D1.3 – Intellectual Output #1 – Part #5

Deliverable 1.3 - Technical Specifications

AN EDUCATIVE PLATFORM BASED ON MAKECODE, CIRCUITPYTHON & SCRATCH FOR CREATIVITY AND PARTICIPATORY SCIENCES USING IOT BOARDS

Let's STEAM

An educative platform based on MakeCode, CircuitPython & Scratch for creativity and participatory sciences using IoT boards

D1.3 – Technical specifications

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Output 1: Pedagogical scenarios	Specifications regarding the extension of the functionalities available on the platforms: After understanding the needs of the teachers and the specifications regarding the educational pathway, one task will be dedicated to define the needed extensions to be made on the three selected platforms to enable them being tailored to the requirements of the teachers, once trained, when they will apply the methodology at the classroom level. Indeed, if the main objective of the project is the training of teachers on the short term, on the long term, it is mandatory to use these set of information to extend the open source tools. In addition, only perfect demonstration activities can be organised if both i) the teachers can fully use the functionalities of the solutions but also if ii) the platforms answer perfectly the education needs of the teachers, to keep motivating them to become contributors. LAB as technical partner responsible for the open source platforms will oversee these activities supported by AMU, UNICE, LATE, UNINA, EA and DW to validate the process. DW and EA will particularly be involved in this subtask as they are going to provide additional help for the development of the extensions in O4.

DISSEMINATION LEVEL

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PP	Restricted to the programme participants including the EC	
CO	Confidential	
CI	Classified	

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Let's STEAM aims at developing a training of teachers' programme dedicated to computational thinking and creativity skills using IoT board and digital tools at larger scale. The project runs from September 2019 to August 2022. It involves 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

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1. INTRODUCTION

The Let's STEAM project has the ambition to target multiple profiles of trainees. 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.

1.1 OBJECTIVE OF TASK 1.3: SPECIFICATIONS REGARDING THE EXTENSION OF THE FUNCTIONALITIES AVAILABLE ON THE PLATFORMS

This deliverable is part of the work carried out in WP1 "Analysis of the different training level needs and technical specifications of the platform" and Output 1 "Pedagogical scenarios including analysis of the teachers needs and translation of their requirements into i) training of teacher's content specifications and ii) technical specifications for classroom development" as it aims to translate pedagogical scenarios and recommendations into requirements for the development of platforms' functionalities enabling the teachers/trainers/policy makers to answer their needs in using programming in STEAM education.

After understanding the needs of the teachers and the specifications regarding educational pathway, the objective of the task linked to the delivery of this document is to specify the needed extensions to be made on the three selected programming platforms to enable them being tailored to the requirements of the teachers, once trained, when they will apply the methodology at the classroom level. The results of the task will be used to identify the needs of the teachers regarding the functionalities they want to use at classroom level as well as their needs in terms of training, tutorials and support. The capabilities and expectations of the students will also be considered even if the teachers are providing the pedagogical approach by their specific experience. In this section, we are hence providing the assessment of all the feedbacks from the teachers to provide a deep analysis of what is available and what is needed nowadays in the open source platforms (MakeCode, CircuitPython and Scratch). Each platform has been selected to answer the specific requirements of the schools depending on their level of STE(A)M.

1.2 SCOPE AND RELATIONSHIP WITH OTHER DELIVERABLES

During the early Let's STEAM stages, we captured the digital competences 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 in the programming platforms (MakeCode, CircuitPython and Scratch). Essentially, there is no discrepancy between the three platforms and these specifications can be considered for all of them. This section summarizes technically and functionally the selected platforms against the needs of the teachers and their students identified in the prior tasks and activities implemented in Let's STEAM and beyond. Hence, D1.3 has strong links with the following project assets:

1.3 CAPITALISE ON THE OUTCOMES OF DELIVERABLE

- ***D1.1 – O1/PART 1: Database of European, national and local initiative and associated networking tools***. A deep analysis of the literature and the projects has been released in D1.1 to benefit from the experience of other initiatives and to get the support of the European STEAM community. This section is providing a first set of pillars to be considered while developing the platforms functionality:
    - Provide an inquiry-based approach, develop a full teachers' training programme.
    - Provide practical skills to teachers and to students on how to use programming open source software and IoT boards.
    - Develop the knowledge of the teachers on how programming can bring creativity, based on a computational thinking vision of coding.
    - Assess the project results under an evaluation scheme integrating gender equity, inclusiveness and well-being of the teachers and students.

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- *Base the functionalities on the recommendations and scenarios built in deliverable D1.2 – O1/PART 3: Contents specifications, including needs analysis, content definition, methodology, and pedagogical scenarios*: In this section, the partners have defined pedagogical scenarios referred as modules that Let's STEAM will develop and offer to its teacher training programme. Taking into account the competence survey and the collected and analysed data, this document is providing insights on diverse module scenarios and levels, from basics to advanced, integrating 3 main contents: "Programming and IoT board functionalities", "Interdisciplinarity and integration" and "Ethics, security and relationships". This section is strongly useful for defining the design thinking methodology that guided the delivery of O1, especially regarding the development of persona referring to the actors of the Let's STEAM project and based on the results of the digital competences survey, and impact mapping, considering the diverse steps of inquiry-based learning and teaching scenarios defined in D1.2.

- *Establish the basis for the development of WP3/IO4: Open source extensions of the MakeCode, CircuitPython, and Scratch platforms for answering the needs of the European teachers in secondary and high schools*. This output will consist of technically developing the platforms' functionalities (MakeCode, CircuitPython and Scratch). The development part will follow the set-up of the different training modules according to a development methodology based on the implementation of a backlog to enhance the agility of the development. To achieve the expected results of this output, extensions of the open source platforms' functionalities will be developed based on the recommendations provided in this section, transforming the requirements identified in the WP1 into user story.

1.4 AGILE COMMITMENT

Through an iterative and incremental agile methodology, the new functionalities defined in O1 will be prioritized and adapted iteration after iteration to best match and address the users' expectations. To achieve this, a partner will be heavily involved as a stakeholder with the development team as the voice of the whole consortium. Each platform will have a different stakeholder. The feedback-driven empirical methodology is underpinned by the three pillars of transparency, inspection, and adaptation. All work should be visible to those responsible for the outcome: the process, the workflow, progress, etc. To make these visible, teams will frequently inspect the product developed and how well the team is working. With frequent inspection, the team can spot when their work deviates outside of acceptable limits and adapt their process or the product under development.

Figure 1 - SCRUM Values - Pillars of the Agile Methodology

Stakeholders, within the partners' organisations, have been selected regarding their prior experience, their pre-existing needs and knowledge of the diverse platforms, as well as the typology of teachers they are in contact with prior to the project:

- **Stakeholder 1 - MakeCode**: Roberto Canonico - UNINA
- **Stakeholder 2 - CircuitPython**: Georgios Mavromanolakis - EA
- **Stakeholder 3 - Scratch**: Cindy Smits – DW

1.5 BACKGROUND – DESCRIPTION OF THE OPEN SOURCE TOOLS USED IN THE LET'S STEAM PROJECT

MakeCode. Microsoft MakeCode is a free, open source platform for creating engaging computer science learning experiences that support a progression path into real-world programming. It brings computer science to life for all students with fun projects, immediate results, and both block and text editors for learners at different levels. Microsoft MakeCode is a joint project between Microsoft Research and Visual Studio to make it simple to program microcontroller-based devices using a modern web app. MakeCode is based on the following main tools:

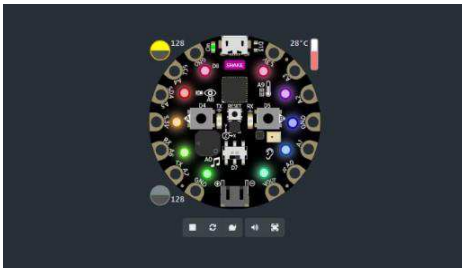
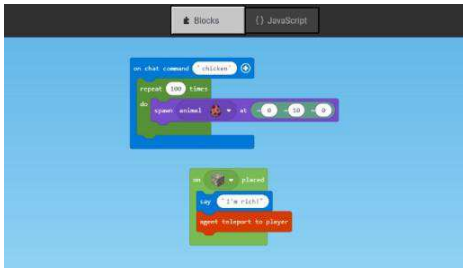
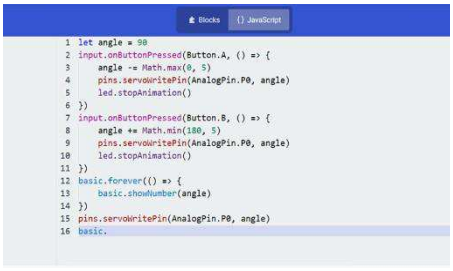
Simulator	Block Editor	JavaScript Editor
		
An interactive simulator provides students with immediate feedback on how their program is running and enable to test and debug their code.	Students new to coding can start with colored blocks that they can drag and drop onto their workspace to construct their programs.	When they are ready, students can move into a full-featured JavaScript editor with code snippets, tooltips, and error detection to help them.

Figure 2 - Overview of MakeCode functionalities

Scratch. With Scratch, the students can program their own interactive stories, games, and animations — and share their creations with others in the online community. Scratch helps young people learn to think creatively, reason systematically, and work collaboratively — essential skills for life in the 21st century. Scratch is designed especially for ages 8 to 16. Scratch is used in more than 150 different countries and available in more than 40 languages. Students are learning with Scratch at all levels (from elementary school to college) and across disciplines (such as maths, computer science, languages, arts, social studies). From May 2009 until May 2019, more than 27,000 educators who support learning with the Scratch programming language shared 4,749 discussion posts, 1,027 resources, and 354 stories with the Online Community. The Scratch project has received financial support from the National Science Foundation, Scratch Foundation, Siegel Family Endowment, Google, LEGO Foundation, Intel, Cartoon Network, Lemann Foundation, MacArthur Foundation. See the credits page for more information.

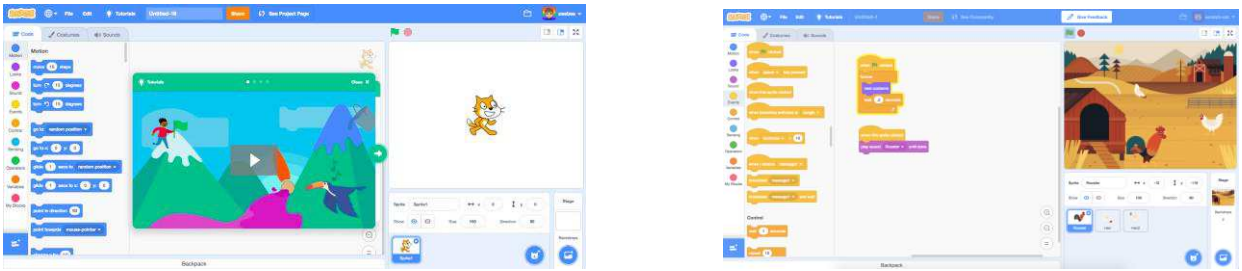


Figure 3 - Scratch screenshots

CircuitPython. CircuitPython is a programming language designed to simplify experimenting and learning to code on low-cost microcontroller boards. With CircuitPython, there are no upfront desktop downloads needed. The core assets of the CircuitPython platform are the following:

1. Quick and Easy: Create a file, edit your code, save the file, and it runs immediately. There is no compiling, no downloading and no uploading needed.
2. Beginner Friendly: CircuitPython is designed with education in mind. It is easy to start learning how to code and you get immediate feedback from the board.
3. Easy Code Updates: Since your code lives on the disk drive, you can edit it whenever you like, you can also keep multiple files around for easy experimentation.
4. Serial Console + REPL: These allow for live feedback from your code and interactive programming.
5. File Storage: The internal storage for CircuitPython makes it great for data-logging, playing audio clips, and otherwise interacting with files.
6. Strong Hardware Support: There are many libraries and drivers for sensors, breakout boards and other external components.

Python is the fastest growing programming language. It is taught in schools and universities as it is a high-level programming language which means it is designed to be easier to read, write and maintain. It supports modules and packages. It has a built-in interpreter which means there are no extra steps, like compiling, to get your code to work. And of course, Python is Open Source Software, free for anyone to use, modify or improve upon.

Figure 4 - Overview of a CircuitPython program

1.6 STRUCTURE

In detail, this section defines and describes all the main/core functional components of the platforms mentioned above based on user stories. Hence, the document has been structured to represent the design-thinking methodology used to deliver the functional specifications and is based on the following sections:

1. An introduction, presenting the background and objectives of the section, and enabling the reader to understand the tools that will be used through the Let's STEAM project. This presentation of the platforms is highly important as the functionalities have been defined for being implementing in all of them and this document will hence not provide a set of specifications per platform, but common to all. In addition, the introduction is providing relevant information on the section's objectives, problems to be solved, input from previous activities and other deliverables to which results will be input.

2. The definition of terms and concepts that have been used and analysed to build the functionalities on pedagogical recommendations.

3. The results of the design thinking methodology in terms of **Impact Mapping and definition of persona** applied to the project, to understand and build on the characteristics of the actors/end-users.

4. The development of **functionalities based on User Stories** and associated use case scenarios.

5. Conclusion.

1.7 PARTNERS INVOLVED IN THE DELIVERABLE CONSTRUCTION

Short name	Contribution in the deliverable
L.A.B	Task leader, development of the functionalities and specifications
AMU	Project coordinator, review and validation
EA	WP and Output leader, review and validation, development of the pedagogical recommendations used to construct the technical specifications
DW	Stakeholder for the agile methodology: review of the functionalities for Scratch integration
EA	Stakeholder for the agile methodology: review of the functionalities for CircuitPython integration
UNINA	Stakeholder for the agile methodology: review of the functionalities for MakeCode integration

2. TERMINOLOGY, GLOSSARY & CONVENTIONS

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.
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.

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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
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.

3. DEFINITION OF THE PRE-REQUISITES

3.1 DEFINITION OF THE METHODOLOGY – IMPACT MAPPING

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:

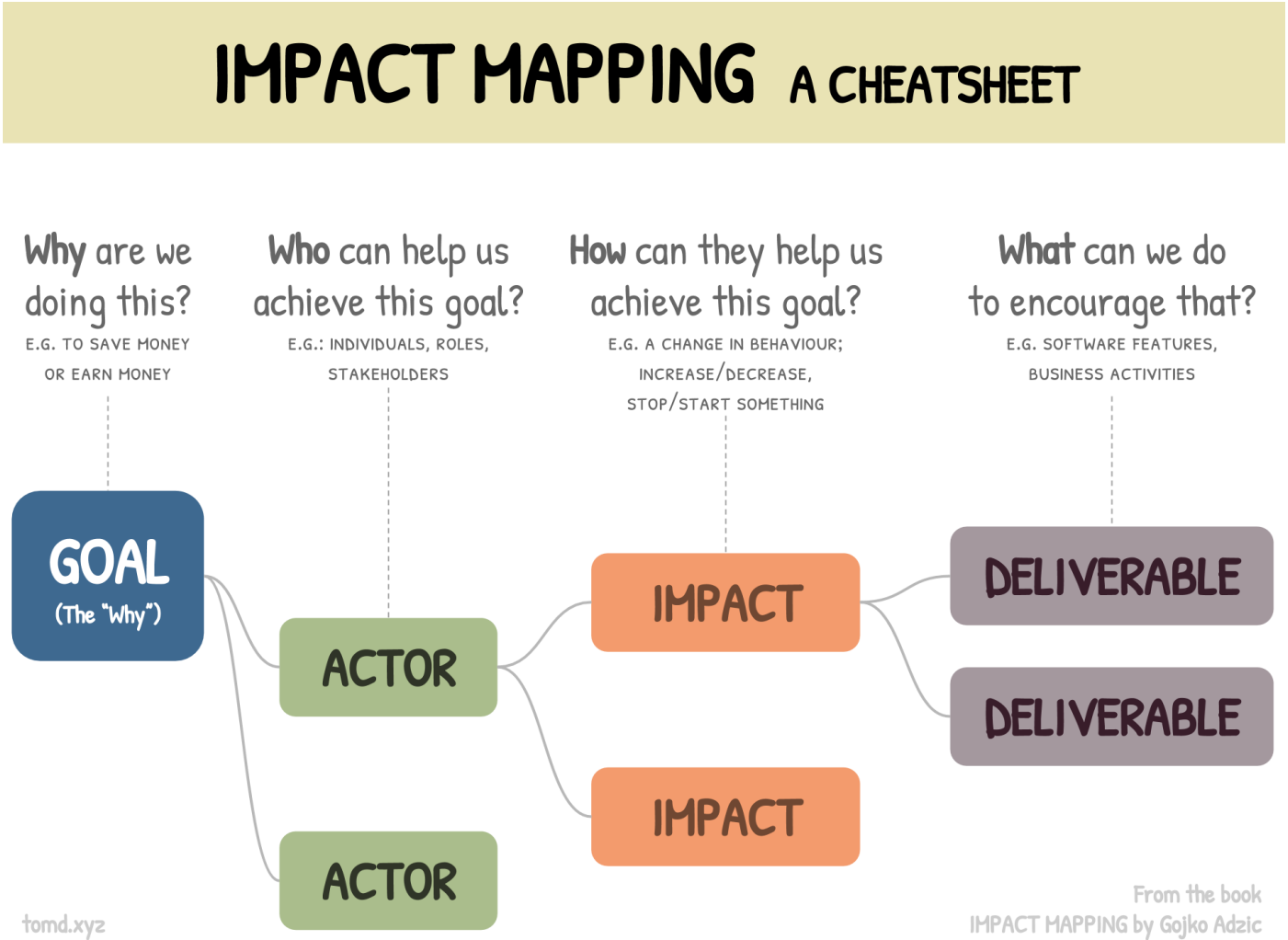

Figure 5 - Overview of the Impact Mapping process

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

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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. 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, 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 business 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.**

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3.2 IMPACT MAPPING APPLIED TO THE LET'S STEAM TECHNICAL SPECIFICATIONS' CONSTRUCTION

3.2.1 STEP 1 – WHY ARE WE DOING THIS? DEFINITION OF FUNCTIONAL GOALS

G1: NEW SKILLS FOR TEACHER

Name	Provide new set of skills for teacher to enhance STEAM approach
Description	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 extension of the three platforms Scratch, MakeCode and CircuitPyhton and the trainings, 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 new form of educational content is not appropriate only to scientific fields. It is a carefully thought out methodology which can be replicate in other fields. Therefore, the project will mainly be focus on schools, but the library sector will be taken into consideration to prove the well effectiveness in another field of the methodology developed. IMP1.1: Design learning contents IMP1.2: Animate training sessions IMP1.3: Follow the classroom IMP1.4: Find adapted contents to their level IMP1.5: Consult training contents IMP1.6: Participate to training sessions IMP1.7: Follow their skills' acquisition IMP1.8: Consult learning pathways and curricula
Targets	CircuitPython, MakeCode, Scratch
Additional target	Needed for the e-learning platform development

G2: PROMOTE ACTIVE AND CREATIVE PEDAGOGY

Name	Promote active & creative pedagogy based on inquiry methods
Description	Teachers are still teaching coding with classic methods which are not relevant with the current world and its digital era and is moreover most of the time adapted to very technical profiles, living some students behind, especially girls in the field of programming. Nowadays, we must switch from learning how to code as an individual item, to teach what to use code for, to enhance creativity, innovation and promote active pedagogy between courses, between schools and towards the students. 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 platforms and IoT boards towards an interdisciplinary approach of scientific topics at school.
Related to Impacts	IMP2.1: Create a project IMP2.2: Manage a project IMP2.3: Follow the project team IMP2.4: Identify the competences needed for resolving a project IMP2.5: Collect data for exploration and experimentation IMP2.6: Export data for analysis and interpretation IMP2.7: Association additional resources (external documents, reports, ...) IMP2.8: Collaborate, brainstorm and exchange ideas IMP2.9: Explore the projects towards the competences
Targets	CircuitPython, MakeCode, Scratch
Additional target	Needed for the e-learning platform development

G2: PROMOTE ACTIVE AND CREATIVE PEDAGOGY

Name	Value collaborative behaviours in teaching and learning through interdisciplinarity, international cooperation & involvement of all disciplines
Description	In order to catch up with the backlog of teachers in the field of programming, a pattern of answer must be created at European scale with local adjustments in order to have a common and strong basis on this subject in the whole Europe. Therefore the project is mandatory developed at the scale of 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.
Related to Impacts	IMP3.1: Share pedagogical resources IMP3.2: Find opportunities for collaborating IMP3.3: Provide contents in many languages IMP3.4: Participate to international and interdisciplinary challenges IMP3.5: Publish the results of the challenges IMP3.6: Access data from other schools and trainees IMP3.7: Understand the national skills framework
Targets	CircuitPython, MakeCode, Scratch
Additional target	Needed for the e-learning platform development

3.2.2 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? DEFINITION OF THE ACTORS AND ASSOCIATED PERSONA.

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.

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. More specifically, personas have been developed around the following actors' profiles:

Table 1 - List of persona

Profile & Description	Linked impacts	Linked Persona
Trainers of teachers delivering the Training of Trainers programme to secondary school teachers	IMP1.1: Design learning contents IMP1.2: Animate training sessions IMP1.3: Follow the classroom IMP2.1: Create a project IMP2.2: Manage a project IMP2.3: Follow the project team IMP3.1: Share pedagogical resources IMP3.2: Find opportunities for collaborating IMP3.3: 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	IMP1.4: Find adapted contents to his level IMP1.5: Consult training contents IMP1.6: Participate to training sessions IMP1.7: Follow their skills' acquisition IMP2.4: Identify the competences needed for resolving a project IMP2.5: Collect data for exploration and experimentation IMP2.6: Export data for analysis and interpretation IMP2.7: Association additional resources (external documents, reports...) IMP2.8: Collaborate, brainstorm and exchange ideas IMP3.4: Participate to international and interdisciplinary challenges IMP3.5: Publish the results of the challenges IMP3.6: 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	IMP1.8: Consult learning pathways and curricula IMP2.9: Explore the projects towards the competences IMP3.7: Understand the national skills framework	Bernard Fournier

Jorge Valiente	The technology fan	CircuitPython, Scratch, MakeCode	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

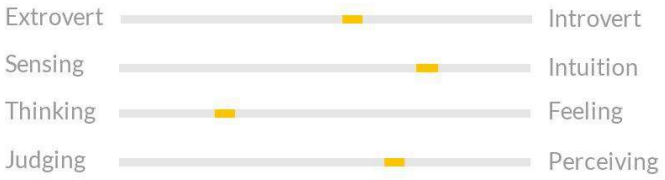
HACKADAY

hackster.io

DIGITAL COMPETENCES

TECHNOLOGY LEVEL

PERSONALITY



Dirk De Brouwer	The Old fashioned	MakeCode, Scratch	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.

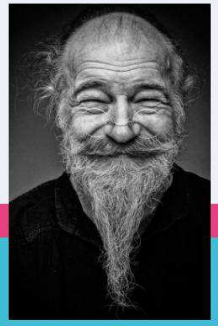
Passionate about Mathematics, he has for many years prepared his best students for the Belgian mathematics Olympics. Five times in his career, his students were finalists and one even finished first in the Midi category. In recent years, he has found it increasingly difficult to motivate his students 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

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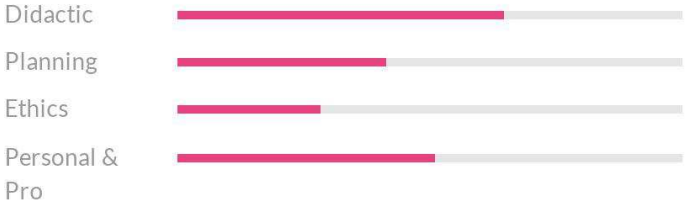
DIGITAL COMPETENCES



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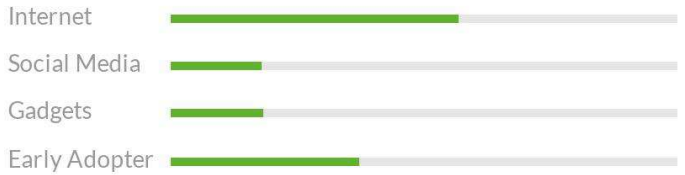

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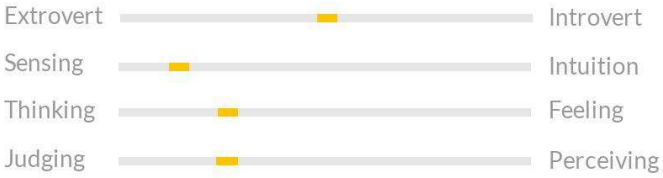


Mélissandre Aubry	The non-specialist	MakeCode	Trainees i.e. secondary school teachers in their position of learners in the ToT programme Secondary schools' teachers in their teaching position

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

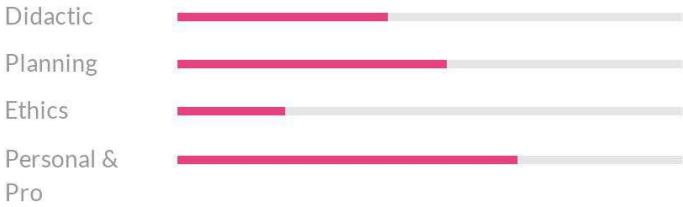
- She is disappointed by the lack of student's commitment in her topic
- She wants to implement more inquiry-based learning however, she is lacking from tools, in a very poorly digitalised topic
- She lacks pedagogical innovative resources in her discipline as at the cross-border between sciences and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

Mélissandre Aubry

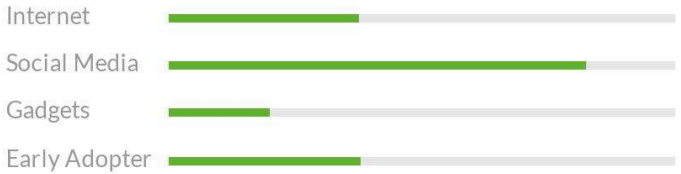
The non-specialist

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



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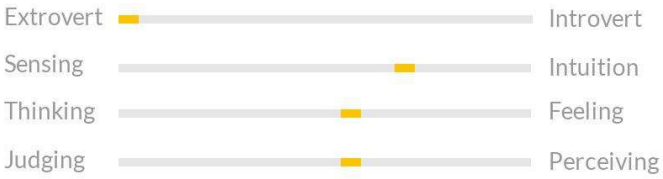


Faustina Baratto	The playful teacher	MakeCode, Scratch	Trainees i.e. secondary school teachers in their position of learners in the ToT programme Secondary schools' teachers in their teaching position

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

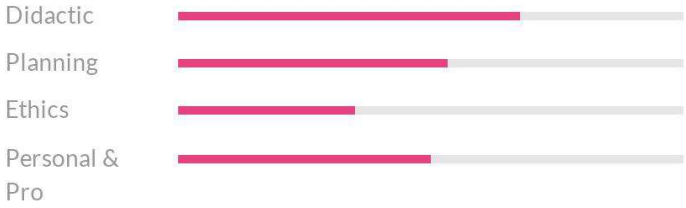
- We need more material to illustrate more experiments with students
- It's hard to understand many Maker projects
- I am not trained in programming and even less in computational thinking

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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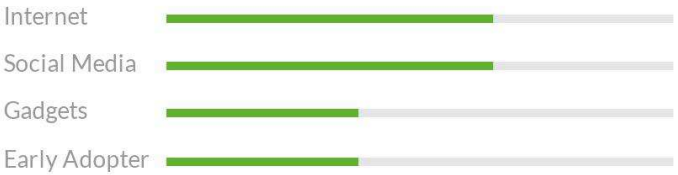

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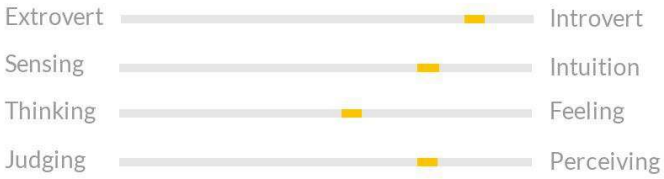


Euthalía Diamantopoulos	The creative	CircuitPython, Scratch, MakeCode	Trainees i.e. secondary school teachers in their position of learners in the ToT programme Secondary schools' teachers in their teaching position

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

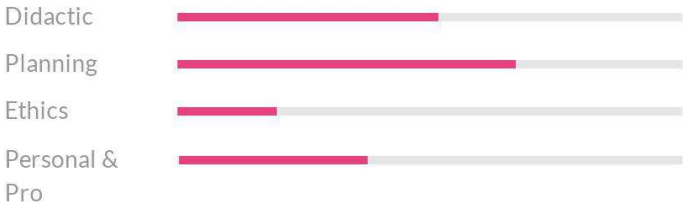
Euthalía Diamantopoulos

The creative

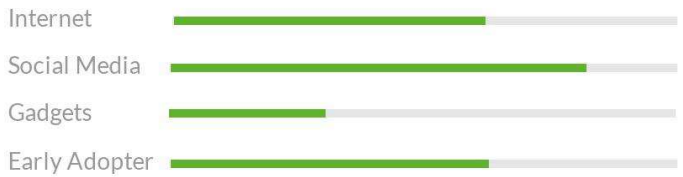
Age: 37 years
Married: No
Kids: No
Education: Master of Fine Arts
Occupation: Secondary school teacher in Applied Art
Year of experience: 10
Location: Athens, Greece

CURIATOR

DIGITAL COMPETENCES



TECHNOLOGY LEVEL



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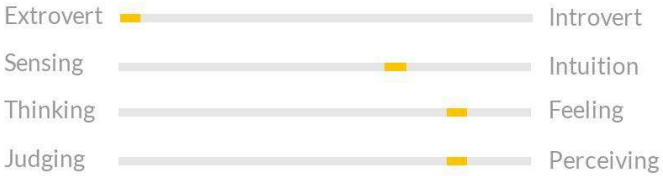


Bernard Fournier	The Policy Maker	CircuitPython, Scratch, MakeCode	Policy Maker

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.

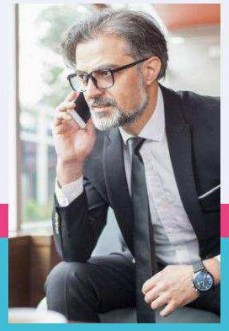
In 2010, he became an Academy inspector in Paris and in 2014, Academic Director of National Education Services.

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

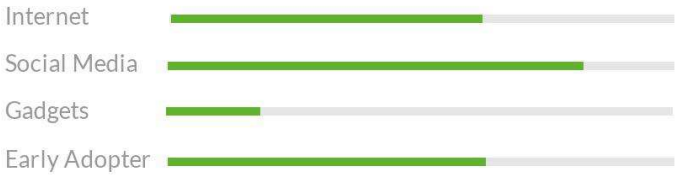
The Policy Maker

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



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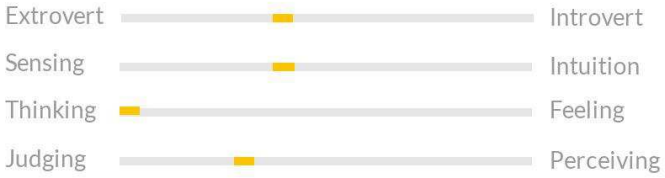

3.2.1 STEP 3 – HOW SHOULD OUR ACTORS' BEHAVIOUR CHANGE? FULL IMPACT MAPPING FOR THE LET'S STEAM TECHNICAL SPECIFICATION

Table 2 – IMPACT LIST – G1: NEW SKILLS FOR TEACHER

ID	Description	Features
Actor 1: Trainers of teachers, Secondary schools' teachers in their teaching position		
IMP1.1: 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.	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
IMP1.2: 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.	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
IMP1.3: 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.	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
Actor 2: Trainees i.e. secondary school teachers in their position of learners in the ToT programme		
IMP1.4: 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.	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

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

ID	Description	Features
IMP1.5: 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.	F24: Launch an exercise outside the learning sessions & practice F25: Access the instructions F26: Play video of tutorials
IMP1.6: 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.	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
IMP1.7: 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.	F32: Access individual dashboard
Actor 3: Policymakers		
IMP1.8: 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.	F33: Access learning pathways F34: Identify the learning outcomes and pedagogical objectives of each pathway F35: Access success story achievements

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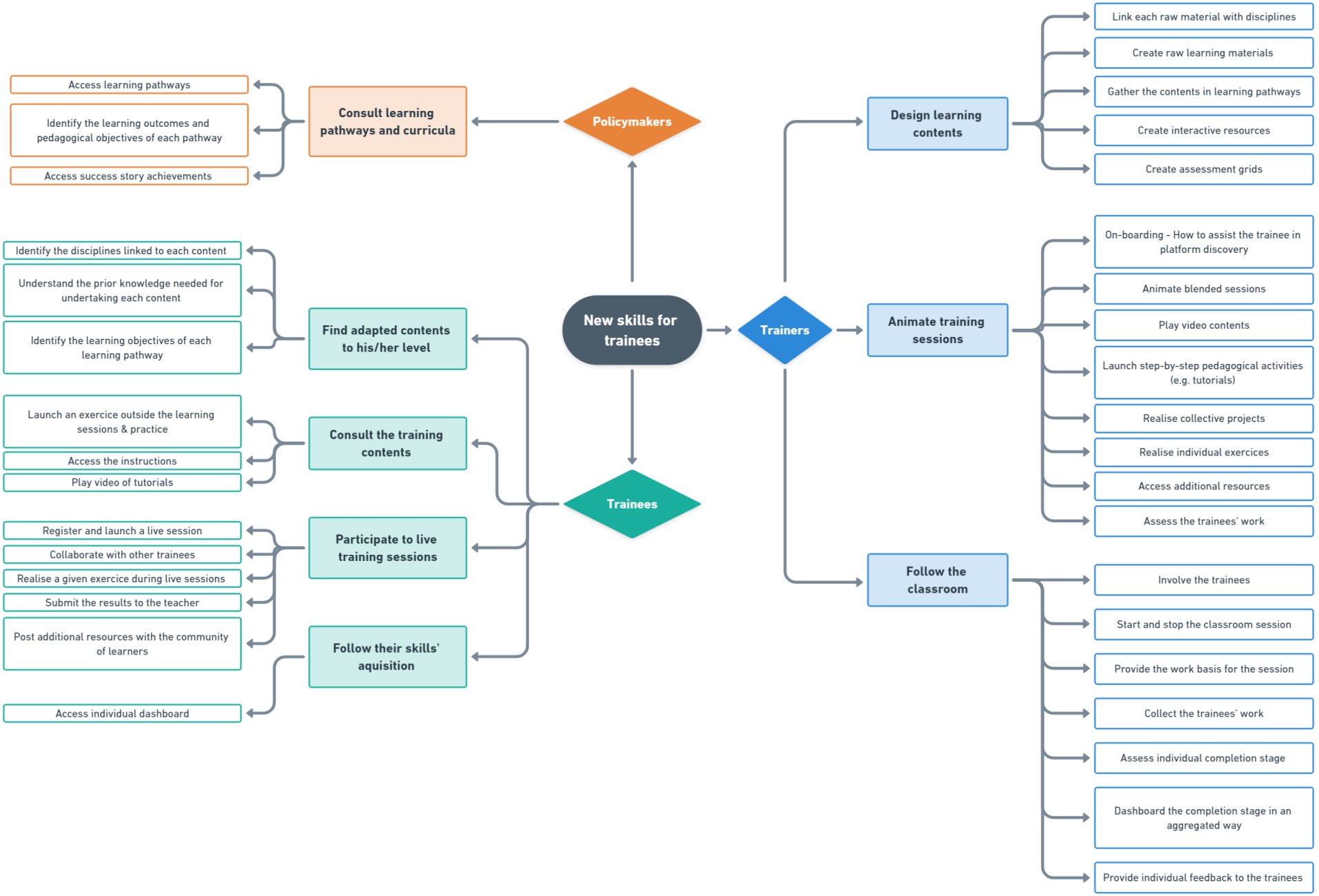

Figure 6 - IMPACT MAPPING - G1

Table 3 – IMPACT LIST – G2: PROMOTE ACTIVE AND CREATIVE PEDAGOGY

ID	Description	Features
Actor 1: Trainers of teachers, Secondary schools' teachers in their teaching position		
IMP2.1: 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.	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)
IMP2.2: Manage a project	Once the projects are created, we will give the possibilities to the trainers to manage the 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.	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
IMP2.3: Follow the project team	As for IMP1.3 "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.	F46: Gather the reports F47: Access the team dashboards F48: Send comments to each team
Actor 2: Trainees i.e. secondary school teachers in their position of learners in the ToT programme		
IMP2.4: 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.	F49: Display the full list of resources F50: Select in the resources available the relevant ones to the inquiry process
IMP2.5: 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	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

ID	Description	Features
	offered by IoT within Let's STEAM.	
IMP2.6: 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.	F56: Export data in CSV or Excel format (data sheet)
IMP2.7: 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.	F57: Attach documents F58: Remove documents
IMP2.8: 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. As for IMP2.7, it is hence 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.	F59: Access chat live for discussing F60: Comment team members' work
Actor 3: Policymakers		
IMP2.9: 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.	F61: Display the list of projects F62: Filter and sort the projects per discipline and learning objectives

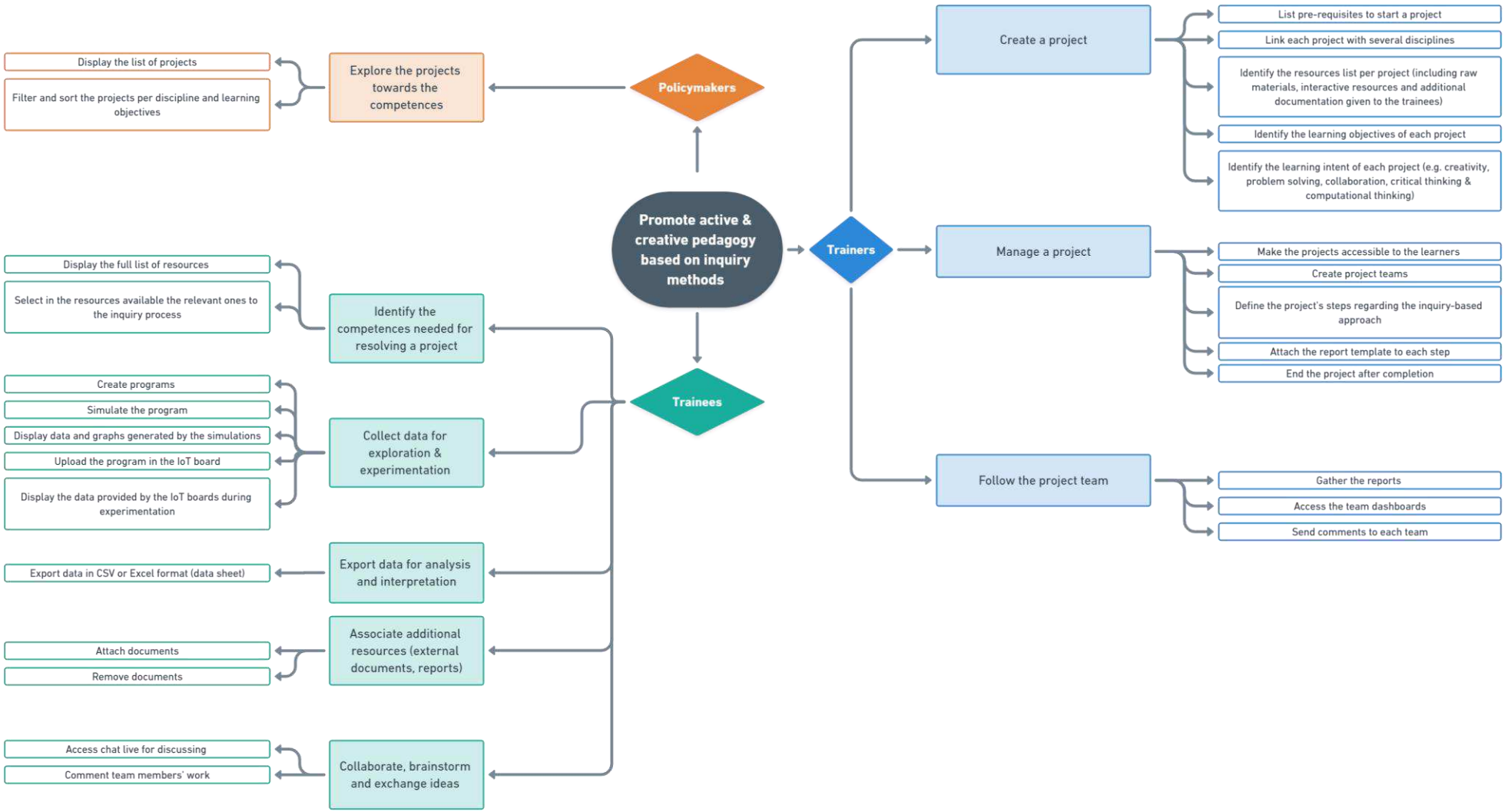

Figure 7 - Impact Mapping - G2

Table 4 – IMPACT LIST – G3: VALUE COLLABORATIVE BEHAVIOURS IN TEACHING

ID	Description	Features
Actor 1: Trainers of teachers, Secondary schools' teachers in their teaching position		
IMP3.1: 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.	F63: Make public the resources developed by the trainers F64: Create and share transdisciplinary challenges
IMP3.2: 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.	F65: List, filter and sort the on-going challenges F66: Contact the teachers in charge of the identified challenges
IMP3.3: 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.	F67: List contents per language F68: Enable the translation of the contents
Actor 2: Trainees i.e. secondary school teachers in their position of learners in the ToT programme		
IMP3.4: 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 …	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
IMP3.5: 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.	F75: Make the results public
IMP3.6: 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	F76: List the public results from challenges F77: Export data F78: Comment the results and share experience

ID	Description	Features
	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.	
Actor 3: Policymakers		
IMP3.7: 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.	F79: Access national dashboards F80: Access the challenges' results

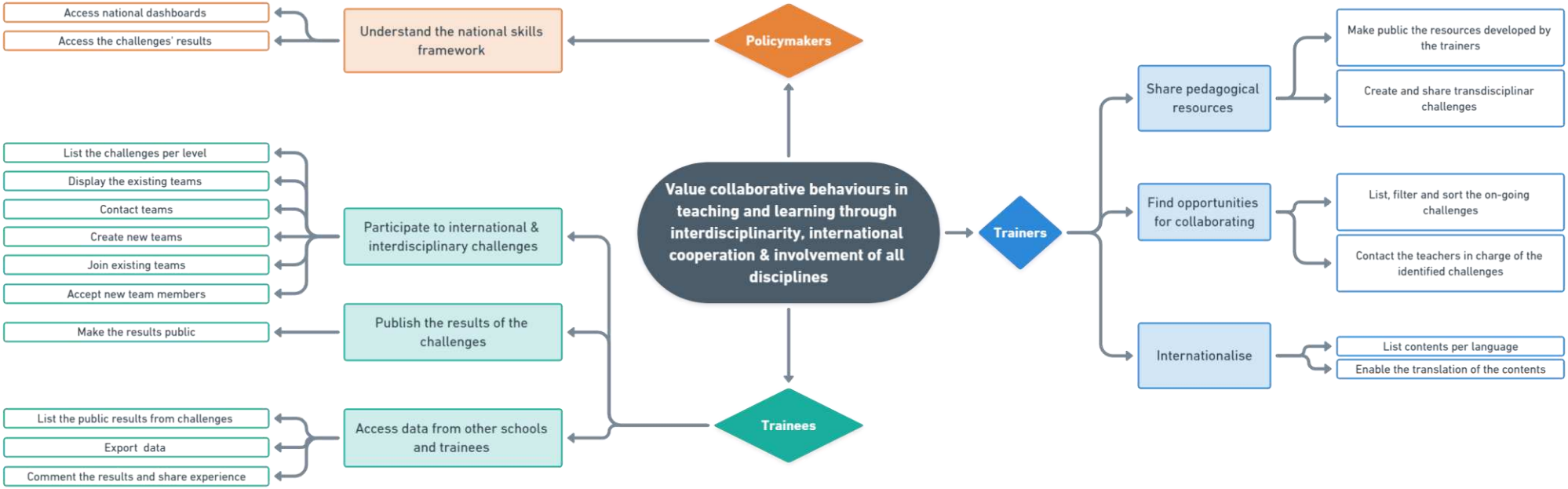

Figure 8 - IMPACT MAPPING - G3

4. STEP 4 – WHAT? – FUNCTIONAL SPECIFICATIONS

The impact mapping methodology has enabled identifying a list of 80 features or functionalities given hereunder:

Table 5 - List of features and related impacts

ID	NAME	RELATED TO IMPACTS
F1	Create raw learning materials	IMP1.1: Design learning contents
F2	Make learning material interactive	IMP1.1: Design learning contents
F3	Gather the contents in learning pathway	IMP1.1: Design learning contents
F4	Associate raw material with a discipline	IMP1.1: Design learning contents
F5	Create assessment grids	IMP1.1: Design learning contents
F6	On-boarding	IMP1.2: Animate training sessions
F7	Animate blended sessions	IMP1.2: Animate training sessions
F8	Play video contents	IMP1.2: Animate training sessions
F9	Launch step-by-step pedagogical activities	IMP1.2: Animate training sessions
F10	Realise collective projects	IMP1.2: Animate training sessions
F11	Realise individual exercises	IMP1.2: Animate training sessions
F12	Access additional resources	IMP1.2: Animate training sessions
F13	Assess the trainees' work	IMP1.2: Animate training sessions
F14	Involve the trainees	IMP1.3: Follow the classroom
F15	Start and stop the classroom session	IMP1.3: Follow the classroom
F16	Provide the work basis for the session	IMP1.3: Follow the classroom
F17	Collect the trainees' work	IMP1.3: Follow the classroom
F18	Assess individual completion stage	IMP1.3: Follow the classroom
F19	Dashboard the completion stage in an aggregated way	IMP1.3: Follow the classroom
F20	Provide individual feedback to the trainees	IMP1.3: Follow the classroom
F21	Identify the disciplines linked to each content	IMP1.4: Find adapted contents to the level
F22	Understand the prior knowledge needed for undertaking each content	IMP1.4: Find adapted contents to the level
F23	Identify the learning objectives of each learning pathway	IMP1.4: Find adapted contents to the level
F24	Launch an exercise outside the learning sessions & practice	IMP1.5: Consult training contents
F25	Access the instructions	IMP1.5: Consult training contents
F26	Play video of tutorials	IMP1.5: Consult training contents
F27	Register and launch a live session	IMP1.6: Participate to training sessions
F28	Collaborate with other trainees	IMP1.6: Participate to training sessions
F29	Realise a given exercise during live sessions	IMP1.6: Participate to training sessions
F30	Submit the results to the teacher	IMP1.6: Participate to training sessions
F31	Post additional resources with the community of learners	IMP1.6: Participate to training sessions
F32	Access individual dashboard	IMP1.7: Follow their skills' acquisition
F33	Access learning pathways	IMP1.8: Consult learning pathways and curricula
F34	Identify the learning outcomes and pedagogical objectives of each pathway	IMP1.8: Consult learning pathways and curricula

F35	Access success story achievements	IMP1.8: Consult learning pathways and curricula
F36	List pre-requisites to start a project	IMP2.1: Create a project
F37	Link each project with several disciplines	IMP2.1: Create a project
F38	Identify the resources list per project (including raw materials, interactive resources and additional documentation given to the trainees)	IMP2.1: Create a project
F39	Identify the learning objectives of each project	IMP2.1: Create a project
F40	Identify the learning intent of each project (e.g. creativity, problem solving, collaboration, critical thinking & computational thinking)	IMP2.1: Create a project
F41	Make the projects accessible to the learners	IMP2.2: Manage a project
F42	Create project teams	IMP2.2: Manage a project
F43	Define the project's steps regarding the inquiry-based approach	IMP2.2: Manage a project
F44	Attach the report template to each step	IMP2.2: Manage a project
F45	End the project after completion	IMP2.2: Manage a project
F46	Gather the reports	IMP2.3: Follow the project team
F47	Access the team dashboards	IMP2.3: Follow the project team
F48	Send comments to each team	IMP2.3: Follow the project team
F49	Display the full list of resources	IMP2.4: Identify the competences needed for resolving a project
F50	Select in the resources available the relevant ones to the inquiry process	IMP2.4: Identify the competences needed for resolving a project
F51	Create programs	IMP2.5: Collect data for exploration and experimentation
F52	Simulate the program	IMP2.5: Collect data for exploration and experimentation
F53	Display data and graphs generated by the simulations	IMP2.5: Collect data for exploration and experimentation
F54	Upload the program in the IoT board	IMP2.5: Collect data for exploration and experimentation
F55	Display the data provided by the IoT boards during experimentation	IMP2.5: Collect data for exploration and experimentation
F56	Export data in CSV or Excel format (data sheet)	IMP2.6: Export data for analysis and interpretation
F57	Attach documents	IMP2.7: Association additional resources (external documents, reports, ...)
F58	Remove documents	IMP2.7: Association additional resources (external documents, reports, ...)
F59	Access chat live for discussing	IMP2.8: Collaborate, brainstorm and exchange ideas
F60	Comment team members' work	IMP2.8: Collaborate, brainstorm and exchange ideas
F61	Display the list of projects	IMP2.9: Explore the projects towards the competences
F62	Filter and sort the projects per discipline and learning objectives	IMP2.9: Explore the projects towards the competences
F63	Make public the resources developed by the trainers	IMP3.1: Share pedagogical resources
F64	Create and share transdisciplinary challenges	IMP3.1: Share pedagogical resources
F65	List, filter and sort the on-going challenges	IMP3.2: Find opportunities for collaborating
F66	Contact the teachers in charge of the identified	IMP3.2: Find opportunities for collaborating

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	challenges	
F67	List contents per language	IMP3.3: Provide contents in many langages
F68	Enable the translation of the contents	IMP3.3: Provide contents in many langages
F69	List the challenges per level	IMP3.4: Participate to international and interdisciplinary challenges
F70	Display the existing teams	IMP3.4: Participate to international and interdisciplinary challenges
F71	Contact teams	IMP3.4: Participate to international and interdisciplinary challenges
F72	Create new teams	IMP3.4: Participate to international and interdisciplinary challenges
F73	Join existing teams	IMP3.4: Participate to international and interdisciplinary challenges
F74	Accept new team members	IMP3.4: Participate to international and interdisciplinary challenges
F75	Make the results public	IMP3.5: Publish the results of the challenges
F76	List the public results from challenges	IMP3.6: Access data from other schools and trainees
F77	Export data	IMP3.6: Access data from other schools and trainees
F78	Comment the results and share experience	IMP3.6: Access data from other schools and trainees
F79	Access national dashboards	IMP3.7: Understand the national skills framework
F80	Access the challenges' results	IMP3.7: Understand the national skills framework

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.

4.1 USER STORIES PER FEATURE

4.1.1 G1: NEW SKILLS FOR TEACHER

Table 6 - User stories per feature – G1: New skills for teacher

`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"

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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
Then he can see the diverse functionalities through a quick overview of the platform way of working

`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
Then Learners cannot complete the linked exercises and submit work to Jorge
And Jorge can consider the session over for assessment

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
Then he can perform offline assessment based on the on-line resources (illustrating the learners' achievements)

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

Given that each trainee is registered individually on the platforms
When a trainee is launching one of the platforms
Then he has access to the learning material to self-practices
And the results of this self-assessment are identified in his/her personal dashboard

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
And then he/she will receive notification of each session launched by Jorge on his/her classroom

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
Then he can display the full contents available

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

4.1.2 G2: PROMOTE ACTIVE AND CREATIVE PEDAGOGY

Table 7 - User stories per feature – G2: Promote active and creative pedagogy

`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
Then I can see the list of skills and objectives linked to all the materials and competences that is linked to the diverse part of the project
And I can display them by discipline

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"
Then he gathers trainers in teams and identify the team in the trainees' list displayed in the platform

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
Then The interdisciplinary team of teachers can close the project

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
And comment the work in the block editor

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

4.1.3 G3: VALUE COLLABORATIVE BEHAVIOURS IN TEACHING

Table 8 - User stories per feature – G3: Value collaborative behaviours in teaching

`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
And identify visually the level (L1, L2, L3), the discipline (STEAM) and the intentions (21st century skills)

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
And share additional documentations with the team (such as his/her personal datasheet on the same challenge)

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

4.2 CONFORMITY MATRIX

Table 9 - Conformity variables

FLEXIBILITY LEVEL	
F0	Zero flexibility - mandatory level
F1	Low flexibility - slightly negotiable level
F2	Intermediate flexibility - negotiable level
F3	High flexibility - very negotiable level
STEP OF VALIDATION	
A	Analysis
D	Demonstration
T	Test
V	Visual or document inspection
VALIDATION PROCESS AND CONFORMITY ASSESSMENT WHILE DEVELOPING	
C	Conform
NC	Not Conform
D	Derogatory acceptation validated after negotiation with all project partners. Could imply billing adaptation.

Table 10 - Conformity matrix (to be updated under development)

ID	NAME	FLEXIBILITY	VALIDATION STEP	CONFORMITY
F1	Create raw learning materials	F0	A	
F2	Make learning material interactive	F0	A	
F3	Gather the contents in learning pathway	F0	A	
F4	Associate raw material with a discipline	F0	A	
F5	Create assessment grids	F0	A	
F6	On-boarding	F0	A	
F7	Animate blended sessions	F1	A	
F8	Play video contents	F0	A	
F9	Launch step-by-step pedagogical activities	F0	A	
F10	Realise collective projects	F0	A	
F11	Realise individual exercises	F0	A	
F12	Access additional resources	F1	A	
F13	Assess the trainees' work	F0	A	
F14	Involve the trainees	F0	A	
F15	Start and stop the classroom session	F0	A	
F16	Provide the work basis for the session	F0	A	
F17	Collect the trainees' work	F0	A	
F18	Assess individual completion stage	F0	A	
F19	Dashboard the completion stage in an aggregated way	F0	A	
F20	Provide individual feedback to the trainees	F0	A	
F21	Identify the disciplines linked to each content	F0	A	
F22	Understand the prior knowledge needed for undertaking each content	F0	A	
F23	Identify the learning objectives of each learning pathway	F0	A	

F24	Launch an exercise outside the learning sessions & practice	F0	A	
F25	Access the instructions	F0	A	
F26	Play video of tutorials	F0	A	
F27	Register and launch a live session	F0	A	
F28	Collaborate with other trainees	F0	A	
F29	Realise a given exercise during live sessions	F0	A	
F30	Submit the results to the teacher	F0	A	
F31	Post additional resources with the community of learners	F1	A	
F32	Access individual dashboard	F0	A	
F33	Access learning pathways	F0	A	
F34	Identify the learning outcomes and pedagogical objectives of each pathway	F0	A	
F35	Access success story achievements	F2	A	
F36	List pre-requisites to start a project	F0	A	
F37	Link each project with several disciplines	F0	A	
F38	Identify the resources list per project (including raw materials, interactive resources and additional documentation given to the trainees)	F0	A	
F39	Identify the learning objectives of each project	F0	A	
F40	Identify the learning intent of each project (e.g. creativity, problem solving, collaboration, critical thinking & computational thinking)	F0	A	
F41	Make the projects accessible to the learners	F0	A	
F42	Create project teams	F0	A	
F43	Define the project's steps regarding the inquiry-based approach	F0	A	
F44	Attach the report template to each step	F0	A	
F45	End the project after completion	F0	A	
F46	Gather the reports	F0	A	
F47	Access the team dashboards	F0	A	
F48	Send comments to each team	F0	A	
F49	Display the full list of resources	F0	A	
F50	Select in the resources available the relevant ones to the inquiry process	F0	A	
F51	Create programs	F0	A	
F52	Simulate the program	F0	A	
F53	Display data and graphs generated by the simulations	F0	A	
F54	Upload the program in the IoT board	F0	A	
F55	Display the data provided by the IoT boards during experimentation	F0	A	
F56	Export data in CSV or Excel format (data sheet)	F0	A	
F57	Attach documents	F0	A	
F58	Remove documents	F0	A	
F59	Access chat live for discussing	F0	A	

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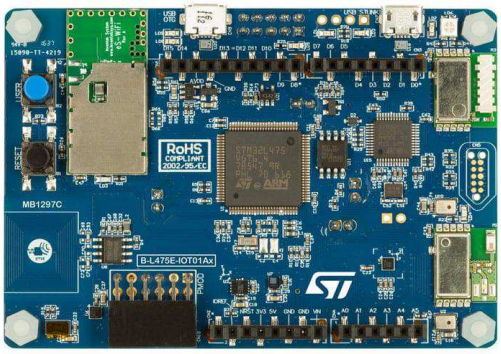
F60	Comment team members' work	F0	A	
F61	Display the list of projects	F0	A	
F62	Filter and sort the projects per discipline and learning objectives	F0	A	
F63	Make public the resources developed by the trainers	F0	A	
F64	Create and share transdisciplinary challenges	F0	A	
F65	List, filter and sort the on-going challenges	F0	A	
F66	Contact the teachers in charge of the identified challenges	F0	A	
F67	List contents per language	F0	A	
F68	Enable the translation of the contents	F1	A	
F69	List the challenges per level	F0	A	
F70	Display the existing teams	F0	A	
F71	Contact teams	F0	A	
F72	Create new teams	F0	A	
F73	Join existing teams	F0	A	
F74	Accept new team members	F0	A	
F75	Make the results public	F0	A	
F76	List the public results from challenges	F0	A	
F77	Export data	F0	A	
F78	Comment the results and share experience	F0	A	
F79	Access national dashboards	F0	A	
F80	Access the challenges' results	F0	A	

5. TECHNICAL SPECIFICATIONS OF THE IOT 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.

5.1 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[1]) 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.
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. Alternatively, I^2C is spelled I2C (pronounced I-two-C) or IIC (pronounced I-I-C).
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.

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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.
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

5.2 LIST OF REQUIREMENTS FOR IOT BOARD DEVELOPMENT

5.2.1 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.

Table 11 - Functional requirements

ID	Feature 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

ID	Feature name	Description
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.
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

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ID	Feature name	Description
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
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

5.2.2 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.

Table 12 - Environmental requirements

ID	Feature 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.

5.2.3 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)).

Table 13 - Physical requirements

ID	Feature 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

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5.3 EDUCATION BOARD OVERVIEW – FUNCTIONALITIES & DESIGN

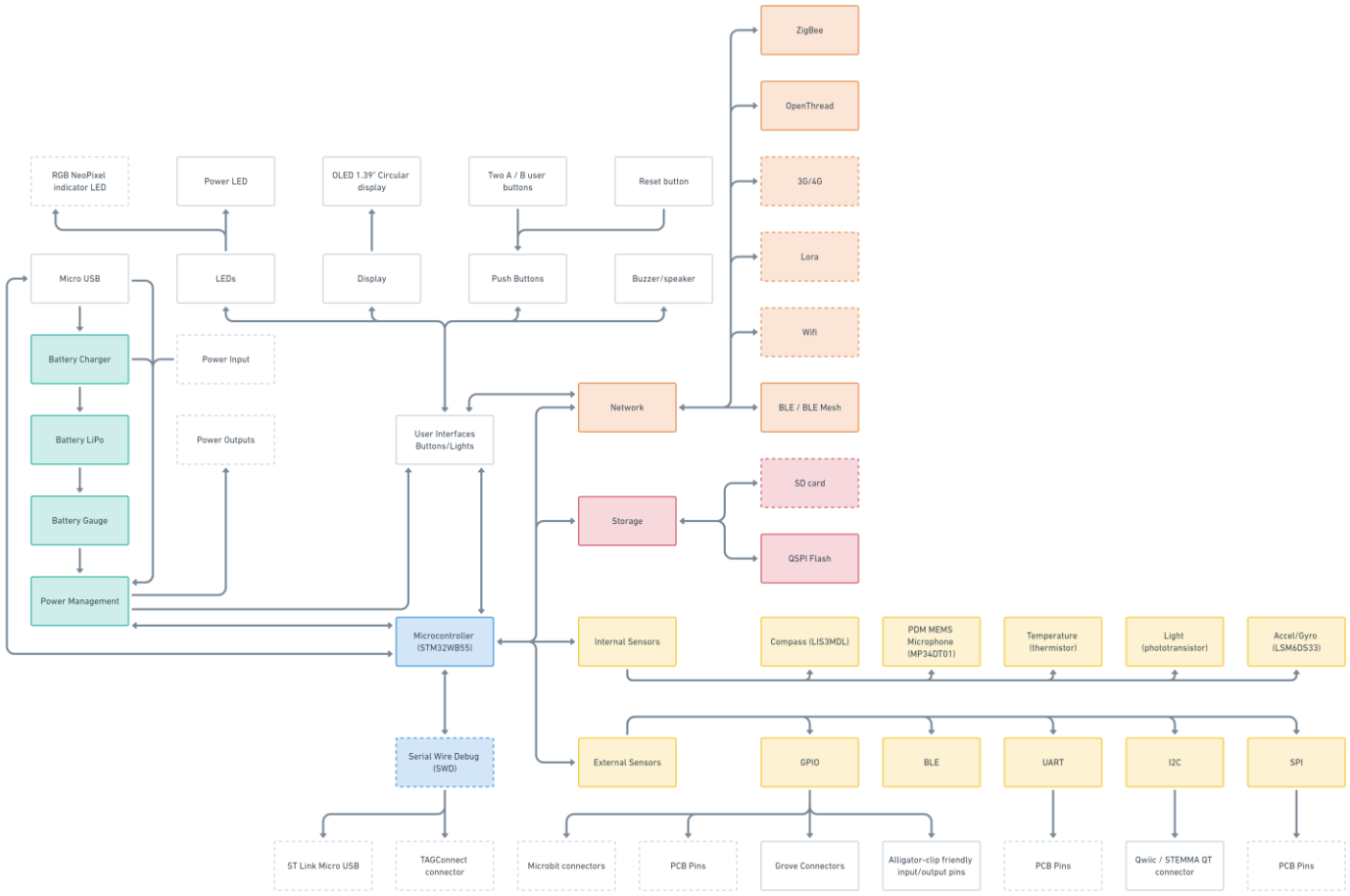

Figure 9 - Overview of the board functionalities

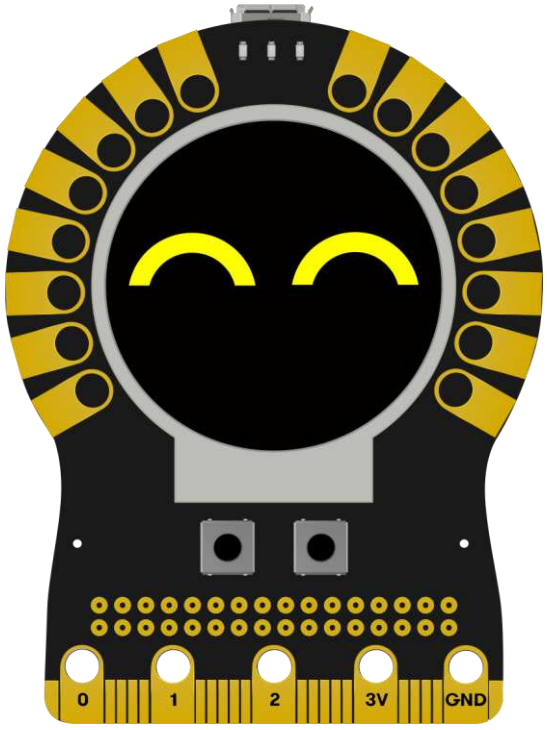

Figure 10 - V1 of the board design

6. CONCLUSION

The objective of this specification is to describe the requirements linked with the development of educational tailored functionalities on the MakeCode, CircuitPython and Scratch platforms that will enable to fulfil the goals of the Let's STEAM project, namely:

- Increasing the skills of the teachers
- Developing an inquiry-based approach of learning programming while enhancing STEAM education
- Developing partnership and collaboration, at the level of disciplines, schools and countries.

The definitions given of the expected impacts and features linked to these objectives are the basis for further refinements in specific task 3.1 "Transforming identified functionalities within WP1 into user story and initializing the project backlog". The aim of this task will be to initialise the product backlog with all functionalities identified in this section. The project backlog will be used as a model of work to be done and contains an ordered list of user stories. This backlog will extend the user stories defined in this document in refining in details the features and identifying bug fixes, non-functional requirements, etc.— whatever must be done to successfully deliver a viable product. The backlog will be ordered into the sequence in which it should be delivered. It will contain the product stakeholder's assessment of value and the development team's assessment of development effort, which are stated in story points using the rounded Fibonacci scale. To develop it as simple as possible, each feature have hence been defined in this deliverable in a simple and directive language, understandable by the end-users.

Persona and Impact mapping.

During the work performed under the construction of the functionalities and specifications, persona have been used to enable personifying the process of technical development. 6 personas have been creating for now, 1 representing a trainer of teachers, 5 representing teachers and 1 being a Policy Maker. These personas will be extended and developed further within an iterative process, refining while meeting and engaging the teachers, the needs, and expectations of the final users. From the analysis of the teachers' needs, identified in D1.2 through both questionnaire' answers and recommendations provided by the Let's STEAM pedagogical partners, D1.3 is hence translating teachers' interests and potential sources of frustration in a set of impacts i.e. behavioural needed changes that can be implied by modifying and tailoring the selected platforms. A total of 24 impacts have been defined, however, additional ones, or refinements will be performed where needed.

Features, conformity matrix and regular update.

80 features have been defined, with a level of flexibility between F0 (no flexibility) and F1 (low flexibility). They will be regularly updated and refined under the conformity matrix linked to the features selected available in this document. These features should enable developing a tailored educational approach in WP3 regarding technical work of the Let's STEAM consortium team. These features have been defined according to three actor profiles (trainer, trainee and policy maker) as stated above in the "Personas" section.

Hardware linked development.

Eventually, this document is rapidly presenting the results of the parallel work performed through in-kind contribution of the STMicroelectronics engineers' team in translating the teachers needs in compatible hardware material. Even if the Let's STEAM project is about training on software use, the development of a tailored IoT boards and the possibilities for all teachers involved to have access to this tool and use it in the classroom will ease the validation of the features' conformity.

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