and measure
the volume.

Learning scenario

The teacher starts by telling the students that Stemie and Stemia have arrived on the Moon, Earth's only natural satellite. The robots are so excited that they decide to play some music.

EUROPEAN KEY COMPETENCIES FOR LIFELONG LEARNING

Mathematical, science and technology and engineering competence

Digital competence

Personal, social and learning to learn competence

PREREQUISITES

A. CONTENTS:

the moon and its characteristics; the Moon/Earth distance; the Moon's movement around Earth; conventional notation (notes, pentagram, ...).

B. PROGRAMMING LANGUAGE:

mBlock programming language.

AIMS

A.1 Knowing the characteristics of the Moon and its movements

A.2 Knowing the characteristics of sound and its propagation

A.3 Decoding and using traditional notation

B.1 State what is needed to produce sound with mBlock.

B.2 Program the robot to play music and measure the volume.

SPECIFIC VOCABULARY

Contents: Satellite, Moon, orbit, athletic track, sound, sound waves, intensity, volume, decibels, the musical scale, the pentagram...

mBlock Programming language: the blocks and actuator to produce music

METHODOLOGIES:

- Problem-Solving ⓘ
- Learning by doing ⓘ
- Project-Based Learning (PBL) ⓘ

EXPECTED TIME: 45 min.

TARGET LEARNERS: 10-13 years old

RESOURCES AND TOOLS:

- PC/Tablet/smartphone/LIM, Stemie
- Notebooks, music notebook, pencil, eraser, ...

INTERDISCIPLINARY LINKS: Maths, Technologies, Engineering

WHAT DOES THE TEACHER DO?

At the beginning of the lesson, the teacher tests their knowledge of the Moon by asking students to write on slips of paper all the words that can be related to it. After this brief introduction, the teacher explains that the Moon travels around the Earth along an elliptical orbit, so the distance from the Earth is not always the same. The teacher presents the activity to be done with Stemie and Stemia: they will have to program the robot to produce sounds and they will have to be able to measure volume.

Before getting to the heart of the challenge, the teacher advises the students to find information about the MOON and provides them with a link they can also access via QR code:

To read more about the Moon scan or look [HERE](#)





WHAT DO THE STUDENTS DO?

Via the devices at his disposal, the students:

- access resources provided by the teacher;
- acquire further and more detailed information about the **MOON**: from the etymology of the name to the observation of the Moon in history, to the objective characteristics of our satellite.

At the end of this preparatory phase, the teacher invites students to share the information they find most interesting and engaging, after which the teacher introduces the part of the lesson relating to sound and its propagation.

WHAT DOES THE TEACHER DO?

The teacher explains that all sounds are caused by mechanical environmental vibrations, even if they are not usually visible. To make this better understood, the teacher offers some practical examples:

- the sound of cars colliding is caused by the vibrations of their surfaces;
- the music of the radio receiver comes from the membrane of the loudspeaker;
- we speak and sing because the vocal cords vibrate in our larynx.

The lesson then focuses on sound waves and their propagation.

The teacher points out that:

- sound does not propagate in a vacuum;
- sound waves can only propagate in environments where particles are present: air, liquids, solids;

- the average speed of sound in air is 330 m/s;
- human audible sound ranges from 16 to 20000Hz, which means that between 16 and 20000 vibrations must occur in 1s to hear;
- not everyone hears the sound of 16 or 20000Hz.

To complete this part, the teacher asks the students to access the new content and provides them with the link and QR code where they can try out different sounds:



You can scan the QR code or click [HERE](#) and try different sounds.

WHAT DO THE STUDENTS DO?

The students:

- frame the QR code with their mobile phone or use a PC/tablet, copy and paste the link;
- read the suggested content.

At the end of this activity, after the usual circle time to share and argue, the teacher assigns the first exercise.

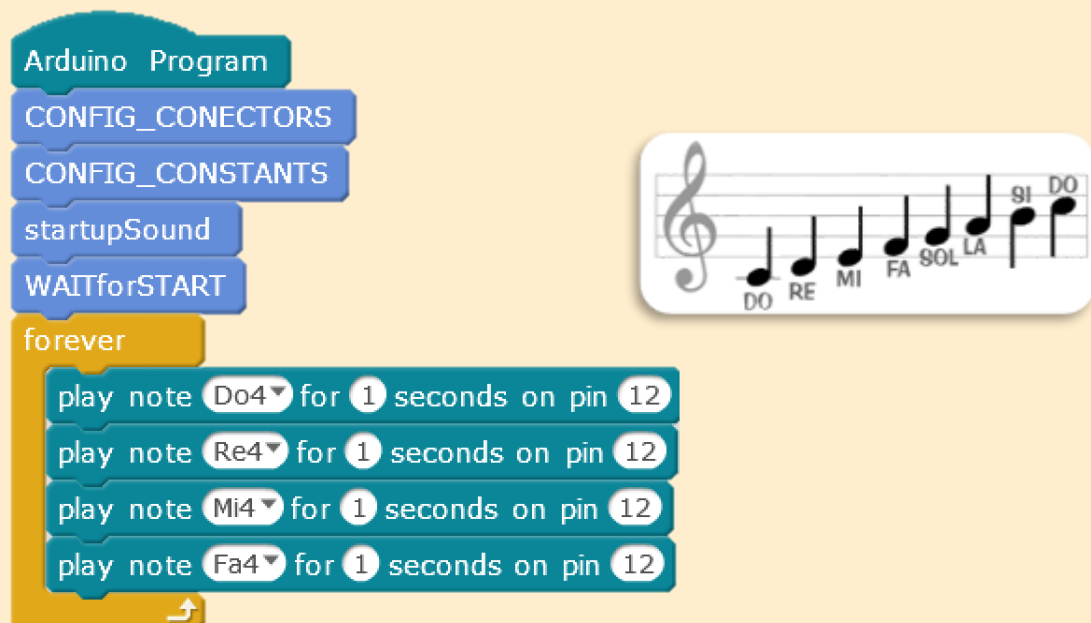
Do you know your robot can make a sound or play music? What does it take to play a scale? Try this and then complete it.



WHAT DOES THE TEACHER DO?

The teacher starts the activity by asking the students if they remember the basic elements of conventional notation and taking up some music objectives that are essential to perform what is required. Then, the teacher:

- reads the delivery together with the students;
- provides the block code to programme the robot to emit a melody.



WHAT DO THE STUDENTS DO?

The students:

- listen to the teacher's request and goes over the indicated music topics;
- dwell on the example shown and analyze the various blocks;
- use the mBlock play note programming blocks, inserting the suggested musical notes, time 0.3 seconds on pin 12;
- insert the wait block, at the end of a cycle of 8 musical notes, programming 0.4 seconds of wait time;
- test the code.

WHAT DOES THE TEACHER DO?

The teacher:

- asks the students if they have succeeded;
- invites the students to try again if the robot does not perform as requested.

At the end of this exercise, having verified the correct functioning of the robot and the entered code, the teacher moves on to the second activity.



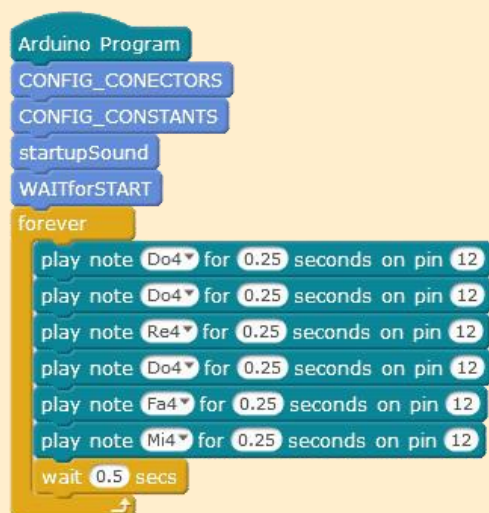
1. Now try to extend the following melody.

Maybe you know what song it is? You can change the tones and try to program it.

WHAT DOES THE TEACHER DO?

The teacher:

- asks the students if they recognised the programmed melody;
- invites them to expand the melody, change the tones and re-programme the robot;
- calls to their memory the pentagram and the writing of the notes on it;
- shows the image of the very short score of the melody;
- provides an example of the new code to be inserted.



WHAT DO THE STUDENTS DO?

The students:

- responds to the teacher's requests, indicating the title of the melody, if they have recognised it;
- reviews the seven musical notes and their position on the staff;
- analyses the blocks of the code provided as an example;
- uses the blocks of the mBlock play note programming, inserting the musical notes suggested, time 0.25 seconds on pin 12;
- inserts the wait block, at the end of a cycle of 6 musical notes, programming 0.5 seconds of wait time;
- tests the code.

WHAT DOES THE TEACHER DO?

The teacher checks with the students that the exercise has been carried out correctly; if not, the teacher suggests identifying the error and reprogramming the robot using the same code.

Having completed the review activity, the teacher continues his story and tells the students that Stemie and Stemia are discussing music in space. To expand

their knowledge, he encourages them to read interesting insights by accessing the link or QR code below:

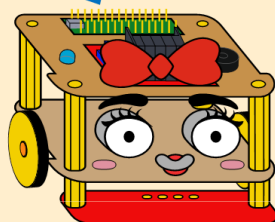
If you want to learn more about music in space, you can scan the QR code or click [HERE](#)



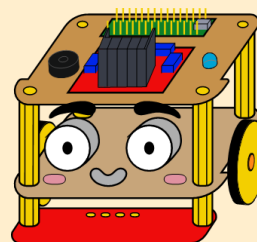
WHAT DO THE STUDENTS DO?

The students follow the teacher's instructions and access the content in the usual manner. At the end of the in-depth reading, a group discussion is initiated and the teacher, in an amusing manner, presents the students with this image of Stemie and Stemia, urging them to read the comics.

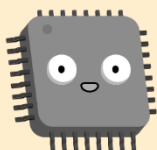
Have you heard? "Jingle Bells" became the first song played in space when, on 16 December 1965, it was broadcast during NASA's Gemini 6A space flight.



I do not understand how the music could sound in space if there is no air!



then proposes the third activity of the fifth challenge:

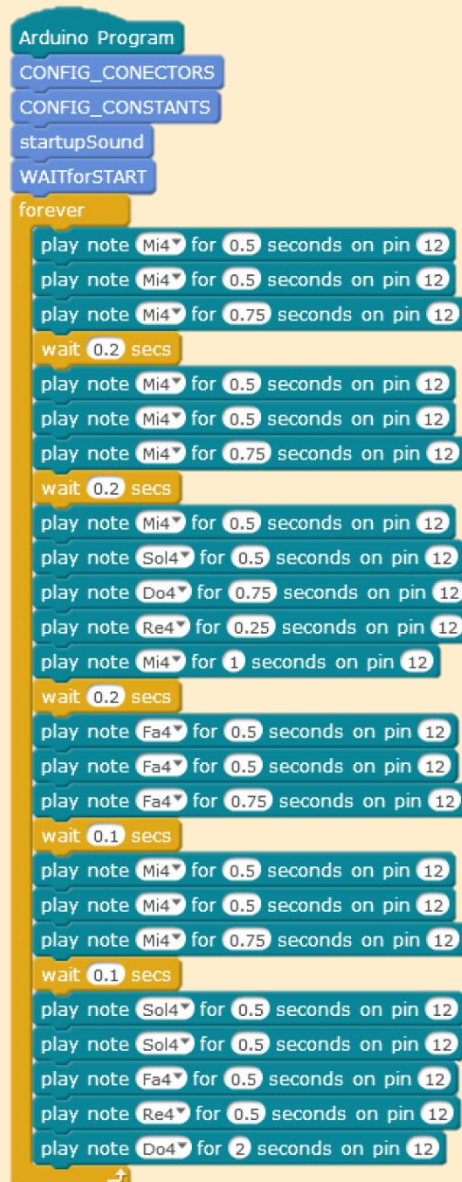


3. Why don't you try to write your favourite song? Search for the notes online and try making Stemie or Stemia play it.

WHAT DOES THE TEACHER DO?

The teacher:

- delivers the new code to programme the robot to play "Jingle Bells";
- reads the delivery and the code together with the students.



WHAT DO THE STUDENTS DO?

The students:

- analyse the blocks used carefully;
- follow the example and program the robot using the blocks and information contained there, carefully;
- verify the accuracy of the code.

Having also completed this activity and verified the accuracy of the robot's programming, the teacher proposes a final reflection on the intensity of sound and its unit of measurement.

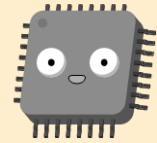
The teacher explains that sound intensity is measured in decibels. The range of sound intensity from hearing to pain threshold corresponds to a range of sound intensity from 0 to 130 dB. Normal human speech is 50-60 dB.

After this initial input, the teacher points out that Stemie and Stemia decided to measure the volume of their "Jingle Bells" singing.

At the end of the activities, the teacher asks students to watch the following video and do the last exercise.



3. Follow the instructions in the previous video and measure the volume of sound your robot emits.



WHAT DO THE STUDENTS DO?

The students:

- watch the video;
- measure the volume of sound the robot emits.

SELF-ASSESSMENT

At the end of the whole activity, the teacher proposes to the students to evaluate the experience and how they passed the fourth challenge.

WHAT DOES THE TEACHER DO?

The teacher:

- urges students to engage in a metacognitive process by asking them to self-assess themselves
- provides a 'form' and asks them to fill it in

If you haven't done it previously, click [HERE](#) to download the file with self-assessment forms, or read the QR code.



- stimulates them to reflect on the path they have followed and on what they have learnt

- asks them to attribute a meaning to the experience they have had by promoting reflection on how it could be spent in real life
- gives feedback to each individual or group useful for improving their subsequent performance

WHAT DO THE STUDENTS DO?

The students complete the entries in the 'form' indicating:

- what knowledge they have learnt;
- how they tried out the experience;
- what they experienced and what the outcome of the operations performed was;
- the meaning they attach to the experience carried out by explaining its value in real life.

I can:	NOT YET	MORE OR LESS	YES, COMPLETELY
Name what is needed to make a sound			
Program the robot to play the music			
Gauge the volume			
Where can these ideas be applied in real word?			

CHALLENGE

6 Flashing lights

GOALS: I can program the robot to turn on the lights in every colour of the rainbow.

Learning scenario

Stemie and Stemia continue their adventures on the Moon. Not to lose each other among cliffs and mountains, they decide to turn on their LED lights and communicate with each other using light signals. In this challenge, the students will learn how to program the robot to turn on the lights.

EUROPEAN KEY COMPETENCIES FOR LIFELONG LEARNING

Mathematical, science and technology and engineering competence

Digital competence

Personal, social and learning to learn competence

PREREQUISITES

A. CONTENTS

Concept of light, speed of light and propagation time of light

Colour spectrum and primary and secondary colours

Wavelength

Prohibitions signs

Concept of sound, speed of sound and propagation of sound

B. PROGRAMMING LANGUAGE

mBlock programming language

AIMS

A.1 acquire knowledge about the concept of light, speed and time of propagation

A.2 understand the distinction between luminous and illuminated bodies

A.3 discover the relationship between light and colours

A.4 calculate the distance between the Earth and the Sun

A.5 calculate how long light and sound take to travel this distance

A.6 acquire knowledge about the concept of sound, speed and time of propagation

B.1 program the robot to turn on the lights

SPECIFIC VOCABULARY

Contents:

Light, speed of light, time of light propagation



The average distance from Earth to the Sun

Colour spectrum: primary and secondary colours

Sound, speed of sound, time of the sound propagation

mBlock Programming language: LED lights, RGB colours

METHODOLOGIES:

- Problem-Solving ⓘ
- Learning by doing ⓘ
- Project-Based Learning (PBL) ⓘ

EXPECTED TIME: 45 min.

TARGET LEARNERS: 10-13 years old

RESOURCES AND TOOLS

- Pc, STEMIE
- notebook
- pens, pencils, erasers
- mobile phone
- link, QR code, charts

INTERDISCIPLINARY LINKS: Science, Technologies, Engineering, Maths

WHAT DOES THE TEACHER DO?

Before starting the first task, the teacher gives students some information.

“Light is emitted by many bodies: the Sun, stars, a light bulb or a candle.

However, we also see other objects: a table, a book, and the Moon... They are visible because the light reflected from them enters our eyes.

When the light bulb is turned on, the whole room is immediately illuminated.

In 1676, the Danish astronomer Ole Rømer, based on the duration of the hasten and delay of Jupiter's satellite, determined that light travels at a speed of 300,000 km/s. He did it perfectly, the exact value of the speed of light now determined is 299792458m/s. The speed of light is slightly reduced when travelling through various transparent environments”.

“In 1666, Newton managed to split light into a spectrum of seven colours: red, orange, yellow, green, cyan, blue and violet. Consequently, the white colour is composite”.

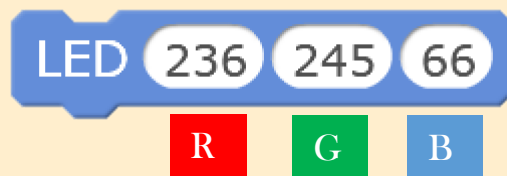
The teacher invites the students to scan the following QR code or click [HERE](#) to observe the model of Newton's experiment



Then, the teacher says that red, green and blue are the primary colours and by mixing them, other colours are obtained, as shown below and asks to scan the following QR code or click [HERE](#) to see an example of how it works



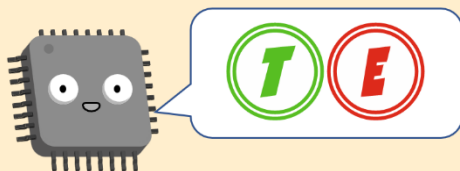
The teacher tells the students that if they want to turn on the LED in yellow of the robot, they must only use a block like the one below:



WHAT DO THE STUDENTS DO?

The students:

- acquire the information that the teacher provided them
- observe the model of Newton's experiment
- see an example of how it works
- know the primary colours
- try to mix the primary colours to see how to obtain other colours
- know the procedure to program the robot to turn LED with an example provided by the teacher

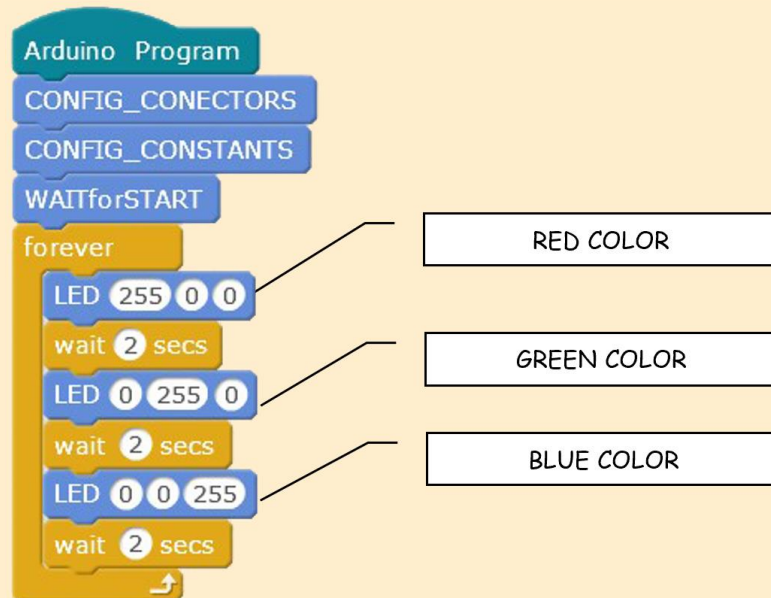


1. Try turning the robot's LED on.

The task that is required of students is to try to turn on the LEDs. To do so, they must write the program.

WHAT DOES THE TEACHER DO?

The teacher gives them an example of a code Block:



The teacher tells the students that if they want to create their colours they can scan the QR code beside or click [HERE](#) to find RGB colour codes



WHAT DO THE STUDENTS DO?

Using mBlock, the students:

- try to program the robot to turn LED with an example provided by the teacher
- know how to find RGB colour codes by linking the “RGB Color Codes Chart”

2. Write a program for all the colours of the rainbow.

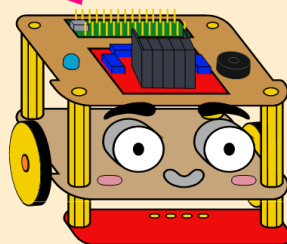
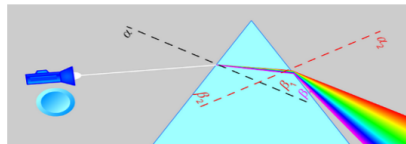


WHAT DOES THE TEACHER DO?

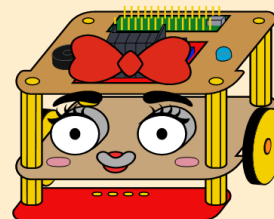
The teacher asks the student to write a program for all the colours of the rainbow, suggesting that RGB colour codes are encoded with numbers from 0 to 255.

Then, the teacher introduces the comic below between Stemie and Stemia providing some information

Do you know why the red colour is at the top?



Oh yes! Red is the fastest and has the longest wavelength. It is least absorbed by air, dust, and water. Therefore, we use it for prohibition signs.



WHAT DO THE STUDENTS DO?

The students reflect on the teacher's request and the indications received to hypothesize how to proceed.



The students, with the use of the exercise book:

- read the comic between Stemie and Stemia and know that red is the fastest and has the longest wavelength. It is least absorbed by air, dust, and water.
- make use of their prior knowledge of light, colour, sound and wavelength and prohibition signals in which the colour red is usually used
- identify contents for which they don't feel prepared and for which they must carry out personal study and research
- discern primary colours from secondary colours by trying to combine them according to the **RGB** codes provided by the teacher
- if they are in doubt about certain answers, they discuss them in small groups and make decisions based on their choice

With the use of mBlock

- use constructs typical of mBlock programming
- write a program and test it to see what happens
- if the programme does not perform its operations correctly, they must be able to find the 'bug', the error, and then 'debug' it
- reformulate the sequence of instructions by rewriting the code to test it again
- if on their own, they cannot get it to work, they can ask their classmates or the teacher for help
- if the programme carries out the operations correctly, they move on to the next request

3. Calculate how long light and sound take to travel this distance (if there is air).



WHAT DOES THE TEACHER DO?

The teacher provides students with information as follows:

- the average distance from Earth to the Sun is $1 \text{ av} = 149,597,870$
- the average speed of light is $300\,000\,000 \text{ m/s}$
- sound does not propagate in a vacuum;
- sound can only propagate in environments where air, liquids, and solids are present
- the average speed of sound is 330 m/s
- the time is calculated according to the formula $t=s/v$ (t- time; s- distance; v-speed)
- time of light propagation is $t=149597870000/300000000 \cong 498 \text{ s} \cong 8,3 \text{ min}$
- time of the sound propagation $t=149597870000/330 \cong 453\,326\,878 \text{ s} \cong 755448 \text{ min} \cong 125924 \text{ h} \cong 5247 \text{ twenty-four hours} \cong 14.37 \text{ years}$

In this task and given the previous information, the teacher asks the students to:
calculate how long light and sound take to travel this distance if there is air.

WHAT DO THE STUDENTS DO?

The students:

- acquire the information that the teacher provided them

- reflect on the teacher's request and the indications received to hypothesise how to proceed
- according to the formula $t=s/v$ (t- time; s- distance; v-speed), students calculate how long light and sound take to travel from Earth to the Sun using the speed of light and the speed of sound and considering once the time of light propagation once the time of the sound propagation
- ask the teacher for clarification if they have doubts
- perform the calculation and compare it with peers

At the end of this last step, the teacher encourages an exchange of information between the students by promoting purposeful peer communication. How many managed to carry out the exercise correctly? How many did not? Why? What mistakes were made? Should they learn more about light, sound, and wavelength? This encourages them to study the subject more to improve their subsequent performance. The students are led to reflect on how the experience went.

SELF-ASSESSMENT

At the end of the whole activity, the teacher proposes to the students to evaluate the experience and how they have passed the sixth challenge.

WHAT DOES THE TEACHER DO?

The teacher:

- urges students to engage in a metacognitive process by asking them to self-assess themselves

- provides a 'form' and asks them to fill it in

If you haven't done it previously, click [HERE](#) to download the file with self-assessment forms, or read the QR code.



- stimulates them to reflect on the path they have followed and on what they have learnt
- asks them to attribute a meaning to the experience they have had by promoting reflection on how it could be spent in real life
- gives feedback to each individual or group useful for improving their subsequent performance

WHAT DO THE STUDENTS DO?

The students complete the entries in the 'form' indicating:

- what have they learned, in this case, information on light and colours, and how to “Program the robot to turn on the light in every colour of the rainbow”
- how they tried out the experience;
- what they experienced and what the outcome of the operations performed was;
- the meaning they attach to the experience carried out by explaining its value in real life

I can:	NOT YET	MORE OR LESS	YES, COMPLETELY
Program the robot to turn on the light in every colour of the rainbow			
Where can these ideas be applied in real word?			

CHALLENGE

7 Creating Sequences and Loops

GOALS: I can name the highest mountain on Mars and program the robot to go in a square and a rectangle.

The challenges continue... we have reached the seventh mission and our robots have finally arrived on Mars.

Learning scenario

The teacher introduces the new learning scenario showing some characteristics of Mars. The planet has morphological similarities with Earth. On its surface, different reliefs make a planet similar to ours. It's in this context that Stemie and Stemia will set out on their exploration of the red planet.

EUROPEAN KEY COMPETENCIES FOR LIFELONG LEARNING

Mathematical, science and technology and engineering competence

Digital competence

Personal, social and learning to learn competence

PREREQUISITES

A. CONTENTS:

Mars and its reliefs

Olympus Mons: height and diameter

B. PROGRAMMING LANGUAGE

go straight and backwards

turn left, right 90°

go in a square/rectangle

create sequences and loops

AIMS

A.1 name the highest mountain on Mars

A.2 know the height and diameter of Olympus Mons

A.2 apply prior knowledge in practical exercises

B.1 program the robot to go straight and backwards

B.2 program the robot to turn 90 degrees on the left/right

B.3 program the robot to go in a square/rectangle

B.4 create sequences and loops

SPECIFIC VOCABULARY

Contents: Square, rectangle, angle, straight and backwards, turn left, turn right



mBlock Programming language: sequences and loops,
motorFRONT/motorREVERSE, motorSTOP

METHODOLOGIES:

- Problem-Solving ⓘ
- Learning by doing ⓘ
- Project-Based Learning (PBL) ⓘ

EXPECTED TIME: 45 minutes

TARGET LEARNERS: 10-13 years old

RESOURCES AND TOOLS

- Pc, STEMIE
- Squared notebook, pens, pencils, erasers, ruler
- Slideshow: photo with Olympus Mons and Portugal physical map
- Science textbooks, astronomical geography
- Google texts and images

INTERDISCIPLINARY LINKS: Science, Maths, Engineering

WHAT DOES THE TEACHER DO?

Before starting the activity, the teacher introduces Mars to the students by providing some specific information about the red planet. After their adventures on the Moon, Stemie and Stemia board their spaceship so they can finally reach Mars. The surface of Mars has a great morphological variety: there are mountains, valleys, craters, basins and volcanoes. It is thought that of all the planets, Mars is the one whose interior cooled the slowest and this allowed surface structures to form until very recent times.

Among the many mountains on Mars, there is one, the highest, which has been named Olympus Mons. It's 25 km high and its diameter measures 624 km.

To give more concreteness to what he is presenting, the teacher shows photographs of Mars and Olympus Mons on the whiteboard (figure 1-2).

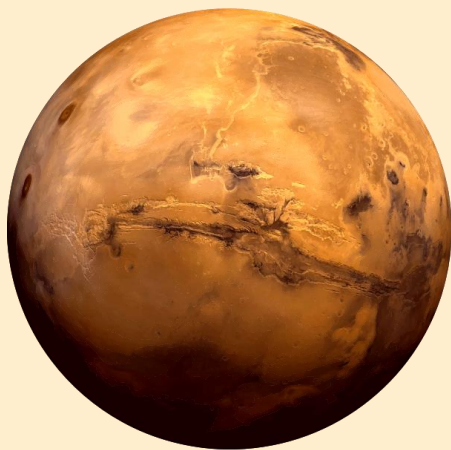


Figure n.1

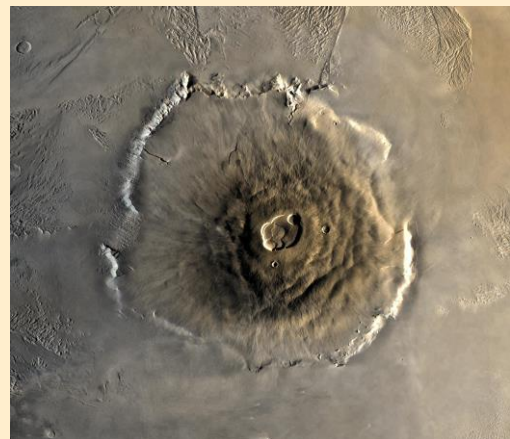


Figure n.2

Once there, they become very excited to see the highest known mountain in our Solar System.

To make the students think, the teacher continues by saying that if we define a square within this mountain to the edge of its circumference, the square's diagonal would be equal to the volcano's diameter – 624 km – with four equal sides, each being about 441 km.

Stemie and Stemia wonder how long will it take to make it around this giant mountain.

To make the quantitative data referring to the height and diameter of Mount Olympus more concrete for the students, the teacher also gives an example referring to the size of Portugal and, in particular, its extension from North to South. To do this, he shows another image on the interactive whiteboard, dwelling on the fact that it is certainly difficult for everyone to imagine 624 km, but we can make a comparison with the length of Portugal from North to South, which is 578 km, as can be seen in the proposed image (figure 3).



Figure n.3

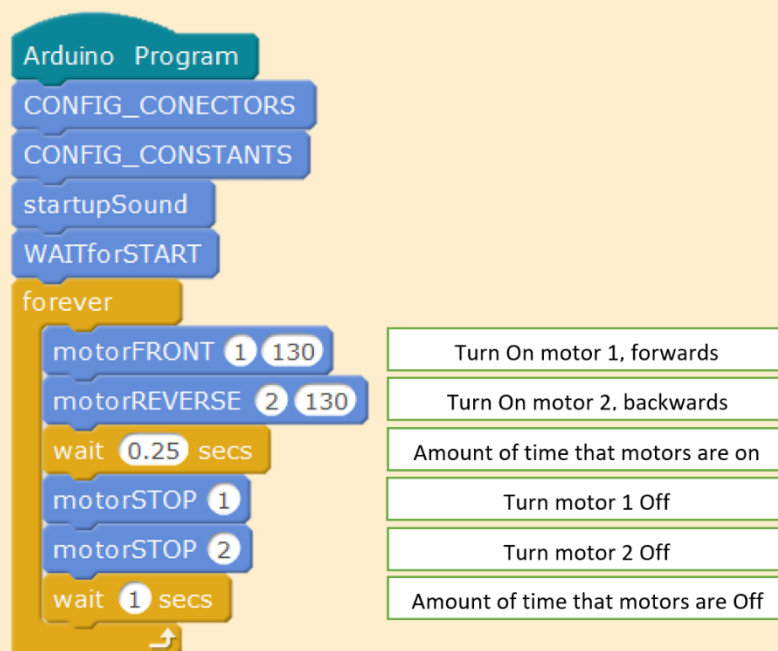
1. Write a sequence of commands to make the robot turn 90 degrees.



WHAT DOES THE TEACHER DO?

The teacher asks the students to write a sequence of commands to make the robot turn 90 degrees

The block code will be as follows:



To check whether the robot runs correctly and thus that the code is written without errors, the teacher:

- suggests that students take an A4 sheet of paper and place the robot on it, start the programme and see what happens. The purpose of this practical exercise will be to get students to think more about this



operation. It will be up to the teacher to lead the students to the following conclusions:

- if the turn is too small, the turn time or speed will have to be increased
- if the turn is too big, it will have to be reduced

WHAT DO THE STUDENTS DO?

The students reflect on the teacher's request and the indications received to hypothesise how to proceed.

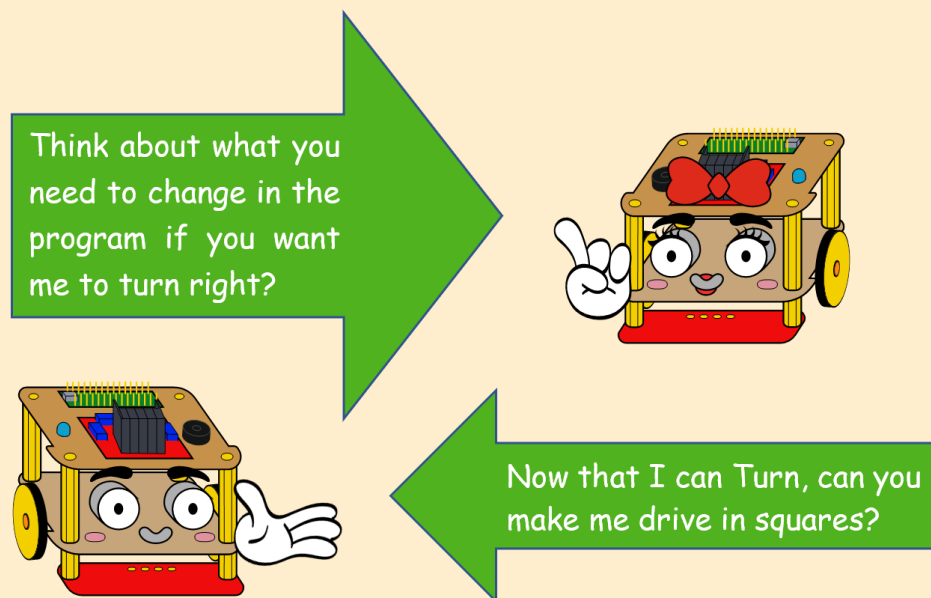
With the use of mBlock the students:

- formulate hypotheses for solving the problem
- use constructs typical of mBlock programming: motorFRONT and motorREVERSE, set the speed to 130 and insert a wait of 0.25 secs, then the motors must stop. To do this they use the motorSTOP block; another wait of 1 sec. This 1 sec allows the student to check if the robot is turning 90 degrees. The entire code must be inserted in a cyclic block 'forever'.

Using the A4 sheet of paper and the robot, the students:

- test the code and see what happens: if the curve is too small, they will need to increase the turn time or speed; if the curve is too big, they will need to reduce it;
- if the programme does not perform its operations correctly, they must be able to find the 'bug', the error, and then 'debug' it

Stemie and Stemia will urge the students to further develop their programs in the comics shown by the teacher.



With the use of mBlock, the students:

- reformulate the sequence of instructions by rewriting the code to test it again
- if on their own, they cannot get it to work, they can ask their classmates or the teacher for help
- if the programme carries out the operations correctly, they move on to the next request

2. Write a sequence of commands so that the robot goes straight for a moment and then turns 90 degrees.

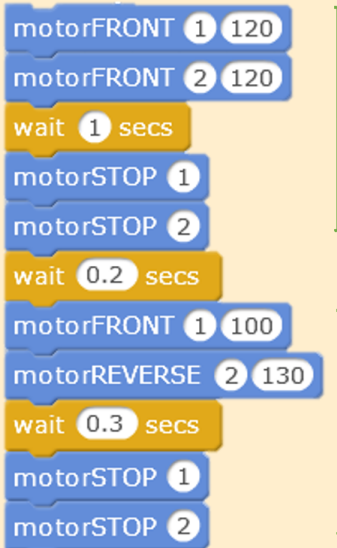


WHAT DOES THE TEACHER DO?

The teacher asks the students to:

- move forwards for 1 second and don't forget to use the motor speeds that they discovered on Challenge 1;
- turn 90 degrees to the left and don't forget to use the time and speeds that they discovered in the previous problem.

So, the teacher provides the mBlock code



The code consists of two main sections. The first section, 'Moving forwards for 1 second', includes: motorFRONT 1 120, motorFRONT 2 120, wait 1 secs, motorSTOP 1, and motorSTOP 2. The second section, 'Turning 90 degrees to the left', includes: wait 0.2 secs, motorFRONT 1 100, motorREVERSE 2 130, wait 0.3 secs, motorSTOP 1, and motorSTOP 2. Brackets on the right group the blocks into these two sections, each with a text box explaining the action and reminding the user to use previously discovered speeds and times.

```
motorFRONT 1 120
motorFRONT 2 120
wait 1 secs
motorSTOP 1
motorSTOP 2
wait 0.2 secs
motorFRONT 1 100
motorREVERSE 2 130
wait 0.3 secs
motorSTOP 1
motorSTOP 2
```

Moving forwards for 1 second.
Don't forget to use the motor speeds you discovered on Challenge 1

Turning 90 degrees to the left.
Don't forget to use the time and speeds that you discovered in the previous problem.

WHAT DO THE STUDENTS DO?

The students reflect on the teacher's request and the indications received to hypothesise how to proceed.

With the use of mBlock, the students:

- formulate hypotheses for solving the problem
- use constructs typical of mBlock programming: motorFRONT 1/motorFRONT 2 set the speed to 120 and insert a wait of 1 sec. To do

this they use the motorSTOP 1/2 block; both the motors must stop; another wait of 0,2 secs.; then motorFRONT 1 sets the speed of motor 100 and motorREVERSE 2 sets the speed of motor 130 and inserts a wait of 0.3 secs. To do this they use the motorSTOP 1/2 block; both the motors must stop.

- test the code and see what happens: they must make use of their previous knowledge and the advice of the teacher not to avoid mistakes
- if the programme does not perform its operations correctly, they must be able to find the 'bug', the error, and then 'debug' it



3. Improve the above sequence so that the robot's path describes a perfect square. Repeat this sequence 4 times.

WHAT DOES THE TEACHER DO?

The robot has to go around Olympus Mons. The teacher asks students to:

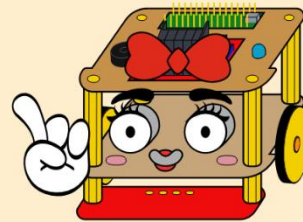
- make use of their previous knowledge to define a perfect square repeating the sequence 4 times
- remember that this repeating sequence is a “loop”

The teacher provides and explains the mBlock code

In addition, the teacher explains that **a sequence of commands used to perform a certain task can also be called a program.**



Repeat 4 times? Hum..
Ah.. of course.. a Square has 4
equal sides.
So, that's what **Loops** are for!



WHAT DO THE STUDENTS DO?

The students:

- reflect on the delivery received
- elaborate operational hypotheses by drawing on their prior/acquired knowledge of programming code
- write the programme using constructs typical of mBlock programming:
- motorFRONT 1 and motorFRONT 2 with the same motor power at 120, a wait of 1 sec. and motorSTOP 1 and motorSTOP 2 to stop both motors, finally a wait of 0.2 sec. allow the robot to move forward and trace one side of the square; motorFRONT 1 with motor power 100 and motorREVERSE 2 with motor power 130, a wait of 0.3 sec. allow the robot to turn 90° and with motorSTOP 1 and motorSTOP 2 the motors stop. The operation will have to be repeated four times, as many times as the sides of the square, so the entire code will have to be entered in a cyclic 'repeat' block with setting 4.

- test the code by verifying the path described by the robot: if it works, they go further; if it detects errors, they debug and try again;
- ask peers for support if they cannot figure out how to solve the problem;
- ask for support from the teacher "facilitator" of the route who helps them to reflect on where they went wrong and how to solve it.

WHAT DOES THE TEACHER DO?

At the end of this topic, the teacher provides students with further information to continue. The teacher asks students:

- if they have heard that Mars is famous for the Mariners' Canyon
- if they know what it is

WHAT DO THE STUDENTS DO?

The students:

- reflect on the delivery received
- elaborate their answers

WHAT DOES THE TEACHER DO?

The teacher:

- listens to the student's answers and says that Stemie and Stemia do not stop surprising each other with their knowledge of Mars's surface.

With the support of comics, the teacher:

- adds to that Mariners' canyon on Mars stretches for about 4 thousand km. The width of the canyon reaches 200 km and 10km in depth.

4. Calculate the area of the rectangle when the robot has to go around Mariner Canyon. Program the robot to go in a rectangle with Sequences and Loops.



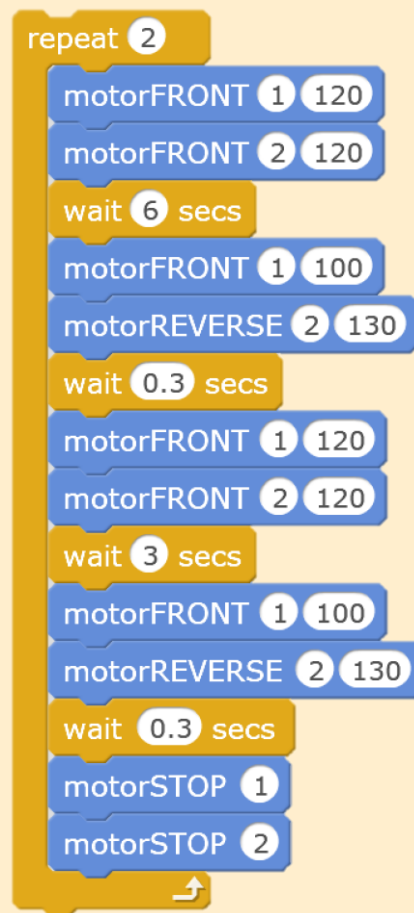
WHAT DOES THE TEACHER DO?

The teacher intends to gradually increase the difficulty of the proposed activities by stimulating logical and computational thinking. This time, the area of the rectangle will be investigated. Asking students to imagine that Stemie and Stemia should describe a rectangle around the Canyon of the Sailors, the teacher proposes to the students to:

- calculate the area of the rectangle to be described by the robot around Mariner Canyon
- improve the programme so that the robot can describe a rectangle around the Mariners Canyon
- reminds students that a rectangle does not have 4 equal sides like a square and that the formula to calculate the area of a rectangle is:

$$S = a \cdot b$$

An example of a program to make Stemie describe a rectangle is maybe the one below. Notice the 2 repetitions, as a rectangle has 2 sets of equal sides.



WHAT DO THE STUDENTS DO?

With the use of the exercise book, the students:

- elaborate hypotheses to fulfil the required delivery
- find the data needed to calculate the area of the rectangle described around Mariner Canyon,
- perform the calculation and compare it with peers
- ask the teacher for clarification if they have doubts

With the use of mBlock, the students:

- elaborate operational hypotheses by drawing on their prior/acquired knowledge of programming code
- write the program using constructs typical of mBlock programming:

SELF-ASSESSMENT

At the end of the whole activity, the teacher proposes to the students to evaluate the experience and how they passed the seventh challenge.

WHAT DOES THE TEACHER DO?

- urges students to engage in a metacognitive process by asking them to self-assess themselves
- provides a 'form' and asks them to fill it in

If you haven't done it previously, click [HERE](#) to download the file with self-assessment forms, or read the QR code.



- stimulates them to reflect on the path they have followed and on what they have learnt
- asks them to attribute a meaning to the experience they have had by promoting reflection on how it could be spent in real life
- gives feedback to each individual or group useful for improving their subsequent performance

WHAT DO THE STUDENTS DO?

The students complete the entries in the 'form' indicating:

- what knowledge they have learnt
- how they tried out the experience

- what they experienced and what the outcome of the operations performed was
- the meaning they attach to the experience carried out by explaining its value in real life

I can:	NOT YET	MORE OR LESS	YES, COMPLETELY
Name the highest mountain on Mars			
Program the robot to go in a square			
Program the robot to go in a rectangle			
Where can these ideas be applied in real word?			

CHALLENGE



8 Organizing thoughts

GOAL: I can program the robot using procedures.

Here we come to the eighth challenge! Stemie and Stemia's journey continues.

Learning scenario

The teacher introduces the lesson by explaining that At knows that the operation of the rocket is based on inertia. Liquid hydrogen and oxygen tanks are installed in the rocket body. Hydrogen is the fuel component and oxygen is the oxidizer. When these substances are injected into the combustion chamber, they ignite and the resulting fuel passes through the nozzle in a jet. The reaction force is directed in the opposite direction. Under the influence of this force, the rocket rises. When some of the fuel is exhausted, the canister containing it separates from the rocket, thus giving additional speed and reducing mass. These rockets are called multistage.

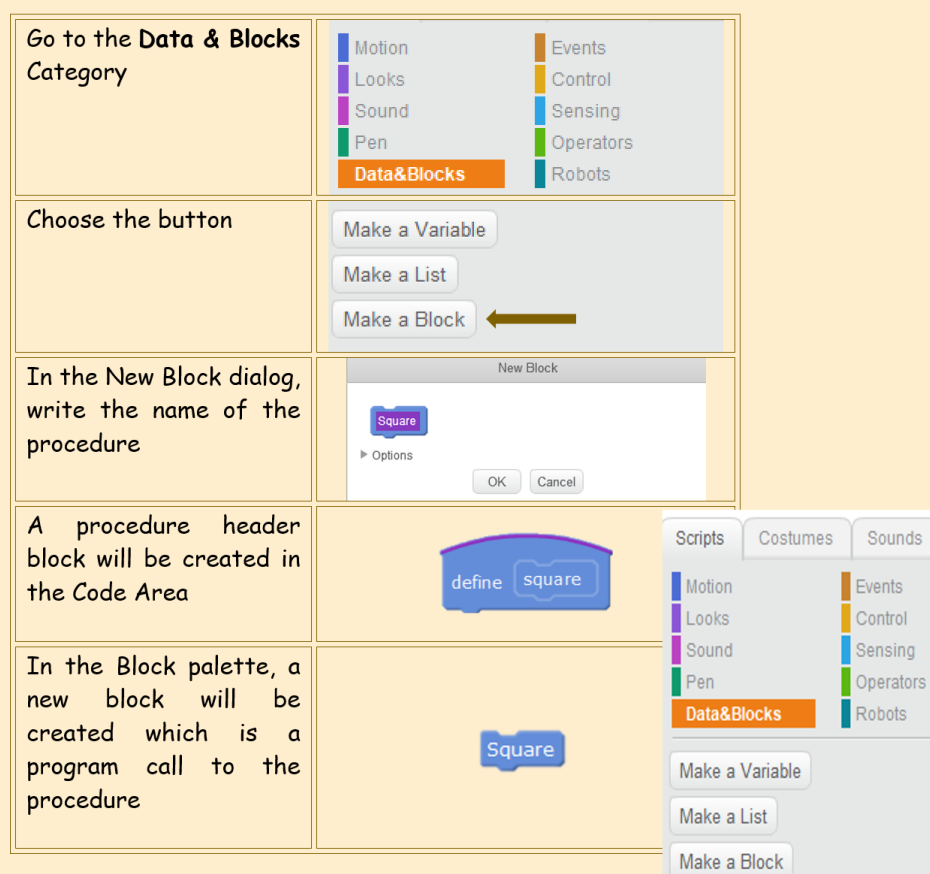
To aid understanding, the lecturer provides students with a link where they can see the separation phases of a space rocket.

You can see how it looks [HERE](#) or scan the QR code.



The teacher explains that rocket operation is based on the division of large work into smaller ones. When programming, if you create large programs, some problems may arise: the text becomes confusing; it is difficult to remember variables; there are many repetitive actions; etc. There is only one solution - to divide the program into independent code modules that complete specific tasks called Procedures.

To better explain the concept, the teacher gives the students the following diagram/ procedure:



A discussion and sharing phase follows, and then the teacher presents the activity to be carried out.



EUROPEAN KEY COMPETENCIES FOR LIFELONG LEARNING

Mathematical, science and technology and engineering competence

Digital competence

Personal, social and learning to learn competence

PREREQUISITES

A. CONTENTS:

Inertia and Reaction force

Basic elements of Chemistry: hydrogen, oxygen, combustion

B. PROGRAMMING LANGUAGE

mBlock programming language

AIMS

A.1 Know the concept of the inertia of bodies

A.2 Know the main characteristics of some elements in chemistry: hydrogen and oxygen

A.3 Know what combustion is

A.4 Know the main combustible materials

B.1 Indicate what is needed to perform a square path with mBlock

B.2 Program the robot using the necessary procedures.

B.3 Know and use the 'function call' to create a subroutine.



SPECIFIC VOCABULARY

Hydrogen, oxygen, fuel, oxidant, combustion, inertia, function call, procedure

METHODOLOGY:

- Problem-Solving ⓘ
- Learning by doing ⓘ
- Project-Based Learning (PBL) ⓘ

EXPECTED TIME: 45 min.

TARGET LEARNERS: 10-13 years old

RESOURCES AND TOOLS

- PC/Tablet/smartphone, STEMIE
- Notebook, pencil, eraser, ...

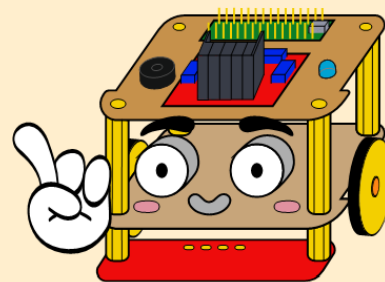
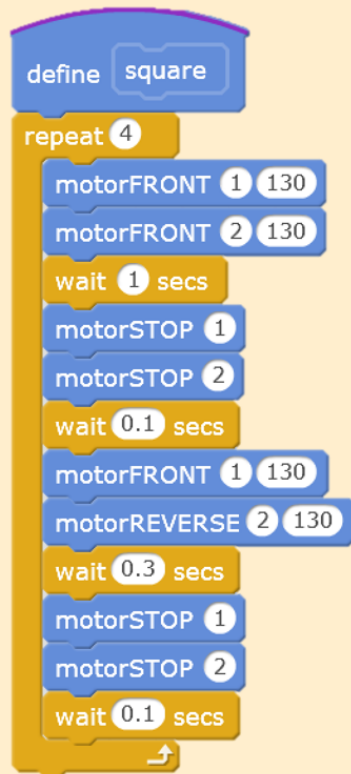
INTERDISCIPLINARY LINKS: Maths, Technologies, Engineering

WHAT DOES THE TEACHER DO?

The Teacher

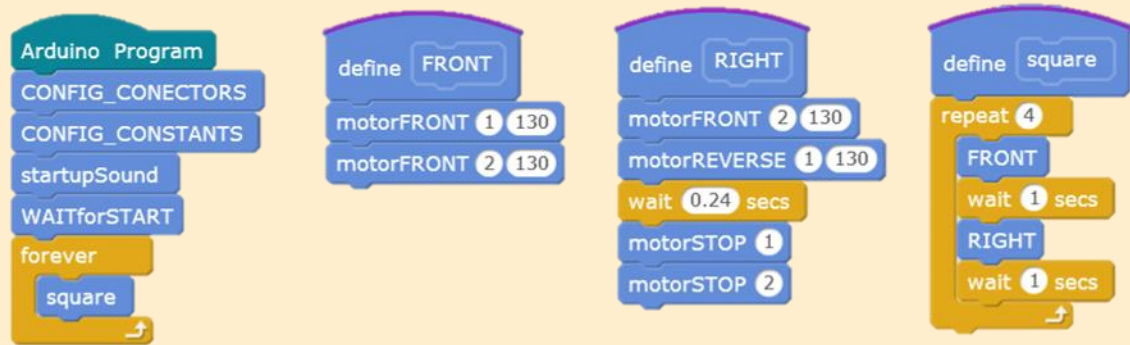
- Starts the first activity by asking the students if they think they can program the robot to perform a square path;
- explains what a function call is;

- hands out these two examples;
- invites the students to reflect on and analyse the blocks used

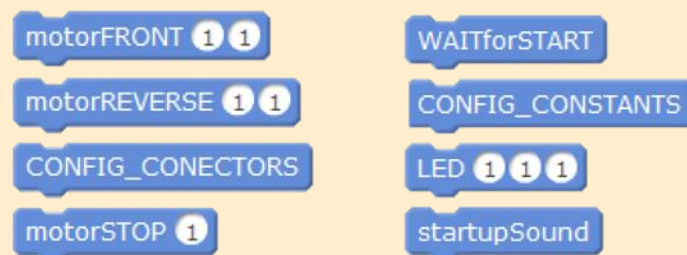


To complete the information, the teacher clarifies **that block names cannot contain spaces**. For example, it is not possible to create a block named SQUARE 1 and another named SQUARE 2 (with the space between the name and number). Instead, it is possible to create SQUARE_1 and SQUARE_2, without the space character.

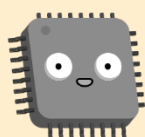
It is possible to write in an even simpler way, just by using, more procedures and writing shorter main code.



The teacher suggests that students take a look at their Stemie project, as there are some procedures already created and some already used:



Having completed the necessary frontal lecture, the teacher presents in an entertaining way and with the help of Stemie and Stemia a bit of rocket history, then presents two exercises.



1. Stemia and Stemie are on Mars and want to go around the canyon and Olympus Mons. Remember what shapes they need to be able to get around? Write a program for their journey using procedures.

2. Can you organize all blocks that you have made until now? For example... music

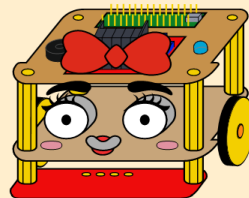
blocks can be placed under a procedure named

HappyBirthday; blocks that make your robot turn left, should be under a procedure called TURN_LEFT, and so on...

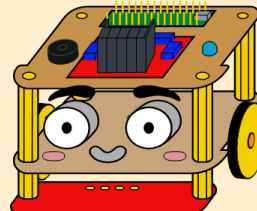


At the end of the activities, the teacher offers a short dialogue between Stemie and Stemia:

I heard that the first rockets were invented by the ancient Chinese. In the 10th century they were used to launch metal-tipped arrows from a bow.



And I heard that in the 17th century Lithuanian scientist Kazimieras Semenavičius was the first to put forward the idea of a multistage rocket and rocket artillery.



WHAT DO THE STUDENTS DO?

The students

- Read the task carefully;
- review the notes, examples and all the material in their possession;
- begin to write down possible solutions in a notebook, taking into account the teacher's suggestions during the lesson;
- deepen autonomously the contents in which they feel less prepared;

- discuss with classmates or the teacher in case of doubts.

The students, **with the use of a mobile phone/pc/tablet access in-depth content** proposed by the teacher and **with the use of mBlock**:

- use constructs typical of mBlock programming;
- analyse the codes presented during the various lessons;
- choose those needed to complete the exercises;
- prepare the code and tests it to see what happens;
- if the programme does not perform the operations correctly, try to find the error and correct it;
- ask his classmates or the teacher for help if he cannot find the bug;
- reformulate the sequence of instructions by rewriting the code to test it again.

At the end of the activities, the teacher promotes a moment of discussion and reflection among the students and with the students. Did they have difficulties performing the exercises? If so, which ones? Were they able to identify useful codes among those proposed by the teacher in the various lessons? Do they need to expand on any topics?

SELF-ASSESSMENT

At the end of the whole activity, the teacher proposes to the students to evaluate the experience and how they passed the fourth challenge.

WHAT DOES THE TEACHER DO?

The teacher

- urges students to engage in a metacognitive process by asking them to self-assess themselves
- provides a 'form' and asks them to fill it in

If you haven't done it previously, click [HERE](#) to download the file with self-assessment forms, or read the QR code.



- stimulates them to reflect on the path they have followed and on what they have learnt
- asks them to attribute a meaning to the experience they have had by promoting reflection on how it could be spent in real life
- gives feedback to each individual or group useful for improving their subsequent performance

WHAT DO THE STUDENTS DO?

They complete the entries in the 'form' indicating:

- what knowledge they have learned;
- how he/she tried out the experience;
- what he experienced and what the outcome of the operations performed was;
- the meaning he/she attaches to the experience carried out by explaining its value in real life

I can:	NOT YET	MORE OR LESS	YES, COMPLETELY
Program the robot using procedures			
Where can these ideas be applied in real word?			

CHALLENGE



9 Following trajectories

GOAL: I can program the robot to follow a line.

THE CHALLENGE

Here we are at the ninth mission...

Learning scenario

The teacher is ready to present a new scenario... the exploration on Mars continues among the canyon systems on the Martian soil... a true wonder!

EUROPEAN KEY COMPETENCIES FOR LIFELONG LEARNING

Mathematical, science and technology and engineering competence

Digital competence

Personal, social and learning to learn competence

PREREQUISITES

A. CONTENTS:

Mars and parallel canyons

Mariner Canyon

B. PROGRAMMING LANGUAGE

Programming the robot using sensors

AIMS

A.1 Get to know Mariner Canyon

B.1 Program the robot to follow the line

SPECIFIC VOCABULARY

Contents: Solar System, Mars, Mariner Valley, Mariner Canyon

mBlock Programming language:

- InfraRed sensors, PIN line left/line middle/line right
- other procedures and the main program

METHODOLOGIES:

- Problem-Solving ⓘ
- Learning by doing ⓘ
- Project-Based Learning (PBL) ⓘ

TIME: 45 minutes

TARGET LEARNERS: 10-13 years old

RESOURCES AND TOOLS :

- Pc, STEMIE
- A3 paper format
- Black sticky tape
- Slides (photo with Mariner Canyon)
- Video links provided by the teacher
- Textbooks on science, astronomical geography
- Texts and images from internet searches
- Videos and documentaries from internet searches

INTERDISCIPLINARY LINKS: Science, Technologies, Engineering

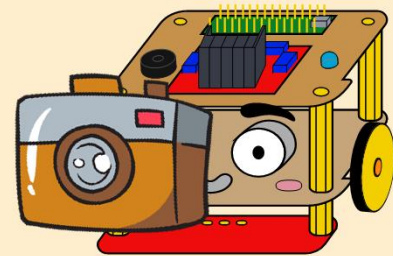
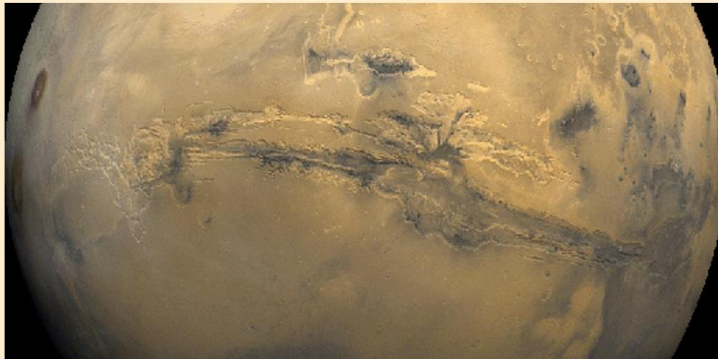
WHAT DOES THE TEACHER DO?

Before starting the lesson, the teacher **provides students with other information on Mars.**

Mars is the closest planet to Earth in terms of living conditions. And not only the Olympus Mons is famous, but also the Mariner Valley, a system of canyons parallel to the Martian equator that extends for about 4,000 km. Mariner Valley is much larger than the canyons on the Earth and is the largest known similar formation in the Solar System. Mariner Valley was discovered by the Mariner 9 spacecraft in 1972.

To know more about the Mariner Canyon scan the QR code
or click [HERE](#)

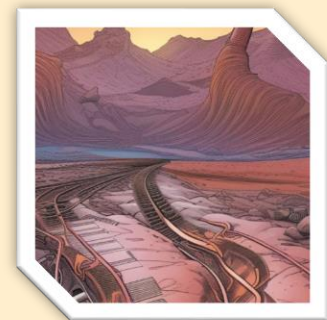




After watching the video from the previous link, the teacher answers any curiosity and questions posed by the students.

Then, the teacher tells the students that Stemia and Stemie want to look around Mariner Valley going along its rim. They find some old and previously unseen tracks and decide to follow them to see where they lead.

To follow a line track, they need to use their **InfraRed sensors**. But they are still damaged from the crash. They need help to solve the problem.

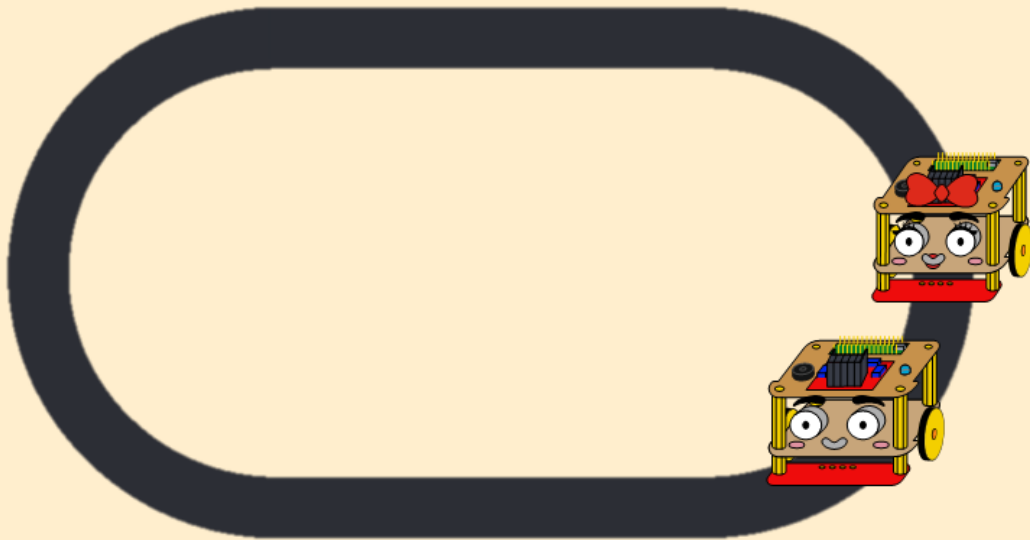


WHAT DO THE STUDENTS DO?

The students:

- watch the video proposed by the teacher
- discuss it with their peer
- express their curiosity
- ask the teacher questions
- wonder how they can help Stemie and Stemia solve the problem.

First, they will need a track to test:

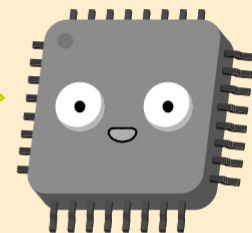


It's possible to access a file to print on an A3 sheet of paper, by scanning the QR code or clicking [HERE](#).



But...

How to follow a line?
With the 3 IR sensors that Stemie and Stemia have, there are only $2^3 = 8$ possible arrangements of the sensors in relation to the line.
Let me summarize....



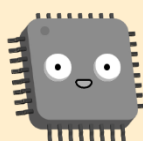
AT provides a table with all 8 possible arrangements of the sensors concerning the relative position to the line.

SENSOR POSITION	LEFT SENSOR	MIDDLE SENSOR	RIGHT SENSOR	ACTION
	0	0	0	DEPENDS ON THE PROBLEM
	0	0	1	RIGHT
	0	1	0	FORWARD
	1	0	0	LEFT
	0	0	0	REVERSE
	0	1	1	A LITTLE TO THE RIGHT
	1	0	0	A LITTLE TO THE LEFT
	1	1	1	DEPENDS ON THE PROBLEM

And Stemie shows the actual sensor to better explain:



Figure 4



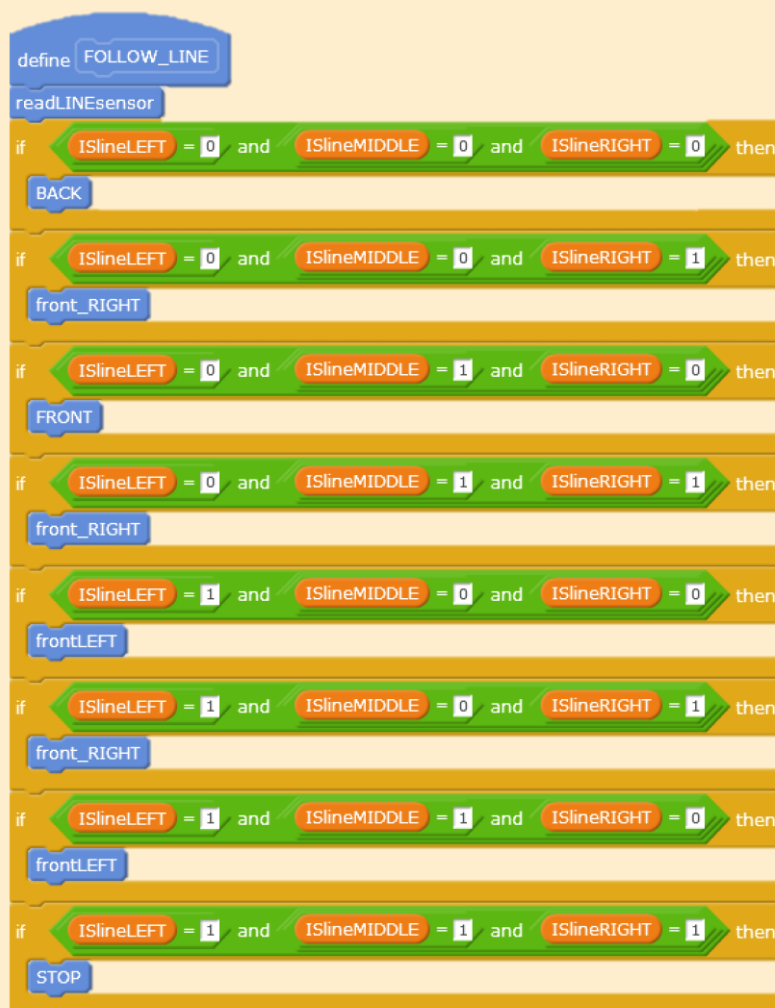
1. Write a procedure to follow the line.

WHAT DOES THE TEACHER DO?

At this point, the teacher gets to the heart of the activity and explains to the students that Stemia and Stemie, intrigued by the sight of this relief, have decided to drive along the edge of Mariner Canyon. Now they will have to learn to drive along a curved line. To follow the line, they need to use an IR sensor.

The teacher

- introduces one of the possible sensor arrangements concerning the line and programming possibilities in the table.(Fig.no.6)



- shows students an explanatory picture
- invites students to write a procedure for drawing the line and gives an example
- invites don't forget to write all the other procedures and the main program as well. The speeds and wait times may have to be adjusted

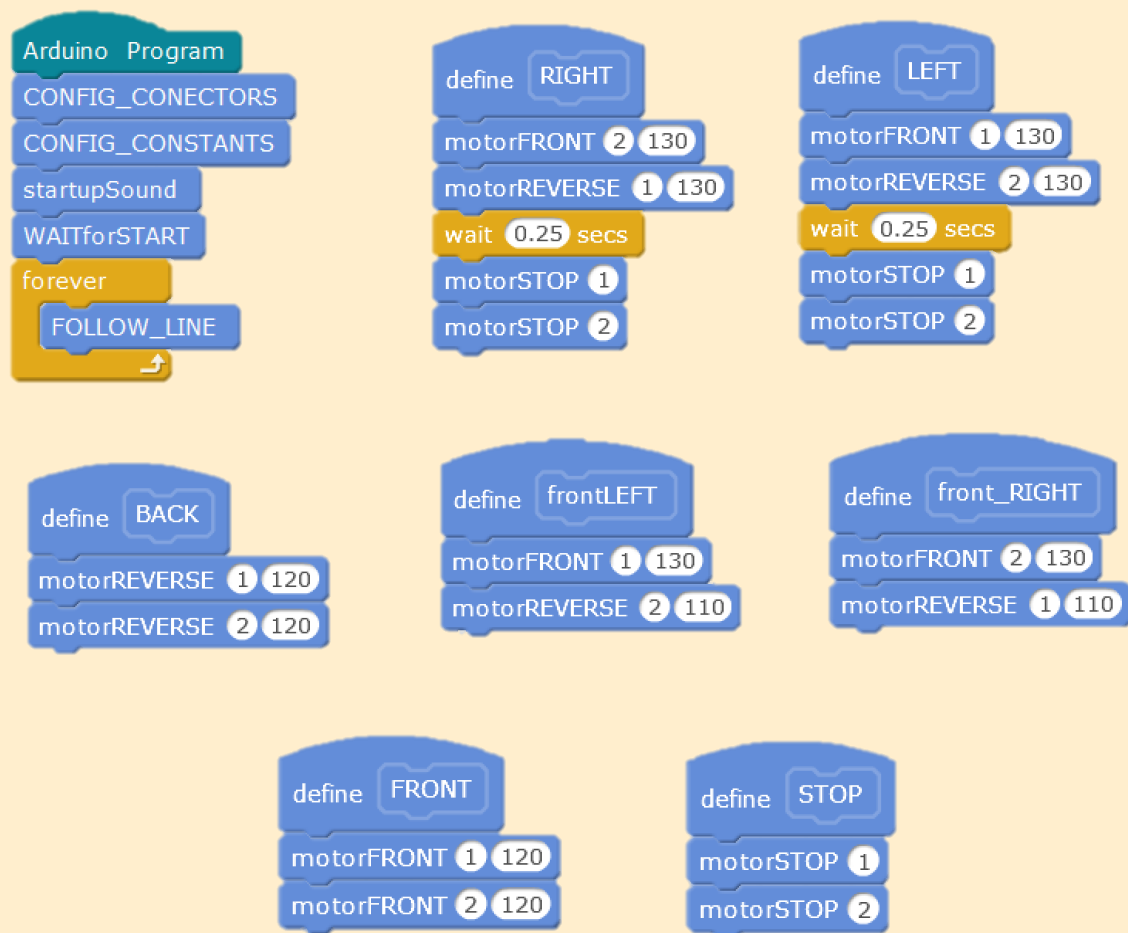
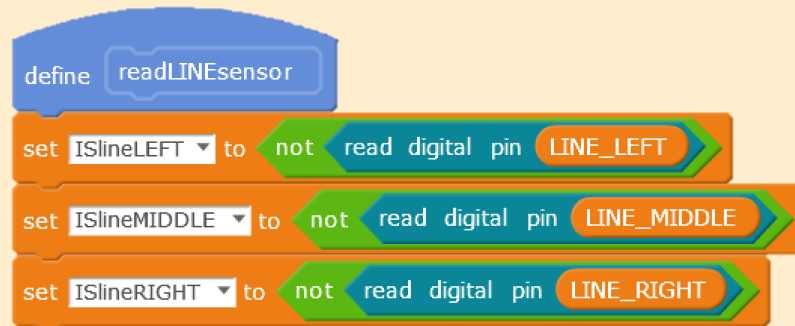


Figure 7

Included in the provided framework in the Stemie mBlock project, there is already a procedure that enables Stemie and Stemia to follow a line.

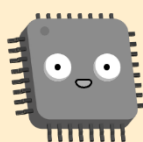
If one reads the project carefully one will find the following procedure:



Making use of Arduino instructions and variables, this procedure reads the pins where the infrared sensors are connected and stores each one of their values in variables that can be used in future programs.

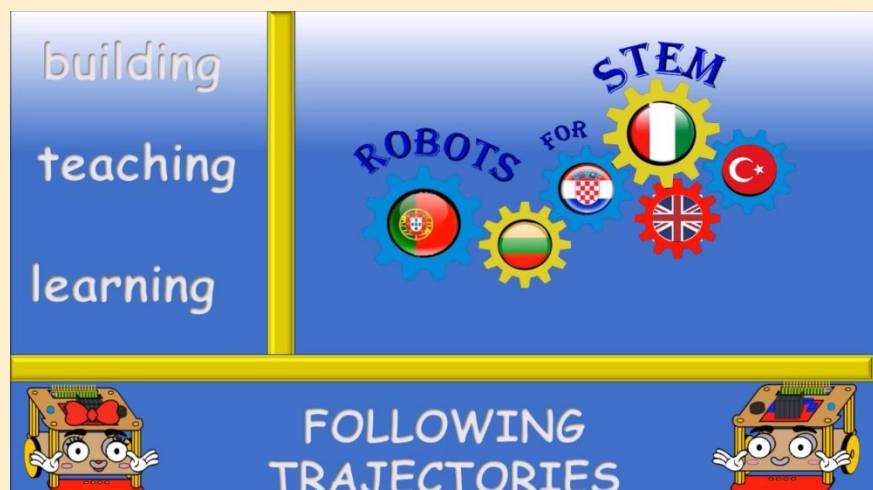
If there is a line under the left sensor, the variable ISlineLEFT will store the 1 value (TRUE). If not, it will store the value 0 (FALSE). The same applies to the other two variables in the procedure.

The teacher then assigns the students the next exercise



Use black sticky tape to cover an irregularly shaped road and go around it following the line.

And shows them the following video.



SELF-ASSESSMENT

At the end of the whole activity, the teacher proposes to the students to evaluate the experience and how they passed the challenge.

WHAT DOES THE TEACHER DO?

The teacher

- urges students to engage in a metacognitive process by asking them to self-assess themselves
- provides a 'form' and asks them to fill it in

If you haven't done it previously, click [HERE](#) to download the file with self-assessment forms, or read the QR code.



- stimulates them to reflect on the path they have followed and on what they have learnt
- asks them to attribute a meaning to the experience they have had by promoting reflection on how it could be spent in real life
- gives feedback to each individual or group useful for improving their subsequent performance

WHAT DO THE STUDENTS DO?

They complete the entries in the 'form' indicating:

- what knowledge they have learned;



- how he/she tried out the experience;
- what the outcome was;
- the meaning he/she attaches to the experience carried out by explaining its value in real life

I can:	NOT YET	MORE OR LESS	YES, COMPLETELY
Program the robot follow the line			
Where can these ideas be applied in real word?			

CHALLENGE



Avoiding obstacles

GOALS: I can program the robot to detect the object and avoid it in two different ways.

Learning scenario

As usual, the teacher sets up a new learning context ... The tenth scenario involves a journey among the asteroids between Mars and Jupiter.

EUROPEAN KEY COMPETENCIES FOR LIFELONG LEARNING

Mathematical, science and technology and engineering competence

Digital competence

Personal, social and learning to learn competence

PREREQUISITES

A. CONTENTS

Solar System: Mars and Jupiter

Asteroid: collisions and consequences

NASA: job and objectives

B. PROGRAMMING LANGUAGE

mBlock programming language:

programming the robot using variables

programming the robot using ultrasonic sensors

AIMS

A.1 learn what an 'asteroid' is and how it is formed

A.2 learn how many asteroids are present in the Solar System

A.3 imagine the consequences of a collision

A.4 identify some objectives of NASA scientists

B.1 program the robot to detect an object and avoid it

B.2 create and name a variable

B.3 store a value in a variable

B.4 rename or delete a variable

B.5 read the distance from the ultrasonic sensor

SPECIFIC VOCABULARY

Contents: Solar System, Mars, Jupiter, asteroid, collisions, consequences, NASA, object, astronomical unit.

mBlock Programming language: variables and Data&Blocks group - the ultrasonic sensor.

**METHODOLOGIES:**

- Problem-Solving ⓘ
- Learning by doing ⓘ
- Project-Based Learning (PBL) ⓘ

EXPECTED TIME: 45 min.

TARGET LEARNERS: 10-13 years old

RESOURCES AND TOOLS

- Pc, STEMIE
- Slides: asteroids pictures
- Video links provided by the teacher
- Textbooks on science, astronomical geography
- Texts and images from internet searches
- Videos and documentaries from internet searches

INTERDISCIPLINARY LINKS: Science, Technologies, Engineering,
Mathematical

WHAT DOES THE TEACHER DO?

Before starting the first task of the tenth challenge, the teacher explains to the students that the first time Stemia and Stemie passed through the asteroid field near Jupiter, they suffered massive damage to their spaceship and themselves.

They are revisiting plans and Jupiter is on them but they face the problem that, again, they have to cross the asteroid ring. They know that a collision with an asteroid can be very dangerous but now they are equipped with sensors that allow them to see the obstacles and bypass them. The only problem is that they don't know how to use them...

The teacher explains to the students that an asteroid is a small body in the solar system orbiting the Sun up to 1000 km. Most asteroids (90-95%) are found in the asteroid ring between Mars and Jupiter. They revolve around the Sun for 3-6 years. About 15,000 asteroids are known in the solar system.

At this time, the teacher proposes to watch a video that the students can access by scanning the QR code or by clicking [HERE](#) to find out what the asteroid ring looks like and how it was formed.



Finally, the teacher:

- tells to the students that the Ultrasonic Sensor used for obstacle detection and distance measurement will help them with the important task;
- asks students if they can help Stemie e Stemia to find out how to work with the Ultrasonic Sensor.

WHAT DO THE STUDENTS DO?

The students:

- watch the video proposed by the teacher
- discuss with peers
- express their curiosity
- ask the teacher questions

WHAT DOES THE TEACHER DO?

After the first 'engagement' activity, the teacher provides a new in-depth study to the students by giving them the next task.

Can you teach Stemie and Stemia how to work with the Ultrasonic Sensor?

1. First, create a variable.

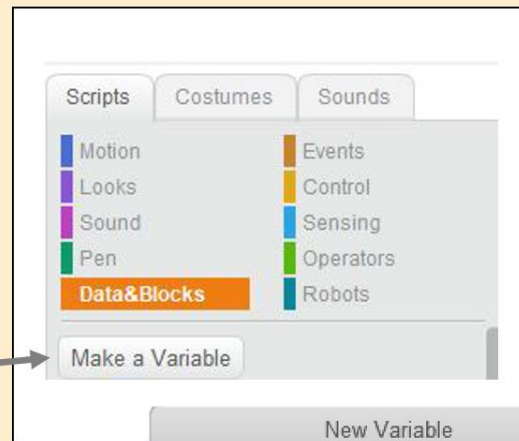


In computer programming, variables are used to store information that can be used later in our program. They are very important in programming. Data like Distance to an object, information on whether there is a line or not and speed can be stored in variables. Others like Age, sex, country, date of birth, and eye colour are also examples of variables in other contexts.

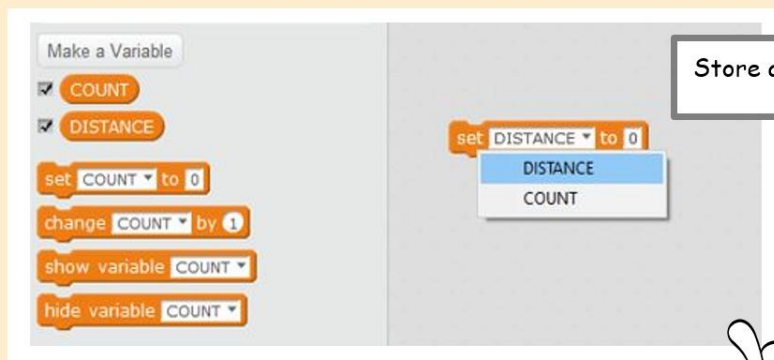
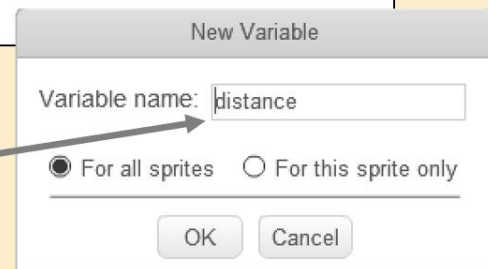
In a previous challenge, when Stemia and Stemie wanted to orbit the planet Jupiter, they were faced with the problem of crossing the asteroid ring. Every collision with an asteroid can be very dangerous. That is why the mission required in this challenge is “Create a variable”.

The teacher teaches the students teaching Stemie how to see obstacles and how to go around them and explains that:

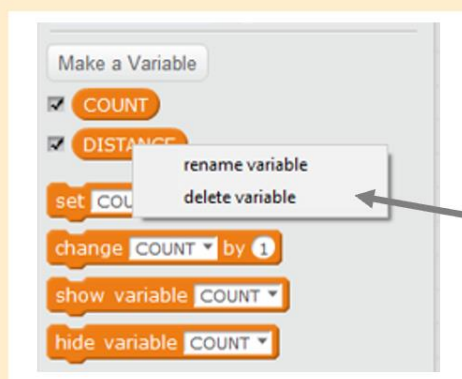
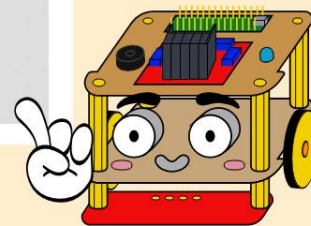
Variables can be created in the **Make a Variable** button in the **Data&Blocks** group of blocks.



Then, write the name of the Variable.



Store a value in a Variable



You can rename or delete a Variable by right clicking the Variable's name and choosing the desired option.

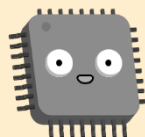
WHAT DO THE STUDENTS DO?

The students:

- reflect on the handover received and begin to imagine how to proceed by confronting peers
- create a variable using the Data&Blocks group
- assign a name to the variable
- store a value in a variable
- rename or delete a Variable by right-clicking the Variable's name and choosing the desired option

WHAT DOES THE TEACHER DO?

After presenting the above procedure, the teacher proposes the second task.



2. Write the program, once have prepared the variable.

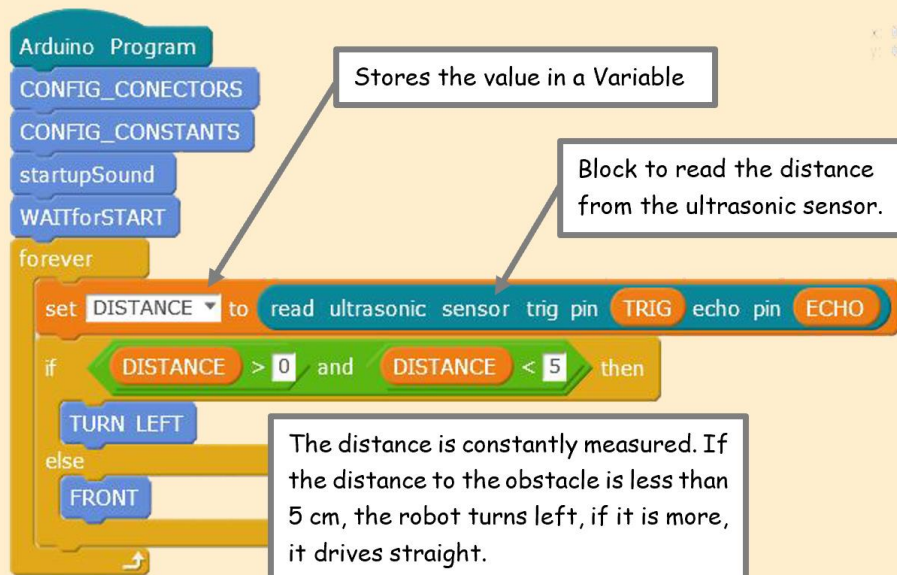
The teacher asks the students to:

- write the programme
- store a value in the variable created
- read the distance from the ultrasound sensor

To make it clearer, the teacher:

- provides the students with an explanatory image of the different steps previously presented

- explains that the distance is constantly measured and that if the distance to the obstacle is less than 5 cm, the robot turns left, if it is greater, the robot drives straight ahead.



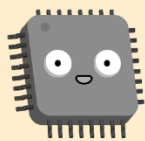
It is important to suggest to the student that for the programme to work, it is necessary to complete the code by writing the **TURN LEFT** and **FRONT** procedures.

WHAT DO THE STUDENTS DO?

The students:

- reflect on the handover received and begin to imagine how to proceed by confronting peers
- write the programme
- store a value in the variable created
- read the distance from the ultrasound sensor

- measure the distance constantly
- test the program and check if it works:
 - if it doesn't work they find the mistakes and they can try
 - if the program works, they have completed the task.



3. Improve the program so that when the robot moves straight, the green light is on but while it turns, the red light shines.

WHAT DOES THE TEACHER DO?

After students have practised many times on the procedures presented, the teacher asks them to **improve the program so that when the robot moves straight, the green light is on but while it turns, the red light shines.**

WHAT DO THE STUDENTS DO?

The students:

- reflect on the handover received and begin to imagine how to proceed
- write the programme
- compare in peers
- test the program and check if it works:
 - if it doesn't work they find the mistakes and they can try
 - if the program works, they have completed the task.

4. Program the robot with the following procedures. Let the robot go towards the object, watch it and draw the trajectory on a sheet of paper.



WHAT DOES THE TEACHER DO?

The teacher asks the students to:

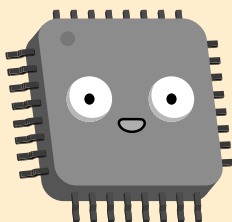
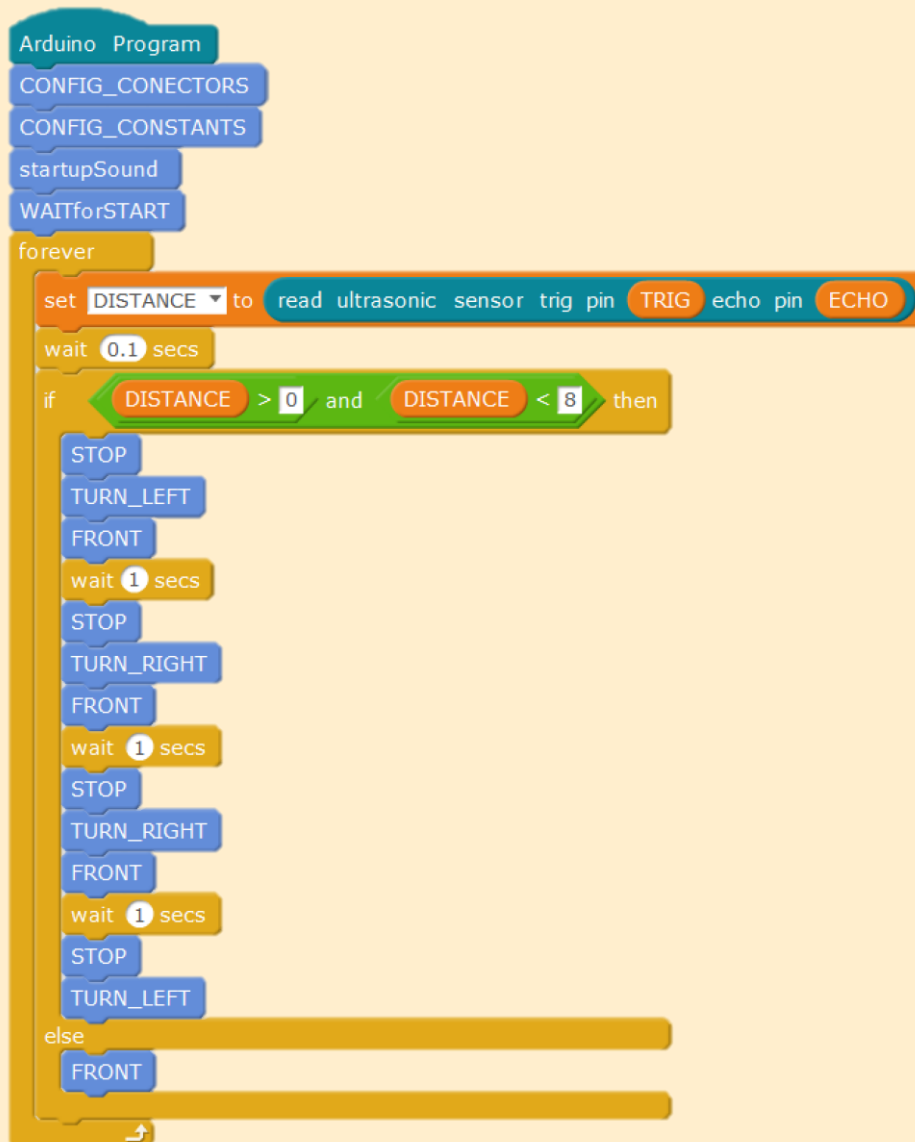
- watch the next video for inspiration
- let the robot go towards the object and watch it
- draw the trajectory on a sheet of paper



Then, the teacher:

- provides students with a block code

- asks students to look carefully at the code to imagine what Stemie or Stemia will do



AT suggests that students be very careful!



WHAT DO THE STUDENTS DO?

The students:

- watch the video for inspiration
- let the robot go towards the object and watch it
- draw the trajectory on a sheet of paper
- read carefully the block code and imagine what Stemie or Stemia will do

WHAT DOES THE TEACHER DO?

At this time, with the support of the dialogue between Stemie and Stemia, the teacher tells the students:

- about 65 million years ago the dinosaurs and some other animals disappeared after an asteroid hit Earth
- Nasa scientists are now experimenting with whether it is possible to change the direction of the asteroid and prevent this from happening
- in September 2022, a 610 kg spacecraft crashed into an asteroid at a speed of 24,000 km/h. To better understand, they can watch the following video: “Click [HERE](#)”.

WHAT DO THE STUDENTS DO?

The students:

- watch the video proposed by the teacher
- discuss in pair
- ask questions to the teacher

SELF-ASSESSMENT

At the end of the whole activity, the teacher proposes to the students to evaluate the experience and how they have passed the tenth challenge.

WHAT DOES THE TEACHER DO?

The teacher:

- urges students to engage in a metacognitive process by asking them to self-assess themselves
- provides a 'form' and asks them to fill it in

If you haven't done it previously, click [HERE](#) to download the file with self-assessment forms, or read the QR code.



- stimulates them to reflect on the path they have followed and on what they have learnt
- asks them to attribute a meaning to the experience they have had by promoting reflection on how it could be spent in real life
- gives feedback to each individual or group useful for improving their subsequent performance

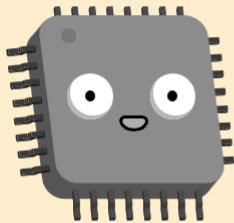


WHAT DO THE STUDENTS DO?

The students complete the entries in the 'form' indicating:

- what knowledge they have learnt, in this case, “Program the robot to detect the object and avoid it turning to one side” and “Program the robot to detect the object and avoid it going around”
- how they tried out the experience;
- what they experienced and what the outcome of the operations performed was;
- the meaning they attach to the experience carried out by explaining its value in real life

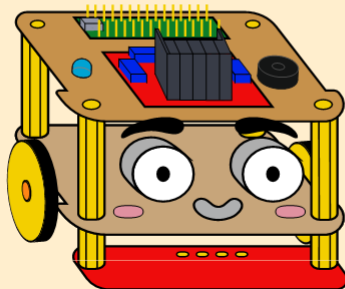
I can:	NOT YET	MORE OR LESS	YES, COMPLETELY
Program the robot to detect the object and avoid it turning to one side			
Program the robot to detect the object and avoid it going around			
Where can these ideas be applied in real word?			



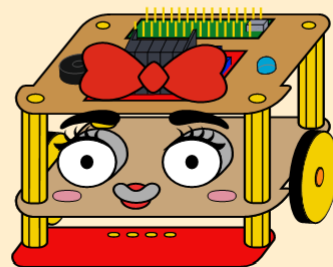
Hi! It's me again!

Thanks to your help, Stemie and Stemia are now 100% functional.

Thank you, master
robot programmer.



After some great
adventures it's time to
go home...We will see
you next time.







ROBOTS FOR STEM, 2023

2020-1-PT01-KA201-078680