CREATIVITY, COMPUTATIONAL THINKING, INQUIRY-BASED LEARNING
FOR INCLUSIVE TECHNOLOGY-ENHANCED ACTIVITIES

IMPACT MAPPING & PEDAGOGICAL SCENARIOS

Intellectual Output #1

INTELLECTUAL OUTPUT 1 - OVERVIEW

IMPACT MAPPING

Impact maps help explain how deliverables connect to user needs and communicate how user outcomes relate to higher-level organisational goals. The impact mapping methodology is based on 4 main questions: *why, who, how and what?* Here is the overview of the Let's STEAM impact mapping driving the development of this deliverable.

GOAL
THE WHY?

- Provide new content in the field of learning programming
- Integrate the results of pre-existing projects and initiatives
- Going beyond the state of the art to propose a clear added value

ACTORS
THE WHO?

- Trainers of teachers including teachers with a high technological interest and background
- Trainees i.e. secondary schools' teachers in their position of learners in the ToT programme, especially with lower technological background and high creativity objectives
- Secondary schools' teachers in their teaching position (same as first and second category)
- Policy makers to sustain the results

IMPACT - THE HOW?

- **Provide a new set of skills for teachers through the creation of a training programme**
- **Promote active & creative pedagogy based on inquiry**
- **Value equity and inclusiveness for designing technology-enhanced activities**
- **Value collaborative behaviours & interdisciplinarity**

DELIVERABLES
THE WHAT?

- 3 progressive and interdisciplinary training modules
- A cooking recipe template for easy learning
- A recognition system based on open badges
- An assessment system for pedagogical integration
- An e-learning platform
- An appropriate hardware ecosystem
- A tailored development of programming learning tools

"HELLO, WORLD!"

This document forms part of the results of the work undertaken under the Intellectual Outputs from the "Let's STEAM" project which has received funding from the European Union's Erasmus + programme under grant agreement n°2019-1-FR01-KA201-062946. Specifically, this document is officially referred to as Intellectual Output #1 *"Pedagogical scenarios, contents & technical specifications"*. Let's STEAM aims at developing a training of teachers' programme dedicated to computational thinking and creativity skills using IoT board and digital tools on a larger scale. The project ran from September 2019 to August 2022.

It has involved 8 partners and is coordinated by Aix-Marseille Université. More information on the project can be found on the project website: www.lets-steam.eu.

LICENCE & RIGHTS

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INTRODUCTION

OBJECTIVES OF THE INTELLECTUAL OUTPUT #1

The Let's STEAM project has the ambition to target multiple profiles. If the main aim is training the teachers, their capabilities in becoming contributors on coding platforms will be assessed at the level of the classroom. Understanding the needs of the teachers is then mandatory to have a tailored project as well as translating these needs into pedagogical specifications for both the trainers themselves in terms of skills, but also for the classroom level to understand how to optimise the acquisition of new competencies in terms of what the platforms (Scratch, CircuitPython and MakeCode) can bring them.

This intellectual output results from the work performed during Let's STEAM Work Package 1 "***Analysis of the different training level needs and technical specifications***" consisting in defining the needs of the teachers and assessing their basic skills related to the capacity of becoming producers of pedagogical content on open source programming platforms. Assessment of the needs at the teachers and at the classroom levels have been performed to create learning scenarios that consider both the training needs of the teachers combined with interdisciplinarity.

Objectives

- Precisely define the needs of the teachers in terms of **competencies** to acquire
- Set up a **framework of teachers' skills** in the field of digital culture and coding perspective
- Validate the **collaborative and creative approach** to be promoted on the platform
- Define the **methodology for content delivery** for both teachers and students
- Translate these needs in **recommendations for the programming tools** to be promoted

Methodology

To achieve the pre-quoted objectives, you will find in this documentation diverse assessments and recommendation levels, based on an impact mapping approach used for answering the following questions:

- **Step 1 – Why are we doing this?** By proposing a **deep context analysis,** the partners have tried to consider why Let's STEAM is useful nowadays in the framework of similar and complementary initiatives that have integrated and assessed the teachers' needs and drivers in developing their digital skills.

- **Step 2 – Who can produce the desired effect? Who are the consumers or users of our product? Who will be impacted by it?** To understand our target audience, the partners have defined several axes of profile assessment, using clear and identified evaluation methods, mainly based on the **analysis of the teachers' needs and pre-existing skills** using the questionnaire developed by the Applied Research Group in Education and Technology of the Universitat Rovira i Virgili. These results have been compiled in "Personas" enabling us to position each axis of course deployment according to a variety of profiles, and avoiding focusing only on technology-oriented teachers.

- **Step 3 – How should our actors' behaviour change? How can they help us to achieve the goal? How can they obstruct or prevent us from succeeding?** To answer this question, partners have worked on the definition of **associated and tailored pedagogical scenarios** to build up the Let's STEAM courses accordingly to a smooth path of training. These recommendations are composed of a general framework associated to a clear pedagogical vision of the programme.

- **Step 4 – What can we do, as an organisation or a delivery team, to support the required impacts?** Eventually, to operationalise the training programme, tools for delivering the contents have been defined in the form of templates for creating the courses, an **online learning framework** to disseminate these scenarios through a learning platform and the **translation of the learning pathway in recommendations for the technical team to develop tailored programming learning tools**.

INTRODUCTION

GLOSSARY

Terminology & Glossary

Pedagogical resource	Resources used to enhance the teaching and learning activities.
Pedagogical Scenario	A pedagogical scenario or learning scenario is an instantiation of an instructional design model for a given subject and a given kind of situation. It basically defines what learners and other actors like the teacher should/can do with a given set of resources and tools.
Pedagogical objectives	Pedagogical objectives refer to the specific expected student learning outcomes i.e. what new skills the student can perform after the activity that he/she was not capable of doing before the activity. Pedagogical objectives are not wide but specific and should be clear to enable the teachers designing the learning activities.
Pedagogical intentions	The pedagogical intention is the aim of the trainer and should not be confused with the pedagogical objectives defined above which defines what the learner will be able to do at the end of the training. For instance, a trainer may have the pedagogical intention of "creating a group dynamic at the start of the training or of clearly explaining the stages of training project management" while the objective could be: "at the end of the training sequence, the participants will be able to find their way around in the course".
Inquiry-based learning	Inquiry-based learning is a form of active learning that starts by posing questions, problems or scenarios. It contrasts with traditional education, which generally relies on the teacher presenting facts and his or her knowledge about the subject. Inquiry-based learning is often assisted by a facilitator rather than a lecturer. Inquirers will identify and research issues and questions to develop knowledge or solutions. Inquiry-based learning includes problem-based learning and is generally used in small scale investigations and projects, as well as research. The inquiry-based instruction is principally very closely related to the development and practice of thinking and problem-solving skills.
Project-based learning	Project-based learning is a dynamic classroom approach in which students actively explore real-world problems and challenges and acquire a deeper knowledge. The aim here is that students gain and develop their knowledge and skills through working extensively to investigate and respond in detail to an issue that is engaging and complex, rather than clear-cut.

Terminology & Glossary

Project	A project is defined as a specific, finite activity that produces an observable and measurable result. A Project is a temporary, unique and progressive attempt or endeavour made to produce a tangible or intangible result (a unique product, service, benefit, competitive advantage, etc.). It usually includes a series of interrelated tasks that are planned for execution over a fixed period and within certain requirements and limitations such as cost, quality, performance, others.
Inquiry & Project-based interrelation	If Inquiry Based Learning is about discovering an answer, Project Based Learning is about exploring an answer. While this technique also begins with a challenge or question, its remit tends to be wider. Using either or both methods will help the students to become independent thinkers, who can gather information on their own, question and interpret it, and then form their own evidence-based conclusions.
Challenge-based learning	Challenge-based learning is similar to problem or project-based learning. While these models have existed for decades, challenge-based learning was created more recently and aims to incorporate 21st century skills into problem-based learning. With challenge-based learning, students are again asked to develop solutions to a complex problem. However, challenge-based learning incorporates technology into the process. The goal of challenge-based learning is to have students come up with real-world solutions to problems, not just to complete a critical thinking exercise. This makes challenge-based learning a natural extension of these other methods.
	The 21st century skills comprise skills, abilities, and learning dispositions that have been identified as being required for success in 21st century society and workplaces by educators, business leaders, academics, and governmental agencies. This is part of a growing international movement focusing on the skills required for students to master in preparation for success in a rapidly changing, digital society. Many of these skills are also associated with deeper learning, which is based on mastering skills such as analytic reasoning, complex problem solving, and teamwork. The skills have been grouped into three main areas: • **Learning and innovation skills**: critical thinking and problem solving, communications and collaboration, creativity and innovation • **Digital literacy skills**: information literacy, media literacy, Information and communication technologies (ICT) literacy • **Career and life skills**: flexibility and adaptability, initiative and self-direction, social and cross-cultural interaction, productivity and accountability

Terminology & Glossary

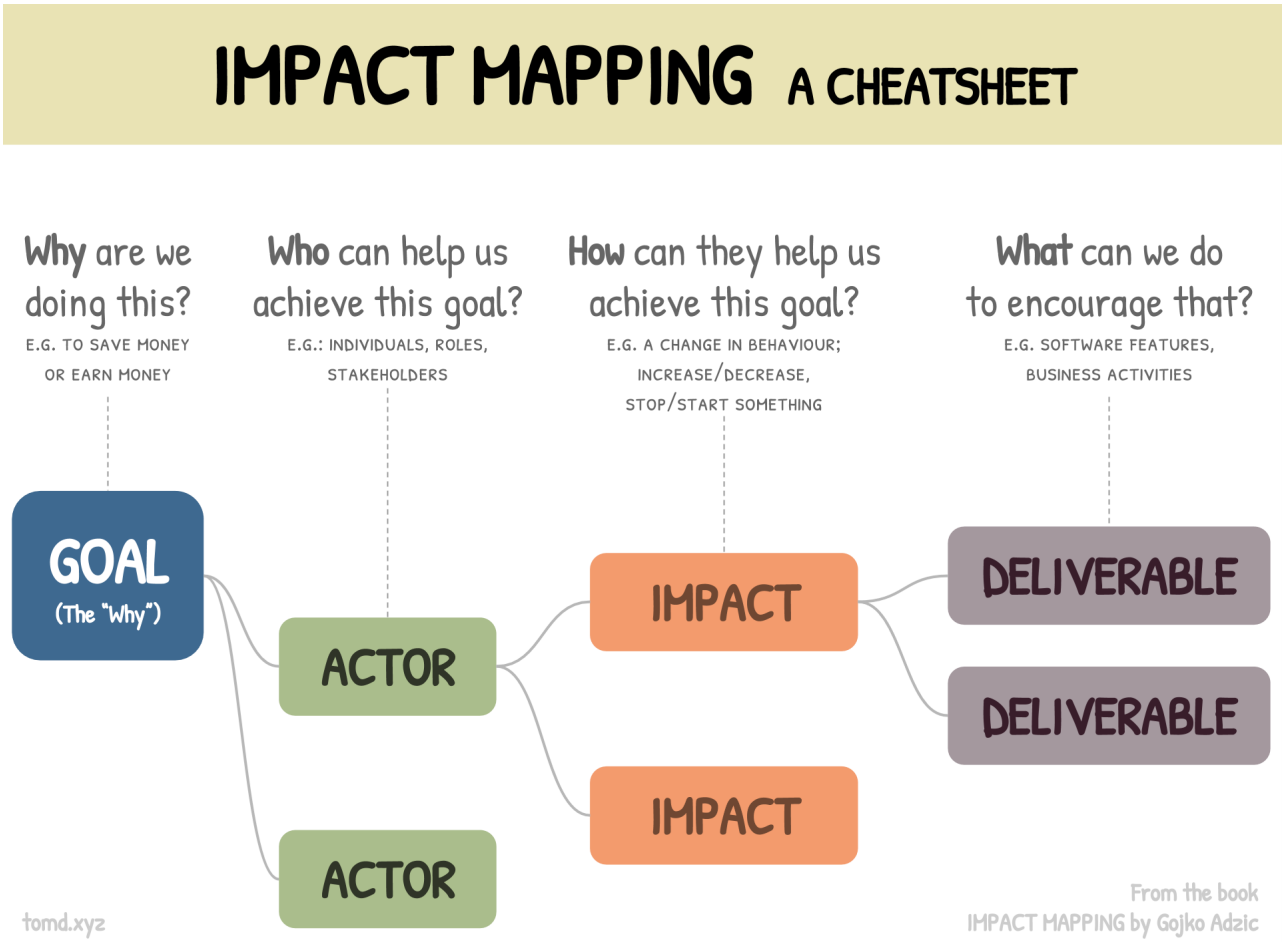
Exploration	Exploration starts from a broad question of ambiguity. There is no known answer to that question, or even a hypothesized one. Exploration is the act of searching for the purpose of discovery of information or resources.
Experimentation	In the scientific method, an experiment is an empirical procedure that arbitrates competing models or hypotheses. Researchers use experimentation to test existing theories or new hypotheses to support or disprove them. Experimentation is based on hypothesis, assumption, or an understood question. Experiments are tests for truth. Experimentation is the step in the scientific method that helps people decide between two or more competing explanations—or hypotheses. These hypotheses suggest reasons to explain a phenomenon or predict the results of an action.
Interrelations between exploration & experimentation	If we are only experimenting, we are not immersing ourselves in contexts. We are not trying to understand contexts of people, place, organizations, and environments in a general way. Experimentation feels great because by having an absolute binary or other quantitative result we feel safe in assurance, and we can communicate that assurance. However, we will never get to "why" in a deep meaningful way. We need to explore, observe, immerse, interpret, synthesize, analyze and ultimately value the exploration of what the total gestalt of a new experience can and will be.
COMDID-A	Name of the survey to assess the self-perception of Teacher Digital Competency (TDC) designed by URV
CreaCube	Playful task to evaluate computational thinking
INCOTIC	Name of the survey to assess the digital competency of students designed by URV
Micro:bit	Pocket-sized, codable computing device, designed to allow children to get engaged and creative with technology
Rubric	Scoring guide used to evaluate the quality of students' constructed responses

METHODOLOGY

BASICS OF IMPACT MAPPING APPLIED TO LET'S STEAM

Impact mapping is a lightweight, collaborative organisational technique for teams that want to make a big impact on software products. It is based on user interaction design, outcome-driven planning and mind mapping.

Impact maps help delivering teams and stakeholders with visualised roadmaps, explaining how deliverables connect to user needs and communicate how user outcomes relate to higher-level organisational goals. The impact mapping methodology is based on 4 main questionings:



Step 1 – Why are we doing this?

This is the goal we are trying to achieve. It might sound like common sense to know this upfront, but very few people working on delivery know the expected objectives. These are sometimes drafted in a vision document, but more frequently exist only at the back of senior stakeholders' minds. Even when they are communicated, goals are often defined in vague terms. Knowing why we are doing something is the key to making good decisions about cost, scope and timelines, both at the start and later when things change.

Research shows that people on the ground **must know the objectives of any activity** in order to react correctly to unforeseen problems. And unforeseen problems are a fact of life in any but the most trivial software. If a product milestone or project succeeds in delivering the expected business goal, it is a success from a business perspective, even if the delivered scope ends up being different from what was originally envisaged. On the other hand, if it delivers exactly the requested scope but misses the business goal, it is a failure. This is true although delivery teams can blame customers for not knowing what they want.

By having the answer to 'WHY?' in the centre, impact maps ensure that everyone knows why they are doing something. That helps teams align their activities better, identify true requirements and design better solutions.

Step 2 – Who can produce the desired effect? Who can obstruct it? Who are the consumers or users of our product? Who will be impacted by it?

These are the actors who can influence the outcome. To deliver high-quality results, we first must **understand who these people are, and what kind of value they are looking for from our products or project outcomes**. In addition to those directly getting value out of our software, we also must consider a host of others who can make decisions that influence the success of a product milestone or the outcome of a project. The software does not work in a vacuum and it rarely controls all the actors who are involved with it. People have their own needs, goals and preferences, which all come into play if we truly care about achieving a business goal instead of just delivering software.

Yet most requirements' models completely ignore this – they focus on what the software should do and not who will benefit from it and who will be worse off when it is delivered. Then somewhere mid-work, a new actor appears from nowhere and everything changes fundamentally, or someone with sufficient decision-making influence just stops the delivery in its tracks. Impact maps make us think about all these decision-makers, user groups and customer segments.

By mapping out different actors, we can prioritise work better – for example focusing on satisfying the most important actors first.

Step 3 – How should our actors' behaviour change? How can they help us to achieve the goal? How can they obstruct or prevent us from succeeding?

These are the impacts that we are trying to create. A key to successful delivery is to **understand what jobs customers want to get done instead of their ideas about a product or service**. This helps delivery organisations investigate different technical options and explore solutions to produce good results. It also helps to focus delivery on supporting users in getting the job done instead of just delivering features.

By listing impacts on the second level of a map, we consider the **desired changes in the behaviour of actors**. This leads to better plans and helps with prioritisation. Different actors could help us or obstruct us in many ways on our route to achieving the key business objectives. Some of the impacts will be **competing, some conflicting, and some complementary**. We do not necessarily have to support all of them, but without considering delivery scope in the context of these activities, it is very challenging to prioritise and compare deliverables.

The hierarchical nature of the map clearly shows **who creates an impact and how that contributes to the goal**. This clear visualisation allows us to decide which impacts best contribute to the goal and identify the risks; this helps immensely with prioritisation.

Step 4 – What can we do, as an organisation or a delivery team, to support the required impacts?

These are the **deliverables, software features and organisational activities**. Delivery plans and requirements documents are often shopping lists of features, without any context that explains why such things are important.

Without a clear mapping of deliverables to objectives, and a justification of that mapping through impacts that need to be supported, it is incredibly difficult to argue about making or not making an investment in certain items. In larger organisations with many stakeholders or product sponsors, this leads to huge scope creep as everyone's pet features and ideas are bundled in.

No wonder such plans often fail. An impact map puts all the deliverables in the context of the impacts that they are supposed to support. This helps with breaking deliverables down into independent chunks that provide clear business value and help us launch something valuable sooner.

A clear hierarchy allows us to group related deliverables, compare them and avoid overinvesting in less important actors or impacts. It also helps us to throw out deliverables that do not really contribute to any important impact for a goal.

Finally, by connecting deliverables to impacts and goals, a map shows the chain of reasoning that led to a feature suggestion, visualising the assumptions of stakeholders. **This allows us to scrutinise those decisions better and re-evaluate them as new information becomes available through delivery.**

STEP 1

WHY ARE WE DOING THIS?

The Let's STEAM consortium is well aware that we are nowadays evolving in a context where more and more initiatives are aimed at developing programming skills and practices, from a practical framework. This background of several projects targeting the increase of coding competencies for students and teachers is highly interesting for the implementation of the Let's STEAM curriculum and brings answer on the "Why Let's STEAM has its own place in this context?". They are already providing a set of educational materials, that can inspire, methodologically guide and give examples of pedagogies that are successful towards teachers.

Networking and clustering with these initiatives during the project is crucial for developing a complementary approach to empower EU-funded projects in sharing and enriching content. In addition, enhancing programming practices by creating synergies at the EU scale between the different initiatives is highly valuable for creating new cooperation in the future and increasing the dissemination level of several interesting projects. As such, documenting this work within the first intellectual output seemed to us the best way to create discussion around the orientation of educational policies and projects in the future.

This first part of Output 1 summarises the identification of complementary initiatives that can inspire the implementation of Let's STEAM and beyond, be used by clustering, networking and creating new partnerships for a better visibility at local, national and EU scale of linked initiatives and a global awareness raising on the importance of programming in the current STEAM curricula. Hence, the partners have worked on the identification of national and European projects, funded under various programs and initiatives, or any kind of initiatives working on the project's themes and creating a network ensuring cooperation, in order to share problems and visions, in order to favour the organisation of joint-discussions and dissemination of results among a larger audience.

In the framework of the first intellectual output, this work has been used for defining the pedagogical pathway needed under Let's STEAM to propose something that is completely new, reusing ideas, methodologies and best practices from diverse initiatives, but ensuring that the Let's STEAM training brings a real added-value and complementarity to those pre-existing projects.

Methodology

The methodology is based on the identification of several categories of interesting undergoing activities outside the consortium:

- Erasmus + projects with similar scope
- Horizon 2020 framework programme
- Competitions a local, national or EU scale
- Initiatives handled by schools
- Facilitator networks, policymakers and EU initiatives
- Supporting organisations

Each category has been assessed regarding their added value in defining the Let's STEAM framework:

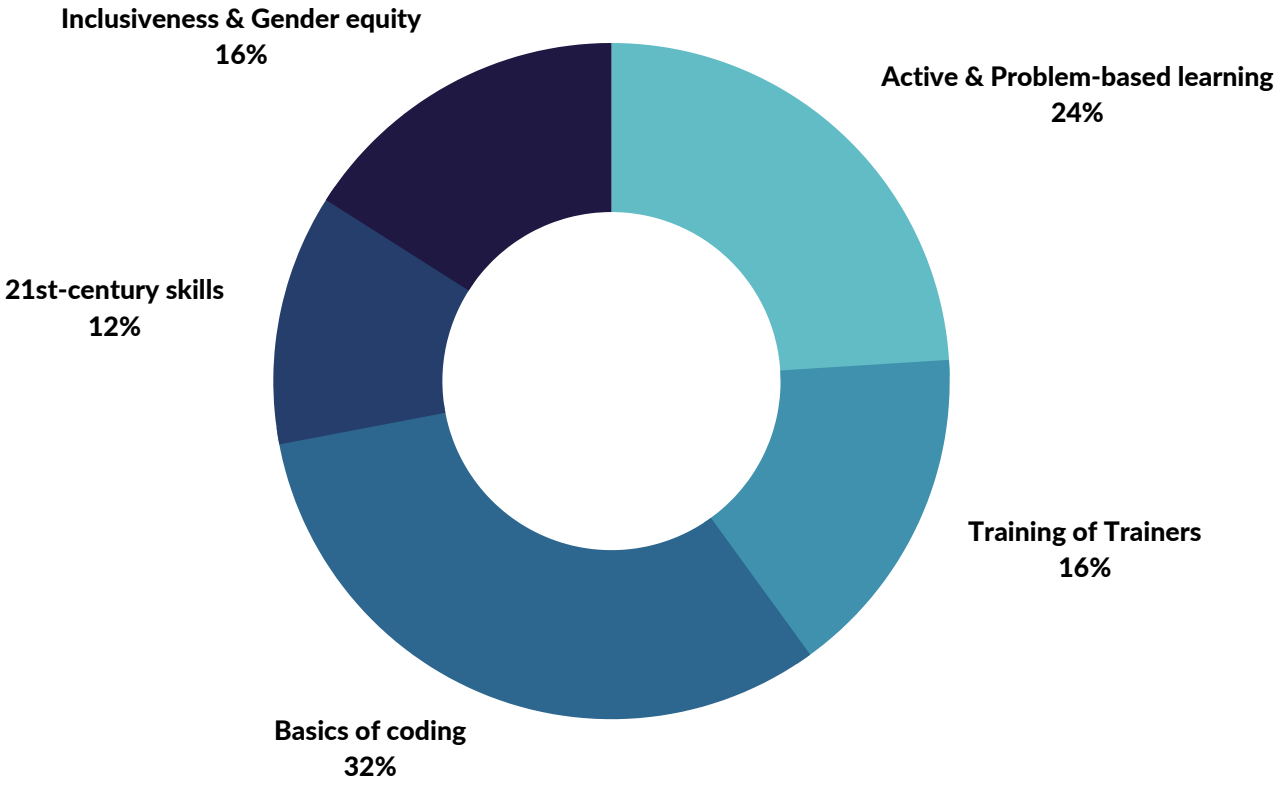
From the assessment of this database, the partners have highlighted:

- The strategy and recommendations coming from the assessment of the initiatives to feed the pedagogical orientation of the project;
- An action plan for synergies and clustering activities.

At the stage of Output 1, this analysis provides a good overview of how the subject targeted by Let's STEAM has been tackled in the past and by the current under-going projects. This analysis aims at structuring the specifications of Let's STEAM by analysing best practices, success and achievements of similar scope projects but also highlighted the potential gaps that Let's STEAM wants to tackle to provide an integrated and complementary vision of computer programming practices at school and beyond. After the end of the project, this analysis can be used in the framework of new cooperation.

These initiatives have been selected among diverse programmes, each of them providing different inputs to Let's STEAM from short-term impacts (such as supporting the specifications' development) and longer-term added value for replicating (identifying partners in diverse European countries not represented in the Let's STEAM consortium), transferring (from needs' analysis of diverse targets, outside the teachers' community), scaling and sustaining the results (through larger initiatives and ambitious programmes).

All of these projects can be classified around 5 cross-objectives: Active & Problem-based learning approach through technology, robotics and IoT (Internet of Things); Training of teachers & trainers and good practices in teaching ICT (Information and Communications Technology); Basics of coding and integration of programming in national curricula; 21st-century skills; Inclusiveness & Gender equality.



Based on this classification, the Let's STEAM project can be shaped around learning and pedagogical scenarios on the intersection between these 4 objectives through the following commitments:

- **Let's STEAM pillar #1: Provide an inquiry-based approach** in which the knowledge of the teachers on programming can bring **creativity**, based on a **computational thinking** vision of coding.

- **Let's STEAM pillar #2: Provide practical skills to teachers and, through cascade effects, to students on how to use programming open source software and programming boards**, from basics (how to launch the software and use the simple functionalities) to the development of a teacher-contributor position (how to create new functionalities).

- **Let's STEAM pillar #3:** Assess the project results under an evaluation scheme integrating **gender equity, inclusiveness and well-being** of the teachers and students as the core added value of the project as a result of the achievement of the 4 pillars presented above.

- **Let's STEAM pillar #4: Encourage the sense of sharing and promoting** activities and results across the teachers' community.

EXAMPLES OF INSPIRING PROJECTS UNDER ERASMUS +

Reviewing the database of the Erasmus + Strategic Partnerships results, several projects have been identified as highly relevant within the context of Let's STEAM. These projects have similar level of ambition, being funded under the same call, and can provide either additional resources, or can be implemented in diverse geographical areas. A pre-assessment of the database has highlighted the projects presented hereunder, providing good insights of each of the categories identified above. In addition, the partners have studied their vision of the context and potential issues nowadays linked to coding and programming practices. These analyses have led to additional information on the assessment of the current needs of the teachers and the students that enable to enlarge and expand the Let's STEAM understanding of the framework in which the project is evolving, comparing with projects under the same scope in terms of targets/budget/ambition. In addition, several projects under mobility and schools' exchanges have been selected providing accurate channels to disseminate the project results towards teachers interested by the topic. From this analysis, 25 projects have been studied from now, presented in the full version of the D1.1 available on the Let's STEAM website and Erasmus + result platform. From these projects, topics of interest have been analysed resulting in a majority of the projects working on the basics of programming:

ACTIVE & PROBLEM-BASED LEARNING APPROACH

INTERDISCIPLINARY AND COLLABORATIVE THEMATIC LEARNING OF TECHNOLOGY AND SCIENCE

What is the project about?

ICAROS stands for Interdisciplinary and Collaborative themAtic leaRning of technOlogy and Science. It is a year-long educational project implemented annually since 2016 as a dedicated extra-curriculum student club of Ellinogermaniki Agogi's High School. ICAROS project is aiming at enhancing educational practices that will lead to better-motivated students with improved study-goal achievements. The assumption is that this can be done through thematic learning with an entrepreneurial learning approach, and student-led knowledge development through experimentation and real-world problem-solving. ICAROS student club and its activities are focusing on the design, development, testing and operation of x-quadrotor drones equipped with cameras and sensors. The project thus makes use of modern technology that captures the imagination of students, as well as innovative methods spanning several disciplines, to demonstrate the real-world applicability of Science, Technology, Engineering and Mathematics (STEM) and other related subjects. The project also aims to inspire students to develop an entrepreneurial approach to science, research and technology and to encourage independent knowledge development, DIY (Do-It-Yourself) and making.

ICAROS Project

Project duration

2016 - 2018

Project Reference

2016-1-SE01-KA219-022131

Action Type

Strategic Partnerships for Schools Only

LINK WITH THE LET'S STEAM TRAINING

The project both tackles inquiry based learning, creativity and programming in which students are central in the motivation axis. For instance, students of ICAROS club have been working on the assembly of drone frames, integration of electronics, testing of components and other tasks to build a complete operational quadrotor drone. This motivation can be showcased to teachers, especially the ones that can be technology-sceptic, for inspiring and motivating them in getting on board.

ACTIVE & PROBLEM-BASED LEARNING APPROACH

USING RETRO GAMING CONSOLES TO REVIVE HANDS ON PLAY AND PROMOTE STEM

What is the project about?

RETROSTEM is an Erasmus+ project run by a consortium of partners from education, academia and industry. RETROSTEM's approach is to promote the acquisition of skills of teachers and students in the digital era by developing innovative learning practices supported by a Raspberry Pi based console and DIY electronics kits. This aims to support teachers in delivering subjects extending their present knowledge and enhancing their understanding of how to effectively engage students in the learning process of programming concepts and STEM subjects through hands-on play in a retro design game console and electronic kits. The project designed a hands-on console and developed a comprehensive of step-by-step instructions, examples of educational activities and training modules for teachers and students of primary and secondary education based on Scratch and Python programming languages and on the Minecraft environment. These are implemented and piloted at a small scale before they are refined and released as final intellectual outputs of the project. They are also translated and are available in four different languages, namely in English, Greek, Polish and Romanian. In the framework of Let's STEAM, RETROSTEM's educational guides and content can be utilized in different countries at schools of primary, secondary and vocational education.

Project duration

2018 - 2020

Project Reference

2018-1-UK01-KA201-048152

Action Type

Strategic Partnerships for school education

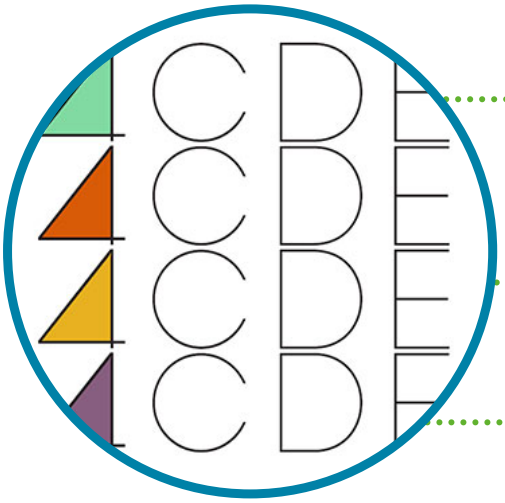
LINK WITH THE LET'S STEAM TRAINING

In the framework of Let's STEAM, STM32 board with its sensors and functionalities can be incorporated in both projects educational activities along with the coding guides and tutorials to be developed, hence providing additional contents and practices to the implementation of challenge-based initiatives. In counterpart, the assumptions and results of those projects, on motivation axis and experimentation-driven approach, can bring strong added-value in understanding how to present the interest of the teachers in getting trained on programming issues. Eventually, the projects developed through ICAROS and RETROSTEM are inspiring initiatives to present concrete outcomes to the teachers in Let's STEAM while recruiting them for the training programme.

CODE, CONTENT CREATION AND CULTURE FOR DIGITAL EDUCATION

What is the project about?

The 4CDE project aims at producing open educational resources (OERs) to be used for professional purposes in the area of ICT learning, with adults and students. These OERs are structured in 44 lessons in the field of programming, narrative methodologies (storytelling), rich media production (photography, video and sound), and digital. The lessons, representing a 120 hrs course, can be accessed by two different paths: a non-formal course (designed for adult education), structured in 4 themes (audiovisual, storytelling, creative code, digital art), or a formal course (designed for formal students) structured in 3 levels (referring to a Borges' story) on one single multilingual platform. A Skills Reference Guide accompanies the lessons and the platform includes all educational resources, pedagogical information, and assessment processes.



Project duration

2016 - 2019

Project Reference

2016-1-BE01-KA204-016280

Action Type

Strategic Partnerships for adult education

LINK WITH THE LET'S STEAM TRAINING

If not directly training teachers and educators, the 4CDE projects is highly relevant to Let's STEAM as the contents and practices created are strongly inspiring for the teachers to be trained on our project. In addition, impact assessments have been performed providing interesting insights for Let's STEAM, based on surveys and questionnaires, and supported by examples of best practices.

KIDSCODR - WE TEACH KIDS PROGRAMMING

What is the project about?

KidsCodr project created a complete training curriculum to teach digital skills for children in age 6-14 years. The curriculum is divided into two parts. The software part where learning takes place in various programs, applications or directly in the programming language. This part is composed of the training modules like Scratch Junior, Scratch, Kodulab, MIT App Inventor, Javascript Games and Minecraft. The hardware part is focused on programming robots and hardware, and this allows students to receive immediate feedback on their work in a real environment (move of the robot, activate functions, etc.). A web application kidscodr.eu, will unite at a glance all the educational materials and creates a system for communication and development of further KidsCodr activities.

Project duration

2016 - 2018

Project Reference

2016-1-SK01-KA201-022606

Action Type

Strategic Partnerships for school education

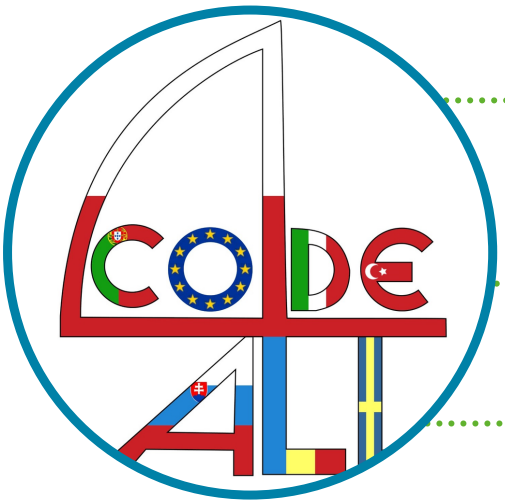
LINK WITH THE LET'S STEAM TRAINING

The KidsCodr project, such as other projects aims at developing programming training programmes, are highly interesting for Let's STEAM as they provide operational contents and examples to feed the part of the training programme that will aim at providing practical skills to the teachers. If not the full objective of Let's STEAM, still all projects already working with CircuitPython, Scratch and MakeCode are considered as sources of functionalities and examples supporting the inquiry-based methodology of the project.

COMPUTATIONAL THINKING AND DIGITAL SKILLS IN EUROPEAN EDUCATION FOR ALL

What is the project about?

The project "CO.D.E4all" wants to create a network of school across Europe to develop the "21st Century Skills"; such as creativity and innovation, critical thinking and problem solving, digital competence, teamwork and collaboration in virtual teams, multiple languages and cultural awareness. Our aim is to develop and share good practices and innovative educational ways to use coding and new technologies at school, for students from 3 to 13 years old , in order to create a computational thinking vertical curriculum . Our aim is also to build a Teachers' “Code European community”, where we can share good coding and computer science practices that we are using in our classroom now, inform other teachers, public, families about our project, collaborate with different nations researchers, technology developers, state, and local leaders to disseminate the idea that technology is advanced in ways that promote young children’s healthy development and learning.



Project duration

2017 - 2019

Project Reference

2017-1-IT02-KA219-036645

Action Type

Strategic Partnerships for Schools Only

LINK WITH THE LET'S STEAM TRAINING

Projects in the category of the 21st century skills’ target are highly interesting for Let’s STEAM as a general framework for the whole project activities’ implementation. Indeed, computational thinking can be a difficult concept to acquire for all, and hence, all the activities pre-developed in other projects, enabling to disseminate the logic and objective of such concept is highly important to help in the teachers’ interest and acceptance of our courses.

DIVERSELY CODING & LIFT ERASMUS + PROJECTS

What are the projects about?

- **DIVERSELY CODING: coding for improving the social inclusion**: The project aims to develop a training course on "Diverse coding", enabling people with specific disabilities: Adults (Age 18-60 years) with hearing disorders to increase their digital skills and programming, with a methodology that applies European recommendations to validate non-formal and informal learning to facilitate recognition and transfer of results. Furthermore, implementing a specific design of the training path and the development of contents. The project is aimed at people who work or who are unemployed with hearing disorders to improve their social integration and improve the informal educational path in such an innovative and formative context.
- **Ladies Code Their Future**: The direct target group of the LIFT project were “disadvantaged women”, defined, for the purpose of this project, as women who face isolation and hardship as a result of them having a low-level of education, being unemployed or living in a rural location where their basic needs for services, employment and education are currently not being met. The project consortium developed the products addressed to the direct target group in various languages (Dutch, English, Hungarian, Spanish, Portuguese, Romanian) for better accessibility: we are aware that English is a "must" for programming, but low level of English language competence should not be an obstacle in making a decision to start learning IT. Their intention of building a career in ICT motivated women taking part in our pilot activities to start developing their language skills too, concomitantly with starting a course in ICT. All basic IT training/coding programmes emphasise that anyone can learn how to program as long as they are willing to put in the time and effort. The LIFT project team built its curriculum, learning platform and “virtual tour” of women role-models in the ICT sector upon this positive, optimistic presumption, encouraging women to dare to think about entering the ICT job market, offering them basic introduction to the world of ICT and coding: our platform being available not only in English but also in Dutch, in Hungarian, Italian, in Portuguese and in Spanish.

Project duration
2018 - 2020

Project Reference
2018-1-IT02-KA204-048292

Action Type
Strategic Partnerships for adult education

Project duration
2017 - 2019

Project Reference
2017-1-RO01-KA204-037202

Action Type
Strategic Partnerships for adult education

LINK WITH THE LET'S STEAM TRAINING

The partners are attached to finding pedagogies that can rely on motivation more than technicity to enable catching young girls for instance in the programming process. The contents developed by the LIFT project can be useful for dissemination activities towards young girls thanks to the work done on representativity, showing success stories to the students of women careers in ICT. The work performed on the axis of motivation is very relevant, and the results will be integrated as guiding principles of Let’s STEAM inspiring activities, especially on the stereotypes issues where LIFT report on “Barriers for Women to Participate in ICT Training and Employment” concludes in “Gender stereotypes.

OTHER INSPIRING INITIATIVES

Several projects funded at national levels have been analysed. These projects offer opportunities for synergy exploitation with regard to the project outcomes with the support of local policymakers and strong organisations, enabling an easier implementation at local scale. In addition to projects, competitions at local, national and EU Scale have been studied. These events are perfect moments to disseminate the content of Let's STEAM and provide additional assets to participants in terms of platform functionalities. Eventually, engaging teachers is a true challenge. Hence, the consortium is keeping track record of several initiatives handled by schools and teachers to enable the development of a compendium of activities that can be considered as inspiring to convince teachers that undertaking our curriculum will help them gain content, motivation and interests from the students. Discover these initiatives here.

- **MIND THE GAP: A SNAPSHOT OF E-SKILLS GENDER DIFFERENCES IN SPAIN (MindGAP).** The main goal of this project is to measure the digital gender gap in terms of self-perception and performance of e-skills and analyse if it predicts women STEM dropout rates in Spain. Main inputs for let's STEAM is that this project may contribute to better understand some of the inequalities underlying when promoting STEM and, in particular, computational and programming activities. These inequalities will be more evident when designing and implementing teacher trainings. By promoting the introduction of a gender perspective, Let's STEAM will increase its inclusiveness.

- **OBSERV@COMDID: AN E-OBSERVATORY FOR THE DEVELOPMENT AND THE PROFESSIONAL PRACTICE OF TEACHERS' DIGITAL COMPETENCE IN PRE-SCHOOL, PRIMARY AND SECONDARY SCHOOL EDUCATION**. This project aims to create an "Observatory" or the use of ICT in Spain in order to evaluate the Teachers' Digital Competence (TDC) and provide strategies to promote the development of Teachers' Digital Competence and their translation to the use of use of digital resources in preschool, primary and secondary school education. For Let's STEAM, the Observatory Observ@COMDID may contribute to understand the relationship between teachers' digital competence (assessed through the questionnaires of the project) and the uses of different ICT in classroom -such as robotics- to identify patterns and better define teachers' needs. Thus, from this analysis the personalization of teacher's training according to the profiles emerging can be more accurately defined. We have been developing a collection of videos to disseminate the results which are being posted in Twitter and in the end section of the homepage. We are developing a series of videos to disseminate the project. Some of them have little relation with Let's STEAM, but other ones (related with gender and STEM practices) are clearly related.

- **STEAMCat**. This is the project of the Ministry of Education of Catalonia which aims at promoting STEAM education in secondary teachers (mostly) by providing specific trainings and follow-up. One of their main foci of interest is the use of robotics in secondary lessons. They explicitly support our Let's STEAM project and, actually, they have collaborated with us in the data gathering.

- **Class'Code**: This is an innovative training program which, since the start of the 2016 school year, has trained education and animation professionals to give them the means to introduce girls and boys from 8 to 14 years old to computer thinking. . It includes 5 online modules (MOOC type) coupled with meeting times between learners. Each module allows in ten hours spread over 3 to 4 weeks, to facilitate the first discovery workshops with young people: creative programming, coding of information, fun robotics and related societal issues. The Class'Code initiative will provide inputs on training contents in addition to a good channel for recruiting teachers in France.

- **Concours Robot ITER**: ITER Robots Master gathered nearly 600 participants on May 24, 2018 in Manosque, France. Organized by the Agence ITER France, with the support of the Aix-Marseille-Nice academy and the engineers of ITER and CEA, ITER Robots allows middle and high school students to work in project teams. Each team presents robotics, general culture and communication tests.

- **Tarraconada & mSchools:** Tarraconada is an Spanish event aimed at secondary students and teachers in which students meet for one day and do ICT activities together using augmented realty. This project is supported by mSchools (educative project of GSMA). We also have contacts with them and we believe that their initiative mSchools Students Awards (in which the Ministry of Education also collaborates) is relevant for the project. These awards are given to students' projects off app development and/or Scratch coding (depending on the age).

- **First Lego League of Reus**: First Lego League of Reus is a robotic Spanish creation program for young people from 9 to 16 years, which is designed to motivate young people with science and technology and teach them important values and knowledge. FLL can be performed in a class but was not designed for that purpose. Teams, made up of ten kids with at least one adult coach, can also come from a pre-existing, extracurricular club or organization, or just be a group of friends who want to do something amazing. Contrary to popular belief, coaches do not need any technical experience. If aimed at the use of robots it can be a good arena to identify teachers to participate in the Let's STEAM project.

- **INTROBOT:** Introduction of educational robotics in preschool teacher training. The aim of this initiative is to promote the use of educational robotics in the degree of Preschool Education, so that future teachers develop the necessary skills for the introduction of robotics as a learning tool. Through the implementation of different lessons students have had the opportunity to observe robots' full potential to create and evaluate educational material adapted to the real needs of the educational context. **The lessons have been already carried out and now results are being analysed to characterize the impact on students, that can enhance the Let's STEAM vision and concept.**

- **The use of mobile devices in the classroom.** Elaboration of educational materials through a collaborative experience of learning service. This project aims at designing teaching and learning materials in an electronic format for preschool and primary education pre-service teachers. Some of the designed materials are focused on robotics, which pose a challenge for participants. This project may contribute to Let's STEAM by showing some of the main teachers challenges when designing robotics activities and implementing them with their students.

FOCUS ON:

NATIONAL THEMATIC EDUCATIONAL CONTEST "BUILD YOUR OWN SEISMOGRAPH"

What is it?

Since 2016, Ellinogermaniki Agogi in collaboration with the National Observatory of Athens organizes a thematic educational contest which runs at the national level in Greece. Eligible to participate are student teams of primary and secondary, both general and vocational, education. The main goal or challenge of each team is to build a DIY seismograph, elaborate on the principles of operation, document the whole procedure, and finally make a comprehensive presentation of their study, work and construction. The evaluation criteria include Overall quality and completeness of work; Scientific correctness; Incorporation of audiovisual material created by students; Emphasis in inquiry-based science learning, problem-solving, creativity and collaboration; Inclusion of students of social or economic disadvantage and/or special needs; Emphasis in promoting awareness within the school or local community of measures of civic protection and precautionary actions in case of an earthquake event.

The contest is communicated officially to all schools from the Ministry of Education of Greece and it runs annually from January to April. Every year the contest attracts the interest of schools across the country, from urban and rural areas. School teams share the devices they built using various hardware technologies such as Arduino, Raspberry Pi, Lego Mindstorm and software programming platforms in Scratch, Python, C++, etc. Among the participants are both vocational schools and schools of students of special needs along with gymnasiums and lyceums of general education.

An evaluation committee assess all submitted entries and accompanying materials of each school team and list the final contest winners. The winning student teams, and their teachers/supervisors are then invited to receive a commemorative symbolic certificate and more importantly to present their work and demonstrate their seismograph in a ceremony is e.g. in Athens Science Festival or other similar events. The ceremony resembles the function of a real scientific conference where different groups of researchers, scientists or engineers present their work and discuss their findings, exchange ideas and experiences towards acquiring and advancing knowledge or providing solutions to problems and challenges. In this way, and throughout their preparation and work in the framework of the contest, students experience a comprehensive practical understanding of how science and technology advance, increase their interest in related subjects and are motivated to consider them as potential career paths. All guidelines, documents/announcements and final winner teams' submitted materials are publicly accessible at http://seismografos.ea.gr/.

LINK WITH THE LET'S STEAM TRAINING

In the framework of Let's STEAM, similar educational contests may be organized for schoolteachers and their students at national level in different countries or at international level in multiple countries. In addition, the STM32 board and the associated features and functionalities on MakeCode, CircuitPython and Scratch can be used for the next challenges to test the Let's STEAM approach.

FACILITATOR NETWORKS, POLICYMAKERS AND EU INITIATIVES – POLICY ADVOCACY AND SUPPORT

During the last decade, the European Commission (EC) has put significant effort in supporting the development of a connected economy, benefiting to all citizens. A European approach to digital transformation means empowering and including every citizen, strengthening the potential of every business and meeting global challenges with our core values. This is the purpose of the work performed by the DG Connect towards the development of the "Digital Single Market", based on several shared commitments that are considered as guiding principles for the implementation of all initiatives linked to ICT, at all stages of our current society.

This strategy includes several key axes integrating the following components.

Technology that works for people. Development, deployment and uptake of technology that makes a real difference to people's daily lives. A strong and competitive economy that masters and shapes technology in a way that respects European values.

A fair and competitive digital economy: A frictionless single market, where companies of all sizes and in any sector can compete on equal terms, and can develop, market and use digital technologies, products and services at a scale that boosts their productivity and global competitiveness, and consumers can be confident that their rights are respected.

An open, democratic and sustainable digital society: A trustworthy environment in which citizens are empowered in how they act and interact, and of the data they provide both online and offline. A European way to digital transformation which enhances our democratic values, respects our fundamental rights, and contributes to a sustainable, climate-neutral and resource-efficient economy.

Europe as a global digital player: The EU is committed to setting global standards for emerging technologies and will remain the most open region for trade and investment in the world, provided that anyone who comes to do business here accepts and respects our rules.

Through this main policy framework, several EU initiatives have emerged. **The Let's STEAM partners are well aware that their support will be the main asset to reaching policymakers and enable, beyond operational and practical course implementation, to participate in a larger movement.** Hence, several organisations have been identified as perfect relays for scaling and transferring Let's STEAM contents and ambitions, and finding support in developing joint activities:

- **EU Code Week** is a grass-roots movement that celebrates creativity, problem-solving and collaboration through programming and other tech activities. The idea is to make programming more visible, to show young, adults and the elderly how you bring ideas to life with code, to demystify these skills and bring motivated people together to learn. EU Code Week was launched in 2013 by the Young Advisors for the Digital Agenda Europe. The European Commission supports EU Code Week as part of its strategy for a Digital Single Market. In the Digital Education Action Plan, the Commission especially encourages schools to join the initiative. The goal is to reach 50% of all schools in Europe by 2020. Schools at any level and teachers of all subjects are especially invited to participate in EU Code Week, to give the opportunity to their students to explore digital creativity and coding.

- **The EU STEM Coalition** is an EU-wide network that works to build better STEM (Science, Technology, Engineering, Mathematics) education in Europe. The goal is to shape STEM education policies and practices that foster economic growth, opportunity and well-being for all. Together with policy makers, education providers and industry, they work on promoting new ways of delivering education and finding and sharing Evidence-based solutions to skills mismatch in STEM. From reducing shortages of STEM skilled people to fostering new ways in which educational institutions, companies and governments can cooperate, STEM coalition provides a unique forum and knowledge hub for data and analysis, best-practice sharing and direct support. They include dedicated platforms, national ministries, regional authorities, research councils, innovation agencies and university networks and many more. The platforms work closely with our European partners and a range national and regional partners to address skills mismatch in STEM throughout the EU.

- **European Schoolnet** is the network of 34 European Ministries of Education, based in Brussels. As a not-for-profit organisation, we aim to bring innovation in teaching and learning to our key stakeholders: Ministries of Education, schools, teachers, researchers, and industry partners. They are driven by our mission to support education stakeholders in Europe in the transformation of education processes for 21st century digitalized societies. They are identifying and testing promising innovative practices, sharing evidence about their impact, and supporting the mainstreaming of teaching and learning practices aligned with 21st century standards for inclusive education. Since its founding in 1997, European Schoolnet has used its links with education ministries to help schools become effective in the pedagogical use of technology, equipping both teachers and pupils with the necessary skills to achieve in the digital society. European Schoolnet is at the forefront of the debate on how to attract more people to science and technology to address the future skills gap that Europe is facing. STEM is one of European Schoolnet's major thematic domains. We have been involved in more than 30 STEM education initiatives, financed through European Schoolnet's Ministry of Education members, industry partners, or by the European Union's funding programmes. The portfolio of European Schoolnet STEM projects ranges from teacher training (Amgen Teach) to technology-enhanced learning (Next-Lab), and science awareness for schools (Space Awareness). European Schoolnet is also leading the work of two strategic initiatives in science and mathematics education in Europe: STEM Alliance and Scientix.

- **WiTEC** was formed as a network in 1988. After more than ten years of networking and project activities related to women and STEM it established itself as a non-profit European association in May 2001. WiTEC aims to increase the number of girls and women studying STEM subjects and to help them progress into related careers and develop women's technical and entrepreneurial skills through training initiatives and projects.

- **Science on Stage Europe** is a network for STEM teachers focusing on the exchange of best practice teaching ideas. The ultimate goal is to improve STEM teaching by supporting educators in their professional development and growth. By spreading innovative teaching concepts among Europe's science teachers, we enable more students to gain the affordable skills they need for a challenging future and encourage them to consider a career in science, ICT or engineering. Since its launch in 2000, Science on Stage has reached about 100,000 teachers and teacher trainers in over 30 countries (extrapolation by country representatives in 2011 and 2015). A network of National Steering Committees in these countries provides the interface to their national STEM teacher communities. Science on Stage Europe is the umbrella organisation that supports the 34 member countries with the realisation of their activities and helps with the coordination of the national festivals. The broadening of the network, the acquisition of new members and various administrative tasks are carried out by the headquarters in Berlin.

- **EERA ('European Educational Research Association')** aims to further high-quality educational research for the benefit of education and society. High-quality research not only acknowledges its own context but also recognises wider, transnational contexts with their social, cultural and political similarities and differences. The association's activities, such as the annual conference, season schools for emerging researchers and publishing, build on and promote free and open dialogue and critical discussion and take a comprehensive and interdisciplinary approach to theory, methods and research ethics. EERA membership is made up of more than 35 national and regional Educational Research Associations from all parts of Europe.

STEP 2

WHO CAN PRODUCE THE DESIRED EFFECT? WHO ARE THE CONSUMERS OR USERS OF OUR PRODUCT? WHO WILL BE IMPACTED BY IT?

Assessment of the target's needs and objectives in the context of STEAM (science, technology, engineering, arts and mathematics) education requires a multidisciplinary approach. STEAM education activities take advantage of the creative computing (Brennan, Balch & Chung, 2014) and maker culture approaches (Dougherty, 2012; Peppler, Halverson & Kafai, 2016) developed in an increasing number of formal and informal settings in recent years.

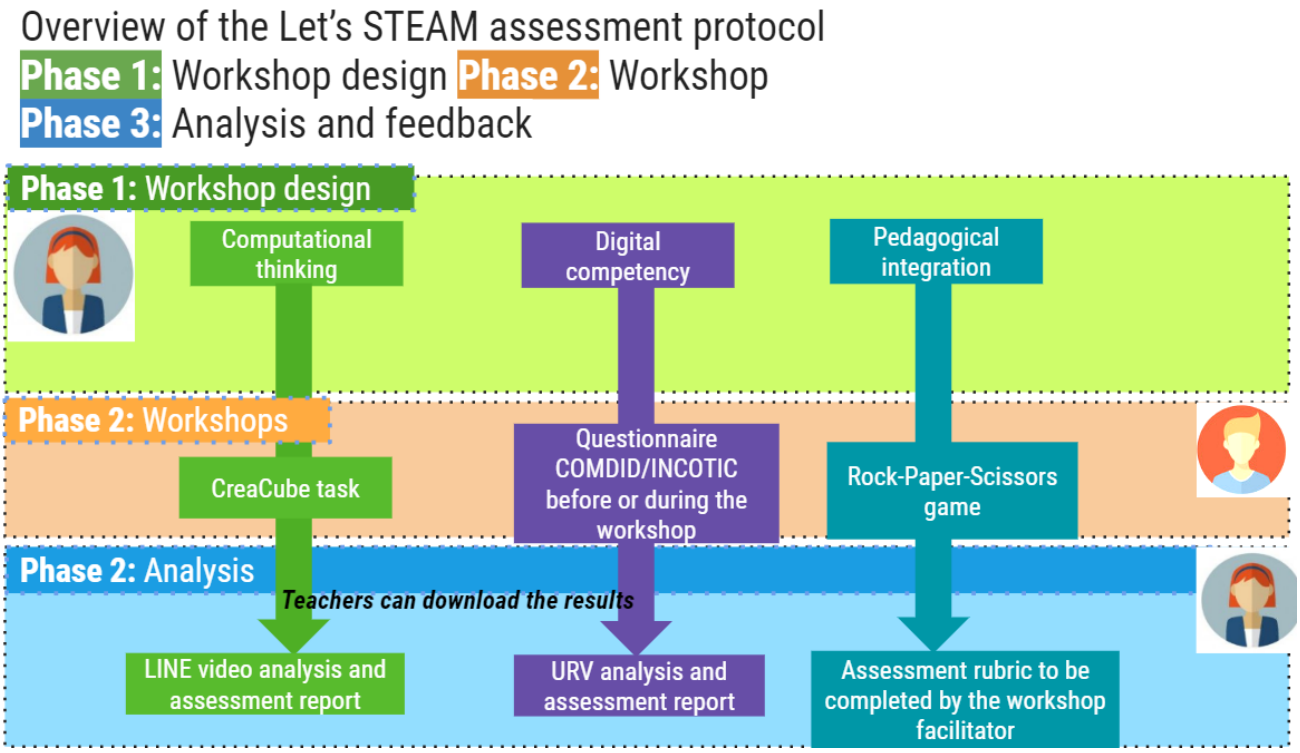
Within the Let's STEAM project we consider creativity as a process that could be supported not only by computers but also by diverse digital technologies, such as robotic components and micro controller cards. Learning-by-making and by tinkering in STEAM activities serves to develop a creative computing approach aiming to engage the learners in the construction of digital and tangible artefacts using technologies (Martin, 2015). According to Mclaren, Stables & Bain (2017) "the articulation and externalization of personal and creative thinking from the 'minds eye' to a tangible outcome is a central issue when engaging in design activity". Maker-based education and STEAM activities through maker-based approaches could therefore be considered as a form of design-based learning in which the learners are engaged in modelling and prototyping a physical, and often digital-enhanced, artefact (Lille & Romero, 2017).

WHO ARE THE CONSUMERS OR USERS OF OUR PRODUCT?

In order to develop a common approach for the partners of Lets' STEAM we developed a mixed methods approach in which self-reported measures are combined with activity-based observations including a modular robotic activity (CreaCube) and a playful activity (Rock paper scissors with Micro:Bit). Hence, Let's STEAM project assessment is developed through a mixed methods approach combining self-reporting measures in the context of teachers' digital competencies (COMDID-A), but also direct observables through the CreaCube task.

Operationally, the Let's STEAM project assessment includes evaluations concerning the different stakeholders of the project activities. The assessment will be based on different areas, according to the main aims of the four different designed assessment activities:

- A1. Computational thinking among learners and teachers
- A2. Teacher Digital Competency (TDC) and students' digital competence
- A3. Pedagogical integration of the activities
- A4. Teachers' attitudes toward STEAM education and its integration in curriculum.



Several sets of activities have been hence proposed to the partners to perform the second step presented in the next pages. Mainly, the partners have focused on questionnaire development leading to the deployment of personas.

TOOL #1

COMPUTATIONAL LEARNING THROUGH CREACUBE TASK

What is it?

The assessment of computational thinking among learners and teachers is developed through CreaCube task and the questionnaire on algorithmic thinking in charge of Learning, INnovation and Education (LINE) research team. CreaCube is a playful task to evaluate computational thinking (Romero, David, & Lille, 2019), here is a description: https://www.researchgate.net/publication/329040986_CreaCube_a_playful_activity_with_modular_robotics. More information about the CreaCube task, recording the video and send it to the CreaCube team for its analysis can be accessed through: https://frama.link/HowToCreaCube. **On March 2020 meeting in Athens, all the partners were introduced to the CreaCube protocol for data collection.**

Description of apparatus

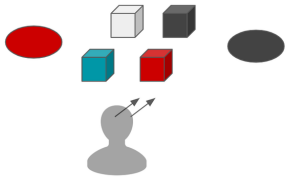
The CreaCube tasks uses a set of four Cubelets which has been given to each Let's STEAM partner during the meeting in Athens. The set of Cubelets include the drive cube (white cubes with wheels and motor), the battery cube (dark blue with a on/off switch and a mini USB charger), the distance cube (black cube with a distance sensor) and the inverse cube (red cube without no visible feature). The cubes are magnetic and can be assembled to act as a robotic system. When the four cubes are assembled in a certain order, the red cube has the potential to inverse the distance sensor signal and allows the system to activate the wheels motor.

Procedure

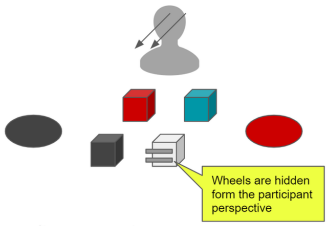
The cubes are set separately as coins of a square instead of aligned in order to avoid a Gestalt bias of regrouping the cubes in a linear way. The special visible features (wheels in the white cube, on/off switch and mini USB charger on the blue cube, distance sensors in the black cube) are hidden by a cover from the participants' perspective in order to avoid to notice them without prior manipulation. First, the participant is invited to listen to the instructions: "You need to build a vehicle of four pieces that move autonomously from the red point to the black point". The recorded inscriptions inform the participant the experimenter cannot provide any help, but the participant has the possibility to listen again the instructions. When the instructions are finished to be played, the experimenter remove the cover that hides the cubes making them finally visible to the participant.

Preparing the cubes on the table (before participants enter to the task place)

1. Verify the **battery cube** (dark blue) is charged. If not, charge it through the mini-usb. The cube needs 90 min to fully charge.
2. Set the **battery cube** switch off.
3. Situate the cubes in the exact position.
4. The affordances (wheels, switch button, sensor) should be hidden to the participant.



Participants' perspective



Video recording perspective

TOOL #2

TEACHER DIGITAL COMPETENCE

What is it?

Teacher Digital Competence is made up of a set of capacities, abilities and attitudes that the teacher must develop in order to incorporate digital technologies into his or her professional practice and development (Lázaro Cantabrana & Gisbert Cervera, 2015). In particular, the TDC is concreted in 4 dimensions, as in the work of Lázaro Cantabrana (2015), which are the following:

- D1 - Didactic, curricular and methodological aspects
- D2 - Planning, organization and management of digital technology resources and spaces
- D3 - Relational aspects, ethics and security
- D4 - Personal and professional aspects

For the Let's STEAM project, TDC will be measured as self-perceived, which refers to the extent to which teachers think they have their TDC developed. This assessment will be carried out through the COMDID-A questionnaire, based on the rubric published in Lázaro Cantabrana (2015) (URV team). In this rubric, 4 different areas (classroom, educational center, educational community and environment, and professional development) are considered for each dimension in which the TDC takes place. Moreover, 4 different levels of development are considered in the rubric. More information about the description of the areas, levels of development and items can be found in Part 3. The English version of the questionnaire can be accessed through the following link: **https://pedagogia.fcep.urv.cat/application_src/index.php/quiz/view/51**.

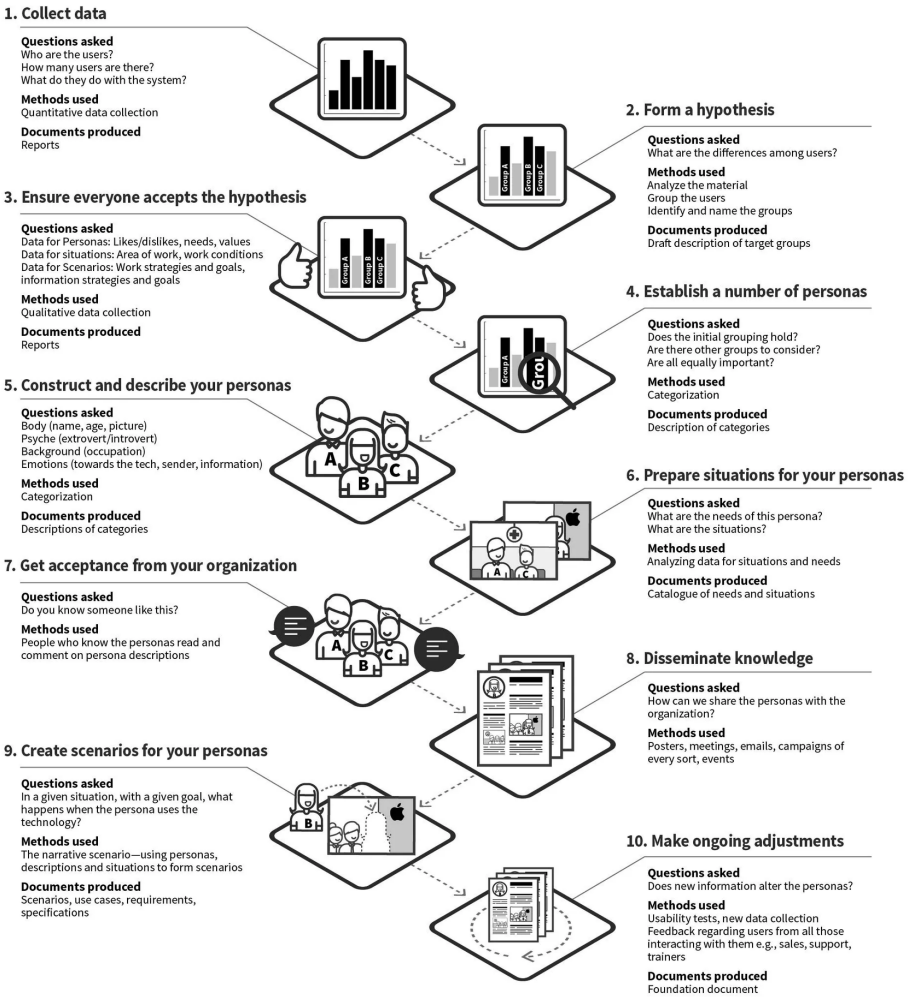
Based on participants' ratings in the questionnaire, their answers are classified into one of the 4 different levels of the TDC. As a formative feedback, at the end of the questionnaire, results are shown to the participant, as well as possible recommendations to improve own's TDC. To assess the impact of each activity on participants' TDC, pre and post tests will be conducted using this described tool before and after teachers' participation in the Let's STEAM activities. Teacher Digital Competence (TDC) is made up of a set of capacities, abilities and attitudes that the teacher must develop in order to incorporate digital technologies into his or her professional practice and development (Lázaro-Cantabrana, Usart-Rodríguez, & Gisbert-Cervera, 2019).

For the Let's STEAM project teachers' self-perception of their Teacher Digital Competence (TDC) will be measured, which refers to the extent to which teachers think they have their TDC developed. This assessment will be carried out through the COMDID-A questionnaire, based on the rubric published in Lázaro-Cantabrana, Usart-Rodríguez, & Gisbert-Cervera, (2019) (Université Rovira i Virgili team). The evaluation of the Teacher Digital Competence considers four dimensions: (i) the didactic, curricular and methodological aspects; (ii) the planning, organization and management of digital technological resources and spaces; (iii) the relational aspects, ethics and security; and (iv) the personal and professional aspects.

Digital competence of students, in a nutshell, is defined by their competence in the use of different ICT and their competence in the management of information (Universitat Rovira i Virgili, URV, 2009). It is evaluated through the INCOTIC questionnaire, which evaluates students' digital competence considering five dimensions: (i) characterization of the access to digital resources and the degree of ICT use in general; (ii) knowledge and use of particular digital resources; (iii) culture and respect in the use of digital information; (iv) efficient access to information; (v) levels of use and efficiency in the communication of information. More information about the description of these dimensions is published in González Martínez, Espuny Vidal, De Cid Ibeas, & Gisbert Cervera (2012) (in Spanish).

TOOL #3

USING PERSONA FOR DESIGN THINKING



Lene Nielsen's poster covers the 10-step process to creating engaging personas that participants are the most likely to find relevant and useful in their design process and as a base for their ideation processes. © Lene Nielsen, All Rights Reserved. Reproduced with permission. See section "Exceptions" in the copyright terms.

What is it?

In design thinking methodology, a persona is not based on any specific person but is an abstract representation of many people with similar characteristics. Personas provide meaningful archetypes which can be used to assess the design development against. Constructing personas will help ask the right questions and answer those questions in line with the users you are designing for.

Personas are fictional characters, which are created based on research (in our case, based on the compilation of feedback from the teachers' community, both through the URV questionnaire, or through informal discussions in the community and surrounding partners) to represent the different user types that might use your service, product, site, or brand in a similar way.

Creating personas helps understand users' needs, experiences, behaviours and goals. It is made to help recognize that different people have different needs and expectations, and it can also help you identify with the user you're designing for. Personas make the design task at hand less complex, guiding the ideation processes, and helping in achieving the goal of creating a good user experience .

Developing personas based on the Let's STEAM insights help to focus on designing the functionalities without having to concentrate on dozens, hundreds, or thousands of people in our target audience, especially considering the wide profiles of teachers: depending on the topic they teach, their level of digital readiness, their interest in the field, their learning goals using digital tools ...

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SURVEY

OBJECTIVES & RESULTS

A total of 41 teachers have answered the questionnaire in the month of March 2020, leading to the issue of this first version of the Output 1. From these teachers, different features can be identified. The questionnaire remains on-line to collect additional data within the project, in an iterative commitment.

Methodology - teachers' skills facing digital tools

It is widely accepted that STEAM education represents a paradigm shift from traditional education methodology and philosophy. Moreover, it is expected that between 2017 and 2027, the jobs that will require STEAM skills and competences will grow by at least 13%.

To tackle this challenge, schools in Europe must implement STEAM strategies and pedagogies to promote interdisciplinary and innovative initiatives within the classrooms focusing at the same time on the development and enhancement of programming and coding skills and competencies of both teachers and students. Let's STEAM project is run by partners from academia, research, education and industry and its aim is to develop a framework and platform to assist the teachers in secondary schools to develop new contents and new skills to motivate their students to become more actors than attendees in knowledge acquisition. This is the case of the platforms Scratch, MakeCode and CircuitPython that in the framework of Let's STEAM will be utilized and interfaced to program, control and interact with an advanced Internet-of-Things educational board entitled "STM32 Discovery kit IoT node" offered by the world leader in the field the STMicroelectronics industrial company. However, at the moment most of school teachers are not yet motivated or trained enough to use these platforms.

In this context, the Let's STEAM project has been designed to provide the set of skills for teachers to enhance their STEAM approach by training them in programming but more importantly to help them understand the potential in terms of pedagogy of interdisciplinary use of programming as a priority and thus be able to create innovative pedagogical content in class with and for their students. To approach their needs, Let's STEAM has implemented in five different countries (Belgium, France, Greece, Italy and Spain) the deployment of a dedicated research questionnaire understanding the needs and the basic skills of teachers with respect to programming capabilities.

The aim of the research was to assess teachers' digital competence in different participant countries, as well as teachers' previous experience with computational thinking and programming languages and expectations regarding their training. For this purpose, a questionnaire with 3 different sections was designed as it is explained as follows.

Assessing teachers' digital competence

The assessment of Teachers' Digital Competence (TDC) was based on the COMDID-A self-assessment tool (i-DEPOT number 116248), an instrument developed by the ARGET research group in previous years. TDC is defined as the set of capacities, abilities and attitudes that the teacher must develop in order to incorporate digital technologies into his or her professional practice and development (Lázaro Cantabrana & Gisbert Cervera, 2015). In particular, the TDC is concreted in 4 dimensions, as in the work of Lázaro Cantabrana (2015), which are the following:

- D1 - Didactic, curricular and methodological aspects
- D2 - Planning, organization and management of digital technology resources and spaces
- D3 - Relational aspects, ethics and security
- D4 - Personal and professional aspects

In each dimension, 4 different areas are considered in which the TDC takes place:

- **Classroom**: In this area, teachers use digital devices in the classroom, design and program teaching and learning activities with digital technologies, manage the classroom, provide feedback and evaluate students with digital technologies and design teaching and learning activities to promote the digital competencies of students.
- **Educational centre**: In this area teachers use and take care of the digital infrastructures and technologies of the centre, respect the organization's digital identity, carry out the follow-up and coordinate the use of the institutional digital resources at the pedagogical level, and incorporate training strategies of the organization in the technological field.
- **Educational community and environment**: Teachers use and organize the resources of the centre to foster social participation.
- **Professional Development**: Teachers configure their personal learning environment, work in a network manner, manage their digital identity, are trained permanently, and model and lead the use of digital technologies.

These areas are relevant because they provide a clear picture of the different situations in which these set of functions and purposes of the TDC have implications and in which a teacher must be competent. Therefore, identified areas should be considered as a reference to know where to collect evidence for the evaluation of the impact of educational strategies and/or for teachers' accreditation.

23 indicators are defined based on these 4 dimensions and areas. In the questionnaire, teachers are asked to choose at which level they feel they can carry out a particular action, which is related to an indicator. Based on their ratings, results of the questionnaire allow to define 4 different levels of development of the TDC (Lázaro Cantabrana & Gisbert Cervera, 2015):

- Beginner Level: Use of digital technologies as enabler and enhancement to the teaching and learning processes.
- Medium level: Use of digital technologies for the improvement of teaching and learning processes in a flexible way and adapted to the educational context.
- Expert level: Use of digital technologies efficiently to improve students' academic performance, the quality of their own teaching, and the quality of the educational center.
- Transformative Level: Uses digital technology, researches on its use to improve teaching and learning processes and transfer the conclusions of their researches to address the needs of the education system.

Assessing teachers' experience and expectations with computational thinking

In a second part of the survey, additional questions were introduced to assess teachers' previous experiences with computational thinking and the use of programming languages, as well as to gather data about their expectations for the lets' STEAM teacher training. To avoid an excessive extension of the questionnaire, 4 additional questions were introduced to:

- Assess the perceived experience of teachers in terms of the time they have been using these resources and the type of resources they usually use in their lessons
- Assess the perceived overall competence when programming
- Assess teachers' expectations for training

The assessment of perceived experience and overall competence in programming were assessed using a 5-point Likert scale. Type of resources and expectations about training were gathered through open questions. Analysis for the closed question was based on basic descriptive statistical methods, whereas open questions were content analysed to identify common themes and elements among participants.

Identifying teachers' professional profile

Finally, in order to better interpret the gathered results and possible bias in the answers, additional information about participants' profile was asked. In particular, participants' gender, age, country, initial background, educational level taught, and years of teaching experience were asked.
Data gathered in all these questions was also analysed through basic descriptive statistical methods.

Questionnaire

The final let's STEAM questionnaire can be accessed at:
https://pedagogia.fcep.urv.cat/application_src/index.php/quiz/view/51

As well, a pdf version of the questionnaire was made in case some teachers had issues with their Internet connection. The on-line version of the questionnaire provides an immediate feedback for each participant's results after the completion of the questionnaire about their own level of TDC, based on the 4 levels described above. As well, some guidelines are provided, according to each participant level, which suggest possible improvements to increase the participants' teacher competence. Results about previous experience and expectations as well as professional profile were not included in the participants' personal report.

Results

The majority of participants are males (61%). Most participants are in their 40s, with being 36 the most frequent answer. Participants most frequent age is comprised between 30 and 38 years old.

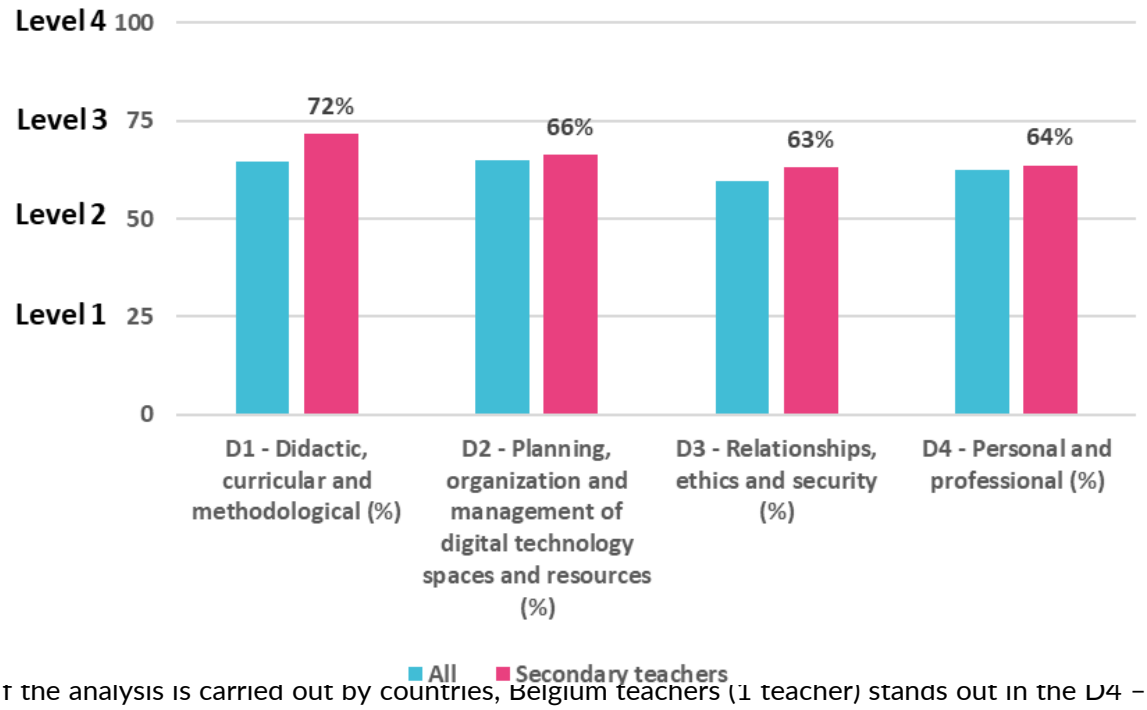
Gathered answers come from Greece (44%), Spain (29%), France (22%), and Belgium (2%). No answer has been gathered yet from Italy and Bulgaria.

Male	25	61%
Female	16	39%
TOTAL	41	100%

The majority of them are in secondary education (54%). Most participants are experienced teachers, with more than 10 years of experience (61%) or between 5 and 10 (29%).

Teacher Digital Competencies.Teacher digital competence is **relatively high** in participant teachers. Overall, teachers display higher values in the **planning, organization and management of digital technology spaces and resources** (D2), as it is displayed in the following graph. However, in all dimensions, all participants' level is between Level 2 (Medium) and Level 3 (Expert) of the teacher's digital competence. In this sense, participant teachers are expected to **use digital technologies to improve the teaching process** in a **flexible way** adapted to the educational context (L2), to improve efficiently students' academic results, their teaching action and the quality of the education centre (L3).

If only secondary teachers are considered, teacher digital competence is more focused on the **didactic, curricular and methodological dimension** (D1) (72%), which is closer to Level 3. Indicators of "**Digital technologies as facilitators of learning**" and "**The students' digital competence in the didactic planning**" display **higher values** in this dimension.



If the analysis is carried out by countries, Belgium teachers (1 teacher) stands out in the D4 – **Personal and professional dimension**, almost at the Levexpert), over the overall mean. However, in the D3 – Relationships, ethics and security, their score is under Level 2. Score for the dimension 1 (didactic, curricular and methodological is also lower than the average sample). However, as only one teacher has answered the questionnaire, these results may have low significance in terms of country representation.

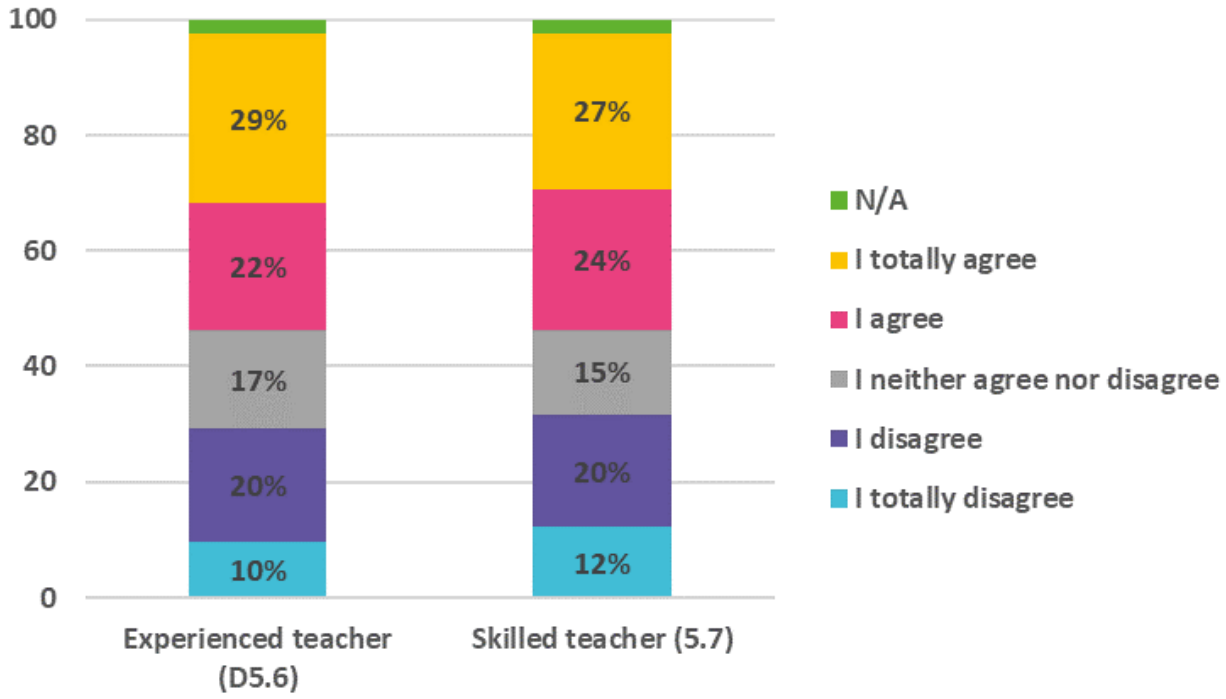
French teachers (9 teachers), score their highest values for the **Didactic, curricular and methodological** dimension (D1), a bit over the mean sample average. In second place, in the personal and professional dimension (D4), but at a similar level than the sample average. D2 and D3 are closer to the level 2 in these teachers and below the sample average levels. Thus, teaching resources would need to provide indications about how, for example, promote the responsible and safe use of new digital technologies in the educational centre and with students.

Finally, participant Spanish teachers (12 teachers), score above the sample mean in all dimensions of the TDC, especially for the Didactic, curricular and methodological dimension (D1), which is above Level 3. Based on the results, Spanish teachers would benefit from teaching strategies addressing the relationships, ethics, and security dimension (D3), and personal and professional dimension (D4). For example, to manage digital spaces to share knowledge and promote the participation and interaction of the educational community, promote the responsible and safe use of new digital technologies in the educational centre, or transfer training in the digital field to improve your own professional practice and the quality of the educational centre.

No data has been gathered about Italian and Bulgarian teachers.

Experienced and skilled perceptions in programming. Most participants feel they have experience programming in class and feel they are skilled teachers when it comes to use programming languages. If the statistics are carried out considering only answers from teachers in secondary school or inter-levels, results are very similar.

Experience in programming languages and using robotics. Participant teachers mostly report using visual programming tools (19 teachers) to promote computational thinking with their students. Scratch is the most used software. General-purpose programming tools are less popular (15 teachers), though still significant. Within this category, Python and C/C++ are the most popular ones (5 teachers mentioned them in both cases). Regarding hardware, Arduino microcontroller is the most popular one (8 teachers use it), followed by Micro:bit (4 teachers) and Lego hardware (4 teachers).



FOCUS RECOMMENDATIONS BASED ON THE QUESTIONNAIRE ANALYSIS

In relation with the content:

- Teachers emphasize the need to focus in the interdisciplinary approach, using programming as a tool/medium, not only as a target itself.
- Almost a third part of the mentions, emphasize the use of programming in connection with other STEM disciplines and with the inquiry approach and in connection with the experimentation/modelling of the real-world phenomena.
- Another third of teachers emphasizes the connection of programming with the arts (visual arts, performing, etc.)
- The final third of the teacher only mention the need to stimulate curiosity and creativity through programming.
- A few numbers of teachers (2) manifest some programming skills to be included (e.g. IoT protocol like MQTT)

In relation with the methodology:

- Many teachers would like project-based learning activities (e.g. guiding question, with a finalised product, connection with inquiry skills...).
- Some teachers would also like the possibility to have different adaptations of the activities according to different educational levels or students' needs. 3 teachers specifically mention a need to have inclusive activities or activity variants to make the product more inclusive.

In relation with the programming platforms:

- Most of the teachers value to have a pool of good examples of project/ activities/ classroom proposals which are already-made and ready-to-implement.
- As well, teachers manifest a need to include explicit teaching strategies in the educational materials offered.

PERSONAS

RESULTS OF THE PERSONA ASSESSMENT

WHO ARE THE CONSUMERS OR USERS OF OUR PRODUCT? DEFINITION OF PERSONAS

Profile & Description	Linked goals	Linked Persona
Trainers of teachers delivering the Training of Trainers programme to secondary school teachers	• Design learning contents • Animate training sessions • Follow the classroom • Create a project • Manage a project • Follow the project team • Share pedagogical resources • Find opportunities for collaborating • Provide contents in many languages	Jorge Valiente
Trainers within secondary schools, hence considered both trainees and trainers		Dirk De Brouwer Mélissandre Aubry Faustina Baratto Jorge Valiente Euthalía Diamantopoulos
The trainees more specifically the teachers that will get trained during the ToT programme	• Find adapted contents to his level • Consult training contents • Participate to training sessions • Follow their skills' acquisition • Identify the competences needed for resolving a project • Collect data for exploration and experimentation • Export data for analysis and interpretation • Association additional resources (external documents, reports...) • Collaborate, brainstorm and exchange ideas • Participate to international and interdisciplinary challenges • Publish the results of the challenges • Access data from other schools and trainees	Dirk De Brouwer Mélissandre Aubry Faustina Baratto Jorge Valiente Euthalía Diamantopoulos
The Policy Makers that will support the integration of these tools in the curricula	• Consult learning pathways and curricula • Explore the projects towards the competences • Understand the national skills framework	Bernard Fournier

Jorge Valiente	The technology fan	Trainers of teachers; Trainees i.e. secondary schools' teachers in their position of learners in the ToT programme; Secondary schools' teachers in their teaching position

BIOGRAPHY

Born in Montcada i Reixac, he always lived in the outskirts of Barcelona. Passionate about new technology, since his childhood, Jorge has always spent a lot of time tinkering with all the objects that came to hand.

After a scientific course, he specialized in IT and obtained a master's degree. At the start of his career, he worked in a large company as a backend developer. Loving to transmit and share, he quickly converted to teaching.

For 8 years now, he has been a teacher in a school located in difficult neighbourhoods. Although it is difficult for him to have the necessary budget to purchase the last educational robot he would dream of having it for his class. Jorge has already introduced programming and programmable cards for a long time in these lessons.

NEEDS

- He needs self-training resources to advance technical skills
- To make new projects with these students, he need programmable board affordable and versatile. He don't want to loose time with a solution non standard and well established.
- Compatibility with several software environments and several hardware target is a crucial point.
- To illustrate how IoT works, he need the possibility to comunicate board to board, board to computer and board to the cloud platform.

FRUSTRATIONS

- I need to learn too many tools due to the lack of interoperability between software and hardware.
- Each board vendor, try to introduce incompatibility inside open-source projects to keep teachers captive.
- In his school, few of his colleagues are interested in programming, programmable cards and the potential of active pedagogies that this opens up.

Jorge Valiente

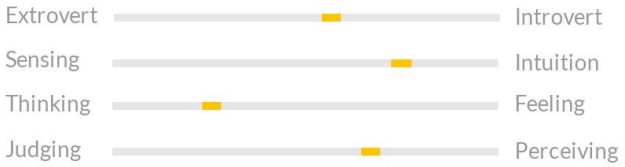
The technology fan

Age: 33 years
Married: Yes
Kids: Justin (1)
Education: Master degree in Computer Science
Occupation: Secondary school teacher in Technology
Year of experience: 8
Location: Barcelona, Spain

DIGITAL COMPETENCES

TECHNOLOGY LEVEL

PERSONALITY



Dirk De Brouwer	The Old fashioned	Trainees i.e. secondary school teachers in their position of learners in the ToT programme Secondary schools' teachers in their teaching position

BIOGRAPHY

Dirk was born in the Flemish countryside in the post-war period. Coming from a family of workers in the steel industry, he is the first of his siblings to access higher education. Pupil of Paul Gochet, he obtained his license in Mathematics in 1982. At the end of his studies, he decides to pass the competitions of secondary education which he succeeds on the first try.

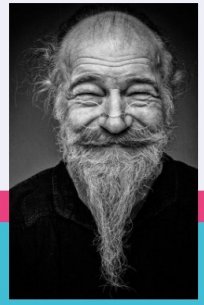
Passionate about Mathematics, he has for many years prepared his best students for the Belgian mathematics Olympics. Five times in his career, his students were finalists and one even finished first in the Midi category. In recent years, he has found it increasingly difficult to motivate his students to do math. He has already tried to introduce digital tools into his teachings but without much success.

NEEDS

- He would create motivative contents to better engage his students in mathematical activities
- He would like to show his students how mathematics can be a concrete tool at the intersection of all scientific and technical disciplines
- He needs to better master digital tools to illustrate his statistics lessons with data from scientific experience conducted by his colleague physicist.
- He would like to offer these students both fun and creative projects to be more involved in learning Mathematics thinking

FRUSTRATIONS

- The student seems to dislike more and more mathematics
- He is afraid that big companies lock his students on proprietary tools.
- He finds it difficult to follow online training that is unsuitable for him and without reflective exchange on teaching practices with other colleagues



Dirk De Brouwer

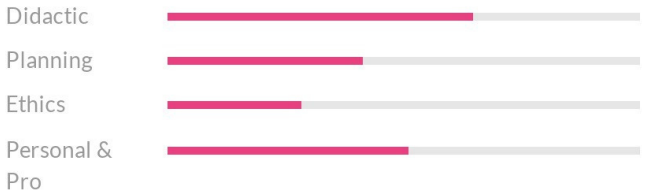
The Old fashioned

Age: 60 years
Married: No
Kids: Ingeborg 33, Klaas 28
Education: Bachelor degree in Mathematics
Occupation: Secondary school teacher in Mathematics
Year of experience: 37
Location: Gand, Belgium

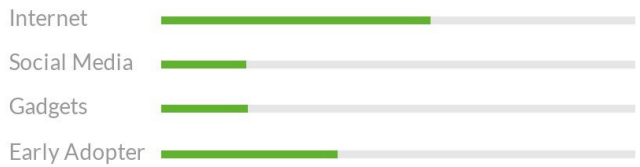
OpenScad

dS AVOND

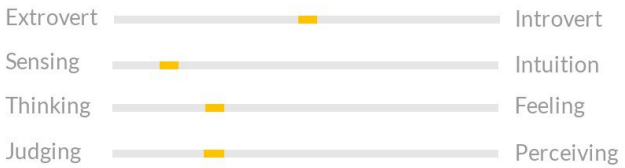
DIGITAL COMPETENCES



TECHNOLOGY LEVEL



PERSONALITY



Mélissandre Aubry	The non-specialist	Trainees i.e. secondary school teachers in their position of learners in the ToT programme Secondary schools' teachers in their teaching position

BIOGRAPHY

Mélissandre is from the north of France. After her studies, she decides to go to nursing school. For several years, she practised her profession at the hospital. Aware of the difficulty of the nursing profession, she decides to reconvert to teaching. At 28, she resumed her studies and passed a master's degree in education science before attempting the contests of French education. After a year of internship in Lille, she chose a position in a rural region.

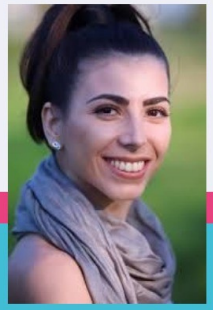
Motivated, passionate and committed, she participates each year with these students in inter-school projects. With the measures of educational continuity during the confinement due to COVID-19, she becomes aware of her shortcomings with digital tools. She is now looking to train on these subjects to offer her students interdisciplinary and creative projects.

NEEDS

- Create innovative contents to better engage my students in my classroom activities
- Undertake a full curriculum on active pedagogies to keep improving her skills and support her pre-existing commitment in transdiciplinary projects
- Exchange with teachers from other STEAM topics, committed to the same approach
- Diversify the opportunities linked to her very specific discipline

FRUSTRATIONS

- She is disappointed by the lack of student's commitment in her topic
- She wants to implement more inquiry-based learning however, she is lacking from tools, in a very poorly digitalised topic
- She lacks pedagogical innovative resources in her discipline as at the cross-border between sciences and social issues.

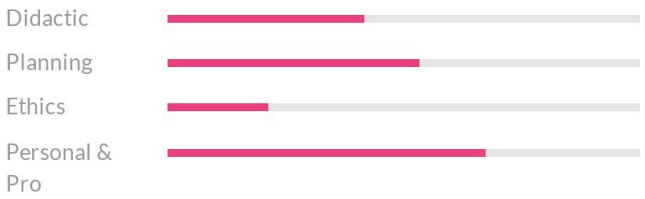


Mélissandre Aubry

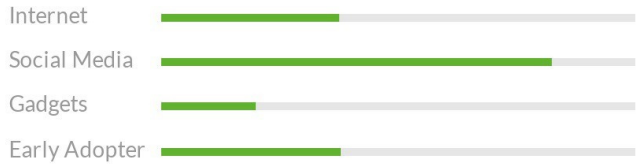
The non-specialist

Age: 34 years
Married: No
Kids: No
Education: Bachelor degree in Science of Nursing and Master degree In Education science
Occupation: Secondary school teacher in Medico-social sciences
Year of experience: 7
Location: Aurillac, France

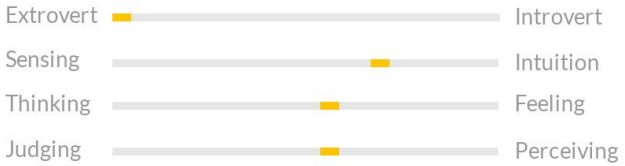
DIGITAL COMPETENCES



TECHNOLOGY LEVEL



PERSONALITY



Faustina Baratto	The playful teacher	Trainees i.e. secondary school teachers in their position of learners in the ToT programme Secondary schools' teachers in their teaching position

BIOGRAPHY

Faustina currently works in a school in downtown Napoli as secondary teacher in Physics. A follower of video games and serious games, she has been trying for several years to introduce this dimension into her teachings.

Always looking for something new, she is currently looking for resources to introduce active pedagogies into these lessons. Not always having all the necessary equipment, the programmable cards and the associated sensors are a good opportunity to confront its students with physical phenomena to study them.

NEEDS

- Learn to design inquiries based activities
- Find new opportunity to build scientific instrument to participate in Citizen Science experiment
- Foster playful learning approach in my classroom
- Find inspiring ressources that I can use/modify/integrate inside my courses

FRUSTRATIONS

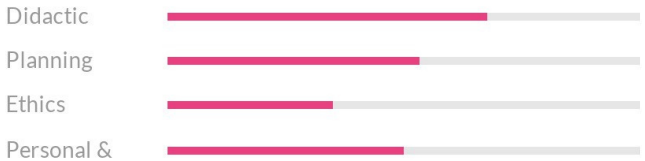
- We need more material to illustrate more experiments with students
- It's hard to understand many Maker projects
- I am not trained in programming and even less in computational thinking

Faustina Baratto

The playful teacher

Age: 40 years
Married: Yes
Kids: Giannina 7, Donatella 10
Education: Master degree in Physics
Occupation: Secondary school teacher in Physics
Year of experience: 15
Location: Napoli, Italy

DIGITAL COMPETENCES



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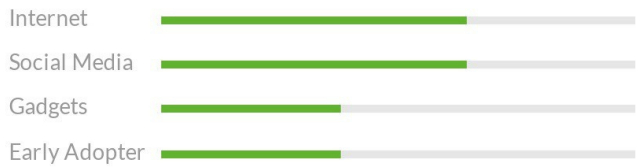

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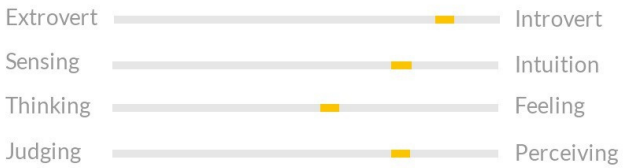


Euthalía Diamantopoulos	The creative	Trainees i.e. secondary school teachers in their position of learners in the ToT programme Secondary schools' teachers in their teaching position

BIOGRAPHY

Euthalía is born in Thessaloniki, Greece's cultural capital. Euthalía rapidly developed a deep interest for living arts that guided her towards Fine Arts studies. After a bachelor degree at the Faculty of Fine Arts of the Aristotle University of Thessaloniki, Euthalía undertook a Master Degree at the University of East London.

Back in Thessaloniki after 2 years abroad, Euthalía decided to transfer these acquired skills to the youngest, firstly through the organisation of story-building interactive art workshops. She participated in planning the gallery's educational programme for schools linked to the Greek National Curricula. Two years after, she joined the Pinewood American International School as a full-time Art Teacher. Euthalía started collaborating with teachers from the engineering department through join projects. Her interest in craft practices was empowered by the used of new practices, such as Arduino programming boards. Nowadays, Euthalía wants to be able to launch these art challenges by herself and needs to acquire practical skills.

NEEDS

- Create living art projects to innovate and explore creativity with her students
- Undertake a full curriculum on programming skills to use the full potential of IoT boards in creating interactive art projects
- Participate in the creation of transdisciplinary curricula with other STEAM teachers to enhance the potential of arts in motivating the students in other disciplines

FRUSTRATIONS

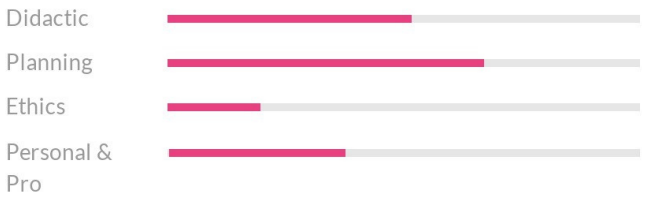
- Being dependant of other teachers if willing to use programming and interactive digital tools
- Seeing art being less targeted by programming opportunities in the curricula

Euthalía Diamantopoulos
The creative

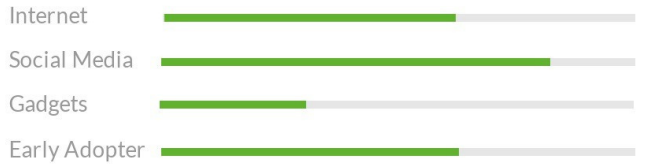
Age: 37 years
Married: No
Kids: No
Education: Master of Fine Arts
Occupation: Secondary school teacher in Applied Art
Year of experience: 10
Location: Athens, Greece

CURIATOR

DIGITAL COMPETENCES



TECHNOLOGY LEVEL



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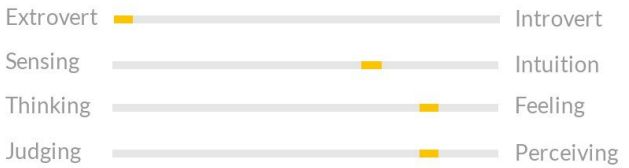


Bernard Fournier	The Policy Maker	Policy Maker

BIOGRAPHY

Bernard Fournier is born in Rouen, both parents being secondary school teachers. After secondary school, Bernard followed a Master Degree followed by a Ph.D. at the prestigious Ecole Normale Supérieure de Cachan in Applied Physics.

Willing to work in Education, after passing the agrégation in 1990, he starting to teach at the Lycée Louis Le Grand in Paris meanwhile teaching at the University of Paris-Saclay.

In 2010, he became an Academy inspector in Paris and in 2014, Academic Director of National Education Services.

Two years ago, Bernard was called by the Ministry of Education and Youth to take the director of the Innovation, Training and Resources department, bringing his vision of innovative practices in Education.

Bernard is highly active in the policymaking European stage, participating to the ET 2020 Working Group on Digital Education: Learning, Teaching, and Assessment, discussing the purposeful and innovative use of digital technologies in education and training, and the development of digital competences.

NEEDS

- He needs to illustrate the choices in terms of eductional policies
- Towards the integration of innovative practices, in cooperation with the Director of Digital Education, he needs to understand the national skills' framework linked to the integration of coding practices
- He needs to better assess and understand the requirements of hardware equipments linked to programming to develop a roadmap of resources affectations in schools

Bernard Fournier

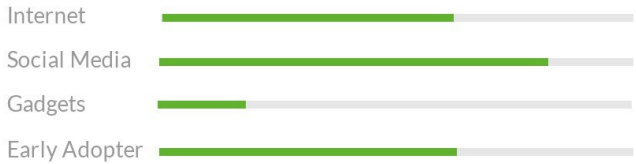
The Policy Maker

Age: 50 years
Married: Yes
Kids: Cassandre (10), Marie (15), Samuel (18)
Education: Master Degree and PhD from the École normale supérieure de Cachan in Applied Physics
Occupation: Deputy Director of Innovation, Training and Resources - General Directorate of School Education - French Minister of National Education and Youth
Year of experience: 20
Location: Paris, France

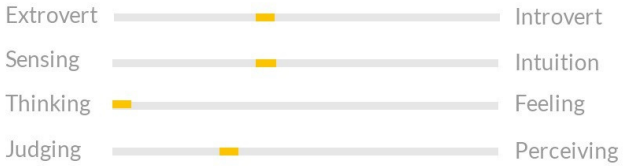
FRUSTRATIONS

- The private hardware sectors is competitive and it is difficult to assess the relevance of the resources needed by the teachers
- The resources affected to hardware equipment might be useless if the teachers are not well trained to use them and we nowadays lack in dedicated training regarding innovative practices to make efficient educational choices

TECHNOLOGY LEVEL



PERSONALITY



STEP 3

HOW SHOULD OUR ACTORS' BEHAVIOUR CHANGE?

Teachers, and in general educators, develop practices of teaching with which they feel comfortable and confident. When they mature it is usually difficult to change them, or they feel insecure to adopt innovative methodologies, technologies or practices such as the educational approach and activities to be developed and proposed in Let's STEAM. However, when asked in surveys, most teachers express the willingness to adopt new methods and models of teaching, that have proven their effectiveness and that lead their students to better results in terms of concept understanding, content knowledge and behaviour or attitude change.

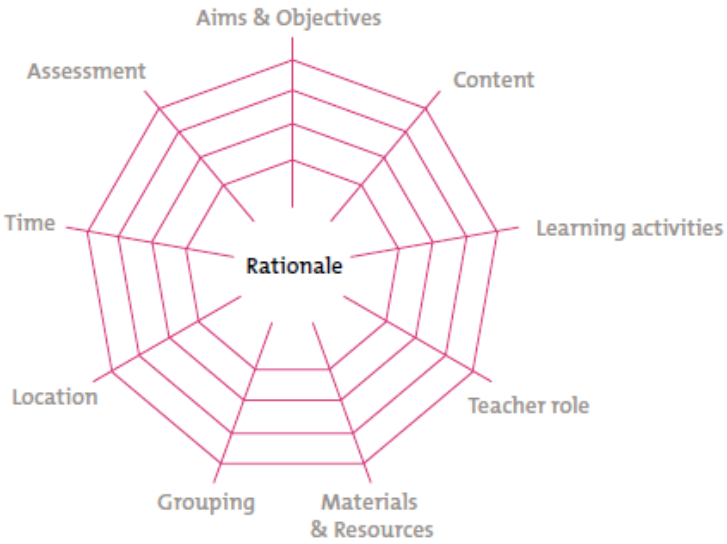
A required condition is that they are thoroughly introduced to practising these new methods before applying them to their everyday classroom teaching. In this respect Let's STEAM aims to develop and offer a comprehensive training programme, encompassing multiple modalities that include support educational materials, examples of best practices and resources integrated into an online platform, and hands-on practice workshops, that will not only help teachers to explore, adopt, implement and improve an already made educational activity or practice but also assists them to gain confidence and experience towards developing their own ones individually or in collaboration with other teachers and educators. The Let's STEAM Teacher Training Programme is our proposal for addressing these specific issues, hence herein we discuss and propose the main design considerations along with general and specific recommendations of features that such a programme can incorporate.

GENERAL RECOMMENDATIONS - DEVELOPING A TRAINING PROGRAMME

In general, when developing educational activities, a training programme or curriculum in partnership it should be emphasized that alongside the process of how an activity is developed, key aspects of the activity itself like aims, learning outcomes, content, teaching and learning methods and assessment methods also need to be considered. Usually in literature (for example see Plomp 2009 and van den Akker 2007) an extended version of key aspects of an activity, and in general the curriculum, is shown in the shape of a spider web, thus metaphorically illustrating that placing additional focus on one of the key aspects this would inevitably influence the shape and the strength of the whole web.

The key aspects of the curriculum as depicted in the following figure are: **rationale, aims and objectives, content, learning activities, teacher role, materials and resources, grouping, location, time and assessment**.

We adopt this spider web model and we suggest that all these dimensions should be clearly defined, be in balance and be addressed in the developed programme. We believe this will strongly assist and facilitate teachers in better embracing the training concept and its objectives.



Curricular spider web as proposed in van den Akker, J. (2007).

Regarding the general process of educational design or development cycle of an activity we follow an approach that focuses on three phases: the analytical, the prototyping and the assessment phase (Plomp 2009).

In the former phase teachers are introduced to an example, they practice it taking the role of learners and analyse it in a reflective and collaborative way. In the second phase, the prototyping, they envisage how to implement the activity with their students, taking the role of action researchers and critical observers. In the last phase, they assess their findings, collaboratively reflect on the results and outcomes. The whole process is implicitly of iterative nature and provide a well-founded overall framework for progressive and gradual acquisition of the proposed training modules or best-practices or the development of new ones. These three phases may not be explicitly imposed or practiced, for example in the mode of three separate distinct workshops, but they can be implicitly infused in the programme in a single session of hands-on training by well selected and designed learning modules with best-practices and example cases.

In this context, we recommend offering teachers dedicated workshops to help them to pre-practice by following examples, develop further and reflect on their practices, their understandings and past experiences, collaboratively reflect on the proposed instruction models, their main advantages and the common mistakes, etc. These workshops, and as a whole the Let's STEAM training programme, can be offered in parallel or within the framework of existing professional development programs, or even better in synergy with other similar projects and initiatives so that more teachers from more schools can be involved.

They can also be grouped into consecutive cycles in line with the school year schedules in each country where workshops of training activities are implemented first in a small number of school teachers, feedback is collected, and findings are shared with other partners in different countries.

In conclusion, in the framework of Let's STEAM and complementary to its main objectives, the training programme is recommended at furnishing, touch upon or strengthen the following general educational objectives:

- **To enable teachers trying new ideas in practice as a means of improvement and as a means of increasing knowledge about the curriculum, teaching, and learning opportunities within STEAM.**
- **To raise their level of critical thinking about teaching and learning, and in general about their practice or commonly adopted methodologies.**
- **To engage them in collaborative and reflective implementation and development of practices.**
- **To facilitate the adoption of innovative approaches in teaching and learning.**
- **To emphasize the importance of sharing experience, expertise and valuable outcomes with other teachers in their community and beyond.**
- **To strengthen their capacity and confidence to become active change agents.**
- **To empower them in engaging in similar approaches that affect their communities and well-being and for their particular needs or interests.**
- **To strengthen their capacity to become educational content creators.**

DEFINING THE GOALS AND IMPACTS SOUGHT IN THE BEHAVIOURAL CHANGES OF OUR TARGET

The main objectives of the LET'S STEAM project are to provide a new set of skills for teachers in order to enhance their capacity to use programming practices in their STEAM approach, to promote active and creative pedagogy and to value collaborative behaviours in teaching and learning. To achieve these goals, the main aspect of the project will be to develop learning content based on the analysis of teachers' digital competencies and their needs and requirements. These, in turn, will be adapted to be included in an e-learning platform, which will expand the access to the learning material, as well as enhance interactivity online and stimulate self-training. From the assessment of these needs, the partners have defined a set of training goals driving the development of these contents.

GOAL #1 OF THE LET'S STEAM TRAINING

NEW SKILLS FOR TEACHERS

Provide new set of skills for teacher to enhance STEAM approach

Most of the teachers do not know how to use the existing tools which have been changed and optimised over and over since their creation. If all schools agree nowadays to put an emphasis on STEAM, however, the use of programming to enhance the related strategies is still underused.

Therefore, training to learn skills in programming but more importantly to understand the potential in terms of pedagogy of interdisciplinary use of programming is a priority towards the teachers. The final aim of these trainings is to raise the motivation among the secondary and high schools' teachers in order to make them create new contents and to raise their creativity.

Thanks to the Let's STEAM training, they will be able to propose new pedagogical content in class and at the same time, raise motivation, collaboration and critical thinking among their students. The methodology developed to train the trainers can be adapted to every subject. Understand the needs of the teachers in a specific field then organize workshops to train them and developed hand-in-hand a tool that will motivate them and help them to develop a new form of educational content is not appropriate only to scientific fields. It is a carefully thought out methodology which can be replicated in other fields. Therefore, the project will mainly focus on schools, but the library sector will be taken into consideration to prove the well effectiveness in another field of the methodology developed.

IMPACTS OF THE GOAL ON THE TARGET AUDIENCE

- Access tailored learning contents
- Participate to training sessions
- Follow skills' acquisition
- Find adapted content to their level
- Consult training contents
- Use the platform to transfer knowledge to trainees / to the classrooms
- Follow trainees' learning progress
- Be attracted by the topic
- Evaluate knowledge
- Certify acquired knowledge
- Consult training content created based on the Let's STEAM training
- Participate to training sessions with adequate and attracting tools
- Consult learning pathways and curricula selected to train in the classroom

GOAL #2 OF THE LET'S STEAM TRAINING

PROMOTE ACTIVE & CREATIVE PEDAGOGY

Based on inquiry methods

Many teachers from the pre-assessment results have declared teaching teaching coding with classic methods which might be less relevant with the current world and its digital era and is most of the time adapted to very technical profiles, with some students left behind, especially girls in the field of programming.

Nowadays, switching from learning how to code as an individual item, to teaching what to use code for, enhancing creativity, and innovation and promoting active pedagogy between courses, between schools and towards the students is a priority.

The main ambition of the Let's STEAM project is hence to answer this challenge by enabling the teachers to create new knowledge and new educational contents by using the knowledge acquired and the platforms and programming boards provided towards an interdisciplinary approach to scientific topics at school.

IMPACTS OF THE GOAL ON THE TARGET AUDIENCE

- Create a project based on the knowledge acquired directly in the programming training platform
- Manage a project
- Follow the project team
- Identify the competences needed for resolving a project thanks to clear activity sheets
- Collect data for exploration and experimentation
- Export data for analysis and interpretation
- Associate different type of resources (external documents, reports, ...) thanks to guidelines and ideas provided in the activity sheets
- Collaborate, brainstorm and exchange ideas
- Explore the projects towards the competences

GOAL #2 OF THE LET'S STEAM TRAINING

VALUE EQUITY AND INCLUSIVENESS

Based on inquiry methods

By ethics, we understand the appropriate and acceptable behaviour in relation to Digital Technology (DT) practices and Internet usage. Computer or digital ethics deal with, for example, the unauthorized use of computer systems, software theft (piracy), information privacy, unauthorized collection, use of information copyright... The responsible and ethical use of DT is an important part of trainees' work and students' learning and, for this reason, it is evidenced in many national curricula.

Today's technologies, apart from having many educational and learning benefits, present some new security and ethical challenges, which might be necessary to consider.

As Let's STEAM activities will be implemented in very different educational contexts, it becomes necessary to appropriately reflect on how these implementations will be carried out.

We argue that this reflection should be carried out with the aim of promoting the engagement of all students and, therefore, ensuring inclusive STEAM teaching and learning practices, adapted to the educational contexts and needs of learners.

IMPACTS OF THE GOAL ON THE TARGET AUDIENCE

- Identify the needs of their students regarding a technology-oriented activity
- Analyse and transform designed STEM educational materials and activities to adapt and increase the inclusiveness especially regarding potential groups of students at a disadvantage which are students with special needs, and women, racial minorities, and low socioeconomic students
- Identify successful strategies that could be implemented in different educational contexts
- Understand the basics of data privacy and exposure of private data when acting on the digital ecosystem

GOAL #2 OF THE LET'S STEAM TRAINING

VALUE COLLABORATIVE BEHAVIOURS

Through interdisciplinarity, cooperation & involvement of all disciplines

In order to catch up with the backlog of teachers in the field of programming, a pattern of answers must be created at a European scale with local adjustments in order to have a common and strong basis on this subject in the whole of Europe.

Therefore the project is mandatory developed at the scale of the European Union, and beyond with the real international vision. Moreover, Let's STEAM will aim at enhancing the power of schools to become contributors of new knowledge at International level.

Nowadays, in the scope of the promotion of citizen science approach, this appeared to be a real added value of Let's STEAM i.e. using IoT boards to create new courses but also to participate to scientific discoveries. Promoting this scheme will be a powerful way to motivate teachers and students.

Eventually, the teachers will be able to work in collaboration with other schools. Everyone will have access to the contents uploaded on the platforms and this will increase the new forms of education and improve the general knowledge, between topics, but also between countries and culture.

IMPACTS OF THE GOAL ON THE TARGET AUDIENCE

- Share pedagogical resources thanks to specific guidelines provided in the Let's STEAM training on this aspect
- Understand how to find opportunities for collaborating and how to manage them
- Discover contents in many languages
- Participate to international and interdisciplinary challenges
- Publish the results of the challenges on the Let's STEAM learning platform
- Access data from other schools and trainees
- Imagine the positive implications of sharing information on the Internet
- Consider to which extent they would share activities or products (such as pictures, videos, or images) that they have made and what prevents them from doing it

SELECTING THE RIGHT PEDAGOGY FOR ACHIEVING THE GOALS - INQUIRY-BASED APPROACH

The Let's STEAM Training Programme is planned to be based on the **comprehensive presentation and hands-on practice of specific modules focusing on particular areas of skills and competencies**. The training programme will support teachers in integrating programming and usage of the IoT board in the standard curriculum and it further aims to provide guidance on curriculum organisation, pedagogical methods, and technical training on tools, platforms and resources.

In the following, we list and elaborate on specific features and characteristics that we recommend that such a programme should incorporate.

- Overall inclusive approach. The programme and its activities should attract and involve teachers of all disciplines, levels of experience, gender, and social or ethnic backgrounds. Specifically:

Gender balance. Training examples, proposed educational activities, projects or ideas should attract the interest of teachers and students of both genders avoiding common stereotypes.

- Social inclusiveness and integration. Similarly, they should be accessible and attract the interest of teachers or students of social or economic disadvantaged areas or in rural or distant sites.

- Multidisciplinary/interdisciplinary collaborative approach. The programme and its activities should address or involve teachers of multiple scientific fields.

- Project-based/Inquiry-based learning approaches. The programme and its activities should preferably be structured or follow inquiry-based methodological/pedagogical processes with steps or phases and furthermore put emphasis on problem-solving, creativity and collaboration.

- Modular structure. The programme and its materials should be modular and staged so that it can be followed by teachers with different levels of needs, expertise, experience etc.

- Replication potential. The proposed approach, programme and activities should be easily transferable to other European countries.

- Low-threshold use of ICT technologies. The proposed online resources, the Let's STEAM e-learning platform and tools should enhance and complement traditional teaching and learning and promote digital literacy for both teachers and students without any prerequisites of prior technical knowledge, and requirements for pre-installed software packages etc.

- Asynchronous, open and online. This will greatly facilitate the participation of schools and teachers from distant areas that can follow the education programme at their own time, pace and frequency.

- Effective game mechanics. Incorporation of basic gaming elements in the offered training modules and activities of the Let's STEAM e-learning platform (e.g. star rating, award scheme of badges or certificates, scoreboard, wall of fame etc.) greatly attracts the interest of both teachers and students. However, this should be well-balanced and purposeful so to retain interest, enhance conscious learning and influence behaviour or attitude change.

- Scientific and technological correctness. Training modules and accompanying materials, including links to online resources, public video instructions etc, should not create gray areas or matters that may create misconceptions to teachers or students, promote pseudo-science etc. Similarly, any developed programs to be run in the proposed platforms should be tested in advance.

- Emphasis on experiential aspects, practical hands-on training and do-it-yourself implementation

Based on these requirements and the defined goals, we discuss the pedagogical scenarios, in short, referred to as modules, that Let's STEAM will develop and offer to its teacher training programme. Taking into account the teacher digital competence survey data and their comprehensive analysis with respect to profiles, needs, experiences and interests/insights as presented in previous sections of the document we propose three focus areas, each having three levels, namely basic, intermediate and advanced. The proposed focus areas are: "Programming and IoT board functionalities", "Interdisciplinarity and integration" and "Ethics, security and relationships". This first proposal has been updated and modified depending on the second output of Let's STEAM in the coursebook.

The first set of modules focusing on **programming** and familiarization specifically with the IoT board aims to provide all necessary instructions, tutorialsand sample code examples on how to program the IoT board and take full advantage of its sensors and functionalities using the proposed platforms in Scratch, MakeCode and CircuitPython. The three modules of this set are progressing from basic to intermediate and finally to advanced. They are all considered as compulsory and should be taken by all teachers, experienced or not, during the training programme.

The second set of modules is focusing on **interdisciplinarity** and practical integration of inquiry-based methodology of learning and teaching. It builds on the knowledge acquired from the first set of modules which is applied in developing more complex and multidisciplinary learning projects and activities using the IoT board and programming platforms. The three modules of this set are also progressing from basic to intermediate and finally to advanced so that can be followed by less or more experienced teachers accordingly.

The third set of modules covers the focus area of **ethics, security, and relationships** which although it is of highly importance, usually it is not adequately well addressed in trainings related to digital literacy and competencies. Therefore, Let's STEAM aims to fill this gap with three dedicated modules on these matters.

With respect to pedagogical framework, the main approach adopted by Let's STEAM is project-based teaching and learning. We consider also implementing inquiry-based methodology which is also utilized by STEM teachers for effective learning. One may draw distinctions between project, inquiry or problem-based learning, however in reality the differences are minor, and all have proven their efficacy in comparison to traditional lecture and worksheet-based forms of teaching and learning. Great projects grow from inquiries in order to solve problems. School students and In general learners found them highly engaging because they are conducting work that is meaningful to them and can connect to real life problems and challenges. Learning begins with a problem to be solved, and the problem is posed in such a way that learners need to gain new knowledge before they can solve the problem. Rather than seeking a single correct answer, they interpret the problem, gather needed information, identify possible solutions, evaluate options and present conclusions.

The whole process gives many opportunities to connect to real-life and real-world challenges, work across disciplines, learn to function and collaborate in teams, communicate their findings and solutions, engage with their peers, experts and communities.

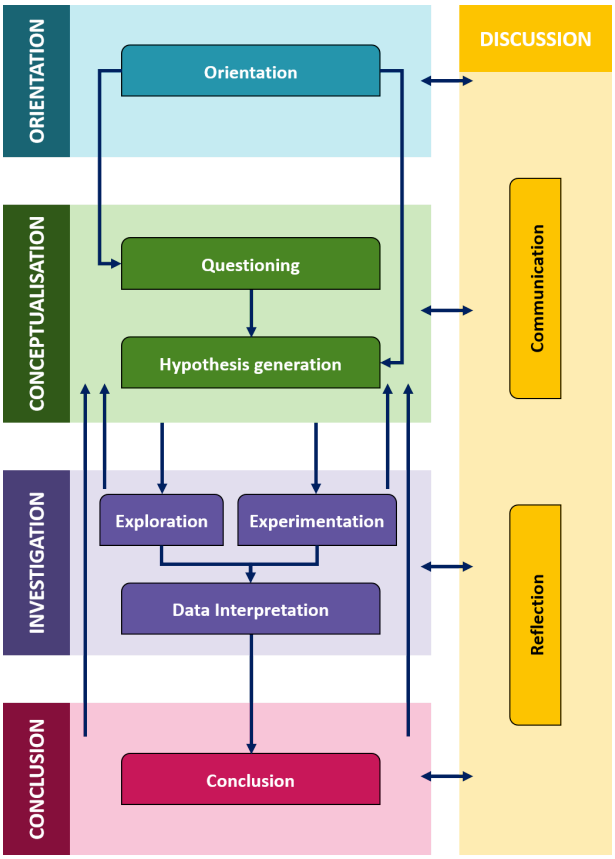
In the following we first present in detail a generic inquiry-based model based on five phases (Orientation, Conceptualization, Investigation, Conclusion and Discussion) that may be useful teachers to follow in case of more STEM-related educational activities. A variation of this is also adopted in the structure of the training modules with a focus on interdisciplinarity and integration that will be presented in following sections. We also discuss in brief types of inquiry.

PEDAGOGICAL APPROACH

PROJECT AND INQUIRY-BASED PEDAGOGY

What is it?

Inquiry-based learning (IBL) is an educational flexible strategy with phases that are often organized in a cycle and divided into subphases with logical connections depending on the context under investigation (Pedaste et al., 2015). This framework entails five general phases (Orientation, Conceptualization, Investigation, Conclusion and Discussion) and seven sub-phases (Questioning, Hypothesis Generation, Exploration, Experimentation, Data Interpretation, Reflection, and Communication). It can be used by teachers in order to conceptualize a structured way to implement inquiry activities and develop multidisciplinary educational projects in their classroom. IBL is not a linear procedure (see Figure below) and learners should be involved with various forms of inquiry, going through different combinations of the phases, not all of them necessarily. For example, if the data analysis is not satisfactory enough, students can return to the conceptualization phase and reconsider their question and/or their experimental design. When students come to a conclusion, new questions can be generated, and the process starts again in a progressive fashion. A description of the processes that each phase encompasses is provided below and the connections between these processes are presented here (Pedaste et al., 2015).



Orientation: Orientation is the phase where the identification of the problem occurs. The topic to be investigated is presented and interest about a problematic situation that can be answered with inquiry is stimulated. The topic under investigation must be relevant to students' daily life, interests and prior knowledge. The teacher's role in this phase is to encourage students to express ideas, prior knowledge and questions about the topic, while promoting interaction and communication between them. For example, students can create concept maps of what they know, do not know or want to know about the topic under investigation. These kinds of activities can also be useful for the next phases of inquiry.

Conceptualization: Conceptualization refers to the understanding of the concept, which relates to the problematic situation presented in the previous phase. It is divided in two sub phases (questioning and hypothesis generation) that lead the learner to the investigation phase. Now the teacher's role is to help students understand how they can formulate questions and/or hypotheses that can lead to an investigation. If students are not familiar with the questioning and hypothesis generation sub – phases, the teacher can choose a structured type of inquiry at first and then progress in more open types of inquiry in order to provide the appropriate guidance.

Questioning subphase: Questions are formulated in order to design an investigation that produces answers. As this skill is developed through inquiry, students can gradually understand which question can lead to investigation and which one is more generative and might lead to different or richer processes.

Hypothesis Generation subphase: A hypothesis is generated through providing explanations of how the identified variables relate (Pedaste et al., 2015). It explains how and why phenomenon functions based on former experiences and prior knowledge (National Science Foundation, 2000).

Investigation: Investigation is the phase where students collect evidence in order to answer their questions and/or test their hypothesis (National Science Foundation, 2000) and includes the sub – phases of exploration, experimentation, and data interpretation. The teacher provides materials that the students might need and keeps them on track so that the process they choose to follow is a process that answers the investigative question. Students should determine what constitutes evidence and collect it. If they are not familiar with this process, a structured type of inquiry can be chosen. The teacher can provide or encourage students to create means (e.g. tables, charts etc.) that can help them organize, classify and analyze the data.

Exploration subphase: Exploration is an open process which generates mostly data concerning the identification of a relation between the variables. It is chosen typically when the question that was formed in the previous phase was generative, because students do not have a specific idea of what to explore or how the identified variables relate to each other (Pedaste et al., 2015).

Experimentation subphase: Experimentation includes the design (e.g. choosing the materials and means to measure) and performing of experiments taking into consideration the variables that need to change, remain constant and be measured. The products of this subphase are data or evidence that can be used later on for analysis and interpretation.

Data Interpretation subphase: According to the National Science Foundation (2000), data interpretation "includes finding a pattern of effects and synthesizing a variety of information" (p. 57). Depending on the concept under investigation and the inquiry procedures that were chosen, finding relations between the variables is sometimes the key for getting the desired outcome (answering the investigative question). Organizing and classifying the data (with graphs, charts, tables, pictures etc.) can benefit this process.

Conclusion: In this phase students draw conclusions based on the investigative question and the interpretation of the data. The teacher's role during this phase, a comparison between the interpreted data and the predictions and initial ideas (that students expressed during the orientation phase) can be stimulated. This process can also lead to new hypotheses and questions about the topic under investigation (as shown in figure).

Discussion: During the discussion phase students articulate their findings through communicating them to others and/or reflecting upon all or some of the stages of inquiry during the process or by the end of it (Pedaste et al., 2015).The teacher's role is to encourage collaboration so that students can present their findings and ideas, provide arguments and give feedback to others. If they are not familiar with these practices, the teacher can provide guidelines that will help them to communicate during all the phases of inquiry.

Communication subphase: Communication includes discussion with others and representation of results in a manner that is understandable to all (National Science Foundation, 2000). It can be applied to a single phase or the whole cycle of inquiry and is usually an external process (Pedaste et al., 2015).

Reflection subphase: In this subphase students reflect on their work, their results and the concept under investigation. Reflection can even give rise to new thoughts regarding the inquiry cycle or a single phase.

Types of inquiry

The types of inquiry vary so that students are actively involved in the process to the extent that they are competent and able to do so. The type of inquiry a teacher may choose to follow is highly dependent on the objectives of the lesson, the age of the students, their previous involvement with inquiry and the scientific skills they have already acquired. As shown below, the more responsibility the student has, the less direction is provided and more open the inquiry becomes (National Research Council, 2000).

The variations of inquiry types concern the increasing or decreasing involvement of the teacher and student in the process. Structured inquiry is directed from the teacher so that students reach a specific result, whereas in mixed inquiry students are more involved during an investigation with the teacher guidance still being the most dominant. These forms of inquiry usually are chosen when students are first introduced to inquiry practices and when there is a focus in the development of a specific skill or concept. Open inquiry provides more opportunities for developing scientific skills, given that during open inquiry the students work directly with the materials and practices in a way that resembles authentic scientific approaches (National Research Council, 2000).

For example, if students lack previous experiences with designing investigations and collecting data, a more structured or guided form of inquiry should be chosen. When students acquire the skills needed, they can progress to more open inquiry activities. Students should at some point participate in all the forms of inquiry, while gradually moving from one form of inquiry to another with the simultaneous progression of complexity and self-direction.

PEDAGOGICAL APPROACH

PROJECT AND INQUIRY-BASED PEDAGOGY

	Learner self direction			
	Structured	Mixed	Guided	Open
Essential Features				
1. Learner engages in scientifically oriented questions	engages in question provided by teacher, materials, or other source	sharpens or clarifies question provided by teacher, materials, or other source	selects among questions, poses new questions	poses a question
2. Learner gives priority to evidence in responding to questions	given data and told how to analyze	given data and asked to analyze	directed to collect certain data	determines what constitutes evidence and collects it
3. Learner formulates explanations from evidence	provided with evidence and how to use evidence to formulate explanation	given possible ways to use evidence to formulate explanation	guided in process of formulating explanations from evidence	formulates explanation after summarizing evidence
4. Learner connects explanations to scientific knowledge		given possible connections	directed toward areas and sources of scientific knowledge	independently examines other resources and forms the links to explanations
5. Learner communicates and justifies explanations	given steps and procedures for communication	provided broad guidelines to use sharpen communication	coached in development of communication	forms reasonable and logical argument to communicate explanations

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STEP 4

WHAT CAN WE DO, AS A DELIVERY TEAM, TO SUPPORT THE REQUIRED IMPACTS?

During the early Let's STEAM stages and translated in the previously developed steps, we captured the digital competencies, goals and ambitions of the teachers that are our first target in terms of course implementation. This assessment allowed the partners to define pedagogical recommendations that enabled to identify basic functionalities that need to be implemented over the three other outputs of the Let's STEAM training. This final step aims at providing supporting concrete tools and specifications, to start efficiently working on the outcomes to be provided namely: the content of the Let's STEAM training (O2), the e-learning platform functionalities (O3), the development of a tailored programming learning online ecosystem (O4).

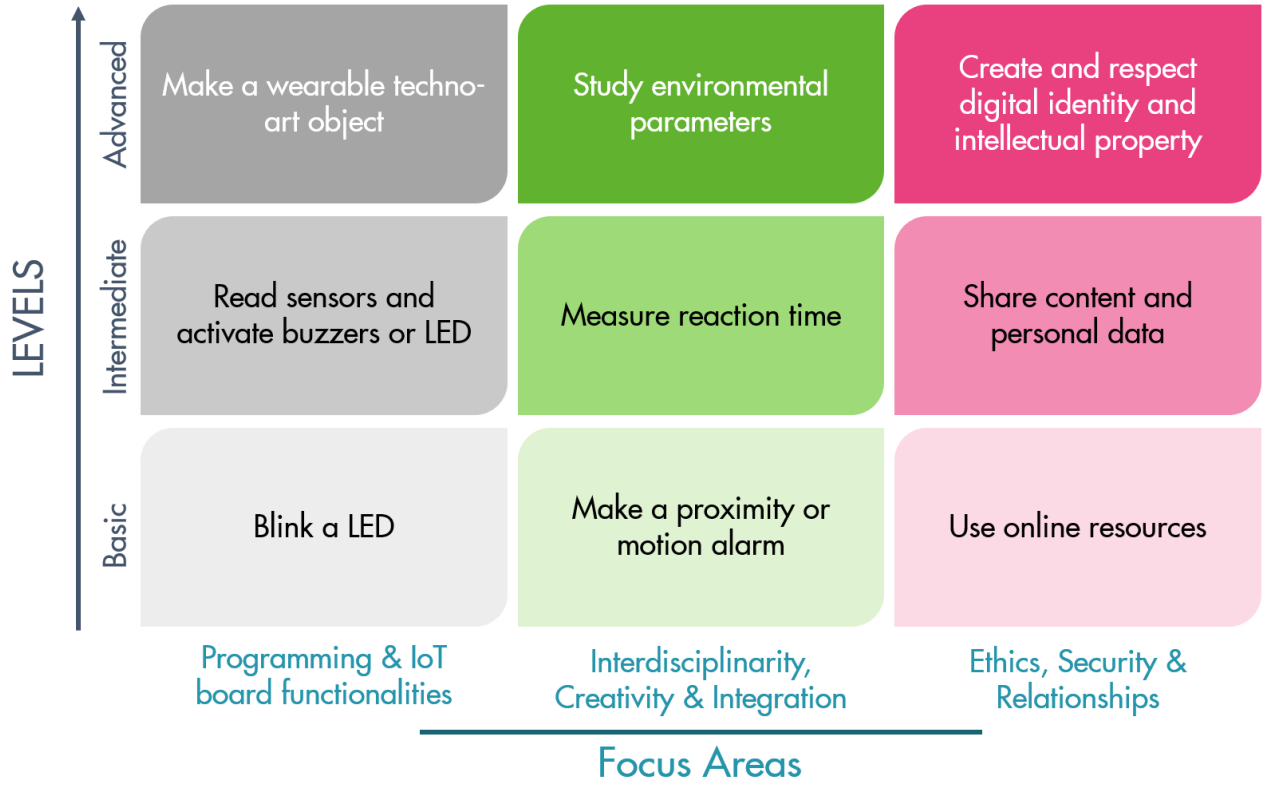
TOOL #1 - A THREE MODULES TRAINING OR TRAINERS

DESCRIPTION OF THE MODULE LAYERS AND EXAMPLES

WHAT CAN WE DO TO SUPPORT THE REQUIRED IMPACTS? OUR TRAINING MODULES

The Let's STEAM project has been designed to provide the set of skills for teacher to enhance their STEAM approach by training them in programming but more importantly to help them understand the potential in terms of pedagogy of interdisciplinary use of programming so that can be able to create innovative pedagogical content in class with and for their students. In this context, Let's STEAM is following a staged methodology to first survey and understand the needs and the basic skills of teachers with respect to programming capabilities; to gather requirements and compile recommendations to enrich the current open source programming platforms of Scratch, MakeCode and CircuitPython and their interface to STM32 board with advanced and tailored functionalities; to propose a training framework and content to be developed.

These stages were described in this document, in particular: in Section 2, the methodology for assessing the digital competencies of teachers; in Section 3, the results from the survey of teachers in each country; in Section 4, the general and specific recommendations regarding the overall design of the teacher training programme to be developed and conducted in the framework of the project; in Section 5, the pedagogical framework of inquiry-based learning and descriptions of training areas along with the main considerations for each proposed module. The proposed focus areas are: "Programming and IoT board functionalities", "Interdisciplinarity and integration" and "Ethics, security and relationships" and each has three dedicated modules. The figure below shows the proposed training modules per focus area and level.



TRAINING A: PROGRAMMING AND IOT BOARD FUNCTIONALITIES

What is it?

This training consists of three modules which are progressing from basic to intermediate and finally to advanced. All three modules are proposed to be compulsory for all teachers participating in the training workshops. This is since this set of modules is particularly focusing on giving them the necessary baseline knowledge with respect to programming using Scratch, MakeCode or CircuitPython. Furthermore, through them they will also get introduced and familiarized with the IoT board, its sensors and functionalities. The three proposed modules are entitled “Blink a LED”, “Read sensors and activate”, “Make a wearable gadget or techno-art object” and are described further below. Each module follows a common structured template with makes it easier to transfer it in a synchronous or asynchronous online learning environment (e-learning platform) and in face-to-face hands-on workshops. The proposed structure includes the following elements:

Introduction
- *Learning objectives*
- *Duration*

Module description step-by-step
- *Tutorial 1*
- *Tutorial 2*
- *Tutorial 3*
- *Conclusion – wrap-up*

Quiz or key questions for knowledge testing

Try this! (optional)
- *Exercise 1:*
- *Exercise 3:*
- *Exercise 3:*

References or additional resources

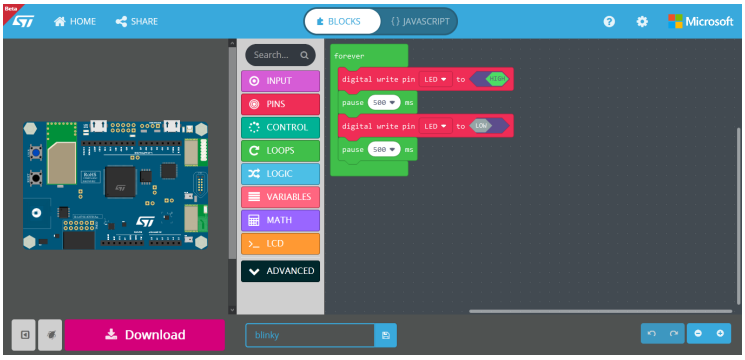
Appendix
- *Source code in Scratch*
- *Source code in MakeCode*
- *Source code in CircuitPython*

TRAINING A: PROGRAMMING AND IOT BOARD FUNCTIONALITIES

Module A.1: Blink a LED

When first using a new hardware board or micro-controller a task to learn how to blink a LED with it is equivalent at software level with the case when one is first introduced to a new programming language and learns to develop a “hello world” program. The sense of accomplishment by learning to do it is not trivial and is critical to engage learners. The objective of this module is to train teachers to use simple electronic components, as the LEDs, already embedded on the board or to make a basic circuit with LED and connect it.

The basic code to switch it on and off is easy and short even for very novice teachers, an example in MakeCode platform is shown in the figure below. Therefore, it is the perfect starting point which then can be followed by further tutorials and practical exercises to introduce gradually the main structures and syntax of a programming language. These are: definitions of variables and functions; recursion through for loops and while loops; conditional statements etc.



Module A.2: Read sensors and activate buzzers or LEDs

Once the first module is completed, we may proceed to learn on how to read the variety of sensors that the IoT board is equipped with. Then depending on their values, we want to make a program to activate and control simple devices, such as a LED to emit light or a buzzer to beep. In a nutshell, the learning objective of this module is to basically introduce one-by-one the sensors embedded on the IoT board.

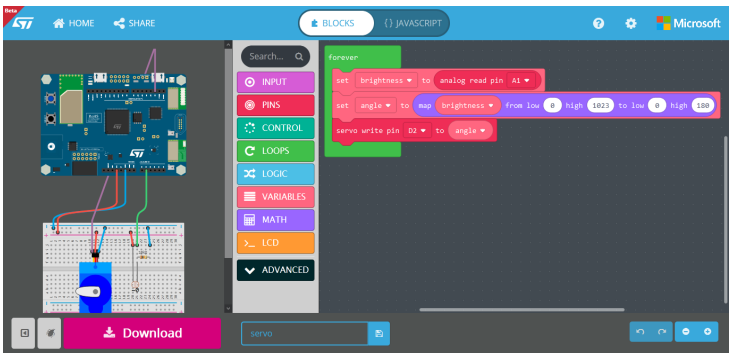
These are: 3-axis accelerometer, 3-axis gyroscope, 3-axis magnetometer, proximity sensor, temperature sensor, pressure sensor, humidity sensor. Through detailed sample code provided, step-by-step instructions (see figure below) and exercises the learner teacher at the end will be able to develop a program e.g. to read multiple sensors, to process their values in order to finally control an output device such as a LED or buzzer.

TRAINING A: PROGRAMMING AND IOT BOARD FUNCTIONALITIES

Module A.3: Make a wearable gadget or techno-art object

This module builds on the knowledge acquired from the previous ones and aims to extend it further. Its objective is to train learners to combine motion and additional sensors in a complementary way in order to activate built-in or external array of LEDs or/and sound devices, servos etc (e.g. see figure below).
It also puts emphasis not only on the technological part but also on the creative aspects as teachers are requested to build at the end a wearable gadget, e.g. a hand-held tilt sensing gadget or a proximity alert device to attach at head-hat or glasses or a crazy-dance-meter etc.

Or similarly teachers can create an object, e.g. an interactive abstract artwork, that senses its surrounding and reacts to it with motion, light or sound. In this way, fun-based DIY activities engage teachers and teaches them practically more advanced features and applications of the IoT board and the coding platforms.



TRAINING B: INTERDISCIPLINARITY AND INTEGRATION

What is it?

The second set of modules is focusing on interdisciplinarity and practical integration of pedagogy of inquiry-based methodology of learning and teaching. It naturally builds on the knowledge acquired from the first set of modules which is then applied in developing more complex and multidisciplinary learning projects and activities using the IoT board and the proposed programming platforms. The three modules of this set are progressing from basic to intermediate and finally to advanced so that may be followed by less or more experienced teachers accordingly, depending on their score results obtained in the digital competence questionnaire.

The three proposed modules are entitled “Make a proximity or motion alarm”, “Measure reaction time”, “Study environmental parameters” and are described further below. As in the previous case, each module follows a common structured template with makes it easier to transfer it in a synchronous or asynchronous e-learning platform and on hands-on workshops. The proposed structure includes the following elements

General information or introduction
- *Description*
- *Learning objectives*
- *Links to curriculum*
- *Duration*
- *Extra materials required*

Module description step-by-step
- *Introduction*
- *Preparation*
- *Investigation*
- *Conclusion*

References or additional resources

Appendix
- *Source code in Scratch*
- *Source code in MakeCode*
- *Source code in CircuitPython*

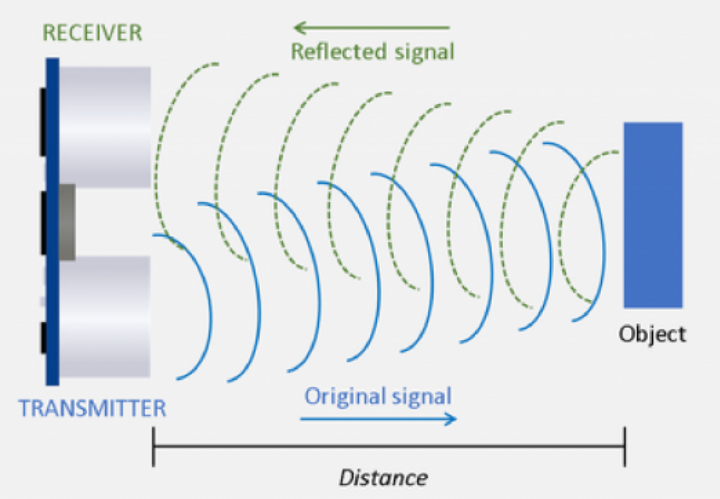
TRAINING B: INTERDISCIPLINARITY AND INTEGRATION

Module B.1: Make a proximity or motion alarm

In this module, learners are guided step-by-step to put together what they have learned so far to create a proximity alarm or stop-light, like the ones that cars have in order to assist drivers when they are parking their cars or the alarms in museums near fragile or precious objects. The main idea of a proximity alarm or stop-light is to show green or beep slowly when there is plenty of room, turn yellow as distance is decreasing, and then red or make loud sound when a minimum distance is reached, i.e. the vehicle or visitor should stop. In addition to proximity distance, an alarming condition may be vibration, touch, increased temperature etc. The operation principle of measuring distance by emitting and receiving a signal is shown in Figure below.

The main objective of this module is on one hand to guide teachers to thoroughly understand and later feel confident to devise a programmatic flow of conditions and controls using the platforms and IoT sensors. On the other, to guide them with respect to pedagogical methodology by giving a practical example on how to link and integrate different disciplines towards an engaging and inspiring interdisciplinary educational project. For example, by implementing this module they have the opportunity to link not only to the Informatics/Computer Science standard curriculum, but also to the Physics curriculum with the subjects of motion, distance, speed, waves, propagation and reflection, sound waves, light waves, spectrum etc.

To the curriculum of Mathematics with the subjects of trigonometry and of basic statistics. To the ones of History/Arts/Humanities by forming research questions and debates on what an invaluable object is to protect by alarm and why if we were museum curators ourselves, historians or citizens of societies in the past. Through this module teachers are also introduced to the main phases of inquiry (introduction, preparation, investigation, conclusion) as discussed in the previous section.

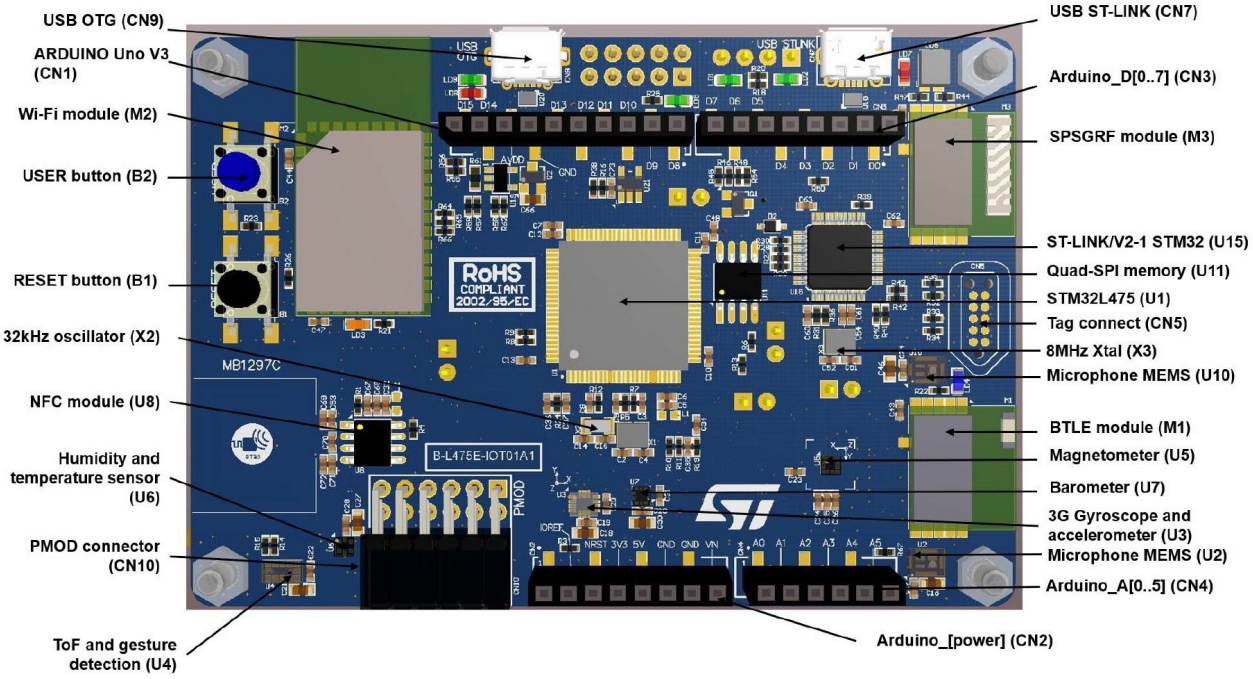


Module B.2: Measure reaction time

With this module teachers will learn to build an experimental apparatus and conduct a scientific investigation following inquiry-based pedagogical model. The starting point is to program the IoT board and one of its push buttons (figure below) to measure and record the reaction time to particular acoustic or visual signals. Then they use it to collect data from different users with respect to e.g. age or/and gender and under different conditions of e.g. noise, time of day, fatigue/stress, peer pressure etc. They then analyze the collected data and draw conclusions on which they reflect. Thus, in practice they conduct themselves a complete scientific investigation by pursuing separate inquiry phases, i.e. introduction/preparation, investigation, presentation/communication, discussion/reflection.

As before, this module has great potential to be linked to different disciplines and domains of the school curriculum and by the knowledge acquired through it to encompass a broader social scope touching upon social responsibility, health and road safety. In particular, it addresses the terms of speed, distance, time interval, linear motion, accelerated/decelerated motion from the Physics curriculum in relation to road safety aspects like reaction time and distance traveled before breaking, safety distance on road, speed limits, speeding violations, etc.

In addition, it includes topics from Mathematics and Informatics curriculum, namely graphical representation of function/data points and basic statistics (Mathematics), use of spreadsheets and analysis of numerical data (Informatics). From Biology curriculum, brain functions, sensory inputs and reaction time in humans, effects of age, fatigue, drowsiness, sleep deprivation, consumption of drugs and alcohol.

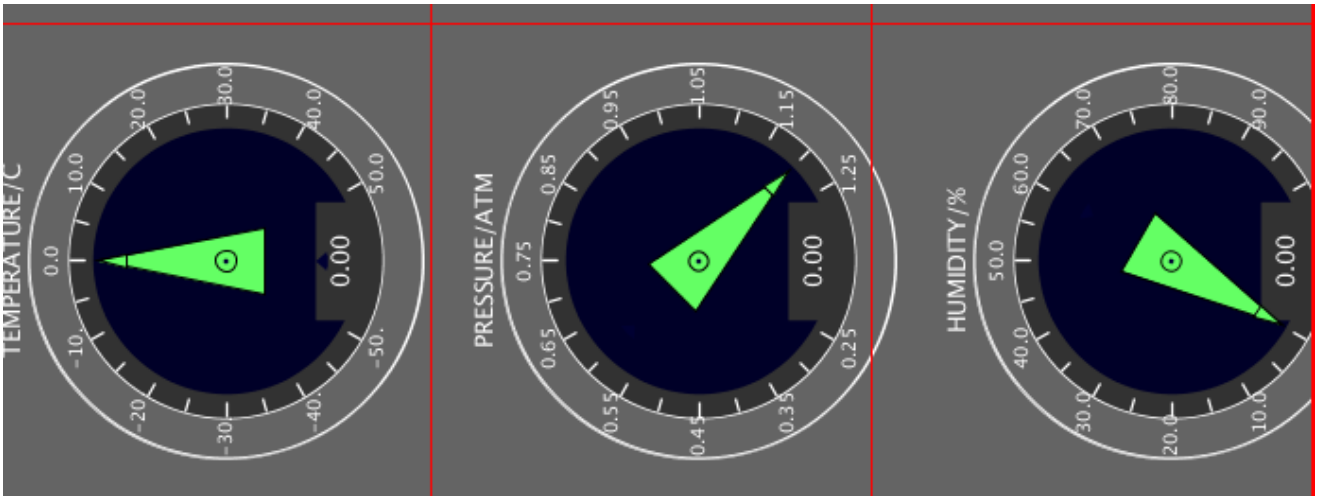


TRAINING A: PROGRAMMING AND IOT BOARD FUNCTIONALITIES

Module B.3: Study environmental parameters

This module utilizes the variety of sensors with which the IoT is equipped so that learners can conduct a comprehensive study of various environmental parameters. Commonly, one logs versus time parameters such as temperature, atmospheric pressure and relative humidity to build a basic weather station as shown on the dashboard in the figure below. Magnetic field measurements can be included, as well as ground vibration sensing and acoustic noise to take advantage of the magnetometer, accelerometer and microphone embedded in the IoT board. The module can be expanded with an engineering perspective by including challenges like what if we wanted to monitor and study the environmental parameters of a different planet (in this case we need to build a rover or an autonomous vehicle to be piloted and controlled by the IoT board), or of an area of high temperature e.g. near fire or volcano.

The interdisciplinary dimensions of this module are plentiful and can be the cornerstone of an educational project with broad scope like global climate change, fragile habitats, environmental protection, natural hazards etc. The module encompasses links to subjects of most school science curriculum disciplines, including Physics, Biology, Chemistry, Geography, Earth Sciences, Ecology but also Engineering and Technology. It offers also ample opportunities of collaboration between learners and schools at local, national or even international levels where e.g. teachers and their students monitor, study and share data collected across sites located at different areas in the same country or in different countries.



FDashboard of a basic weather station monitoring temperature, atmospheric pressure and relative humidity

TRAINING C: ETHICS, SECURITY AND RELATIONSHIPS

What is it?

The third set of modules covers the focus area of ethics, security and relationships. Although it is of highly importance, usually it is not adequately well addressed in trainings related to digital literacy and competencies. Therefore Let's STEAM aims to fill this gap with three dedicated modules on this subject. They are entitled: "Use online platforms and resources", "Share content and non-personal data" and "Create and respect digital identity and intellectual property". They are progressing from basic to intermediate and finally to advanced level to match with the current experience of the learner.

For the modules of this training set we do not propose a structured template at this moment as we believe a more flexible format of workshops may be more appropriate in this case. Even so, a general flow of hands-on tasks to span over a variety of learning elements is recommended as described in each module below. In other words each module should be considered as a scenario of use consisting of certain tasks that exemplify best-practice, common mistakes or misconceptions, ethical use and "do's and don'ts", followed by debate and reflection sessions among learners.

Module C.1: Use online platforms and resources

In this module learners are guided through basic use of an existing or mock-up e-learning platform, online portal or repository of educational resources. Tasks to complete may include user registration, profile creation, download and upload of materials, meta-data editing. Learners may be asked to adopt and later exchange roles between passive user and active contributor of learning materials like the ones they developed in previous modules such as source code, lesson plans for in-school implementation, project ideas etc. The objective is that they get a better sense on one hand of the direct advantages of mutual benefit of resources that are made online and public but also on the other on the importance of ethical use and responsibility by retaining and asserting copyright and authorship. Each task can be followed or complemented by a round-the-table debate and reflection over previous experiences, common mistakes and best-practices.

Module C.2: Share content and non-personal data

This module is basically a follow-up of the previous one with the addition of the subjects of privacy and security. By a series of do's and don'ts tasks and exercises learners are role-playing certain situations where personal data, like home address, telephone numbers or any other sensitive information and details, that can easily put their privacy and security at risk are shared by mistake, thoughtlessness or misleading prompts. Each task can not only be complemented by reflection over previous experiences and common mistakes but also by discussions about broader challenges and opportunities at societal level with respect to privacy and security at the Internet-of-Things era, the commercialization of data, the needs for top-down and bottom-up regulation and standardization etc.

TRAINING C: ETHICS, SECURITY AND RELATIONSHIPS

Module C.3: Create and respect digital identity and intellectual property

This module aims to give learners a better understanding of the importance of the concept of digital identity at individual and organizational/school level. Its objective is to provide example best-practices so that teachers can feel confident to gradually become change agents and have transformative roles within their schools and community of colleagues and students. Topics to be included are: creation and maintenance of basic rules, protocols of practice, inclusion of visual institutional image in shared content at online repositories and portals/platforms, understanding the notion of intellectual property etc. Basic guidelines can be given also on how to initiate change by e.g. organizing training workshops or hands-on practice days in school for fellow teachers, coordinating work-groups for essential tasks, participating in related events for community building.

As in previous one, this module as well can consist of a series of do's and don'ts tasks, assigned exercises, tips and hints so that teachers interactively and collaboratively practice its content. It may conclude with an overall wrap-up section that summarizes the key points addressed in the training on ethics, security and relationships, along with a concise memory list of rules of conduct.

TOOL #2 - A COMPREHENSIVE WAY OF DELIVERING CONTENT

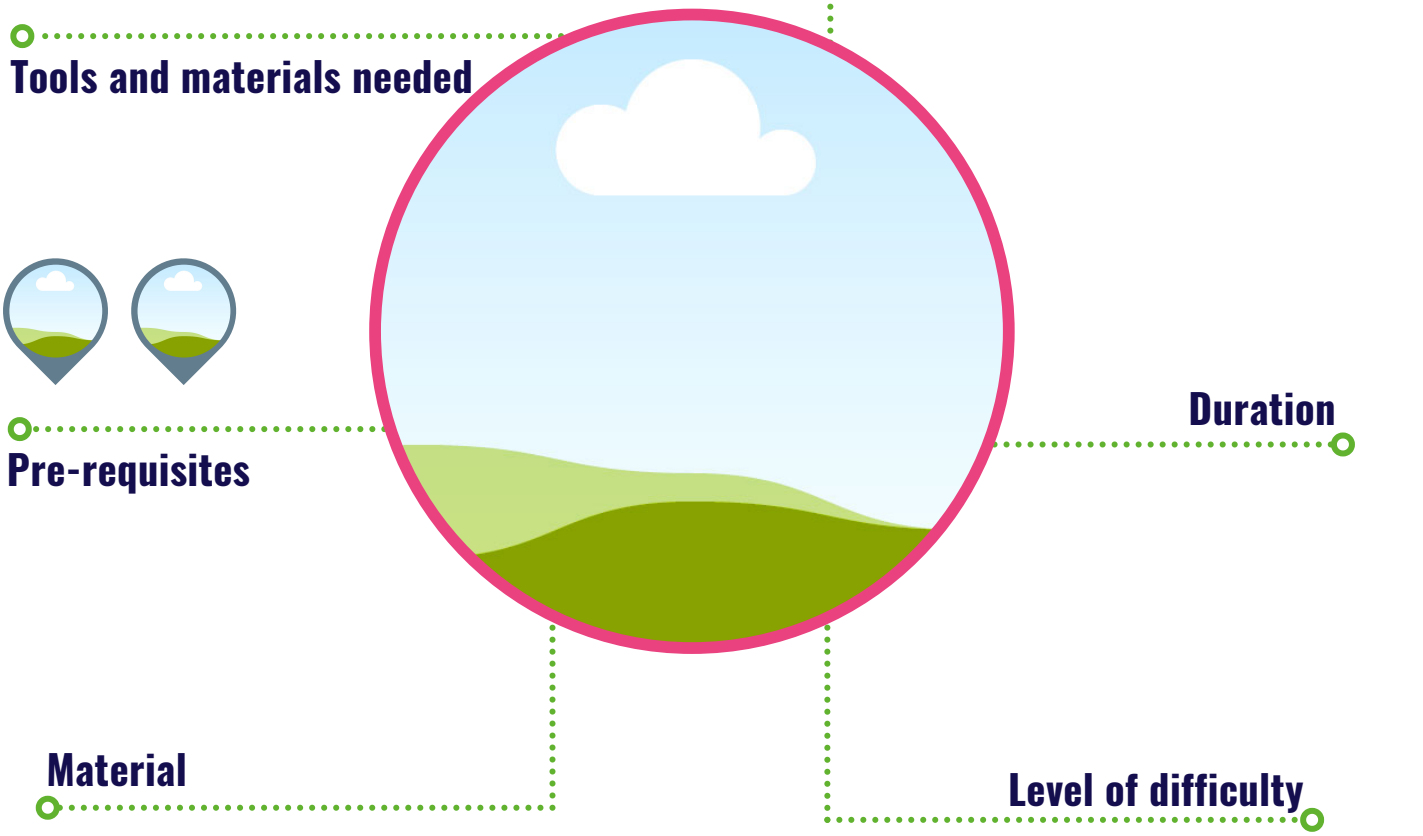
COOKING RECIPE ACTIVITY SHEET TEMPLATE

TYPE OFRESOURCES - ACTIVITY SHEET #X

TITLE

SUBTITLE

#ID



LEARNING OBJECTIVES

TITLE

Brief presentation of the tools and sensors used in this activity sheet:

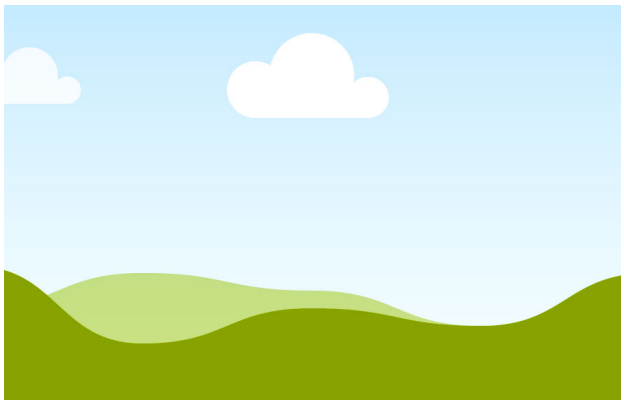
STEP 1 - MAKE IT

Add as many sub-steps as necessary

Sub step 1: Title

Detailed description of the actions to be carried out.

1

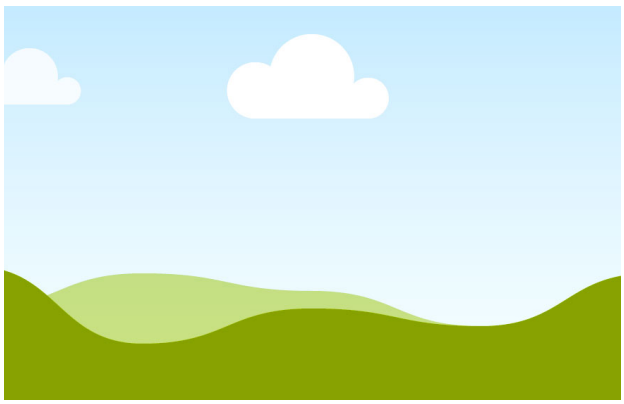


Caption for illustration of sub-step 1

Sub step 2: Title

Detailed description of the actions to be carried out.

2



Caption for illustration of sub-step 2

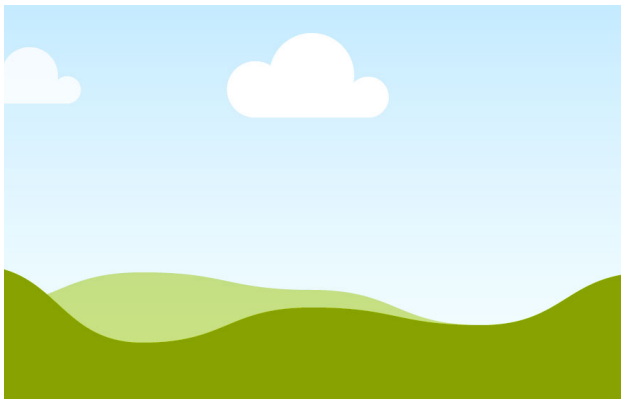
TITLE

ETAPE 1 - CONSTRUIRE

Sub step 3: Title

Detailed description of the actions to be carried out.

3

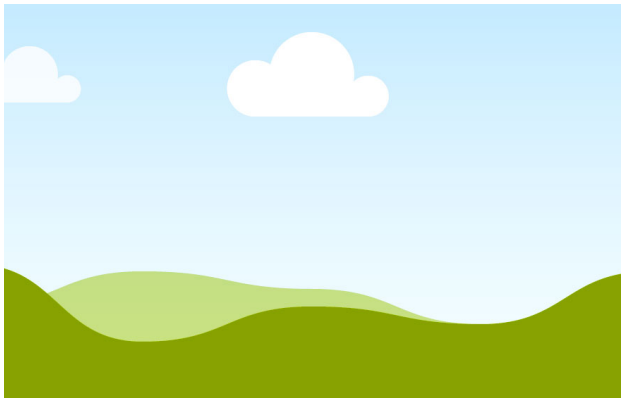


Caption for illustration of sub-step 3

Sub step 4: Title

Detailed description of the actions to be carried out.

4

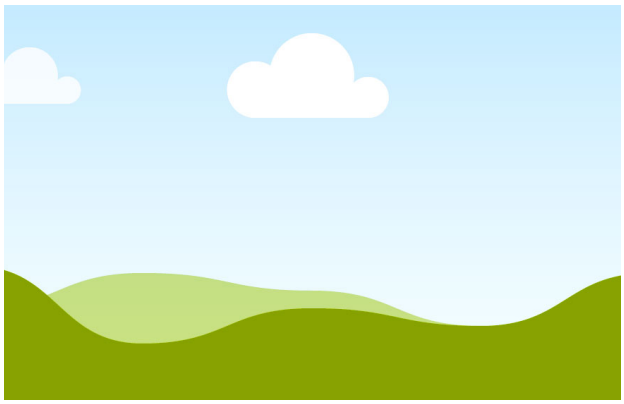


Caption for illustration of sub-step 4

Sub step 5: Title

Detailed description of the actions to be carried out.

5



Caption for illustration of sub-step 5

TITLE

STEP 2 - CODE IT

```
//Your code
```

How does it work?

TITLE

STEP 3 - IMPROVE IT

Idea 1 - Brief description of the potential uses of this activity sheet for conducting side projects

Idea 2 - Brief description of the potential uses of this activity sheet for conducting side projects

GOING FURTHER

References and online resources

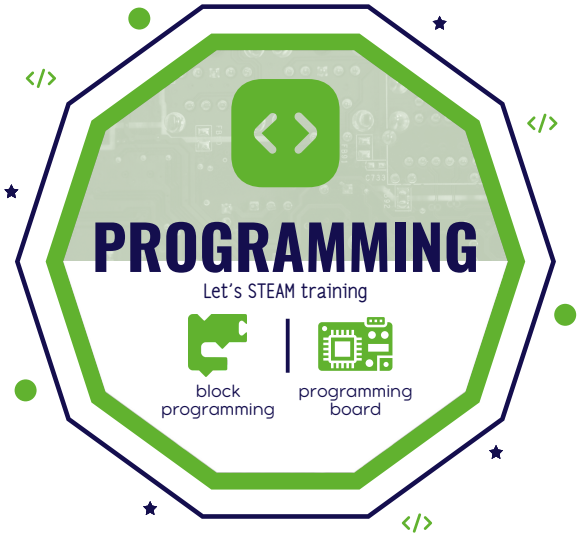
Explore other activity sheets

TOOL #3 - A SIMPLE RECOGNITION SYSTEM

TRANSLATION OF THE GOALS IN BADGES FOR THE TRAINEES

WHAT CAN WE DO TO SUPPORT THE REQUIRED IMPACTS? OPEN BADGES

Thanks to this work of project definition regarding teachers' needs, the partners have defined 4 axes of valorisation of the teachers' skills through the creation of 4 open badges dedicated to the project. They can be acquired through the e-learning platform or during physical sessions.



TOOL #4 - TEMPLATE FOR EVALUATING THE IMPACTS

ASSESSMENT OF THE PEDAGOGICAL INTEGRATION

ASSESSMENT ACTIVITY

ASSESSMENT OF THE PEDAGOGICAL INTEGRATION OF THE ACTIVITIES

What is it?

The assessment of the pedagogical integration is developed through two assessment tables (see below) for the activities Micro:Bit Rock-Paper-Scissors (https://microbit.org/) game evaluated in prior studies (Ball et al., 2016), which is based in the traditional game Rock-Paper-Scissors. The Rock-paper-scissor is a Micro:Bit activity, which can be accessed through the following links: http://www.ahc.me.uk/blog/bbc-microbit/bbc-microbit-rock-paper-scissors-lizard-spock-project. Some variants of the Rock-Paper-Scissors game can be found here: https://www.kreativekorp.com/miscpages/rps/. The assessment tables of the Rock-Paper-Scissors game evaluate the workshop facilitator and the participant are the following:

Workshop facilitator questionnaire:

English : https://enquetes.unice.fr/index.php/735286?lang=en
Français: https://enquetes.unice.fr/index.php/735286?lang=fr

Workshop facilitator	Not observed	Not clearly observable	Observed
Identification of participants' prior knowledge			
Activity orchestration. The facilitator organises the activity allowing all participants to actively engage in the activity			
Problem solving. The facilitator takes advantage of participants' problems to develop their problem-solving capacities.			
Debriefing. After the task, the debriefing helps to learn concepts developed through the activity.			

Workshop participant questionnaire (for each participant):

English : https://enquetes.unice.fr/index.php/717888?lang=en
Français: https://enquetes.unice.fr/index.php/717888?lang=fr

Participants	Not observed	Not clearly observable	Observed
Design of simple algorithms using loops, and selection i.e. if statements.			
Declaration and assignation of variables.			
Use of variables and relational operators within a loop to govern termination.			
Use of logical reasoning to predict outcomes.			
Detection and correction of errors i.e. debugging, in algorithms.			
Creation of programs that implement algorithms to achieve given goals.			
Understanding that programming bridges the gap between algorithmic solutions and computers.			

TOOL #5 - A DIGITAL LEARNING ECOSYSTEM

LIST OF FEATURES NEEDED FOR THE E-LEARNING PLATFORM

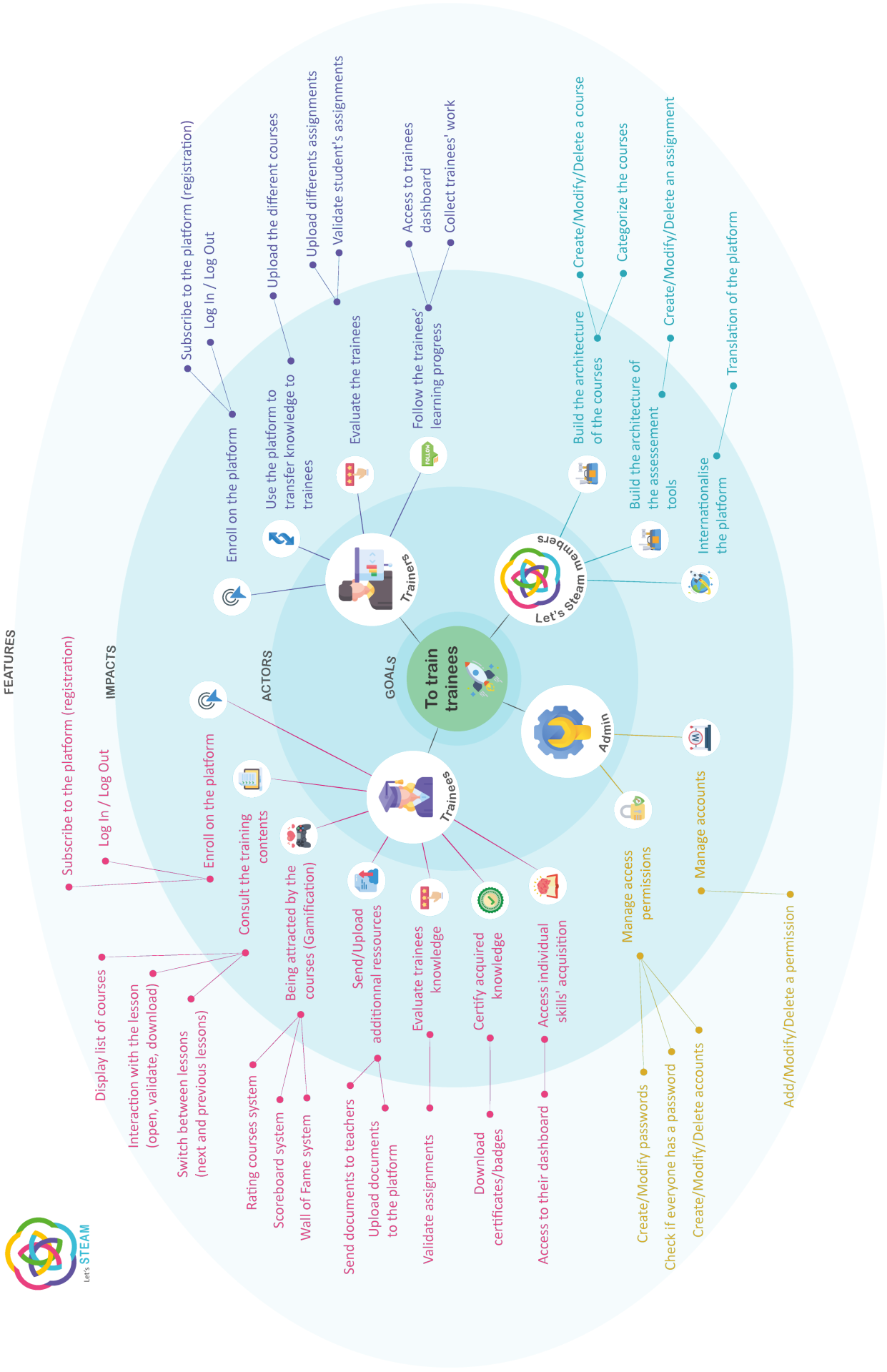
WHAT CAN WE DO TO SUPPORT THE REQUIRED IMPACTS? E-LEARNING PLATFORM

Needed features	Goal on the learning space	Description
F1: Subscribe to the platform **F2: Log in / Log out**	Enroll on the platform	• Teachers need to be enrolled on the platform in order to use it. • Trainees need to be enrolled on the platform in order to use it.
F3: Upload the different courses	Use the platform to transfer knowledge to trainees	Teachers need to upload the courses to provide the training content to the trainees.
F4: Access to trainees' dashboard **F5: Collect trainees' work**	Use the platform to transfer knowledge to trainees	Teachers need to track the learning progress of trainees.
F6: Upload different assignments **F7: Validate students' assignments**	Evaluate the trainees	Teachers need to perform evaluations of the trainees in order to verify that they understood the course.
F8: Display list of courses **F9: Interaction with the lesson (open, validate, download)** **F10: Switch between lessons (next and previous lessons)**	Consult training contents	The trainees have specific expectations as they also are teachers at secondary school. Hence, they will have high expectations in terms of accessibility and ease of use, practice and reuse training contents for their own skills or for transmitting them in a second stage to their learners. They should be able to get self-trained, especially for those who will follow the e-learning pathway.
F11: Rating course system **F12: Wall of fame system** **F13: Scoreboard system**	Being attracted by the courses	Gamification system, aimed at sustaining the interest of the trainees.
F14: Send documents to teachers **F15: Upload documents to the platform**	Send/Upload additional resources	Trainees should be able to send/upload additional documents to teachers or to the platform.

Needed features	Goal on the learning space	Description
F16: Validate assignments	Evaluate trainees' knowledge	Trainees need to have their skills evaluated through the completion of the assignments prepared at each level.
F17: Download certificates/badges	Certify acquired knowledge	Trainees need to be able to show that they have successfully completed a module and acquired the necessary knowledge.
F18: Access to their dashboard	Access individual skills' acquisition	Trainees need to have an access to their dashboard in order to have an overview of their achieved progress.

FOR ADMIN PURPOSES - FUNCTIONNALITIES FOR THE CONSORTIUM MEMBERS		
Needed features	Goal on the learning space	**Description**
F19: Create/Modify/Delete a course **F20: Categorize the courses**	Build the architecture of the courses	The consortium partners will be the ones responsible for the development of the e-learning material, based on the 3 focus areas suggested in D1.2
F21:Create/Modify/Delete an assignment	Build the architecture of the assessment tools	The consortium partners will also develop the specific assessment tool which will be used for evaluating the knowledge acquired by trainees.
F22: Translation of the platform	Internationalise the platform	Partners will be responsible for the translation of the e-learning platform and the learning material in the 4 project languages
F23: Create/Modify passwords **F24: Check if everyone has a password** **F25: Create/Modify/Delete accounts**	Manage accounts	The Admin will be responsible for all the back end of the e-learning platform.

WHAT CAN WE DO TO SUPPORT THE REQUIRED IMPACTS? E-LEARNING PLATFORM



TOOL #6 - A TAILORED VERSION OF LEARNING PROGRAMMING TOOLS

TECHNICAL SPECIFICATIONS AND USER STORIES

The objective of this tool is linked to the deployment of new extensions on popular learning programming tools to enable them to be tailored to the requirements of the teachers. The platforms integrate Scratch, CircuitPython and MakeCode. This last tool will be specifically explored during Let's STEAM to develop a dedicated version, in addition to propose a strategy for the other two platforms.

PART I - LIST OF NEEDED FEATURES FOR TRANSFORMING PROGRAMMING PLATFORMS IN LEARNING TOOLS

Needed features	Goal	Description
F1: Create raw learning materials **F2: Make learning material interactive** **F3: Gather the contents in learning pathway** **F4: Associate raw material with a discipline** **F5: Create assessment grids**	Design learning contents	The teachers should be able to offer and promote a learning experience for his/her trainees without any obstacle to approaching new technologies such as IoT practices. Trainers should be able to produce and give access to raw, interactive and playful contents to facilitate the delivery of new skills. These contents should be developed with the full commitment of the trainers as contributors, with the support of the pedagogical Let's STEAM team to understand the best pedagogical pathways towards motivation of the students, targeting less technical but highly contextualized and illustrated contents.
F6: On-boarding **F7: Animate blended sessions** **F8: Play video contents** **F9: Launch step-by-step pedagogical activities** **F10: Realise collective projects** **F11: Realise individual exercises** **F12: Access additional resources** **F13: Assess the trainees' work**	Animate training sessions	Once the learning contents will be developed, the trainers need to be able to animate training sessions, physically and on-line, based on the raw and interactive materials created. These training sessions will only be efficient with a perfect understanding by the teachers of the platforms' functionalities otherwise, it might become counterproductive to use the platforms as learning materials.
F14: Involve the trainees **F15: Start and stop the classroom session** **F16: Provide the work basis for the session** **F17: Collect the trainees' work** **F18: Assess individual completion stage** **F19: Dashboard the completion stage in an aggregated way** **F20: Provide individual feedback to the trainees**	Follow the classroom	To assess the relevance between the training programme and the concrete acquisition of skills by the trainees, the trainers should be able to follow this competences acquisitions by managing, collecting and assessing the work of the learners. These data, aggregated, will give additional elements for the trainers to evaluate the completion of a skill framework at the level of a classroom and individually.

Needed features	Goal	Description
F21: Identify the disciplines linked to each content **F22: Understand the prior knowledge needed for undertaking each content** **F23: Identify the learning objectives of each learning pathway**	Find adapted contents to the level	The trainees, in their position of secondary school teachers willing to acquire new skills to enhance their teaching materials and methods, need to find adapted contents to their level and requirements. Not all the teachers will have the same pre-existing knowledge in technical and practical IoT competences. If they are not well guided among training contents in identifying what is the best pathways for them, we risk losing them in the learning process.
F24: Launch an exercise outside the learning sessions & practice **F25: Access the instructions** **F26: Play video of tutorials**	Consult training contents	The trainees have specific expectations as they also are teachers at secondary school. Hence, they will have high expectations in terms of accessibility and easiness to use, practice and reuse training contents for their own skills or for transmitting them in a second stage to their learners. They should be able to get self-trained, especially for those who will follow the e-learning pathway.
F27: Register and launch a live session **F28: Collaborate with other trainees** **F29: Realise a given exercise during live sessions** **F30: Submit the results to the teacher** **F31: Post additional resources with the community of learners**	Participate to training sessions	The specific aim of Let's STEAM is to provide a whole training session for secondary school teachers where they will be able to collaborate and get trained to achieve a concrete set of skills pre-defined in D1.2. To reach this goal, the teachers/trainers should be able to attend live and collaborative courses and provide concrete work.
F32: Access individual dashboard	Follow their skills' acquisition	To change trainees' behaviours regarding their level of skills in IoT, they need to be able to follow their process and achievements. To do so, a skill-based framework, where teachers as trainers can understand what concrete competencies and their link with classroom activities' implementation should be developed. If trainers are not feeling their evolvement, we will lose their commitment to the full courses as they need to understand the usefulness of the Let's STEAM programme.

Needed features	Goal	Description
F33: Access learning pathways **F34: Identify the learning outcomes and pedagogical objectives of each pathway** **F35: Access success story achievements**	Consult learning pathways and curricula	As policy makers, the objective in having access to the results of Let's STEAM in terms of functionalities on coding platforms is linked to the capacity to understand the potential opportunities but most importantly the obstacles and limits of integrating systematically programming as part of curricula in secondary schools. During the project, for each goal shared by the Let's STEAM targeted actors, the policymakers will be involved to get more insights on how efficiently support this shift to programming in curricula. At this stage, the skills acquisition framework of the teachers will enable them to understand the needed support to teachers by being able to follow the development of their competences.
F36: List pre-requisites to start a project **F37: Link each project with several disciplines** **F38: Identify the resources list per project (including raw materials, interactive resources and additional documentation given to the trainees)** **F39: Identify the learning objectives of each project** **F40: Identify the learning intent of each project (e.g. creativity, problem solving, collaboration, critical thinking & computational thinking)**	Create a project	In addition to the goal of increasing teachers' skills, Let's STEAM ambitions to enhance pedagogies in teaching programming by developing an inquiry-based approach developed in D1.2. This methodology will be supported in terms of platforms' functionalities to enable organising and delivering the interactive contents following an inquiry process. This will only be enabled if the trainers have the capacity to create and value a project-based approach. Linking them to pedagogical intentions and objectives will enable catching the trainers' interest as it will create a bond between their role as teachers and the motivation pattern of the learners.
F41: Make the projects accessible to the learners **F42: Create project teams** **F43: Define the project's steps regarding the inquiry-based approach** **F44: Attach the report template to each step** **F45: End the project after completion**	Manage a project	Once the projects are created, we will give the possibilities to the trainers to manage them i.e. interrelate them with the trainees and use the platforms as steps towards the completion of the inquiry-based approach. In this way, our work will enable them to concretely work under this process, and not only apply it theoretically to their teaching pedagogy.

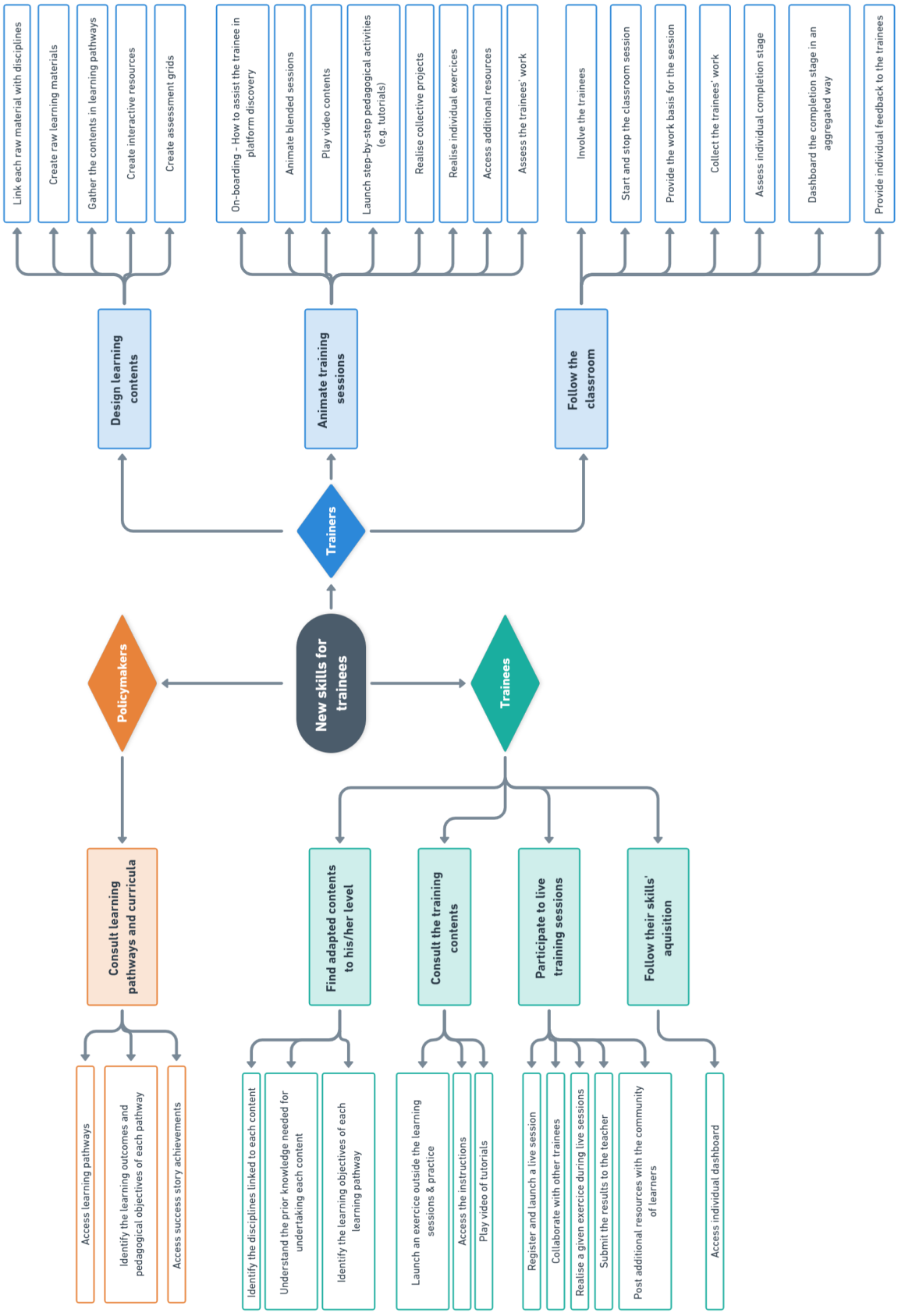
Needed features	Goal	Description
F46: Gather the reports **F47: Access the team dashboards** **F48: Send comments to each team**	Follow the project team	As "Follow the classroom", same functionalities should be applied at the level of the projects or challenges to ensure that the pedagogy developed under the second goal is promoting the acquisition of skills.
F49: Display the full list of resources **F50: Select in the resources available the relevant ones to the inquiry process**	Identify the competences needed for resolving a project	To be able to question the challenges offered in an efficient and interesting way, it is mandatory that the learners are able to position themselves in a skill-based scope to understand the needed competences that will be used to resolve a project. This will enable developing short training courses to reach the required level and have an efficient learning pathway for both trainers and trainees.
F51: Create programs **F52: Simulate the program** **F53: Display data and graphs generated by the simulations** **F54: Upload the program in the IoT board** **F55: Display the data provided by the IoT boards during experimentation**	Collect data for exploration and experimentation	The whole inquiry-based approach is linked to the capacity to explore, experiment, gather clues and question data. In this way, using IoT is a core added value. This will be the main asset of the platforms for the learners i.e. the possibility to create programs that will simulate and generate from real-world data that can enable validating or questioning the learners' hypothesis. This is the basic capability offered by IoT within Let's STEAM.
F56: Export data in CSV or Excel format (data sheet)	Export data for analysis and interpretation	Even if linked to an offline activity animated by the teachers, the interpretation of data can only be effective if the learners can extract them in a format that is readable for them, in the commonly used way i.e. CSV or Excel. If the learners cannot easily extract the data, we will lose their interest for the platforms as it will not facilitate their learning process.
F57: Attach documents **F58: Remove documents**	Association additional resources (external documents, reports, ...)	In an inquiry-based approach, questioning the hypothesis against the state-of-the-art is a crucial step. If we want to make the platforms central in the learning process of the trainees, understanding that the inquiry-based method is supporting acquisition and interest for STEAM education as for programming competences, additional functionalities, linking the digital environment with off-line activities should be added, especially in providing additional resources, substantiating the findings by external experimentations.

Needed features	Goal	Description
F59: Access chat live for discussing **F60: Comment team members' work**	Collaborate, brainstorm and exchange ideas	Through the implementation of an inquiry-based approach, the objective in term of learning experience is to develop several of the 21st century skills especially collaboration and critical thinking. It is major for the platforms to integration functionalities that can enable and guide the learners in this cooperative framework while creating a digital ecosystem that is the most integrated as possible, not to lose the interest of the learners.
F61: Display the list of projects **F62: Filter and sort the projects per discipline and learning objectives**	Explore the projects towards the competences	By exploring the projects with a competence-oriented approach, the policy makers will be able to illustrate the pedagogy with success stories. In addition, the inquiry-based method allows not only to develop coding skills, but to deepen the STEAM achievements and knowledge, hence relevant for the whole science and arts curricula. This double sort will enable policy makers to better understand the added value of active pedagogies and the tools such as IoT to reach it.
F63: Make public the resources developed by the trainers **F64: Create and share transdisciplinary challenges**	Share pedagogical resources	The third main behaviour change overseen by the Let's STEAM implementation is opening collaboration between teachers, across disciplines, across schools and countries. The first step of reaching this main goal is through publication of the pedagogical resources as shared learning material. This will enable enlarging the interest of the teachers for cooperation as it will give additional opportunities to create challenges and to motivate the learners.
F65: List, filter and sort the on-going challenges **F66: Contact the teachers in charge of the identified challenges**	Find opportunities for collaborating	If the objective is to collaborate, we should be able to provide the right functionalities to ease the identification of cooperation opportunities. Indeed, language, culture, time or lack of partnerships' background may hinder the teachers from looking by themselves for collaborations. Through the platforms, direct possibilities will be given to resolve challenges together, that will provide the right methodology and framework to start at small scale finding partners in other schools and countries.
F67: List contents per language **F68: Enable the translation of the contents**	Provide contents in many languages	A main obstacle for collaboration is often the language especially in education and STEAM where the vocabulary can be very specific. This can be a main barrier to the implementation of the Let's STEAM vision. Tackling translation is then a crucial aspect of the functionalities to be developed.

Needed features	Goal	Description
F69: List the challenges per level **F70: Display the existing teams** **F71: Contact teams** **F72: Create new teams** **F73: Join existing teams** **F74: Accept new team members**	Participate to international and interdisciplinary challenges	As for the trainers, the learners should be able to start collaboration. This is a cascade process: • As secondary school teachers, being trained, this will enable launching cooperation for future partnership and perform a "beta test" of collaborating at the classroom level • As learners (secondary school students), this will have major positive outcomes in terms of collaboration skills, but also mind openness, language competences, development of cultural knowledge …
F75: Make the results public	Publish the results of the challenges	Publishing the results of the challenges is major for inspiring new collaborations. This will strengthen the number of materials available for the learners and will illustrate the potential of the Let's STEAM approach.
F76: List the public results from challenges **F77: Export data** **F78: Comment the results and share experience**	Access data from other schools and trainees	Through collaboration, it is actually the two other goals that will be highly positively impacted. Through the publication of results as said in IMP3.5, new raw materials and interactive contents will be delivered to enhance the first goal i.e. increasing skills. Through the publication of a high number of additional data, from other schools and classrooms challenges, the inquiry-based approach will be more and more effective, by enabling the development of additional STEAM experimentation, feeding the hypothesis of the learners.
F79: Access national dashboards **F80: Access the challenges' results**	Understand the national skills framework	Education and training play a crucial role in enabling young people to develop key competences, especially those identified as core for the 21st century and, thereby, provide the conditions for the best possible start in life. The EU policy makers hence support the recognition of skills and qualifications to make it easier to study and work anywhere in Europe. Several measures to support the transparency and recognition of knowledge, skills, and competences have been developed. Through this impact, these specific policy makers will have access to additional data per country, enabling to assess the same activities and challenges performed in different background. This will raise the knowledge available on STEAM education activities in Europe and support the implementation of the New Skills Agenda for Europe as well as the Digital Education Action Plan.
F67: List contents per language **F68: Enable the translation of the contents**	Provide contents in many languages	A main obstacle for collaboration is often the language especially in education and STEAM where the vocabulary can be very specific. This can be a main barrier to the implementation of the Let's STEAM vision. Tackling translation is then a crucial aspect of the functionalities to be developed.

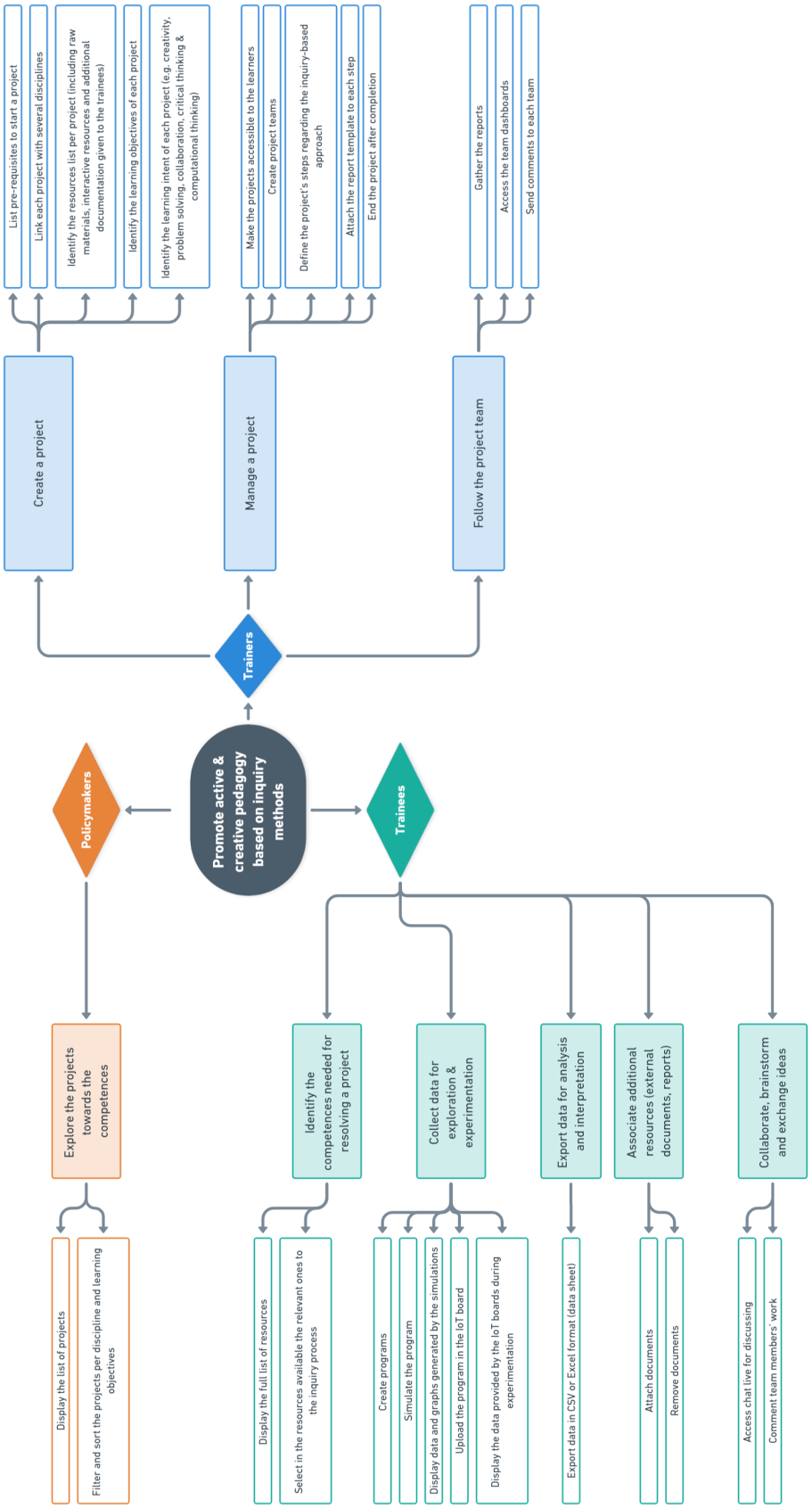
FUNCTIONALITIS FOR ACHIEVING GOAL #1 OF THE LET'S STEAM TRAINING

NEW SKILLS FOR TEACHERS



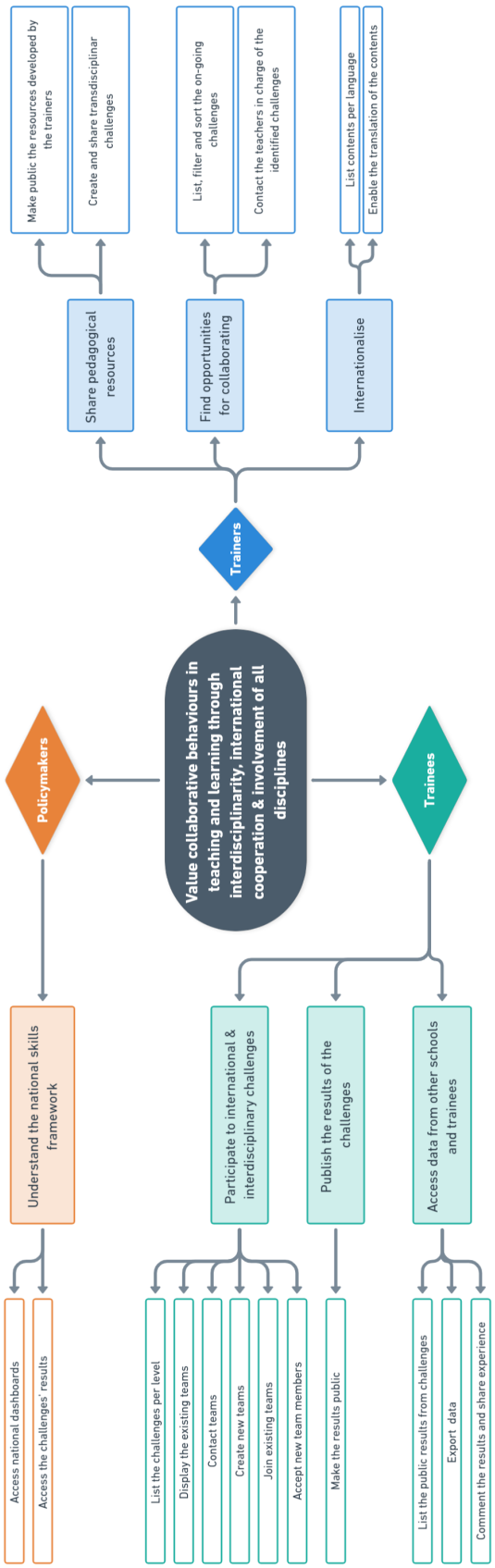
FUNCTIONALITIS FOR ACHIEVING GOAL #2 OF THE LET'S STEAM TRAINING

PROMOTE ACTIVE & CREATIVE PEDAGOGY



FUNCTIONALITIS FOR ACHIEVING GOAL #4 OF THE LET'S STEAM TRAINING

VALUE COLLABORATIVE BEHAVIOURS IN TEACHING



PART II - USING USER STORY TO BETTER SPECIFY THE FUNCTIONAL NEEDS OF THE PLATFORMS

A user story is a description of functionality or part of functional written in the everyday or business language which captures what a user does or needs to do. User stories provide rapid way of handling customer requirements instead of formal requirement documents and without performing administrative tasks related to their maintenance and are more specifically beneficial as Features are the basis for writing acceptance tests with test-driven development and it helps avoid misunderstandings of documentation (specifications and requirements of the customer), and errors in the logic of the application.

Within this document, the partners will provide the technical specifications through a list of functionalities, each of them being developed as a user story, using the "Gherkin language", a line-oriented language that uses indentation to define structure. Line endings terminate statements (called steps) and either spaces or tabs may be used for indentation, using the following structure:

```
Feature: Some terse yet descriptive text of what is desired

As a description of the user
I want to functionality
So that benefit

Scenario: Some determinable situation contains a description of the scenario.
    Given some precondition
    When some action by the actor
    Then some testable outcome is achieved
```

Analyzing these user stories and scenarios is hence a precondition for identifying the software (here the three platforms) requirements given the fact that they present the actual needs and expectations of the end-users and thus facilitate the requirements elicitation process. This section presents the list of functionalities using these presentation, format and structure.

WHAT CAN WE DO TO SUPPORT THE REQUIRED IMPACTS? TAILORED PROGRAMMING TOOLS

`Feature: F1 - Create raw learning materials`

`As a` Trainer

`I want to` Create raw learning materials

`So that I can` Design learning contents

`Example of scenario within Let's STEAM`

Given Jorge has access to the platforms as trainer
When Jorge generates one action "Display numbers on the screen" to be done on the platforms
Then the trainees have individual access to it a unique learning material "How to display numbers on the screen"

`Feature: F2 - Make learning material interactive`

`As a` Trainer

`I want to` Make learning material interactive

`So that I can` Enhance learning contents for the trainees

`Example of scenario within Let's STEAM`

Given the creation of raw learning materials on the platforms such as "Display numbers on the screen"
When the trainees access the raw material and perform it "Display numbers on the screen"
Then the screen displays a visual representation of the "Numbers on the screen"

`Feature: F3 - Gather the contents in learning pathway`

`As a` Trainer

`I want to` Gather the contents in learning pathway

`So that I can` Provide a course based on a learning objective to my trainees

`Example of scenario within Let's STEAM`

Given the creation of a set of raw materials such as "Display numbers on the screen" & "Measure temperature"
When Jorge linked them on the platforms
Then the trainees can achieve a larger challenge such as "Display the temperature on the board"

Feature: F4 - Associate raw material with a discipline

As a Trainer

I want to Associate raw material with a discipline

So that I can Orientate the learners in the learning objectives of the materials

Example of scenario within Let's STEAM

Given the creation of the raw materials by Jorge
And the display of an icon highlighting the discipline linked to each content
When the learners start a course
Then they see which topic of STEAM education they are performing activities in

Feature: F5 - Create assessment grids

As a Trainer

I want to Create assessment grids

So that I can Associate learning contents to a set of skills and achievements

Example of scenario within Let's STEAM

Given the creation of raw learning contents
And the development of learning courses and pathways
And the association of each content and path to a specific discipline
When the trainees will undertake a course, they will have access to the set of competences and skills to be achieved
And they will complete the programme according to these assessment grids
Then Jorge as trainer will be able to follow their evolvement

Feature: F6 - On-boarding

As a Trainer

I want to Understand how the platform is working

So that I can Animate learning sessions efficiently

Example of scenario within Let's STEAM

Given Jorge is a trainer with access to the platforms
When he is launching one of the platforms for the first time

`Feature: F7 - Animate blended sessions`

`As a` Trainer

`I want to` Animate blended sessions

`So that I can` Enlarge my trainees' community

`Example of scenario within Let's STEAM`

Given the capacity to engage learners on the e-learning platform
When Jorge give them access to the learning material on the coding tools
Then the additional learners have all the solutions to follow a course in a blended way

`Feature: F8 - Play video contents`

`As a` Trainer

`I want to` Play video contents

`So that I can` Illustrate my thoughts during the training sessions with interactive and visual materials

`Example of scenario within Let's STEAM`

Given the creation of interactive learning contents
And the possibility to gather them in a video
When Jorge click on the video option on the platform
Then a full video of the whole steps towards "Displaying the temperature on the board" is showed to the students

`Feature: F9 - Launch step-by-step pedagogical activities`

`As a` Trainer

`I want to` Launch step-by-step pedagogical activities

`So that I can` Support my learners in while beginning on the platform

`Example of scenario within Let's STEAM`

Given the creation of interactive learning contents
When the learners launch the content "Generate a blinking patter" for the first time
Then specific guidance settled by the teacher will appear such as "Place the `show leds` block in the `forever` block and draw a pattern"

`Feature: F10 - Realise collective projects`

`As a` Trainer

`I want to` Realise collective projects

`So that I can` create interactions between my trainees

`Example of scenario within Let's STEAM`

Given the enrolment of several trainees on a course
When Jorge launch an exercise to the classroom
Then Learners can have access to a common collaborative block editor to work collaboratively

`Feature: F11 - Realise individual exercises`

`As a` Trainer

`I want to` Realise individual exercises

`So that I can` Assess individually the skills acquired by my trainees

`Example of scenario within Let's STEAM`

Given the enrolment of several trainees on a course
When Jorge launch an exercise
Then Learners can have access to an individual identified block editor to submit individual work

`Feature: F12- Access additional resources`

`As a` Trainer

`I want to` Access additional resources

`So that I can` Include additional offline activities performed by my students as contents and assets for assessment

`Example of scenario within Let's STEAM`

Given that the learners have access to a depository
When they put additional resources linked to a specific exercise
Then Jorge gets notified automatically by the platform to include the resources in the assessment process

Feature: F13 - Assess the trainees' work

As a Trainer

I want to Assess the trainees' work

So that I can Evaluate the evolvement and consider my session achieved

Example of scenario within Let's STEAM

Given that the learners are performing collective exercise
And that the learners are performing individual exercise
When all the duties are completed
And all the results have been validated by the students as final
And all the additional resources are available to Jorge
Then Jorge can perform an assessment based on the assessment grids pre-defined

Feature: F14 - Involve the trainees

As a Trainer

I want to Involve the trainees

So that I can start my class with the planned registered number of learners

Example of scenario within Let's STEAM

Given the list of enrolled trainers
When Jorge gives the online access to the full list of learners
Then Learners can see all the materials displayed for a specific course

Feature: F15 - Start and stop the classroom session

As a Trainer

I want to Start and stop the classroom session

So that I can Manage the time and access of the class

Example of scenario within Let's STEAM

Given the predefinition of the classroom session objectives and duration
When Jorge clicks on start the session button
Then Learners can have access to the whole functionalities
And when Jorge click on the stop the session button

Feature: F16 - Provide the work basis for the session

As a Trainer

I want to Provide the work basis for the session

So that I can Launch the learning session

Example of scenario within Let's STEAM

Given the definition of materials linked to a session
And the development of learning pathways
And the development of step by step resources
When the learners will log in for the first time of a session
Then they will access on-boarding materials that will need to get go through to launch the session

Feature: F17 - Collect the trainees' work

As a Trainer

I want to Collect the trainees' work

So that I can Assess the achievements of my learners

Example of scenario within Let's STEAM

Given the definition of assessment grids
And the access to the results of collective exercise
And the access to the results of individual exercise
And the access to additional resources
When the session is finished
Then Jorge will collect automatically the work performed by each student

Feature: F18 - Assess individual completion stage

As a Trainer

I want to Assess individual completion stage

So that I can Provide individual feedback and assess the skills of my learners

Example of scenario within Let's STEAM

Given the automatic delivery of individual work performed by the students
When Jorge has collected them

Feature: F19 - Dashboard the completion stage in an aggregated way

As a Trainer

I want to Dashboard the completion stage in an aggregated way

So that I can Follow my classroom as a whole

Example of scenario within Let's STEAM

Given the automatic gathering of the work performed by the students
When Jorge displays the general assessment
Then he can see dashboard of the classroom achievements

Feature: F20 - Provide individual feedback to the trainees

As a Trainer

I want to Provide individual feedback to the trainees

So that I can Provide the results of the assessment and support to my learners individually

Example of scenario within Let's STEAM

Given the display of a chat functionality
And the notification of all achievement of the learners
When Jorge receives a notification
Then He can perform continuous assessment
And Notify on the platform the learners for additional support

Feature: F21 - Identify the disciplines linked to each content

As a Trainee

I want to Identify the disciplines linked to each content

So that I can Find adapted contents to my learning objectives

Example of scenario within Let's STEAM

Given that Jorge has identify a discipline linked to each raw material
And the display of an icon identifying the discipline
And the possibility to sort material per discipline
When the trainees set the search criteria on "Mathematics"
Then the platform is displaying all learning materials linked to "Mathematics"

Feature: F22 - Understand the prior knowledge needed for undertaking each content

As a Trainee

I want to Understand the prior knowledge needed for undertaking each content

So that I can Find adapted contents to my level

Example of scenario within Let's STEAM

Given Jorge as trainer is attaching to each learning pathways step by step guidelines
And Jorge is linking all contents as path of learning
And Jorge is applying specific pre-requisite per material
When a trainee is selecting one pathway
Then a documentation including the list of materials to have been undertaken prior to starting the pathway will be automatically displayed to him/her

Feature: F23 - Identify the learning objectives of each learning pathway

As a Trainee

I want to Identify the learning objectives of each learning pathway

So that I can Understand the objectives of the pathway in terms of skills and new behaviours to be acquired

Example of scenario within Let's STEAM

Given Jorge as trainer is attaching to each learning pathways additional documentation regarding the learning and pedagogical background and objectives of the content
When a trainee is selecting one pathway
Then a documentation including the learning objectives of the pathway is displayed automatically prior to starting the linked activities

Feature: F24 - Launch an exercise outside the learning sessions & practice

As a Trainee

I want to Launch an exercise outside the learning sessions & practice

So that I can Individually consult the training content and self-train myself

Example of scenario within Let's STEAM

`Feature: F25 - Access the instructions`

`As a` Trainee

`I want to` Access the instructions

`So that I can` Understand what is expected from me as learners in undertaking learning content

`Example of scenario within Let's STEAM`

Given Jorge as trainer has developed step by step tutorials and on-boarding elements
When a trainee is getting connected to the platforms for the first time
Then he/she will undertake the on-boarding steps to understand the platform functioning
And when a trainee will join a learning session
Then he/she will have access to the learning repository with Jorge's instructions for the session

`Feature: F26 - Play video of tutorials`

`As a` Trainee

`I want to` Play video of tutorials

`So that I can` Understand the first steps of undertaking a training content

`Example of scenario within Let's STEAM`

Given Jorge as teacher has developed step by step tutorials linked to each material
When a trainee is selecting one material
Then the tutorial will be offered automatically when opening the content for the first time

`Feature: F27 - Register and launch a live session`

`As a` Trainee

`I want to` Register and launch a live session

`So that I can` Participate to training sessions

`Example of scenario within Let's STEAM`

Given each trainee has access to a personal account
And Jorge can send invitations to join a specific live session to his students
When a trainee is accepting the invitation
Then if he/she is not registered yet, the platform will request registration from him/her
And then if he/she is registered he will directly access in his/her personal dashboard, the link to launch a live session

Feature: F28 – Collaborate with other trainees

As a Trainee

I want to Collaborate with other trainees

So that I can Participate to training sessions and develop the feeling of classroom on-line

Example of scenario within Let's STEAM

Given Jorge as teacher is opening the session to multiple trainees
And Jorge animates collective exercises
When a trainee is enrolled in a collective training
Then he/she will have access to a collaborative block editor to create join results
And he/she will have access to a chat live to discuss with other trainees

Feature: F29 – Realise a given exercise during live sessions

As a Trainee

I want to Realise a given exercise during live sessions

So that I can Participate to the session in producing the expected results

Example of scenario within Let's STEAM

Given Jorge as teacher has set learning objectives associated with assessment grids
When Jorge is launching a live exercise
Then the trainee will receive an automatic notification for completing the exercise in live through individual block board

Feature: F30 – Submit the results to the teacher

As a Trainee

I want to Submit the results to the teacher

So that I can Get assessed by the trainer

Example of scenario within Let's STEAM

Given the trainee has performed an individual or collective exercise
When the trainee will click on the button "Submit"
Then the results of the exercise will be automatically sent to the teachers
And they will be registered in the trainee's personal dashboard

Feature: F31 – Post additional resources with the community of learners

As a Trainee

I want to Post additional resources with the community of learners

So that I can Value offline activities especially results given using the programs developed through the platforms and plugged on the IoT board

Example of scenario within Let's STEAM

Given the trainees are performing activities outside the platforms (offline or in other platforms)
When a trainee posts a documentation in the classroom drive
Then the trainers and trainees can consult it

Feature: F32 – Access individual dashboard

As a Trainee

I want to Access my individual dashboard

So that I can Follow my skills' acquisition level

Example of scenario within Let's STEAM

Given that the results of the exercises, comments from the teachers, track of the chat sessions and instructions are automatically saved on a personal dashboard
And Jorge provides on this dashboard the results of the assessment grids
When a trainee gets connected to his account
Then he/ she can have access to the dashboard
And he/she will see graphically his/her achievements and skills' level

Feature: F33 – Access learning pathways

As a Policy Maker

I want to Access learning pathways

So that I can Understand the STEAM requirements in using programming boards

Example of scenario within Let's STEAM

Given that external organisations and people can register online to have access to the platforms' contents
When Bernard accesses the platforms

Feature: F34 – Identify the learning outcomes and pedagogical objectives of each pathway

As a Policy Maker

I want to Identify the learning outcomes and pedagogical objectives of each pathway

So that I can Understand the link between the contents and the curricula

Example of scenario within Let's STEAM

Given that Bernard accesses the platforms
When he can display the pathway
Then he accesses additional information including learning outcomes and guidelines

Feature: F35 – Access success story achievements

As a Policy Maker

I want to Access success story achievements

So that I can Illustrate future policies with best practices

Example of scenario within Let's STEAM:

Given Jorge gives access to Bernard to the results of the exercises
When Bernard displays this information on the platform
Then he can download examples of pathways with screenshots

Feature: F36 – List pre-requisites to start a project

As a Trainer

I want to List pre-requisites to start a project

So that I can Guide my learners in launching an inquiry-based approach

Example of scenario within Let's STEAM:

Given Jorge has created learning materials
When Jorge creates a project e.g. "Climate change monitoring across Europe"
Then Jorge gathers the pre-requisite materials needed to undertake the challenge as "Monitor temperature" & "Display temperature"

Feature: F37 – Link each project with several disciplines

As a Trainer

I want to Link each project with several disciplines

So that I can The project can be used by several teachers on the basis of interdisciplinarity

Example of scenario within Let's STEAM:

Given the creation of the "Climate change monitoring across Europe" project
When the project is displayed to the teachers' community
Then Science teachers can create a pathway on "Understanding the natural greenhouse effect"
And Faustina, as Physics teacher, can create a pathway on "Energy flows and temperature changes"
And Jorge, as a Technology teacher, can create a pathway on "Making a thermogram"
And Euthalía, as an Art teacher, can create a pathway on "Designing a game on Climate Change across Europe"
And Dirk, as a Mathematics teacher, can create a pathway on "Recognize trends in data and use them to predict future changes"

Feature: F38 – Identify the resources list per project

As a Trainer

I want to Identify the resources list including raw materials, interactive resources and additional documentation

So that I can Start a project

Example of scenario within Let's STEAM:

Given the definition of projects
When Jorge or any other teacher is displaying a project
Then he/she has access to a specific section displaying all the contents, sorted by category

Feature: F39 – Identify the learning objectives of each project

As a Trainer

I want to Identify the learning objectives of each project

So that I can Engage my students in the learning process

Example of scenario within Let's STEAM:

Given the creation of project gathering several raw materials
When I display a project

Feature: F40 – Identify the learning intentions of each project

As a Trainer

I want to Identify the learning intentions of each project (e.g. creativity, problem solving, collaboration, critical thinking & computational thinking)

So that I can Link a project with a larger goal

Example of scenario within Let's STEAM:

Given the definition of one or several 21st century skill objective per raw material
When Jorge displays the list of materials per project
Then the icons of disciplines and of intentions are appearing visually

Feature: F41 – Make the projects accessible to the learners

As a Trainer

I want to Make the projects accessible to the learners

So that I can Manage a project

Example of scenario within Let's STEAM:

Given the creation of the project "Climate change monitoring across Europe"
When a trainee is searching for materials linked to the diverse disciplines
Then the project is displayed to him/her

Given the creation of the project "Climate change monitoring across Europe"
When the trainer wants to launch a session on climate change
Then the trainee receives an invitation to follow the project "Climate change monitoring across Europe"

Feature: F42 – Create project teams

As a Trainer

I want to Create project teams

So that I can Launch collaboration and facilitate the development of inquiry-based approaches in the classroom

Example of scenario within Let's STEAM:

Given Jorge as trainer has the list of trainees
When launching the project "Climate change monitoring across Europe"

Feature: F43 – Define the project's steps regarding the inquiry-based approach

As a Trainer

I want to Define the project's steps regarding the inquiry-based approach

So that I can Facilitate the work of the trainees

Example of scenario within Let's STEAM:

Given the trainees are launching the activity "Climate change monitoring across Europe"
When they will click on start
Then they will have access to an overview of the steps of the inquiry-based approach
And when they will consider one step finish
Then they will notice it by validating a checklist in the platform that will give access to the next block editor

Feature: F44 – Attach the report template to each step

As a Trainer

I want to Attach the report template to each step

So that I can Give to the students, additional guidelines and methodology

Example of scenario within Let's STEAM:

Given the trainees are launching the activity "Climate change monitoring across Europe"
And they are starting Step 1 – Orientation when they will overtake pre-requisite raw contents
When the Step 1 will be over
Then they will have access to a report template enabling to provide the results to the teacher

Feature: F45 – End the project after completion

As a Trainer

I want to End the project after completion

So that I can Collect the results and provide feedbacks

Example of scenario within Let's STEAM:

Given the completion of all steps by the trainees of the challenge and sub-challenges "Climate change monitoring across Europe"
When all the report templates have been collected

Feature: F46 – Gather the reports

As a Trainer

I want to Gather the reports

So that I can Assess the completion

Example of scenario within Let's STEAM:

Given the completion of all steps by the trainees of the challenge and sub-challenges "Climate change monitoring across Europe"
When all the report templates have been completed by the trainees
Then The interdisciplinary team of teachers are noticed of report available
And can download them

Feature: F47 – Access the team dashboards

As a Trainer

I want to Access the team dashboards

So that I can Follow the project team

Example of scenario within Let's STEAM:

Given the creation of team
When activities will be performed at team level
Then the results will be automatically sent to a team dashboard, accessible by the teachers

Feature: F48 – Send comments to each team

As a Trainer

I want to Send comments to each team

So that I can Support the project team in my role of facilitator

Example of scenario within Let's STEAM:

Given the development of a chat functionality
When the trainees are performing activities
And the teachers are monitoring the results on the dashboards
When the teachers are identifying a trouble
Then they can start a chat live session with the project team

Feature: F49 – Display the full list of resources

As a Trainee

I want to Display the full list of resources

So that I can Identify the competences needed for resolving a project

Example of scenario within Let's STEAM:

Given the creation of the "Climate change monitoring across Europe" project
When the trainee is launching the project
Then he/she can see the full list of resources and linked pathways "Understanding the natural greenhouse effect", "Energy flows and temperature changes", "Making a thermogram", "Designing a game on Climate Change across Europe", "Recognize trends in data and use them to predict future changes"
And display the full list of raw materials associated to each sub-pathway

Feature: F50 – Select in the resources available the relevant ones to the inquiry process

As a Trainee

I want to Select in the resources available the relevant ones to the inquiry process

So that I can Create my personal learning ecosystem

Example of scenario within Let's STEAM:

Given the full list of raw material
When a trainee is starting the "Climate change monitoring across Europe"
Then he/she can affect specific contents to resolving the challenge by checking them as relevant

Feature: F51 – Create programs

As a Trainee

I want to Create programs

So that I can Collect data for exploration and experimentation

Example of scenario within Let's STEAM:

Given that the trainee is undertaking the "Recognize trends in data and use them to predict future changes" pathway
When he/she is gathering on his/her block editor the linked activities to collect data on temperature
Then he/she can create a full program to monitor and display temperature data with IoT boards

Feature: F52 – Simulate the program

As a Trainee

I want to Simulate the program

So that I can Collect data for exploration and experimentation

Example of scenario within Let's STEAM:

Given that the trainee is undertaking the "Recognize trends in data and use them to predict future changes" pathway
When he/she creates a full program to monitor and display temperature data on his/her block editor
Then he/she can see simulation on the digital board based on random temperatures

Feature: F53 – Display data and graphs generated by the simulations

As a Trainee

I want to Display data and graphs generated by the simulations

So that I can Collect data for exploration and experimentation

Example of scenario within Let's STEAM:

Given that the trainee is undertaking the "Recognize trends in data and use them to predict future changes" pathway
When he/she launch the simulation on the digital board based on random temperatures
Then the random data will be gathered and displayed on the dashboard

Feature: F54 – Upload the program in the IoT board

As a Trainee

I want to Upload the program in the IoT board

So that I can Collect data for exploration and experimentation

Example of scenario within Let's STEAM:

Given that the trainee is undertaking the "Recognize trends in data and use them to predict future changes" pathway
When the program is ready to be tested
And the IoT board is connected to the computer
Then the trainee can click on download to upload the program on the board and test it in real life

Feature: F55 – Display the data provided by the IoT boards during experimentation

As a Trainee

I want to Display the data provided by the IoT boards during experimentation

So that I can Collect data for exploration and experimentation

Example of scenario within Let's STEAM:

Given that the trainee is undertaking the "Recognize trends in data and use them to predict future changes" pathway
When the trainee will have collected data on the IoT board
And connected the IoT board to the computer
Then he/she can click on transfer to upload on the platform data from real life experiment that will be displayed in his/her personal dashboard

Feature: F56 – Export data in CSV or Excel format (data sheet)

As a Trainee

I want to Export data in CSV or Excel format (data sheet)

So that I can Export data for analysis and interpretation

Example of scenario within Let's STEAM:

Given the completion of all steps from simulation to data gathered on the field
When all the data are transferred in the trainee's personal dashboard
Then he can click on download data to obtain a workable datasheet format

Feature: F57 – Attach documents

As a Trainee

I want to Attach documents

So that I can Associate additional resources (external documents, reports, ...)

Example of scenario within Let's STEAM:

Given that the trainee is undertaking the "Recognize trends in data and use them to predict future changes" pathway
When he/she has identified state-of-the-art additional data
Then the trainee can upload them in his/her personal data folder or personal/team dashboard

Feature: F58 – Remove documents

As a Trainee

I want to Remove documents

So that I can Delete the non-useful material

Example of scenario within Let's STEAM:

Given that the trainee can upload them in his/her personal data folder or personal/team dashboard
When he has finished exploring them
And if they are non-relevant
Then he/she can click on delete

Feature: F59 – Access chat live for discussing

As a Trainee

I want to Access chat live for discussing

So that I can Collaborate, brainstorm and exchange ideas

Example of scenario within Let's STEAM:

Given the necessary teamwork under the inquiry-based approach
When a team will want to communicate
Then they can access a live chat functions working on team based with channels enabling to discuss within team, outside of teams and with the trainer

Feature: F60 – Comment team members' work

As a Trainee

I want to Comment team members' work

So that I can Collaborate, brainstorm and exchange ideas

Example of scenario within Let's STEAM:

Given the necessary teamwork under the inquiry-based approach
When a team will want to communicate
Then they will be able to post comment on the block editor as an extra functionality

Feature: F61 – Display the list of projects

As a Policy Maker

I want to Display the list of projects

So that I can Explore the projects towards the competences

Example of scenario within Let's STEAM:

Given the access of external organisations and users on the platforms
When Bernard registers and select the project section
Then he can have access to the full list of projects

Feature: F62 – Filter and sort the projects per discipline and learning objectives

As a Policy Maker

I want to Filter and sort the projects per discipline and learning objectives

So that I can Explore the projects towards the competences

Example of scenario within Let's STEAM:

Given Bernard registers and select the project section
When he sees the full list of projects
Then he can select "Mathematics" & "Creativity" and display the related projects

Feature: F63 – Make public the resources developed by the trainers

As a Trainer

I want to Make public the resources developed by the trainers

So that I can Share pedagogical resources with a large European Community

Example of scenario within Let's STEAM:

Given the creation of contents
When Jorge is publishing them on the platforms
Then it is accessible to the whole community with no restriction

Feature: F64 – Create and share transdisciplinary challenges

As a Trainer

I want to Create and share transdisciplinary challenges

So that I can Make the community of teachers enlarge the project-based approach

Example of scenario within Let's STEAM:

Given the creation of a challenge
When Jorge is publishing it on the platforms
Then It will be displayed to the whole community with no restriction

Feature: F65 – List, filter and sort the on-going challenges

As a Trainer

I want to List, filter and sort the on-going challenges

So that I can Find opportunities for collaborating

Example of scenario within Let's STEAM:

Given the creation of the challenge "Climate change monitoring across Europe" by Jorge in Spain
When Faustina is displaying the list of challenges from Italy
Then she can see that Jorge started a challenge in Spain
And then she can explore the results and contents of the classroom of Jorge

Feature: F66 – Contact the teachers in charge of the identified challenges

As a Trainer

I want to Contact the teachers in charge of the identified challenges

So that I can Find opportunities for collaborating

Example of scenario within Let's STEAM:

Given Faustina is displaying the list of challenges from Italy
And she is exploring Jorge's challenge "Climate change monitoring across Europe"
When accessing the contents
Then she can access a chat session to contact Jorge

Feature: F67 – List contents per language

As a Trainer

I want to List contents per language

So that I can find contents in English or in my native language

Example of scenario within Let's STEAM:

Given Faustina is displaying the list of challenges from Italy
And she speaks fluent English, Italian and French
When she selects the three languages in the searching tool's filters
Then she can have access to the full list of under-going challenge in a language she understands

Feature: F68 – Enable the translation of the contents

As a Trainer

I want to Enable the translation of the contents

So that I can Access contents in languages that I do not master

Example of scenario within Let's STEAM:

Given Faustina is displaying the list of challenges from Italy
And she speaks fluent English, Italian and French but she is not speaking Greek
When she accesses a content developed by Euthalia
Then she can translate them automatically to enlarge the materials she can access

Feature: F69 – List the challenges per level

As a Trainee

I want to List the challenges per level

So that I can Participate to international and interdisciplinary challenges under my competence framework

Example of scenario within Let's STEAM:

Given Jorge, Dirk, Euthalia, Faustina and Mélissandre are launching challenges in their country
And are defining pre-requisite linked to G1 and G2 functionalities
When a trainee is accessing the challenge section by his/her own
Then he can display the full list of challenge

`Feature: F70 – Display the existing teams`

`As a` Trainee

`I want to` Display the existing teams

`So that I can` Participate to international and interdisciplinary challenges

`Example of scenario within Let's STEAM:`

Given the creation of teams within schools by the teachers
When a trainee displays the list of challenges
And select one challenge such as "Climate change monitoring across Europe"
Then he/she visually identifies with avatar the working teams on a specific section

`Feature: F71 – Contact teams`

`As a` Trainee

`I want to` Contact teams

`So that I can` Participate to international and interdisciplinary challenges

`Example of scenario within Let's STEAM:`

Given the trainee selects the challenge "Climate change monitoring across Europe"
And he/she visually identifies with avatar the working teams on a specific section
When he/she clicks on the team
Then he/she accesses the team specific section including a chat function

`Feature: F72 – Create new teams`

`As a` Trainee

`I want to` Create new teams

`So that I can` Enrol other trainees in participating to international and interdisciplinary challenges

`Example of scenario within Let's STEAM:`

Given the trainee selects the challenge "Climate change monitoring across Europe"
When accessing the specific challenge section
Then he/she can decide to launch a recruitment for team members in addition to the existing teams

Feature: F73 – Join existing teams

As a Trainee

I want to Join existing teams

So that I can Participate to international and interdisciplinary challenges

Example of scenario within Let's STEAM:

Given the trainee selects the challenge "Climate change monitoring across Europe"
And he/she visually identifies with avatar the working teams on a specific section
When he/she clicks on the team
Then he/she accesses the team specific section including a chat function
And then he/she can claim for membership upon acceptance of the person (one trainee considered as administrator of the team) in charge of the team

Feature: F74 – Accept new team members

As a Trainee

I want to Accept new team members

So that I can Enlarge my team in participating to international and interdisciplinary challenges

Example of scenario within Let's STEAM:

Given a trainee is creating a team to answer to the challenge "Climate change monitoring across Europe"
When he/she gets contacted by another trainee to join the team
Then he can accept / refuse the request

Feature: F75 – Make the results public

As a Trainee

I want to Make the results public

So that I can Publish the results of the challenges

Example of scenario within Let's STEAM:

Given the completion of the challenge "Climate change monitoring across Europe"
When all the reports have been filled in
Then I can click on "publishing"

`Feature: F76 – List the public results from challenges`

`As a` Trainee

`I want to` List the public results from challenges

`So that I can` Access data from other schools and trainees

`Example of scenario within Let's STEAM:`

Given a trainee is displaying the challenges
And filters them according to the completion status
When accessing a completed challenge
Then he/she can display the results that have been considered as publicly available

`Feature: F77 – Export data`

`As a` Trainee

`I want to` Export data

`So that I can` Enlarge my data from the ones of other schools and trainees

`Example of scenario within Let's STEAM:`

Given a trainee is displaying the challenges
And filters them according to the completion status
When accessing a completed challenge
Then he/she can download as CVS or Excel the datasheets that have been considered as publicly available

`Feature: F78 – Comment the results and share experience`

`As a` Trainee

`I want to` Comment the results and share experience

`So that I can` Give access to my experimentations to other trainees and schools

`Example of scenario within Let's STEAM:`

Given the completion of the challenge "Climate change monitoring across Europe"
And given that all the reports have been filled in
When accessing the results
Then a trainee can put comments

Feature: F79 – Access national dashboards

As a Policy Maker

I want to Access national dashboards

So that I can Understand the national skills framework

Example of scenario within Let's STEAM:

Given the completion of the same challenge "Climate change monitoring across Europe" in France, Italy, Belgium, Spain and Greece
When all the reports have been filled in
And all the activities assessed and reported in an aggregated way (see G1)
Then Bernard can compare the results between countries

Feature: F80 – Access the challenges' results

As a Policy Maker

I want to Access the challenges' results

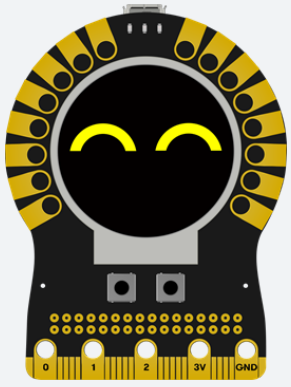
So that I can Understand the national skills framework

Example of scenario within Let's STEAM:

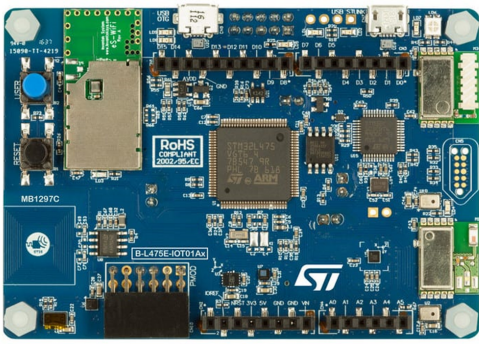
Given the completion of the same challenge "Climate change monitoring across Europe" in France, Italy, Belgium, Spain and Greece
When all the reports have been filled in
And all the activities assessed and reported in an aggregated way (see G1)
Then Bernard can download the results for supporting future policies at national or European level

TOOL #7 - SELECTING THE APPROPRIATE HARDWARE

SPECIFICATIONS OF THE PROGRAMMING BOARD



Within the Let's STEAM project, the partners, teachers and schools participating to the activities will benefit from an in-kind support from STMicroelectronics in the provision of 400 IoT boards, that will remain in the property of the participating teachers. These boards (STM32 For Education) are being developed to be fully tailored to the needs of the teachers in cooperation with the engineers' team in ST.



The technical specifications of this board have been hence defined to comply with the functionalities described and the needs of the teachers. This section consists in defining the steps to technically develop the Educational IoT Board.

Terminology and glossary linked to the board development

2G	2G (or 2-G) is short for second-generation cellular network. With General Packet Radio Service (GPRS), 2G offers a theoretical maximum transfer speed of 40 kbit/s.
3G	3G is the fourth generation of wireless mobile telecommunications technology. It is the upgrade for 2.5G and 2.5G GPRS networks, for faster data transfer speed. 3G telecommunication networks support services that provide an information transfer rate of at least 144 kbit/s.
4G	4G is the fourth generation of broadband cellular network technology, succeeding 3G. Potential and current applications include amended mobile web access, IP telephony, gaming services, high-definition mobile TV, video conferencing, and 3D television.
BLE	Bluetooth Low Energy (Bluetooth LE, colloquially BLE, formerly marketed as Bluetooth Smart) is a wireless personal area network technology designed and marketed by the Bluetooth Special Interest Group (Bluetooth SIG) aimed at novel applications in the healthcare, fitness, beacons,[2] security, and home entertainment industries.

Terminology and glossary linked to the board development

Bluetooth	Bluetooth is a wireless technology standard used for exchanging data between fixed and mobile devices over short distances using short-wavelength UHF radio waves in the industrial, scientific and medical radio bands, from 2.400 to 2.485 GHz, and building personal area networks (PANs).
I2C	I^2C (Inter-Integrated Circuit), pronounced I-squared-C, is a synchronous, multi-master, multi-slave, packet switched, single-ended, serial computer bus invented in 1982 by Philips Semiconductor (now NXP Semiconductors). It is widely used for attaching lower-speed peripheral ICs to processors and microcontrollers in short-distance, intra-board communication.
IO	Input/Output pin
LiPo	Lithium polymer battery, or more correctly lithium-ion polymer battery (abbreviated as LiPo, LIP, Li-poly, lithium-poly and others), is a rechargeable battery of lithium-ion technology using a polymer electrolyte instead of a liquid electrolyte. High conductivity semisolid (gel) polymers form this electrolyte. These batteries provide higher specific energy than other lithium battery types and are used in applications where weight is a critical feature, like mobile devices and radio-controlled aircraft.
LoRa	LoRa (Long Range) is a low-power wide-area network (LPWAN) technology.
LQFP64	Low-profile Quad Flat Package (LQFP) is a surface mount integrated circuit package format with component leads extending from each of the four sides.
PCB	A printed circuit board (PCB) mechanically supports and electrically connects electrical or electronic components using conductive tracks, pads and other features etched from one or more sheet layers of copper laminated onto and/or between sheet layers of a non-conductive substrate. Components are generally soldered onto the PCB to both electrically connect and mechanically fasten them to it.
QFN	Flat no-leads packages such as quad-flat no-leads (QFN) and dual-flat no-leads (DFN) physically and electrically connect integrated circuits to printed circuit boards. Flat no-leads, also known as micro leadframe (MLF) and SON (small-outline no leads), is a surface-mount technology, one of several package technologies that connect ICs to the surfaces of PCBs without through-holes.

Terminology and glossary linked to the board development

RTC	A real-time clock (RTC) is a computer clock (most often in the form of an integrated circuit) that keeps track of the current time. Although the term often refers to the devices in personal computers, servers and embedded systems, RTCs are present in almost any electronic device which needs to keep accurate time.
SMT/SMD	Surface-mount technology (SMT) is a method in which the components are mounted or placed directly onto the surface of a printed circuit board (PCB). An electronic device so made is called a surface-mount device (SMD).
STM32	STM32 is a family of 32-bit microcontroller integrated circuits by STMicroelectronics. The STM32 chips are grouped into related series that are based around the same 32-bit ARM processor core, such as the Cortex-M33F, Cortex-M7F, Cortex-M4F, Cortex-M3, Cortex-M0+, or Cortex-M0. Internally, each microcontroller consists of the processor core, static RAM, flash memory, debugging interface, and various peripherals.
TVS	Protection diode
UFL	UFL is a miniature RF connector for high-frequency signals up to 6 GHz manufactured by Hirose Electric Group and others. U.FL connectors are commonly used in applications where space is of critical concern, most often Mini PCI cards for laptop computers. U.FL connectors are commonly used inside laptops and embedded systems to connect the Wi-Fi antenna to a Mini PCI card. Another common use is connecting GPS antennas.
USB	Universal Serial Bus (USB) is an industry standard that establishes specifications for cables and connectors and protocols for connection, communication and power supply between computers, peripheral devices and other computers.
VBat	Battery Voltage
VQFN	Very thin quad flat no-lead

FUNCTIONAL REQUIREMENTS

A **functional requirement** defines a function of a system or its component, where a function is described as a specification of behaviour between outputs and inputs.

ID	Name	Description
FCT-01	Power In	The system must be able to be powered by a 5V power supply unit
FCT-02	Battery	The system must be equipped with a Li-Po type backup battery pack allowing the system to operate in the event of a power failure
FCT-03	Battery Charging	The system must be able to recharge the internal battery in case of presence of the power supply unit. Charging will be carried out through a connector of the type micro USB
FCT-04	Battery Gauge	The system must be able to know the state of charge of its internal battery
FCT-05	Battery Discharge Standard	The system must be able to operate for 2 days on internal battery in standard mode
FCT-06	Battery Discharge long stand	The system must be able to operate between 5 to 10 days on internal battery in long stand mode
FCT-07	User Interface	The system must be able to inform the user of its operating status thanks to front panel indicators
FCT-08	User Interface	The system must be able to turn off the indicator lights after 30 seconds if its power supply is on internal battery
FCT-09	User Interface	The power LED should remain solid green when the power supply is connected. The power indicator should flash green with a duty cycle of 50% in the event of BLE pairing. The power LED should remain solid red in the event of a system error. The power indicator should flash red with a duty cycle of 50% in case of low battery.
FCT-10	User Interface	The 3G / Lora LED is off when the network is not active. The 3G / Lora LED should remain solid green if all is well. The 3G / Lora LED should slowly blink green when asked or attempted to connect to the server. The 3G / Lora LED should flash red in the event of a network error or no server connection.

ID	Name	Description
FCT-11	Command interface	The system must be able to be switched on and off by the user using a push button on the front panel if the switching time is greater than or equal to 3 seconds.
FCT-12	Command interface	The system must be able to pair a BLE device if the duration of switching on the push button is less than or equal to 1 second.
FCT-13	Command interface	The system must be able to restart using a RESET push button
FCT-14	Radio Bluetooth	The system must be able to communicate by Bluetooth BLE BlueNRG-2 radio from ST Microelectronics
FCT-15	Radio Lora	The system must be able to communicate by LoRa radio
FCT-16	Radio 3G	The system must be able to communicate by 3G radio
FCT-17	Radio 3G	The system must include a SIM card connector in nano format
FCT-18	3G Antenna	The system must be able to integrate a solution allowing the connection of an external 3G antenna
FCT-19	Lora Antenna	The system must be able to integrate a solution allowing the connection of an external LoRa antenna
FCT-20	Bluetooth Antenna	The system must integrate an internal Bluetooth antenna
FCT-21	Microcontroller	The system must integrate an STM32 ARM Cortex-M microcontroller with an hardware cryptography module
FCT-22	UART	The system must integrate pads on its PCB for the UART signals
FCT-23	I2C	The system must integrate pads on its PCB for the I2C signals
FCT-24	SPI	The system must integrate pads on its PCB for the SPI signals
FCT-25	VIN	The system must integrate pads on its electronic card for the 5V, 3V3 and GND power supplies
FCT-26	RTC	The system must integrate a real time clock
FCT-27	Flash Memory	The system must integrate a memory allowing the backup of the network settings

ID	Name	Description
FCT-28	USB Programming	The system must be able to load its embedded software through a USB port
FCT-29	Service Port	The system must integrate a factory debugging and software loading service port

ENVIRONMENTAL REQUIREMENTS

Environmental requirements limit the effect that external environment (natural or induced) is to have on the system, and/o the effect that the system is to have on the external enveloping environment.

ID	Name	Description
ENV-01	Temperature	The system must be able to operate in the ranges - 20 ° C to 85 ° C
ENV-02	Lifetime	System must be able to operate for 70,000 hours
ENV-03	ESD Protection	The input and output connectors must be equipped with ESD protection
ENV-04	IP Code	The system must comply with the IP34 standard
ENV-05	Command Interface Position	The system must integrate the control interface on the front side of the board.
ENV-06	User Interface Position	The system must integrate the display elements on the front side.

PHYSICAL REQUIREMENTS

Physical requirements state the required physical characteristics (properties of matter) of the system (e.g. mass, dimension, volume, centre of gravity, surface coefficient of friction, density, etc)).

ID	Name	Description
PHY-01	Size	The system must be contained in a volume less than 50 mm from length by 70 mm wide and by height 10 mm
PHY-02	Weight	The weight must be ≤ 100 gr
PHY-03	Battery integration	The system can integrate a battery in the rear

WANT TO GET INVOLVED?

ASK US QUESTIONS

Get in touch with us by mail: manon.ballester@lets-steam.eu
Discuss with us in our chat: https://chat.lets-steam.eu/

GET TRAINED AND FIND OUR RESOURCES

Physically in one of the partner countries: Greece, France, Italy, Spain, Belgium (contact us for more information)
Online through our e-learning platform - https://training.lets-steam.eu/
On GitHub: https://github.com/letssteam/

GIVE US FEEDBACK AND CORRECTIONS

This coursebook has been made with the best quality as possible and a true will to participate in the emergence of amazing content in the field of programming. Though, we are only humans! Should you discover mistakes or corrections to be made, do not hesitate to get in touch with us! We will make sure you get rewarded and credited for your help!

PARTNER WITH US IN NEW PROJECTS

All the members of the Let's STEAM consortium are open to new cooperation, either with schools but also with creative companies and actors. We are launching regularly new initiatives. Keep us updated if you want to join them with us!

FIND US ONLINE

www.lets-steam.eu
@letssteamproject
@lets_steam_eu

APPENDIX

QUESTIONNAIRE FOR ASSESSING TEACHERS' DIGITAL COMPETENCE

As teachers, we ask you to participate in the evaluation of the impact of the activities of Let's STEAM project. The aim of the project is to develop teachers' professional skills to participate creatively and collaboratively in the creation of new STEAM educational contents fostering interdisciplinary and creative thinking in STEAM education with IoT technologies. The project is lead by the Institute Universitaire de Technologie (Aix en Marseille Université) and financed by Erasmus+ programme (2019-1-FR01-KA201-062946). In order to inform and help us in the design of effective educational materials, we would like to ask you to participate answering the following questionnaire. This questionnaire aims at measuring teachers' perception of their own Teacher Digital Competence (TDC), which are the skills that teachers need to use digital technology effectively and appropriately for educational purposes. Again, this questionnaire is not an assessment, but their results will highly contribute to improve the outputs of the let's STEAM project. This questionnaire was developed by the ARGET research group (ref. 2017SGR1682) of the Universitat Rovira i Virgili (Spain). The questionnaire takes around 15 minutes and is structured around the four dimensions that make up TDC: (1) Didactic, curricular and methodological; (2) Planning, organization and management of digital technology spaces and resources; (3) Relationships, ethics and security; (4) Personal and professional. The questions are based on these four dimensions and TDC indicators. They assess the skill level the person considers they have at the time of answering the questionnaire. In addition, other data (such as biodata, and personal opinion about your experience) is asked to better interpret the results. We would like you to answer this questionnaire with the utmost rigor and responsibility possible.

Ethical commitments of the data gathering: The Let's STEAM project operates within an ethic of respect for any persons involved in or touched (directly or indirectly) by the research project, including the consortium involved in the project. The commitment of the consortium is to treat participant individuals fairly, sensitively, and with dignity and freedom from prejudice, in recognition of both their rights and of differences arising from age, gender, nationality or any other significant characteristic. Your participation in the survey involves no risks of any kind. If you consent your participation, your identity will be kept confidential and only members of the research team will have access to the project data. Participation in the questionnaire is completely voluntary. There is no penalty for opting not to take part. You can also withdraw from the questionnaire at any time without giving explanations and with no negative consequences, just by letting us know through any communication channel. As well, you can, if you wish, exercise your rights under the European General Data Protection Regulation concerning this project's data filing system (SR0071) by making a request to (carme.grimalt@lets-steam.eu), and enclosing your ID document with the request. In all cases, you will receive a written response stating what action has been taken within the legal time limit.

One year after the end of the project, the research data and database will be anonymised and made available to other interested researchers. Personal identifiers will be destroyed in this case.

Please, check the following boxes if you agree:

☐ I have read and understood the information about the research project, and I have had the opportunity to ask questions which have been answered to my satisfaction, through email.

☐ I consent to my voluntary participation.

☐ I consent to my contributions being cited literally, provided there is no mention of any information which can make my answers identifiable.

☐ I understand that the anonymised information (with no personal identifiers) on this project will be placed at the disposal of other researchers sometime after the project has ended.

We appreciate your collaboration in advance.

DIMENSION 1: DIDACTIC, CURRICULAR AND METHODOLOGICAL

DIGITAL TECHNOLOGIES AS FACILITATORS OF LEARNING

I feel I can... *(Mark the option that relates to you the most)*

☐ **Level 1**. Use support software in the classroom to carry out teaching activities.

☐ **Level 2**. Do activities with the students that involve resolving problems collaboratively using digital technology resources.

☐ **Level 3**. Propose activities with the students that involve analysing a problem in a group, proposing alternative solutions, negotiating the results and publishing them using digital technology resources.

☐ **Level 4**. Stimulate autonomous learning and collaborative work by transforming and creating knowledge based on problems that must be solved using digital technology resources.

☐ **Level 0**. I don't feel I can do what is described in this level.

THE STUDENTS' DIGITAL COMPETENCE IN THE DIDACTIC PLANNING

I feel I can... *(Mark the option that relates to you the most)*

☐ **Level 1**. Design teaching activities that use digital technologies.

☐ **Level 2**. Include searching for, treating, storing and sharing digital information in different formats in the didactic planning.

☐ **Level 3**. Guide and collect in the didactic planning the use and good use of digital technologies for publishing information and working collaboratively.

☐ **Level 4**. Design competence-rich activities (functional, transversal and oriented to autonomy) that involve using complex skills (solving real problems and situations, interpreting, communicating, etc.) and in which there is a "good use" of digital technologies.

☐ **Level 0**. I don't feel I can do what is described in this level.

PROCESSING INFORMATION AND CREATING KNOWLEDGE

I feel I can... *(Mark the option that relates to you the most)*

☐ **Level 1**. Teach how to search for information by accessing different sources of different types.

☐ **Level 2**. Teach how to use information sources of different types according to criteria of quality, truthfulness and pertinence.

☐ **Level 3**. Teach how to classify, sort and select information from different sources applying criteria of quality, truthfulness and pertinence.

☐ **Level 4**. Teach how to create and transform information that has previously been stored and recovered following a system that allows a shared use.

☐ **Level 0**. I don't feel I can do what is described in this level.

ATTENTION TO DIVERSITY

I feel I can... *(Mark the option that relates to you the most)*

☐ **Level 1**. Use digital technologies to increase motivation and facilitate the learning of students with specific educational support needs (SESN).

☐ **Level 2**. Use digital technologies to respond to SESN as an element of accessing the curriculum, taking into account the inclusion of students.

☐ **Level 3**. Elaborate materials and personalized resources to attend to the SESN of the students and compensate inequalities in access to technology.

☐ **Level 4**. Share with other professionals the digital didactic material resources to meet SESN taking into account the concept of "design for all" and accessibility standards.

☐ **Level 0**. I don't feel I can do what is described in this level.

METHODOLOGICAL LINE OF THE CENTRE

I feel I can... *(Mark the option that relates to you the most)*

☐ **Level 1**. Know the centre's guidelines for including digital technologies in the classroom and take them into account in the teaching plans.

☐ **Level 2**. Program and carry out activities aimed at developing digital competence according to the methodological guidelines and resources available.

☐ **Level 3**. Include DC in significant activities (functional, transversal and favouring autonomy) that involve the use of digital technologies to build and share knowledge.

☐ **Level 4**. Propose new innovative methodological strategies and be a teaching model for Digital Competence work.

☐ **Level 0**. I don't feel I can do what is described in this level.

STUDENT ASSESSMENT, TUTORING AND FOLLOW-UP

I feel I can... *(Mark the option that relates to you the most)*

☐ **Level 1**. Use digital resources for tutoring and following up students (meetings, attendance, assessment, reports, etc.).

☐ **Level 2**. Use shared digital resources to assess and monitor students together with the other professionals of the centre.

☐ **Level 3**. Use a digital resource to share the assessment and monitoring of students with their families.

☐ **Level 4**. Manage and use digital resources (environments, digital portfolios, etc.) to monitor school performance and assess students at the centre and educational administration levels.

☐ **Level 0**. I don't feel I can do what is described in this level.

DIMENSION 2: PLANNING, ORGANIZATION AND MANAGEMENT OF DIGITAL TECHNOLOGY SPACES AND RESOURCES

MANAGEMENT OF DIGITAL TECHNOLOGIES AND SOFTWARE

I feel I can... *(Mark the option that relates to you the most)*

☐ **Level 1**. Evaluate and select the existing resources and tools for the work in the classroom.

☐ **Level 2**. Select and use the most appropriate resources and tools for different teaching situations.

☐ **Level 3**. Combine the use of different digital technologies according to their potential, reflectively analysing the students' performance based on the use of these technologies.

☐ **Level 4**. Research into teaching situations based on using digital technologies and innovate according to the results obtained.

☐ **Level 0**. I don't feel I can do what is described in this level.

LEARNING ENVIRONMENTS

I feel I can... *(Mark the option that relates to you the most)*

☐ **Level 1**. Use the digital technologies of the classroom (fixed and mobile devices, etc.) depending on each teaching situation.

☐ **Level 2**. Adapt the teaching activities to the available spaces and digital technologies in the centre.

☐ **Level 3**. Modify teaching spaces with digital technologies to improve them and optimize the available infrastructure based on shared criteria.

☐ **Level 4**. Organize and manage the centre's spaces according to criteria of optimizing and providing digital technologies according to a previous analysis of needs.

☐ **Level 0**. I don't feel I can do what is described in this level.

SPACES WITH DIGITAL TECHNOLOGIES IN THE CENTRE

I feel I can... *(Mark the option that relates to you the most)*

☐ **Level 1**. Identify the spaces at the centre that have digital technologies and know how they work.

☐ **Level 2**. Use the different spaces and digital technologies of the centre responsibly with the students.

☐ **Level 3**. Include innovations in the use of digital technology resources and virtual spaces in my daily activities with students.

☐ **Level 4**. Manage spaces with digital technologies based on the results obtained in the analysis of their daily practice.

☐ **Level 0**. I don't feel I can do what is described in this level.

PROJECTS FOR INCLUDING DIGITAL TECHNOLOGIES

I feel I can... *(Mark the option that relates to you the most)*

☐ **Level 1**. Follow the centre's guidelines on the use of digital technologies in teaching.

☐ **Level 2**. Be an active part of the centre's teams and contribute personal experience and knowledge about digital technologies.

☐ **Level 3**. Lead a team working at the centre taking charge of managing the use of digital technologies in the daily teaching practice.

☐ **Level 4**. Lead and coordinate inter-institutional projects on including digital technologies in teaching.

☐ **Level 0**. I don't feel I can do what is described in this level.

DIGITAL TECHNOLOGY INFRASTRUCTURES

I feel I can... *(Mark the option that relates to you the most)*

☐ **Level 1**. Use digital technologies responsibly and use a protocol to resolve incidents.

☐ **Level 2**. Adopt the innovations on the responsible and updated use of resources in my teaching practice.

☐ **Level 3**. Resolve problems with the equipment for personal and classroom use autonomously and make suggestions for improving its use.

☐ **Level 4**. Manage the use of digital technologies and promote the maintenance and good use of the technological infrastructure of the centre.

☐ **Level 0**. I don't feel I can do what is described in this level.

DIMENSION 3: RELATIONSHIPS, ETHICS AND SECURITY

ETHICS AND SECURITY

I feel I can... *(Mark the option that relates to you the most)*

☐ **Level 1**. Respect copyright in the teaching materials and use personal digital technologies responsibly and safely.

☐ **Level 2**. Serve as a model for the ethical use of digital technologies during activities with students.

☐ **Level 3**. Serve as a model for other professionals in the responsible and safe use of digital technologies.

☐ **Level 4**. Propose guidelines for the responsible, ethical and safe use of digital technologies.

☐ **Level 0.** I don't feel I can do what is described in this level.

DIGITAL INCLUSION

I feel I can... *(Mark the option that relates to you the most)*

☐ **Level 1.** Enhance the access and use of digital technologies for all students to compensate for inequalities.

☐ **Level 2**. Participate in the centre's organization of attention to diversity, taking actions to compensate for inequalities in access and the use of digital technologies.

☐ **Level 3.** Promote the use of the centre's digital spaces and technological resources by the educational community, through participation in actions aimed at compensating for inequalities.

☐ **Level 4**. Train members of the educational community with actions aimed at generalizing the use, management and dissemination of good practices in the use of digital technologies.

☐ **Level 0**. I don't feel I can do what is described in this level.

COMMUNICATION, DISSEMINATION AND KNOWLEDGE TRANSFER

I feel I can... *(Mark the option that relates to you the most)*

☐ **Level 1**. Use digital tools to communicate and share personal knowledge with other teachers.

☐ **Level 2**. Manage open network resources to publish experiences and share them.

☐ **Level 3**. Train teachers in the use of digital technologies to share and create knowledge through activities recognized by the educational administration.

☐ **Level 4**. Be a reference in the use of technological resources to disseminate and share my knowledge, transforming the school institution into a centre of innovation at the service of the community.

☐ **Level 0**. I don't feel I can do what is described in this level.

THE CENTRE'S DIGITAL IDENTITY

I feel I can... *(Mark the option that relates to you the most)*

☐ **Level 1**. Know the centre's digital identity, and the need to respect the documentation models and protocols related to the visual identity of the centre.

☐ **Level 2**. Include the centre's visual identity in my documentary creations and virtual spaces.

☐ **Level 3.** Participate in maintaining the institutional image in the centre's virtual spaces.

☐ **Level 4.** Manage the centre's virtual spaces to transmit the centre's digital identity.

☐ **Level 0**. I don't feel I can do what is described in this level.

DIGITAL CONTENT AND EDUCATIONAL COMMUNITY

I feel I can... *(Mark the option that relates to you the most)*

☐ **Level 1**. Access and comment on the contents distributed in different digital spaces in the centre.

☐ **Level 2.** Use the digital spaces of the centre as the editor of some of them with the aim of sharing knowledge and experiences.

☐ **Level 3**. Manage my own digital space to publish and disseminate my professional knowledge and involve the educational community.

☐ **Level 4**. Create and manage virtual spaces to disseminate collective knowledge and encourage communication and interaction among the members of the educational community.

☐ **Level 0**. I don't feel I can do what is described in this level.

DIMENSION 4: PERSONAL AND PROFESSIONAL

PERSONAL LEARNING ENVIRONMENT (PLE)

I feel I can... *(Mark the option that relates to you the most)*

☐ **Level 1.** Use different desktop and web applications to manage classroom contents and access information.

☐ **Level 2.** Set up my PLE using digital tools for learning, information sources and a personal learning network.

☐ **Level 3.** Collaborate with the teachers of the centre in the creation of their PLE.

☐ **Level 4**. Advise on the use of PLEs in the educational community.

☐ **Level 0.** I don't feel I can do what is described in this level.

IDENTITY AND DIGITAL PRESENCE

I feel I can... *(Mark the option that relates to you the most)*

☐ **Level 1.** Have a digital profile and an updated online professional curriculum.

☐ **Level 2.** Encourage online learning among members of the educational community. Use social and professional networks as a means of communication and professional interaction.

☐ **Level 3.** Use professional development networks to promote the use and awareness of their importance to the community members.

☐ **Level 4**. Use professional digital identification in communications on a regular basis and update my profile in the virtual spaces of the centre.

☐ **Level 0.** I don't feel I can do what is described in this level.

LEADERSHIP IN THE USE OF DIGITAL TECHNOLOGIES

I feel I can... *(Mark the option that relates to you the most)*

☐ **Level 1**. Use digital technologies with students and act as a reference in terms of their use.

☐ **Level 2**. Use digital technologies, integrating them into my teaching, and sharing experiences with colleagues.

☐ **Level 3**. Coordinate the use of digital technologies at the centre level.

☐ **Level 4**. Advise the centre on the use and management of digital technologies and share experiences and good practices.

☐ **Level 0.** I don't feel I can do what is described in this level.

VIRTUAL LEARNING COMMUNITIES: FORMAL, NON-FORMAL AND INFORMAL

I feel I can... *(Mark the option that relates to you the most)*

☐ **Level 1**. Access and use shared educational materials in a network for classroom teaching.
☐ **Level 2**. Use online learning as a means of lifelong learning.
☐ **Level 3**. Encourage online learning among members of the educational community.
☐ **Level 4**. Manage a learning ecosystem among the members of the educational community and other institutions.
☐ **Level 0**. I don't feel I can do what is described in this level.

LIFELONG LEARNING

I feel I can... *(Mark the option that relates to you the most)*

☐ **Level 1.** Do training activities, recognized by the educational administration, related to digital technologies.
☐ **Level 2**. Learn continually ("anywhere and anytime") through training activities related to digital technologies and recognized by the educational administration.
☐ **Level 3**. Transform my teaching practice by including digital technologies in it, including the knowledge gained in training activities: "training transfer".
☐ **Level 4**. Participate as an educator in lifelong learning activities for teachers in relation to digital technologies.
☐ **Level 0**. I don't feel I can do what is described in this level.

CREATION AND DIFFUSION OF DIDACTIC MATERIAL WITH OPEN LICENSES

I feel I can... *(Mark the option that relates to you the most)*

☐ **Level 1**. Share didactic materials reworked and freely distributed in the network.
☐ **Level 2**. Prepare open didactic materials and share them in the network following a standard that facilitates the search and accessibility.
☐ **Level 3**. Organize, label and catalogue open educational resources (OER) by types, areas and educational stages according to the needs of the educational community.
☐ **Level 4**. Promote the use of OER through the creation and/or dissemination of open repositories of teaching materials.
☐ **Level 0**. I don't feel I can do what is described in this level.

EXPERIENCE IN ACTIVITIES ABOUT COMPUTATIONAL THINKING

To which extent do you agree with the following? *(Mark the option that relates to you the most)*

	I totally disagree	I disagree	I neither agree nor disagree	I agree	I totally agree	I don't know/no comment
In relation to coding, I am an experienced teacher: I have been working with at least one coding language from time ago.						
In relation to coding, I am a skilled teacher: I feel competent coding						

Could you tell us your experience promoting computational thinking skills with your students? Please, be as concrete as possible (e.g. which activities have you developed, which coding languages have you used, if any...)

What would you like to find in a course/training content for teachers aimed at providing more creativity to STEM education through programming? Please, be as concrete as possible

BIODATA

WITH WHICH GENDER DO YOU MOST IDENTIFY?
☐ Male
☐ Female
☐ Other (please, provide your answer): _____

AGE
Please, provide your age (in numbers): _____

COUNTRY
☐ Belgium
☐ France
☐ Greece
☐ Italy
☐ Spain

BACKGROUND
In which field did you carry out your main training? (e.g. degree, graduate...)
☐ Science field
☐ Maths field
☐ Technology/ Engineering field
☐ Social Sciences
☐ Language and humanities
☐ Arts
☐ Physical education
☐ Culture and values
☐ Other (Please, specify) _____

EDUCATIONAL LEVEL WHERE YOU TEACH
☐ Primary Education (from 6 to 12-year-old students)
☐ Secondary Education (from 12 to 16-year-old students)
☐ Interlevel
☐ Other (please, provide your answer): _____

YEARS OF TEACHING EXPERIENCE
☐ Less than 2
☐ From 2 to 5
☐ From 5 to 10
☐ More than 10

EMAIL
Please, provide your email for receiving the report of this questionnaire: _____

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