weSTEAM

skills framework

INTRODUCTION

WeSTEAM project

WeSTEAM is the Erasmus+ project aimed at enhancing the **role of women in science and the attractiveness of science courses for female students** through the development, testing and dissemination of a methodology based on the STEAM approach.

INTRODUCTION

the first STEP

of the project is designing and disseminating a **reference framework for strengthening and assessing women STEM students' Art Thinking capacity.**
This will allow both students and educational organizations (universities and informal education centers) to gain awareness of the skills they need to enhance in order to complement their curricula according to a STEAM approach.

INTRODUCTION

in this document you will find:

1. Methodology

a brief overview of the steps that led to the creation of the framework

2. Casebook

a collection of best practices implemented at the European level in STEAM education field

3. Creative process

a comparison of the creative process as seen by artists and scientists, respectively

4. Skills framework

the framework of phases, actions and skills that characterize a STEAM creative process

1. METHODOLOGY

Here are the **main actions and outputs** that led to the creation of the WeSTEAM skills framework:

1. The characteristics of a STEAM practice

HOW: focus group among project partners to identify the characteristics of a STEAM educational practice

OUTPUT: template and descriptors of the characteristics of a STEAM educational practice

2. STEAM education Best Practices

HOW: each partner has identified two best practices in the field of STEAM education in their country

OUTPUT: STEAM education best practices casebook

3. The phases of the creative process: focus groups

HOW: the representative partners of the cultural / creative sector (Ars Electronica, Espronceda, Sineglossa) each organized a focus group with artists, in order to identify the phases, actions and skills that characterize a creative process

OUTPUT: template of the creative process's phases (Art)

4. Validation of the creative process: focus group

HOW: the representative partners of the scientific sector (Changemaker, Lulea University) organized a focus group with students from scientific faculties, in order to compare the creative process applied to the artistic field with the creative process applied to the scientific field

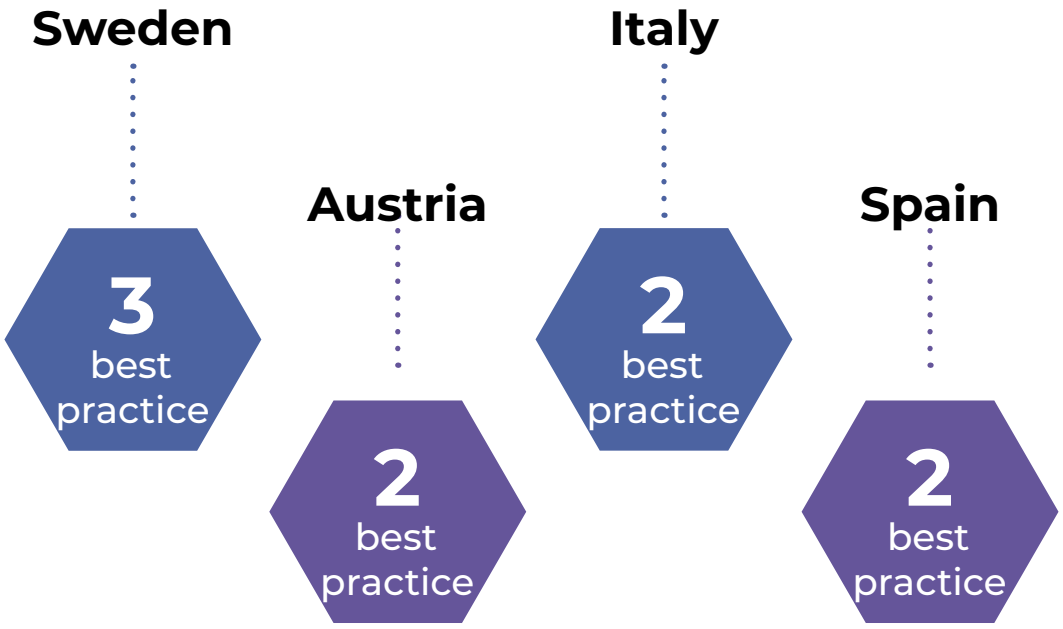
OUTPUT: template of the creative process's phases (Science)

5. WeSTEAM skills framework

HOW: starting from all the outputs produced in the previous phases and from the literature review, the PR leading partner (Sineglossa) structured the WeSTEAM skills framework, validated by all partners

OUTPUT: WeSTEAM skills framework

In this casebook you will find some best practices in STEAM education implemented at European level:



Reading these practices will help you to deepen different approaches to STEAM education and to draw inspiration for the creation of your own STEAM initiatives.

For the selection of practices, we have identified the template of the characteristics of a STEAM practice:

CHARACTERISTIC OF A STEAM PRACTICE

Creative
Collaborative
Experiential
Process-oriented
Sustainable

Creative:

to innovate the future you need to re-invent the existing » a STEAM practice must encourage out of the box thinking, stimulating participants to think in a visionary and disruptive way

Collaborative:

bringing together different disciplines means having a democratic and inclusive approach » a STEAM practice must favor transversal participation and exchange between participants

Experiential:

the combination of art and science cannot be taught from a desk » a STEAM practice must make participants get their hands on things, involving them in a direct and active experience

Process-oriented:

“There are not correct answers but engaging ones” » a STEAM practice must enhance individuals and creative freedom, focusing on the process rather than the final goal

Sustainable:

innovation cannot be effective if it does not consider real-world needs » in a world facing increasing challenges, from climate change to digitization, a STEAM practice must foster the development of environmentally and socially sustainable ideas

The Mathematical Garden_Tekniskamuseet

Stockholm, Sweden

WHAT

The Mathematical Garden provides a fun experience where **you can discover that mathematics is to be found everywhere – in nature, art, music and technology** – in the form of patterns, symmetry, golden ratios, numerical sequences and fractals.

HOW

The playground features a slide in the shape of a nautilus shell, a triangular climbing web, fraction columns, a fence inspired by the Koch curve, a hopscotch court with a very special sequence of numbers, and a tortoise featuring a magic square in its shell.
There are also xylophones and a dance mat, illustrating the mathematical relationship that exists between different tones. The cultivation boxes are home to sunflowers and daisies, where the proportions and fractals of the golden ratio are reproduced in every flower, and the roof of the gazebo is formed to reflect branches that follow Fibonnaci's number sequence. **The golden ratio's spiral form permeates the entire garden, and mathematical relationships can be seen everywhere.**

TARGET » Children between 8 to 13 years old.

WHY

Mathematics is a really important thing in our life. You can find mathematics everywhere, such as in Art, biology, music, sport, pattern and body. The main principle of engineering in any field is to know mathematics. **We cultivate the minds of children and adolescents from childhood to mathematics with different methods such as playing tricky games, puzzles, Art and sports.**
The mathematical garden designs different kinds of things for teaching mathematics to children. Some of things children and adolescents can try on mathematical garden:

- Solving puzzle maze.
- Play on different musical instruments- they also can discover how tones and fractions are related to each other.
- Go on the slide -it is inspired by the shape of the nautilus shell, which is just one example of beautiful mathematical shapes found throughout the natural world.
- Jump on the fraction columns and find out if you can see how different numbers are related.
- Climb to the top of the gigantic climbing web. This contains many geometric shapes, the strongest of which is the triangle.
- Test how a parabola works – whisper into it and see if your friend at the parabola opposite can hear you.

These are ways to make them interested in mathematics and technology and help them to find their skills and improve that.

www.tekniskamuseet.se

Play Beyond Play – enter the world of computer games_Tekniskamuseet

Stockholm, Sweden

WHAT

Play Beyond Play is a complete experience featuring game stations and imaginative game environments.
Nostalgia, amusement and advanced digital technology are brought together as we tell the story of Sweden's computer game industry. Gaming is one of the most globally widespread cultural forms. It is also an industry that is driving the development of digital technology at a rapid pace. The Play Beyond Play exhibition takes over an entire floor – 1,000 square meters of gaming fun. We have created an experience where you can not only try your favorite games and explore the game history, but also step into, and let yourself be immersed by games.

HOW

In Game Demo you can try games that are still under development. They have been created with focus on specific areas, such as the design or unusual user interfaces. Such as Pump the Frog, a puzzle game that uses a bicycle pump to control the game.
You can also try virtual cognitive behavioral therapy, currently being tested in a scientific study at the Sahlgrenska University Hospital in Gothenburg. You can create your own avatar. You scan yourself and choose looks and accessories. When done, you can let your avatar wander out in the exhibition together with previous visitors and stay in the world of computer games forever.

TARGET » +10 years old.

WHY

This place is quite a clear example of STEAM. You can see art, science and technology in one place with different tools and games.
If someone visits this place, they will automatically become interested in engineering and technology.

www.tekniskamuseet.se

Exploratoriet: Skellefteå Science Center_

CEO, Sara Stengård

Skellefteå, Sweden

WHAT

The vision is tough: to create Sweden's foremost educational center. Skellefteå and Sweden need to find the stars of the future in the **technical and scientific professions**. And **the Exploratorium will inspire a new generation in science and technology** with experiences and interactivity. Knowledge should be fun!

We are soon facing an incredible shortage **of skills in the technical and scientific professions.** In Skellefteå, which is an industry and technology-dependent city, we take that shortcoming seriously. Therefore, Skellefteå municipality together with the business community in the region has decided to build a **science center.**

HOW

The exploratoriet is an attractive arena where knowledge is fun. Exploratoriet fills an entire house, on Nordanå, with **experiments** and fun challenges. **Physics, chemistry, technology, astronomy, ecology, etc.** - visits to many scientific levels will be offered here. Interactivity, the joy of discovery, and playfulness will attract the interest of the technology churches among the young visitors. And probably also the child in adult visitors. Exploratoriet creates a unique Skellefteå model with a strong **pedagogical** core that is strengthened through good collaboration between schools, universities, companies, and other actors, primarily in Skellefteå and surrounding regions, but also nationally and internationally. The purpose is primarily to **reach children and young people in preschool, elementary school, and high school,** but the Exploratorium will also in the long run become an attraction for visitors, an experience for the whole family.

Exhibitions: There is a total of 800 square meters of exhibition space with **exhibitions and interactive experiments.** Here you will find, among other things, the Forest, the City and the Sun. Explore, experience, discover in the interactive sound exhibition Decibel - hear, make and touch sound. Here you can, among other things, create sound waves, play laser harp and explore the development from the music box to Spotify. With these exhibitions, exploratoriet, of course, wants to create interest in technology and science. How does hearing work? Can you feel the sound? What does technical development look like? How do we handle and use sound in the future? The digitalization that is taking place in all industries means that the need for sound technology is also increasing.

Technology Tour: The purpose of **Teknik on tour** is to make exploratoriet's pedagogical programs in technology available to those schools that have a long journey to the Exploratorium. Technology on tour is available for all year groups and schools outside Skellefteå central town.

NTA - nature and technology for everyone: NTA is a school development program, which consists of different themes. Here the student uses a scientific way of working by making predictions, laboratory work and documenting.

Digital complement to the NTA box Movement and construction: If you want to complement your work with the NTA box Movement and construction with programming and control, you can test the material that exploratoriet have developed on behalf of NTA.

Strengthening students' digital skills: In preschool, it is about gaining a first understanding of programming. The children are given a creative space and have the opportunity to shape their own learning process at the same time as they become familiar with programming and coding. A varied workflow with analog games that together with digital tools lay the foundation. It provides the opportunity to work broadly with both mathematics, language, NO- and SO-oriented subject areas. Educators should be able to use programming as a way of working for different ages, regardless of a subject area, as a step in developing students' abilities. The code bags will give educators equal opportunities to work with programming. These code bags include all the materials needed to get started with programming (e.g. robots, teacher guides, learning tablets).

TARGET » Children and young people in preschool, elementary school, and high school

WHY

Exploratoriet applies the fundamentals of STEAM approaches to engage children and young people to learn via practical activities such as experiments, exhibition, nature, and technology activities and co-activities.

exploratoriet.se

Future Inventors lab_ National Museum of Science and Technology "Leonardo da Vinci" and Rocca Foundation

Milan, Italy

WHAT

Future Inventors is an **educational space** that aims to develop an innovative approach to involve children aged 11 to 13 in STEM (Science, Technology, Engineering and Mathematics) and to **enrich teaching** with new educational tools for teachers, overcoming the traditional distinction between scientific and artistic subjects. Future Inventors proposes an active and experiential learning process, a totally new approach in which the original contamination between STEM and art, digital and analog, physical and virtual come together in the same experience. To experience this contamination, **several digital art installations have been created in collaboration with international artists** such as Michael Bromley, Anders Lind, Machiel Veltkamp and Moritz Simon Geist. During the activities, the **active participation and direct manipulation of the analog and digital tools and languages** that the laboratory proposes to explore STEM contents is expected.

HOW

Starting from an immersive and engaging experience in the laboratory, Future Inventors offers teachers and students at lower secondary school an innovative approach to the education of scientific subjects.

The project was developed in collaboration with teachers of scientific and artistic subjects from various Italian regions, contributing to the definition of the method which was then experimented directly with teachers and students in some Lombard schools. **Image and Sound** are the main themes around which the proposed educational experiences and activities revolve, as they are **multidisciplinary areas contained in the school program and digital languages widely used by young people.** Together with Image and Sound, the Pixel was chosen as a basic and unifying element, inspired by digital culture.

Through the use of digital, artistic and expressive languages, the project develops an approach that invites students to deepen its characteristics and teachers to use it also in other curricular areas. **Overcoming the traditional divisions between subjects and helping students to think beyond disciplinary boundaries** is in fact one of the objectives that the Rocca Foundation has set itself by supporting this project.

Among the works created, a remarkable example of STEAM approach is Cooperative Aesthetics, a collection of installations in which the space is transformed into a digital environment where you can live an audiovisual aesthetic experience. Everyone can move freely, triggering a different phenomenon and influencing sounds and images projected on the wall and floor. **In this experience, interaction, communication and collaboration between users is fundamental**. At the base of the experimentation, the concept of collaborative aesthetics, in which there is a strong social and relational component.

TARGET » The main target are children between 11 and 13 and their teachers; however, the art installations can be used by all museum visitors.

WHY

Future Inventors combines the capacity of art to generate interaction and relationship with education. The works of art used in the workshops are at the same time a real artistic product, created by internationally renowned artists with their own language and their own aesthetic, and a tool for educating the young - but also the museum public - to scientific principles. Future Inventors therefore represents a perfect combination of artistic research and languages and education in STEM disciplines, promoting a creative, interactive and collaborative learning experience through artworks that enrich both the museum's collection and its ability to engage the audience.

www.museoscienzaa.org

Liceo STEAM International (STEAM International highschool)

Bologna, Rovereto, Parma, Italy

WHAT

The STEAM highschool offers a course of study capable of **leading students to face the challenges of today's complex global society,** recovering the Italian spirit in its best sense: a unique and winning mix of creativity - utility - communicativeness.
The STEAM highschool is inspired by the vision spread in Italy at the beginning of the modern era: the meeting of concepts of Platonism (ideas as models, the soul as mediator, man as micro-demiurge) and Aristotelianism (the substance within nature, the complexity of life, the finalistic order of the world) to instill in the students new courage in imagining, experimenting and taking the reins of their own future.
The lessons cover the 5 core areas, with a focus on the sciences to be applied through current (and future) technologies.
The course of study is developed in 36 weeks and 1224 hours of lessons-activities per year, of which at least 50% in English, over five days of at least six hours of study or work per day.

HOW

In the STEAM International model, the teaching methods and study-work times are deeply revisited. **The teachings alternate study and practical activities, constantly challenging students to a problem-solving approach**, to enhance their growth at all levels. How does this happen? Thanks to the fact that a profound revision of the teaching methods and study-work times was carried out, according to a triple geometry lesson planning:

- CL - Core Lessons
  Lessons and activities with a focus on the essential contents of five general areas (Science, Technology, Mathematics, Art and Social Studies, Languages and Performing Arts).
- CC - Crash Courses
  One day every two weeks, intensive course on case analysis and advanced applications of a given knowledge, in various production sectors or cutting-edge services.
- ALL - Action Learning Labs
  Three projects a year with final products, each focused on an area and with great attention to the social impact and the meaning of the project: Mecha (focus on mechanical, mechatronics, engineering products), Bit (focus on digital products), Life (focus on bioengineering products), Social (focus on sustainable services).

Students are assessed not by marks but by SUBJECTS:
each course takes into account 4 dimensions of competence:

1. Knowledge and understanding: subject-specific content acquired in each grade / course (knowledge) and self-representation of its meaning (understanding).

2. Thinking: the use of skills and / or processes of critical and creative thinking on the content given, also as a function of alternatives.
3. Application: the use of knowledge and skills to create connections within and between different operational contexts.
4. Communication: the sharing and expression of meanings through various forms.

TARGET » Highschool students.

WHY

To face the complex problems of the contemporary world, complex solutions must be worked out. The methodology adopted by the STEAM highschool addresses the need of complexity by overcoming the concept of subject - and grade - in favor of transversality, understood both as transversality between disciplines (art and social studies together with scientific subjects), and as transversality between hard skills and soft skills, through an assessment system that considers non-cognitive skills.

liceosteam.it

KI & Du (AI & You)_ Ars Electronica

Linz, Austria

WHAT

What is artificial intelligence anyway? How intelligent is artificial and what does it have to do with me?

The tour of the Understanding AI exhibition not only gives students a basic understanding of this technological phenomenon, but also discusses the range of applications that AI brings. Technology has arrived in our everyday lives and, with humans as its role model, makes its own decisions. What is good and what is fatal and what role humans play in these neuronal networks will be discussed with the help of scientific and artistic examples. The Workshop is an add on to this tour and called “Machine Learning”.

For machines to learn at all, they need quite a bit of attention and hard training in the form of data. **The Machine Learning Studio offers a practical insight into machine learning: you can train self-driving model cars or see how robots perceive their environment.**

HOW

The workshop consists of a guided tour through the “Understanding AI” exhibition at the Ars Electronica Center and continues in a workshop setting of our Machine Learning Studio at the Museum. This activity is open to max. 15 participants and takes around 2 hours.

Exhibition: The exhibition “Understanding AI” presents the most important technical aspects of artificial intelligence as well as concrete examples of how they are used. Here visitors can discover how machines and their sensors “perceive” the world in comparison to humans, what machine learning is, or how automatic facial recognition works, among other things. They can also learn about various social and ethical issues such as deep fakes (deceptively genuine-seeming pictures or videos made automatically using neural networks), the effects of using digital methods for profiling, and the hidden side of our everyday electronic devices such as smartphones. New creative applications made possible by artificial intelligence are also on display for visitors to experience. There are no easy answers about how to use artificial intelligence or what its dangers are, but Understanding AI provides a broad basis of information to help us navigate this complex field.

Machine Learning Studio: In the Machine Learning Studio, visitors can use computer vision and machine learning applications to discover how machines learn and perceive their environment. Working with tech trainers, they can build and train self-driving model cars here, program robots with facial recognition, and gain insights into how they can teach these devices a wide variety of activities. Step-by-step, they can experience not only how these technologies function, but also that everything the machines know is determined by us.

The Machine Learning Studio not only offers insights into the hidden inner life of our learning devices—it is also a place where prototypes and

objects can be maintained or repaired by the tech trainers, and museum procedures are revealed that are usually kept behind the scenes.
Techtrainers demonstrate descriptively interactive applications and visitors can understand the principles of "Machine Learning" through their own experiments and test its limits.
The Machine Learning Studio deals with the different methods of how machines "learn" what they should do. This includes classical programming using code input, input methods such as using a controller, and machine learning in the sense of Artificial Intelligence.
In the sense of an "Open the Box" claim of the Techtrainers, visitors can participate when things are going to be fixed or misused in the show workshop and thus hacked. The use of open-source technologies plays an important role so that visitors can imitate this at home. We want to "demystify" the technology by explaining the hardware and software.

TARGET » From fifth grade students to secondary school level.

WHY

Forward-looking technologies, art and social change are key milestones in our program – the focus is always on people. In this regard, we don't see the Ars Electronica Center as a temple of knowledge that provides many interesting facts, but rather as a museum that can listen, that is interested in the views, ideas and concerns of its visitors.
We consider a playful, creative approach, enthusiasm for new ideas and the commitment to making them accessible to a broader public to be particularly important in this respect. The Workshop AI & You uses this approach to bring the topic of AI and Machine Learning to secondary level students through hands-on experiments.

ars.electronica.art

Archetype Expectation Management_

Andrew Newman (Projectmanager), Ars Electronica
Linz, Austria

WHAT

between collaborators from different disciplines and professions before comArchetype Expectation Management is **a workshop program designed to facilitate empathy and understandingmencing** a transdisciplinary project together. It utilizes methods from UX Design and Design Thinking to uncover and address preconceptions and cognitive bias that participants may have of the different thought styles and project cultures of their fellow collaborators.

HOW

This workshop consists of two three-hour sessions.
The method was originally devised and delivered within an 18-month art and science residency program. The residency program aimed to connect artists with scientists who have had minimal experience in art and science collaboration. **Scientists from all disciplines were asked to apply through an open call** offering scientists the opportunity to collaborate with a selection of leading European artists nominated by the host organisation. Within the submission process scientists were asked to preference which artists they would like to collaborate with, submit a CV and to provide short written responses to the following questions:

1. What do you think the future holds?
2. Why should the arts and science work together?
3. How do you collaborate?

Based on these responses, a shortlist of scientists was drawn up by the host organisation in consultation with nominated artists and with the support and guidance of members of a multidisciplinary scientific board established for the program, who provided disciplinary specific expertise when necessary. **Shortlisted scientists then underwent a matchmaking process consisting of interviews with facilitators from the host organisation and artists.** The final selection of scientists who would collaborate with the artists was predominantly made at the discretion of the artist themselves, in consultation with the host organisation.
The teams of artists and scientists were then tasked with conceiving and developing a project together in response to a broad thematic framework outlined by the host organisation. The type of output or outcome produced within the project was open-ended, with the only specific requirement being that it was documented in some form.

TARGET » Higher education students, small research project teams who have no prior experience working with collaborators from the specific disciplines that make up the team, artists, scientists, researchers.

WHY

Difficulties of communication between different disciplines or different professions is the primary source of friction within facilitated art and

science programs. These difficulties extend beyond not simply sharing the same specialized vocabulary, and are often rooted in differing and sometimes conflicting values of participants that can strongly influence the fundamental “interpretation and applications of outputs and outcomes” (Wiesman et al.) of the project they are undertaking together. Archetype Expectation Management tackles these problems through interactive exercises that facilitate team empathy, transdisciplinary collaboration and communication and understanding between collaborators from different disciplines.**Difficulties of communication between different disciplines or different professions is the primary source of friction within facilitated art and science programs.** These difficulties extend beyond not simply sharing the same specialized vocabulary, and are often rooted in differing and sometimes conflicting values of participants that can strongly influence the fundamental “interpretation and applications of outputs and outcomes” (Wiesman et al.) of the project they are undertaking together. Archetype Expectation Management tackles these problems through interactive exercises that facilitate team empathy, transdisciplinary collaboration and communication and understanding between collaborators from different disciplines.

steaminnovation.org
(The workshop is not online yet)

ars.electronica.art

STEAM BCN_ Barcelona Activa

Barcelona, Spain

WHAT

Barcelona Activa has created STEAM BCN (Science, Technology, Art, Engineering and Mathematics) to foster science and technology vocations from pre-school to secondary school, offering tools and resources to both teaching staff and families.

The project focuses on the gender perspective and demystification of the scientist associated with a background and socio-economic status. Workshops, training capsules, visits to research centres, ideathons, etc. have all been designed to be rolled out in schools, libraries, universities or Fab Labs, among others.

The two of its most notable programmes are Makers a les aules [Makers in the Classrooms] and Inspira STEAM [STEAM Inspires]. The former is aimed at state primary school teachers.

It involves training students and teachers together to jointly create educational maker projects based on STEAM in classrooms, with the objective that teachers will be able to develop their own educational projects in the future, and incorporate the technologies they have used.

***Inspira STEAM* is a pioneering project that fosters a scientific-technological vocation in girls and young women**, and is run by professional women from the world of research, science, and technology.

These professionals act as mentors, sharing their experience with the children, giving guidance, challenging stereotypes, and placing great emphasis on the contributions women scientists have made throughout history and the current work women do involving modern technology.
As part of the STEAM BCN program, a major annual STEAM conference event is organised.

HOW

In the major event, activities are designed according to topics with a complexity that makes them difficult to explain in the classroom, hence they are turned into ludic experiments to make them easier to understand. This also **helps teaching innovation in classrooms and the dialogue between scientific methods and the creative process.**
Students are accompanied by monitors who are also UPC students, making for an event created by and for students. This makes the process even more conducive to learning. Examples of experiments that students can participate in range from building a rocket powered by water pressure, learning the importance of sustainable mobility models thanks to Bicing or studying the concepts of acceleration, speed and power at the roller coaster in Tibidabo.

One of the goals of the project, which has seen eleven thousand students take part in the last four years, is to combat gender stereotypes, **highlighting women role models to boost science vocations among girls and achieve real parity.**

TARGET »

For the other project activities: Family, students and professor.
For the major event: Secondary and baccalaureate students.

WHY

The varied and multidisciplinary approach that touches on both issues related more to technological innovation and science. In addition, **most of the workshops are created by the students themselves and this allows a deepening and an increase of different skills.**

ajuntament.barcelona.cat

ajuntament.barcelona.cat

Makers per la inclusió_ Colectic

Barcelona, Spain

WHO

Colectic is a non-profit cooperative project that works for the inclusion, autonomy, and empowerment of individuals and communities in the social, labor, and technology fields, and aims to understand and use technology as a tool for participation and social transformation.

WHAT

Makers per la inclusió is a project that offers citizens an opportunity to approach digital manufacturing in a broad sense. From playful and educational activities, it aims to introduce concepts, work skills and bring knowledge and techniques that are not accessible to citizens living in the Raval. Initially, Makers for Inclusion carried out an awareness-raising task, based on carrying out outreach activities that arouse interest and encourage the learning of techniques related to digital manufacturing. It is also essential the involvement of educational agents in the territory and the development of complementary activities to the educational curriculum, extracurriculars, open workshops... In which areas? Scratch programming, electronics with Arduino and free hardware, sound technologies, digital manufacturing, 3D printing, video game creation, internet of things, etc.

3 lines of works:

- **Work on technological vocations, directing participants to less precarious work camps**
- **Work to improve the self-perception, autonomy and empowerment of the participants. Although they do not end up working in this branch, the acquisition of knowledge and skills a priori far from their experience improves their social situation.**
- **Analyze possibilities of new professional profiles around technology and education, based on detected needs of the school community in the neighborhood.**

HOW

marked by a socio-economic bias. While it is true that in Barcelona there are many experiences that bring digital manufacturing closer to the public. Successful experiences continue to occur among sectors of the population with a medium-high socio-educational profile. Spaces and projects in this area are often not permeable to **neighborhoods where there is a high risk of exclusion, the socio-economic level of its inhabitants is below the city average, and where the results of the education system require special support.** This is a situation where there is the risk of creating a two-speed Barcelona, an innovative and creative one, and one that goes after it, creating a second-level digital divide.
This project wants to work to avoid this crack in the Raval of Barcelona, a neighborhood where the organization Colectic have been working at community level since their birth and where they are already making bets

for the social transformation of the environment, and for the social and solidarity economy.
The project is built to solve a community challenge where technology adds a specific value, implemented by young people.
The focus on approaching these new techniques and technologies is strongly.

TARGET » Makers for Inclusion is aimed at children and young people, women, vulnerable groups or those at risk of exclusion, families, agents of the educational community, non-profit organizations and social education professionals.
Audience competence: Starter
Age Range: 14-99

WHY

The project has a strong social inclusion value because it operates in one of the most economically weak neighborhoods of Barcelona and at the same time is one of the most multiethnic. The project can promote the improvement of the social situation of the participants, specifying also the centres that are very important to direct young people towards new educational itineraries thanks to the intersection of digital and creative skills.
The project has been positive in improving the self-perception, autonomy and empowerment of the participants.
In the project document, **the organisation states that they have seen changes in motivation towards STEAM careers and improved interpersonal relationships in the classroom (confirmed by teachers' feedback). 50% of the students said they were more motivated to study CS/engineering after our workshops.**

colectic.coop

steamonedu.eu

To identify the skills framework, we asked **both artists and scientists** which are the most important skills involved in a creative process[1].
The first step was the definition of the **phases** that make up a creative process, each of which was then associated with the respective **key actions** (what actually happens during that phase?) and the **key skills** (which skills are particularly important for the success of that phase?).

Here are the two processes compared
(the keywords common to both of them have been highlighted):

phases of creative process[2]

ARTISTS	SCIENTISTS
1. **Descriptor:** Ideation / Topic & Message **definition** (what and why) **Actions:** collecting inputs, mind -maps, conversations, drawings, writing (e.g., key words) **Skills:** **Open-mindedness** Imagination Curiosity Commitment (motivation, determination) **Empathy** Initiative	**1.** **Descriptor:** Identifying the challenges / **Problem definition / Research** **Actions:** literature review, gather references, reading and exploring the potential solutions, discussions, brainstorming **Skills:** **Open-mindedness** **Empathy** Listening **Analytical thinking** Communication
2. **Descriptor:** Preparatory research **Research** / Refine idea **Actions:** benchmarks, context analysis, fieldtrips, reading and visiting (e.g., exhibitions), interviews, discussing **Skills:** **Critical/Analytical thinking** Connecting dots Self-discipline Curiosity	

[1] To define the creative processes, we organized three focus groups with groups of artists - the results of which were then clustered into a single process - and a focus group with a group of students and researchers of scientific subjects.
[2] Among the skills indicated in the artistic creative process, we decided not to include Creativity, since the artists themselves identified it as a cross-cutting skill in the entire process, of which it represents the purpose. Since scientists have instead associated Creativity with specific stages of the process, in the case of the scientific creative process we have chosen to keep it.

phases of creative process

ARTISTS	SCIENTISTS
3. **Descriptor:** Experimentation **Actions:** brainstorming, visual images and mind maps, tools and materials choice **Skills:** Goal-oriented thinking (deadlines, etc.) Openness to the unknown Flexibility, Adaptability Optimism Visionary	**2.** **Descriptor:** Idealization (defining what to create) **Actions:** planning, schedule, set up goals **Skills:** Organization skills
4. **Descriptor:** **Development** / Review / Testing **Actions:** residencies, discussing, feedback collection (presenting the idea, trial exhibitions), drawing and writing, prototyping **Skills:** Awareness, Self-reflection Openness to criticism Adaptivity Teamworking (conflict resolution) Tolerance for failure Empathy, listening **Problem solving** Self-discipline Decision making **Disruptiveness** Critical/Analytical thinking Resource management	**3.** **Descriptor:** **Developing** ideas **Action:** proposing a solution, testing, discussing the outcomes with the stakeholders, monitoring, improving **Skills:** **Problem solving** Creativity **4.** **Descriptor:** Implementing the idea and analyzing results **Actions:** testing, workshop, focus group, prototyping, questionnaires, playtesting, collecting feedbacks, iteration **Skills:** Thinking outside the box **Disruptiveness** Communication

phases of creative process

ARTISTS	SCIENTISTS
5. **Descriptor:** Production **Actions:** completion, communication and dissemination, further development **Skills:** Empathy Communication Passion Open-mindedness Curiosity	**5.** **Descriptor:** Production **Actions:** further research, monitoring, documentation, reflecting **Skills:** Observing

Although there are some differences, both with respect to the distribution of phases and with respect to the words used, **the two processes have a lot in common.**
The **first phase** - which artists divide into two sub-phases - is that of the **definition**: of the message, in the case of artists (*which topic I want to deal with and why I deal with it*); of the problem to be solved / challenge to be faced by scientists. The definition is accompanied by **research**. This is the phase in which **materials are collected and analyzed**: analytical thinking is indeed a key skill for both groups. This is also the phase in which we open ourselves to the outside world, not only through analysis, but also through the **exchange with others**, so much so that both groups indicate discussion as a key action and open-mindedness and empathy as key skills.

The phase of definition and research is followed by the **phase in which the nature of the outcome is established.** Although the groups refer to different actions and skills - more creative those of artists, e.g. mental, more rational those of scientists, e.g. planning - both of them agree on an intermediate phase between the collection of ideas and the outcome development, in which the nature of what is to be developed is established (for example by choosing tools and materials) and **objectives are set**: if for scientists setting objectives is in fact a key action, for artists the goal-oriented thinking is a key skill.

The **development** of ideas into something concrete is the heart of the process, which scientists divide into two sub-phases: apart from this difference in the distribution of phases, this is the passage on which the two groups come closest, both with respect to actions that characterize the phase (testing and prototyping, collecting feedback and iterating the sequence) and with respect to skills. This is the stage where scientists mention creative and out of the box thinking as key skills, and both groups mention the ability to **think disruptive**. For both of them this is also the phase in which it is necessary to know **how to face and overcome obstacles** (problem solving) and communicate with the outside world: in

order to collect feedback for the improvement of their outcome, scientists mention communication as a key skill, while the artists mention the **listening ability** and empathy.

For both groups the last phase is that of **production**, in which **the outcome is completed**. The main difference between the groups is that, while for the artists the heart of this phase is the **sharing of the outcome** with the outside world (audiences or stakeholders such as galleries), for the scientists the heart of this phase is the observation and monitoring of the effects produced by the outcome, in order to establish the basis for further research and thus starting the iteration process again. Although the actions and skills indicated by the artists are mainly aimed at external communication, they also indicate further development as a key action in this phase, which for both groups therefore represents the **starting point for a new creative process.**

By crossing the two processes and reflecting on the **converging elements** - key actions and skills for a creative process, indicated by both groups - and on the **diverging elements** - actions and skills that can mutually integrate and enrich the processes, we have identified the main phases of the creative process, for the definition of which we borrowed words suggested by the artists during the focus groups:

1. PHASE OF INCUBATION
2. PHASE OF IMAGINATION
3. PHASE OF CREATION
4. PHASE OF EVOLUTION

For each phase we have identified the key actions and key skills, thus composing the WeSTEAM skills framework.

4. SKILLS FRAMEWORK

The WeSTEAM skills framework is a tool to **create or verify training experiences** (from academic curricula to workshops) **in the STEAM field**, the educational field that integrates scientific disciplines (Science, Technology, Engineering and Mathematics) with Art, in order to foster an imaginative approach in the design of creative solutions or innovative outcomes.

To facilitate the creation of processes that support trainees from the initial conception to the final production of an outcome, the framework is divided into **phases,** each of which proposes a series of **actions** that can serve as a **guide for the identification of exercises and activities**, and a series of **soft skills** that the exercises / activities should **stimulate.**

The framework also includes the **transversal skills** which run through all the phases of the creative process, on which the trainees should be asked to reflect at the end of the process, in the **assessment / self-assessment and retrospective** stages.

WeSTEAM skills framework

1. PHASE OF INCUBATION

Where you define & research

Actions
Collecting inputs
Discussing
Exploring

Skills
Analytical thinking
Curiosity

2. PHASE OF IMAGINATION

Where you idealize & set goals

Actions
Choosing tools and content
Visualizing
Planning

Skills
Goal-oriented thinking
Visionary

4. SKILLS FRAMEWORK

3. PHASE OF CREATION

Where you test & collect feedback

Actions
Prototyping
Reviewing
Iterating

Skills
Listening
Problem solving
Teamworking
Tolerance for failure

4. PHASE OF EVOLUTION

Where you produce & re-start

Actions
Communicating
Reflecting
(Further) developing

Skills
Observation
Passion

TRANSVERSAL SKILLS

Awareness
Communication
Critical thinking
Disruptiveness
Empathy
Open-mindedness

1 PHASE OF INCUBATION

The purpose of this phase is to guide the trainees in **choosing and studying** the topic they want to deal with or the problem they want to solve.
For both artists and scientists, the input for initiating a creative process can be a commission from a client, an opportunity to be grasped (e.g., the release of a new technology) or a personal need to be satisfied (for example the desire to focus attention on a certain theme or to face a certain challenge).
Even in an educational context, you can decide to leave the choice of the "object" of the process to the trainees or to give them a "commission" (e.g., imagining a new application of a technology or addressing the challenge of climate change).
The choice of the theme or problem is accompanied by **research**: in this phase, the trainees must be stimulated to **collect and analyze materials** and to **explore** what has been done and what could be done regarding the object of their creative process.

ACTIONS

Collecting inputs: searching for in-depth materials on the topic or challenge being addressed (e.g., best practices, literature reviews, references, benchmarks); analyzing the materials, identifying strengths and weaknesses, recurring elements, models to take as examples; classifying the materials, both through cataloging tools (e.g., Excel tables) or through creative tools (e.g., mind maps)
Discussing: deepening the topic through discussions with stakeholders (clients, experts on the topic), using structured tools (e.g., interviews), informal dialogues, or both
Exploring: gathering stimuli through direct experience, e.g., field trips and visits to museums, exhibitions, research centers

SOFT SKILLS

Analytical thinking: to investigate a topic, it is not enough to gather information, you must also shape it: this means being able to interpret information objectively, putting aside your preconceptions, and knowing how to process it creatively, combining disparate elements to create something innovative or solve a problem
Curiosity: *"You never stop learning,"* goes a famous adage: this means approaching the research phase with the attitude of an explorer, aware that to gain a better understanding of things you must never stop digging and that next to a road already beaten there is always an unexplored path

PHASE OF IMAGINATION 2

The purpose of this phase is to help trainees **shape the idea,** establishing what they want to achieve and what steps and resources are needed to make it happen.
For both artists and scientists, this is a particularly delicate phase, as it requires a great **balance between the creative side** (being able to visualize something that does not yet exist) **and the rational side** (being able to estimate the steps and tools needed to create that something).
Even in an educational context, it is important to give equal weight to both components, using Art Thinking to stimulate the trainees' capacity of imagination without neglecting the organizational aspect, which is essential to avoid getting lost along the way of the creative process.

ACTIONS

Choosing tools and content: shaping the idea by establishing its main components (e.g., the materials or tools to be used to implement it and/or the macro-sequence of content that will make up the whole)
Visualizing: creating a visual outline of the idea through the use of creative tools (e.g., mind maps, drawings, keywords writing)
Planning: developing the plan for implementing the outcome, establishing goals, timelines, human and material resources

SOFT SKILLS

Goal-oriented thinking: in order to achieve a goal, you need to think ahead, estimating the steps and the resources necessary to pursue it: this means being able to establish achievable, prioritized and timetabled tasks and to manage your time and resources accordingly
Visionary: to visualize an idea, you have to imagine what does not yet exist: this means being able to let go your creativity, without putting rational restraints (e.g., "it is too much", "it cannot be done", etc.) on what your imagination is suggesting to you

3 PHASE OF CREATION

For both artists and scientists, this phase is t**he heart of the creative process**, where the idea idealized in the previous phase takes concrete form. This is the stage in which to **put the hands in the dough**, making the first version of an artwork or a machine, or carrying out the first tests of a scientific experiment. This is also the stage in which to reopen the exchange with the outside world, **gathering feedback** to understand what to improve and how to improve it.
In an educational context, it is important to **ensure the practical dimension of this phase**, creatively using available resources (a digital interface, for example, can also be prototyped at the analog level). Even with limited time available (e.g., in the case of a workshop of a few hours), it is important to make trainees understand the importance of this phase, in order to stimulate a **process-oriented approach** that does not rush toward the final result but knows how to value experimentation, learning from mistakes and failures.

ACTIONS

Prototyping: creating a model of the outcome of a more or less defined level (based on the complexity of the outcome), but effective to be tested (shown/used/experienced, etc.)
Reviewing: collecting feedback through informal or semi-structured methods of discussion (dialogues with stakeholders, questionnaires, focus groups, trial exhibitions or presentations)
Iterating: starting from the feedback collected, focusing on strengths and weaknesses of the outcome and return to prototyping, enhancing the strengths and improving the weaknesses.

SOFT SKILLS

Listening: to value the feedback that other people offer about your work you need to really listen to what they are saying: this means putting yourself aside to give space to the other, having trust and respect for their opinions, and trying not to judge the message before it is delivered
Problem solving: this is the phase when things will often not go as you imagined: this means being ready to react proactively and being willing to compromise, trying to look at the big picture to find alternative ways to overcome the obstacles
Teamworking: even if it is led by one person, this phase of a creative process always involves other people (e.g., clients and collaborators): this means accepting the sharing of tasks and responsibilities, having respect for each person's role, and being willing to mediate to facilitate conflict resolution
Tolerance for failure: "Ever tried. Ever failed. No matter. Try again. Fail again. Fail better.", says a famous aphorism by Samuel Beckett: this means being able to cope with failures, both on an emotional level, focusing on your sense of purpose, and on a rational level, using failures as a lesson to understand what to improve.

PHASE OF EVOLUTION 4

The end of the creative process is the **production of the final version** of the outcome.
For artists, the final production is accompanied above all by the communication of the outcome to stakeholders (e.g., exhibition centers) and audiences. For scientists, the main action that accompanies the final production is reflecting on how to use what has been accomplished to start new research.
In a STEAM educational practice, it is important to consider both of these aspects, guiding trainees as much in **taking into consideration the outside world**, understanding to whom and how the outcome should be communicated, as in the **awareness that a creative process never really comes to an end:** the final stage is nothing more than a stimulus to start incubating new ideas again.

ACTIONS

Finalizing: completing the outcome at its highest possible level of definition
Communicating: identifying who the main target audiences of the outcome are and developing one or more ideas for its dissemination, considering both the "message" (key words and concepts to make it understood its meaning, value, etc.) and the tool (presentations, catalogs, etc.)
(Further) developing: reflecting on the process in retrospect (how did the outcome change between the idealization and finalization phases, what were the most exciting aspects, what were the aspects that most interested stakeholders) and imagine what could be the starting point to begin a new process

SOFT SKILLS

Observation: having delivered the message does not mean having closed off communication with the outside world; on the contrary, this is the phase in which you can collect the most interesting feedback: this means knowing how to observe the reactions to your work, both taking an empathic point of view and setting up monitoring tools and actions
Passion: if you can't teach someone to be passionate about something, you can certainly practice finding a passionate approach to your work: this means being able to identify what about the creative process has most tickled your "emotional strings" and use it as a re-starting point

TRANSVERSAL SKILLS

Awareness: in such a complex and multifaceted process, that brings together creativity and rationality, self-expression and decision-making, it is important to keep in touch with yourself: this means being able to understand and express your emotions and thoughts, in order to avoid falling victim to stress and frustration, and to self-discipline in respect to tasks and timelines

Communication: communicating is nothing more than putting another person in a position to comprehend what you are saying: this means that at all phases of the process, especially those involving an exchange with the outside world, you must be able to use the other's point of view to understand both what to say (the content) and how to say it (the container)

Critical thinking: to develop an idea, you have to handle a lot of information coming from different sources, from synthesizing research materials to analyzing feedbacks: that means having a questioning, challenging and self-regulatory approach to knowledge, being aware of potential biases, to compare and combine information in order to draw logical conclusions

Disruptiveness: to create something new, you must start from what has already been done and then overcome it: this means that at all phases of a creative process, especially those involving generating new ideas and shaping them, you have to be brave enough to step out of your comfort zone and explore the unknown

Empathy: several phases of the creative process, from initial incubation to gathering feedback to final dissemination of the outcome, require the ability to put yourself in someone else's shoes (clients, audiences, stakeholders): this means having respect for otherness, understanding other people's feelings, experiences and values

Open-mindedness: During the creative process you must be able to welcome inputs from outside, in order to seize opportunities, prevent risks and solve problems: this means being receptive to novel ideas and willing to modify your opinions and actions, understanding the context and adapting yourself to it.

CREDITS

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