STEAMERs

The STEAMERs
Module 1

Module 1: <u>Theoretical foundations</u>

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1. THEORETICAL FOUNDATIONS

1.1 DESCRIPTION OF STEAM METHODOLOGY

The term STEAM was created by the National Science Foundation (NFS) in the United States in the 1990s. With the aim of developing new areas of knowledge and providing the students with an appropriate set of skills for new technological and digital developments.

The term **STEM** is an acronym for **S**cience, **T**echnology, **E**ngineering and **M**athematics.

According to this methodology, it is the student who builds his or her knowledge and the tools to solve everyday problems. Basically, the system follows up their interest through attractive themes closer to their reality. The main objective is to understand what has been studied in the classroom, but in a more challenging and practical context (everyday life).

The learning of these disciplines is encouraged through hands-on training, as the children work through experimentation. The projects are developed by the children, making them the main actors of their own learning experience.

Summarizing, STEM methodology develops the following skills in students:

- Research
- Critical Thinking
- Problem Solving
- Creativity
- Communication
- Collaboration

1.1.1 STEAM METHODOLOGY

The methodology is based on the same education principles as STEM, including **Arts**. The aim is to foster the student´s creativity, to promote innovation and to associate logical thinking with creativity.

In the traditional curriculum, arts have very little relevance and teaching hours. However, this method argues that arts skills improve creativity, problem solving, critical thinking, autonomy and communication.

This is why arts were added to the four subjects of the **STEM** model (**S**cience, **T**echnology, **E**ngineering and **M**athematics) to evolve to what is known today as **STEAM** (**S**cience, **T**echnology, **E**ngineering, **A**rts and **M**athematics). STEAM education results in a multidisciplinary learning process, through the development of projects based on everyday life situations.

Educational systems based on STEAM methodology are becoming increasingly common within academic projects and communities. Mainly because:

- It supports proactive learning.
- It develops skills in creative problem solving and mathematical logical thinking, developing as the management of emotions.
- It integrates learning through ICT.
- It encourages teamwork and teach how to make decisions together (as they develop research, collaborate and design hypotheses).
- It teachs through first-person experimentation, thereby improving the long-term retention of the learned concepts.

1.2 DESCRIPTION OF EDUCATIONAL ROBOTICS

Educational robotics is an interdisciplinary teaching environment. It is based on the use of robots and electronic components to enhance the development of children's skills and competences. It works especially in STEAM disciplines, although it can also cover other areas such as linguistics, geography and history.

Within this approach, Educational Robotics is considered as a privileged didactic resource with great potential for students from an early age and as a highly motivating element, being the perfect gear to generate multidisciplinary environments.

Educational robotics is a tool that facilitates the acquisition of knowledge in a playful way, based on principles such as interactivity, collaborative work, and the development of logical-mathematical thinking. The demand for a more scientifically focused education places educational robotics as an important element for the development of STEAM areas.

The application of educational robotics encourages the following social skills in children and young people:

1. **Teamwork**: During the process of group work, the children understand that the objective become more feasible if they work together.
2. **Discipline and commitment**: They understand and assimilate the importance of being orderly, patient and committed to achieve the project´s results.
3. **Experimentation/Trial and error**: The outcome of their work become evident very quickly, as they can see for themselves whether they are right or wrong. By experimentation, they learn that making mistakes is part of the process.
4. **Increases self-esteem**: As they understand that failure is a key element in all learning, they develop resilience and lose the fear of making mistakes.
5. **DIY (Do it yourself) empowerment**: gaining autonomy by making robots by themselves and solving different problems.

On the other hand, it encourages the development of the following competences related to scientific-technological training:

6. **Programming language**: They acquire their first notions of programming and understand that it must have an order, a structure and a method.
7. **Computational thinking**: With the design and creation of robots, they learn abstract concepts, breaking down a large problem into small parts and to

propose solutions, that can be represented as sequences of instructions and algorithms.

8. **Scientific attitudes**: They acquire and put into practice attitudes such as curiosity, wonder, analysis and research. They learn to search, obtain and handle information.
9. **Interest in technological culture**: They have a first approach to the notion of technological culture, through computers, Internet and multimedia content.
10. **Creativity and innovation**: They realise that there is no single valid solution. This allows them to use their creativity to look for innovative solutions, also learning from their peers, beyond the first possible solution.

1.3 The importance of ICT

The appereance of new technologies, have transformed our society. Students learn in a different way and new methodologies are being used by the teachers. Technology can help us to discover new ways of thinking.

The use of ICT can enhance both the practical and theoretical aspects of STEM teaching and learning. Consider the following potential contributions:

- Enhance work production through ICT tools that expedite lengthy or difficult manual processes, focusing more time on critical thinking, discussion, and data interpretation.
- Assist with collecting and analyzing data.
- Increase the prevalence and scope of relevant information by linking school STEM learning to contemporary knowledge and providing access to experiences not feasible by other means.
- Improve educational outcomes through autonomous and collaborative learning, while increasing student motivation and engagement.
- Increase global awareness, through collaboration with international classrooms.
- Support exploration and experimentation by providing immediate, visual feedback.
- Focus attention on real-world applications through relevant technologies.

ICT offers access to a wide variety of Internet resources and tools that facilitate and extend opportunities for STEM learning both inside and outside the classroom.

1.4 Critical Thinking

We live in the age of ICT and we have an infinite amount of information that we can access freely. We need to help students to be able to discern between all the information that is relevant, what are the reliable sources. Allowing them to make their own decisions, and to have their own opinion based on contrasting information.

This type of thinking would have the following benefits for the students:

- Curiosity in a wide range of subjects.
- Concern to be and stay well informed.
- Self-confidence in one's own reasoning abilities
- Open-mindedness to divergent world views and understanding of other people's opinions.
- Honesty in confronting one's own prejudices, stereotypes or self-centred tendencies.
- Prudence in making and altering judgements.

1.4.1 CRITICAL THINKING IN THE CLASSROOM

The experts affirm that from an early age, children have grow immersed in a culture of critical thinking, being attentive in front of complex situations, etc.

For that reason, it is considered beneficial to work the critical thinking habilities within the classroom. The most used model highlights eight forces and they are the following:

1. **Time**: Provide sufficient time and respect individual differences.
2. **Opportunities**: Propose authentic activities in which different cognitive processes can be developed and different tasks can be involved.
3. **Routines**: These are tasks that help to structure, order and develop different ways of thinking in the learning process and promote their autonomy.
4. **Language**: To implement a language of thought; where different cognitive processes can be described, distinguished and reflected upon.

5. **Modelling**: Students share their ideas, exchange views and discuss them; thinking is developed together.
6. **Interrelationships**: Context where one can speak self opinions and respect for each other's ideas is encouraged, developing an atmosphere of trust where strengths and weaknesses are shown.
7. **Physical environment**: Create an emotional environment of trust and a physical space to stimulate the culture of thinking, such as a classroom, laboratory or workshop.
8. **Expectations**: Establish a "menu" for learners to know the learning objectives so the learners can focus on what they need to think about.

1.5 Educational Methodologies

The key principles that describe the STEAM methodology are significant learning, student motivation, cooperative learning and critical thinking.

1.5.1 SIGNIFICANT LEARNING

Actual´s society is characterised by an enormous amount of content and is known as the era of comunication. By contrast, the human mind is forced to process a lot of data and must change and evolve at great speed. The learning mechanism par excellence is significative learning convingin both, the classroom and everyday life. The experts highlight two conditions for meaningful learning to take place:

- Significant learning attitude on the part of the learner, i.e. a predisposition.
- Presentation of significant material: presents a logical relationship that allows interaction on the part of the learner.

1.5.2 MOTIVATION AND ITS IMPORTANCE

From the point of view of the teaching-learning process, motivation refers to the will to learn and to the interest that the learner has in his or her own learning or in the activities that lead to it

From the students' perspective, two types of motivations must be considered: the intrinsic ones, that are inherent to their personality, and the extrinsic ones, that appear through the teaching and learning process driven by the teacher.

Another aspect to take into account is family or cultural contexts. The teacher must manage the whole process in such a way that the objectives can be achieved, by providing strategies for tackling the various tasks, which is called **achievement motivation.**

Some of the tricks to motivate the students are:

- Develop intrinsic motivation: interesting activities for students, the use of the surprise factor, using games and activities, variety in the organisation and structure of classes.
- Giving students the leading role.
- Avoid giving too much importance to evaluation.
- Transferring self-motivation to students.
- Use novel concepts: technological resources and ICT.

In summary, the experts assert that motivation is the engine that leads us to act and to achieve what we set out to do. Motivation also increases effort and persistence in the tasks, leads to students' initiative, improves their skills and performance.

1.5.3 Cooperative learning

Johnson & Johnson (1999), considered as the fathers of the term **cooperative learning**, define it as "the didactic use of small groups in which students work together to maximise their own and each other's learning".

The same authors affirm that learning is the students' own and that it requires their direct and active participation. It is achieved when working cooperatively to achieve common goals.

It should be borne in mind that working in groups is not cooperative learning. For it to be so, the authors state that the following 5 elements are necessary:

- Positive interdependence: teachers set a clear task and a common goal, so that efforts benefit all members of the group. Generating commitment from all, success and failure depends on the group.
- Individual and group responsibility: everyone is responsible for their task within the group, along with the achievement of the objectives. Each learner's performance is evaluated in order to identify who needs more help and members are empowered.
- Encouraging interaction: pupils promote each other's success by sharing resources, congratulating each other's achievements and helping each other, which in the future, will be supportive in the school environment.

- Interpersonal and team skills: all members must learn and be motivated to exercise leadership, decision-making, communication and conflict resolution skills.

1.6 Evaluation:

When we talk about the teacher's work, it is important to point out that behind every activity there must be an evaluation. And it is necessary also to differentiate between evaluation and grading. It is often thought that one is synonymous with the other, but it is not. It is possible to evaluate without grading or giving marks, and that is precisely when evaluation has the greatest impact on the learning of the youngest pupils.

Formative evaluation seeks to improve teaching and learning processes. Its main objective is to obtain information in order to help students to improve.

This type of evaluation is characterised by a closer teacher-student relationship, where the monitoring of the student's learning is sought. It also has great benefits for students' learning: greater motivation and involvement, responsibility for their learning, helps the teacher to detect their difficulties and adapt future sessions for their understanding, etc.