

Deliverable 4.2

Best practices report



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Abstract	This report synthesises and documents the methodological approach and best practices identified across all national implementations of the STEAM Innovation Ecosystem project during WP3 (Tasks 3.1–3.5). It captures the pedagogical strategies, innovative teaching methods, and effective practices employed across three discipline modules: Learning STEAM Through Theatre (Greece), Learning STEAM Through Music (Cyprus and Italy), and Learning STEAM Through Making and Tinkering (Portugal), and draws on evidence from 1525 students and 198 teachers across four European countries during the school year 2025–2026. The report identifies one best practice per country, grounded in real school implementation evidence, and documents what each school did that worked particularly well and can be replicated by others. It is addressed to educators, policymakers, and educational organisations seeking to understand, adopt, or scale integrated STEAM education approaches across Europe and beyond.
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1. Introduction

1.1. Purpose and scope of the report

This methodological approach and best practices report (D4.2) focuses on synthesising and documenting the methodological approach and best practices identified throughout the duration of the project, with particular reference to the implementation activities carried out during WP3 (Tasks 3.1-3.5). It serves as an analytical and reflective document that moves beyond description to capture the essence of what worked, why it worked, and what conditions made it possible, so that others can replicate it.

The report is addressed to three overlapping audiences. For educators and trainers, it provides evidence-grounded insights into how integrated STEAM education can be effectively designed and delivered. For school leaders and policymakers, it offers a clear account of what the STEAM Innovation approach achieved in real schools across four European countries, and what systemic conditions can ensure such positive outcomes in education. For educational organisations and networks seeking to scale or disseminate STEAM education, it provides a documented, replicable model built on genuine implementation evidence.

1.2. How the best practices were identified: the three selection criteria

Best practices in this report are defined from the perspective of the school: *what did a school team do that worked particularly well and can be meaningfully replicated by other schools in other contexts?* It is important to note, however, that none of the practices documented here emerged in isolation. Each school team was supported throughout the implementation process by their partner organisation, through structured mentorship, professional development workshops, on-site visits, and sustained one-to-one guidance. The conditions that made these practices possible, sustained support, clear pedagogical frameworks, and consistent mentoring relationships, are themselves part of what needs to be replicated. The STEAM Innovation Best Practices Guide (D3.2) provides complementary documentation of the support structures, methodologies, and facilitation approaches that underpinned the school implementations, and should be read alongside this report by any educator or organisation seeking to replicate these practices in their own context.

The identification of best practices drew on three criteria:

- **Impact:** evidence of improved learning outcomes, student engagement, and skill development, drawn from teacher observation, student results, qualitative feedback, and the evaluation results from national festival events.
- **Feasibility and applicability:** the degree to which the practice can be replicated across different school types, age groups, resource levels, and national contexts without requiring specialist infrastructure or exceptional conditions.
- **Shared experiences:** qualitative evidence from students and educators about what the experience meant to them, what it developed in them, and what they would recommend to others on the basis of having lived through it.

One best practice per partner has been documented, drawn from real WP3 implementation evidence. Each is presented using a consistent template that details what the school did, how they did it, what it produced, and what others can learn from it.

2. Methodological approach

2.1 The integrated framework: Inquiry-based learning and design thinking

The STEAM Innovation project's methodological approach, as established in the Educational and Methodological Blueprint (D2.2), rests on the integration of two complementary pedagogical frameworks: Inquiry-Based Science Education (IBSE) and Design Thinking (DT). Together, these frameworks create what the project calls an 'ideas become reality' mindset, one that positions students as active investigators and creative producers simultaneously, rather than as passive recipients of pre-packaged knowledge.

Inquiry-Based Science Education is a student-centred pedagogical model in which learners pose questions, gather and analyse evidence, construct explanations, and communicate conclusions, following a process that mirrors genuine scientific practice. Rather than transmitting knowledge from teacher to student, IBSE creates the conditions for students to discover and construct understanding through guided but genuinely open investigation. This approach develops subject-specific knowledge and cross-disciplinary competencies like critical thinking, evidence-based reasoning and collaborative problem-solving, that are central to the STEAM Innovation project's ambitions.

Design Thinking is a solution-oriented creative process that structures students' work through four iterative phases: Feel, Imagine, Create, and Share. These phases, adapted from the Double Diamond model of the British Design Council and aligned with the OSOS Open Schooling Model, provide the practical and organisational spine of all three STEAM Innovation modules. They ensure that students move from curiosity and inquiry through creative production to public presentation in a structured yet flexible way, and that the artistic dimension of each module is not an afterthought but a genuine mode of inquiry.

The Feel → Imagine → Create → Share cycle in practice

- **FEEL (Question + Evidence):** Students identify real problems, pose their own questions, and gather evidence. Teachers facilitate dialogue rather than directing. The scientific or social theme emerges from student questioning, not from teacher assignment. This phase is the most frequently underestimated and the most important.
- **IMAGINE (Analyse + Explain):** Students analyse their findings, map creative possibilities, and develop concepts. The teacher becomes a facilitator: coordinating discussion, challenging

assumptions, and encouraging brainstorming. Students begin to see how their scientific understanding can take an artistic form.

- **CREATE (Connect):** Students produce their artistic artefact, a theatrical performance, a musical composition, a maker prototype. Iteration, experimentation, and productive failure are expected and celebrated. Every creative choice should be traceable to a scientific decision.
- **SHARE (Communicate + Reflect):** Students present their work to real audiences, classmates, community members, parents, Cultural and Creative Industries (CCI) professionals, and at local or transnational festivals. Reflection is structured and evidence based. The public dimension of sharing is not optional: it is the pedagogical completion of the process.

2.2 The incubator model

The STEAM Innovation project frames its entire educational approach as an incubator model, a structured process that takes student teams from their first encounter with a scientific or social theme through to a publicly presented, community-embedded artistic product. The four stages of the incubator (Train → Create → Mentor → Disseminate) were implemented consistently across all three discipline modules and all four partner countries, providing a common architecture that could be adapted to very different national contexts while maintaining methodological coherence.

- **Train:** teachers and students were introduced to the module's pedagogical approach, scientific content, and artistic tools through structured workshops and facilitated sessions. In Portugal, this took the form of an accredited teacher training course of 50 hours. In Greece, three national workshops supported by one-to-one mentoring. In Cyprus and Italy, full-day on-site workshops followed by sustained weekly support.
- **Create:** students moved through the Feel? Imagine? Create? Share cycle to produce an original STEAM artefact, a theatrical performance, a music composition, or a maker prototype. This was the core of the educational experience, extending across several months and requiring sustained teacher facilitation and peer collaboration.
- **Mentor:** professionals, consortium partners, artists, and community stakeholders provided external mentorship to student teams, connecting educational learning to professional practice and introducing entrepreneurial thinking, market research, branding, intellectual property, and the concept of a product with genuine community value.

Disseminate: student work was shared publicly at national showcase events and, for selected teams, at the transnational festival in Matera, Italy. The public dimension of dissemination is integral to the methodology: it changes the stakes for students and transforms learning into civic participation.

2.3 Five core principles applied across all three modules

Across all national implementations and all three discipline modules, five principles were consistently applied. These are not abstract values but concrete design requirements that shaped every decision from lesson planning to assessment.

Principle	What it meant in practice
Student agency	The scientific theme, the artistic form, and the creative approach were always chosen by students, not assigned by teachers. Student ownership of the inquiry direction was treated as a non-negotiable condition of genuine engagement.
Interdisciplinarity as a design requirement	The integration of science and art was built into the structure of every module from the outset, not added as a decorative layer. Every creative decision was required to have a scientific justification, and every scientific concept was expected to find an artistic form.
Cultural heritage and sustainability as content	Local cultural heritage and environmental sustainability were not background themes but genuine content dimensions. Students connected their scientific inquiry to their cultural context and to the sustainability challenges of their communities.
Inclusion by design	Activities were designed from the outset to allow students with different strengths, backgrounds, and abilities to contribute meaningfully. At least 60% of participating students came from underrepresented or marginalised groups. Inclusion was a design constraint, not an aspiration.
Real audiences and public sharing	Every module culminated in a public performance or presentation before a real audience. The knowledge that real people would witness their work changed how students invested in it and transformed learning into civic and cultural participation.

2.4 The methodology in national contexts: Adaptations and challenges

A defining feature of the STEAM Innovation methodology is its designed flexibility. The shared framework of IBSE, Design Thinking, and the incubator model was adapted significantly across the four national contexts, producing implementations that were methodologically consistent but contextually distinct. These adaptations are not deviations from the model but evidence of its genuine applicability across diverse educational systems.

In Greece, the methodology was embedded within the established Learning Science Through Theatre network, allowing Science View to implement the project at a scale, 27 school teams across 13 regions, that would not have been achievable in a new context. The adaptation involved integrating diverse artistic formats (live music, choreography, AI-supported music, robotics demonstrations, digital storytelling) and using online mentoring to support geographically dispersed schools. The primary challenge was maintaining scientific rigour across a large and diverse set of school teams with very different curriculum contexts and expertise levels.

In Cyprus, the methodology was adapted to serve two radically different age groups and school profiles simultaneously. At secondary level, data sonification became the primary mode of STEAM integration, requiring students to develop genuine programming skills (Python, MIDI generation) alongside musical and scientific understanding. At primary level, embodied performance and original composition became the dominant forms. The adaptation required designing two entirely distinct methodological pathways within the same module framework, supported by sustained weekly mentoring. The primary challenge was maintaining engagement and momentum across a five-month implementation period with very limited prior experience of this type of interdisciplinary work among the teaching teams.

In Italy, the methodology was adapted to the context of an artistic upper secondary school (Liceo Artistico), where students already possessed significant technical skills in visual arts, audiovisual production, and graphic design. Across the Italian teams, the adaptation involved deepening the social and ethical dimensions of the scientific themes, connecting environmental sustainability, inequality, and gender equality to experimental sound design and audiovisual storytelling. The primary challenge was guiding students with strong artistic identities toward genuine STEAM integration, rather than artistic production that merely referenced scientific themes.

In Portugal, the methodology was delivered through an accredited teacher training model, a distinctive adaptation that prioritised teachers' professional development as the primary vehicle for reaching students. Rather than working directly with schools, NUCLIO trained 56 teachers from 11 schools

across 4 training courses, covering design thinking, student assessment, electronics, programming, 3D printing, video and sound editing. The primary challenge was managing the significant diversity of teacher experience and confidence levels across courses and ensuring that the 25 hours of autonomous student implementation were adequately supported between training sessions.

3. Best Practices

This section documents one best practice per discipline module, drawn from real school implementation evidence across the four partner countries. Each best practice is presented from the perspective of the school: *what did this school team do that worked particularly well and can be replicated by others?* The cases were selected on the basis of the three criteria, impact, feasibility, and shared experiences, and are documented using a consistent template to enable comparison and replication.

Country	Theme	Creative Medium	Scientific topic	Why it is a best practice	Easily replicated?
Italy	Music	Sound design & video	Climate change; ecological balance; human impact on ecosystems; biodiversity and habitat degradation; environmental and acoustic pollution; ecosystem resilience; SDGs 13 and 15	Students transformed scientific concepts into emotionally engaging audiovisual narratives, using changes in natural and human-generated soundscapes to communicate a local and global environmental challenge.	✓
Cyprus	Music	Data sonification	Data science and mathematics, specifically the collection, organisation, and analysis of sports performance statistics and the application of systematic mapping rules to translate numerical variables	Students transformed real-world data into emotionally engaging musical compositions, using systematic mapping between numerical variables and musical parameters to communicate scientific understanding through sound, demonstrating that data analysis and artistic expression are not opposing modes of knowing but two dimensions of the same act of inquiry.	✓

Greece	Theatre	Development of a theatrical performance	Human body systems and the coordination of organs in adolescent daily life	This practice can work as a best example because the scientific content was embedded in the dramatic action rather than added as an explanation around it. Each organ-character had a functional reason to act, cooperate or compete, so the coordination of the human body became the source of the story itself. Personification and humour helped students and audiences engage with complex biology without reducing it to memorised definitions.	✓
Portugal	Making and Tinkering	3D modelling and printing; Electronics and programming: paired with digital multimedia documentation	Hydrostatics and hydrodynamics (water pressure and flow dynamics), renewable solar energy generation/storage, and sensor-based microcontroller automation.	Students solved a real-world local environmental problem (drought and school garden irrigation during holidays) through a multi-age and cross-disciplinary collaboration. Students combined Physics, ICT, Eco-Escolas, and Multimedia, they created a functional solar-powered automated irrigation prototype that may help the school. This project demonstrates how maker education and design thinking can produce tangible and sustainable solutions for the community.	✓

3.1 Learning STEAM Through theatre:

The Organs You Carry - 1st Junior High School of Argyroupoli, Greece

School Profile and Context

School type	Junior high school (lower secondary), Argyroupoli, Greece
Students involved	17 students (3 Grade A; 6 Grade B; 8 Grade C)
Teachers involved	1 teacher
School context	Mixed-age theatre group across all three grades; curriculum-linked biology; accessible production resources; strong school and community dissemination.
Module	Learning STEAM Through Theatre
Scientific theme	Human body systems and the coordination of organs in adolescent daily life
Artistic form	Humorous personification, collaborative scriptwriting, acting, set/costume design, lighting and sound
Performance title	The Organs You Carry
Showcase event	LSTT Festival 2026, Athens, 25 April 2026; municipal event, 29 April 2026
Mentorship support	Science View: national teacher workshops and targeted school mentoring, 2025-2026

What the school did

In the FEEL phase, the team started from a question closely connected to students' lives: what has to happen inside a teenager's body for an ordinary day to be possible? Students explored the functions and interdependence of organs and body systems, identifying moments in daily life when several systems must respond at the same time.

During the IMAGINE phase, scientific functions were transformed into characters, relationships and dramatic problems. The students and teacher jointly developed the script around George, an average teenager whose organs must coordinate as he wakes up, prepares for school, follows his lessons and tries to make a good impression on a classmate. Humour was used deliberately to make the scientific content approachable; the opening comic sequence was written by a Grade C student and performed by the whole group.

In the CREATE phase, responsibility was shared across the team. Students collaborated with their teacher on scriptwriting, direction, set design and costume design, while a Grade C student managed lighting and sound. A familiar musical cue from The Smurfs was used as the alarm-clock sound. The production did not depend on advanced technology, artificial intelligence, video, PowerPoint, original music or choreography, showing that a strong STEAM performance can be produced with accessible school resources when the scientific idea and theatrical concept are clear.

In the SHARE phase, the performance was presented live at the Learning Science Through Theater Festival 2026. The school also communicated the work through its website, the theatre group's Facebook page, posters and promotional material. It was presented to a professional group of science teachers as a best-practice example and was later showcased at an annual municipal event held at the Municipality of Elliniko-Argyroupoli's facility for people with disabilities.

Why it worked

The practice worked because the scientific content was embedded in the dramatic action rather than added as an explanation around it. Each organ-character had a functional reason to act, cooperate or compete, so the coordination of the human body became the source of the story itself. Personification and humour helped students and audiences engage with complex biology without reducing it to memorised definitions.

Student agency was distributed across creative and technical roles. The whole group contributed to the script and production, while individual students assumed responsibility for the humorous introduction, lighting, sound and public representation. This made participation possible for students with different strengths and levels of confidence, including those who preferred writing, design or technical work to acting.

The project was also feasible. It used a curriculum-related topic, an everyday narrative and low-cost theatrical means, while the public performance created a real purpose for research, rehearsal and

communication. The combination of mixed-age collaboration, a clear shared product and a real audience strengthened ownership and sustained the work through to completion.

Evidence of impact

The available evidence is primarily qualitative and implementation based. Seventeen students from three grades contributed to a completed public performance, with documented student involvement in scientific interpretation, writing, production and technical delivery. The performance was presented at the national festival, recorded in the project anthology and made available through the LSTT media archive, with the required parental consent for photos and video.

The work also travelled beyond the festival: it was shared with the school community and general public, presented to science teachers as a best-practice example, and showcased in a municipal inclusion-oriented setting. These multiple uses indicate that the output was understandable and relevant to different audiences. Project-specific pre/post feedback that was used for both the teachers and the students, demonstrates positive results. Concerning the teacher pre and post journals that were kept as well as the questionnaire in which reply demonstrate that the approach was very useful and supportive especially concerning the mentorship approach that was used in the project. Concerning students the feedback indicates that there were improvements in their motivation and interest in the STEM field as well as artistic fields. Strong evidence as well, lies in the quality of the finished artefact, the breadth of student participation, professional recognition and subsequent community dissemination.

What can be replicated

The central model is highly transferable: select a familiar daily situation, identify the body systems involved, research their functions and transform them into characters whose actions must remain scientifically accurate. The same structure can be adapted to digestion, respiration, circulation, immunity, stress, sleep, exercise or health education, and can be used with different age groups and in different languages.

For educational reuse, the performance can be repackaged as a small theatre-learning kit containing the script, organ character cards, short scientific notes, a body-system relationship map, role descriptions, rehearsal prompts, a peer-feedback rubric and a performance reflection sheet. Schools can retain the low-resource format or add movement, music, projections or digital media as optional extensions. The original resources are available upon request and may be reused with appropriate

credit to the student team and school; any wider publication should also clarify permissions, attribution and media consent.

Lessons learnt

A key lesson is that scientific mapping should come before final scriptwriting. Students need to agree what each organ does, how systems interact and which simplifications are acceptable before humour and dialogue are finalised. This protects scientific accuracy while still allowing imaginative interpretation.

Clear role allocation and sufficient rehearsal time are equally important, especially in a mixed-age team. Non-acting roles should be planned from the beginning so that writing, design, sound, lighting, documentation and communication are recognised as genuine learning contributions. Finally, the script and supporting materials should be organised as a reusable educational package rather than remaining only as a one-time performance.

3.2 Learning STEAM Through music: Turning data into music

Music Pythons: 'From Goals to music', Secondary school of Panayia Theoskepasti, Paphos, Cyprus

School Profile and Context

School type	State secondary school, Paphos, Cyprus
Students involved	4 students, aged 15
Teachers involved	4 teachers: 2 ICT, 1 Mathematics, 1 Physics; music teacher as artistic consultant
School context	Isolated area; majority of students from migrant backgrounds; fewer opportunities to participate in projects of this nature
Module	Learning STEAM Through Music
Scientific theme	Data sonification: the systematic translation of numerical sporting statistics into original musical composition
Artistic form	Dual MIDI composition generated by a student-built Python programme, accompanied by audiovisual presentation
Performance title	'From Goals to Music'
Showcase event	"The Sound of Science, Students transform data into music", Paphos Municipality Hall, 11 May 2026
Mentorship support	Inquiry Fuse, through weekly sessions, school visits, and individual mentoring from January to May 2026

What the school did

The project began in the FEEL phase with a question that the students brought to their first mentoring session: what if we could hear data instead of just seeing it? This question led the team to the concept of data sonification, the translation of numerical variables into musical parameters, and to the decision to work with football statistics, one of the most universally engaging data domains for young people, as the scientific raw material for their composition.

In the IMAGINE phase, students collected and organised goal statistics for Lionel Messi and Cristiano Ronaldo across the period 2012–2025, recording goals by year and by type (open play, penalties,

headers) in a structured spreadsheet. They calculated estimated distributions for different goal types using historical career percentages, applying genuine mathematical reasoning. They then designed a comprehensive mapping system linking each data variable to a specific musical parameter: year-by-year goal totals to pitch within the C Major scale, goal types to rhythm and dynamics (open play goals as fast melodic notes, penalties as steady rhythmic accents, headers as low accompanying notes or powerful drum hits), and player identity to instrument choice (Messi to piano, Ronaldo to electric guitar and drums).

In the CREATE phase, the team wrote a Python programme that reads the Excel data directly and generates MIDI files automatically, without the use of external libraries. This was a genuinely ambitious technical act: students had to understand and implement MIDI file structure at a fundamental level, designing and building their own instrument for transforming data into sound. The programme underwent multiple rounds of testing and refinement, with students adjusting the mapping rules based on what the music sounded like and whether it accurately reflected the data. The two resulting compositions, Messi's piano piece, smooth and melodically progressive, and Ronaldo's electric guitar and drums composition, powerful and rhythmically intense, were strikingly different in character, directly reflecting the differences in the underlying data.

In the SHARE phase, students presented their compositions and their methodology at the national showcase event in Paphos Municipality Hall, explaining the scientific method, the mapping decisions, and the critical insight that had emerged through the process: that data is never fully objective, because the assumptions embedded in a mapping system shape the musical outcome. This philosophical reflection, arriving through practice, not through instruction, was one of the most powerful outcomes of the project.

Why it worked

The data domain was student-selected and emotionally meaningful. Football statistics were not imposed as the dataset; they emerged from student interest during the early mentoring sessions, when the team were given genuine freedom to choose what they wanted to investigate. This ensured that the demanding technical work of data collection, analysis, and programming was sustained by genuine curiosity about the subject matter rather than by obligation, a distinction that matters enormously over a five-month implementation period.

The technical ambition of the project was scaffolded by Inquiry Fuse but never substituted. The team chose to build their own Python programme rather than use an existing sonification tool, and Inquiry Fuse supported that decision by providing guidance on MIDI file structure and helping students work through specific programming challenges, without doing the work for them. The result was a programme that the students genuinely built and genuinely understood, and that confidence in their own technical capability was itself one of the most significant outcomes of the project.

What made the practice genuinely STEAM rather than simply technical was that the mapping system required scientific reasoning and artistic judgement simultaneously. Every mapping decision, which instrument represents which player, which musical parameter represents which data variable, required students to ask two questions at once: does this mapping accurately represent the data, and does it produce music that communicates the data's meaning to a listener? This dual standard, applied consistently across every creative choice, is the mechanism through which STEAM integration becomes real rather than nominal.

Perhaps the most significant outcome of the project was one that could not have been planned in advance. The insight that data is never fully objective, that the assumptions embedded in a mapping system shape the musical outcome, was not introduced to the students as a theoretical concept. It was discovered by them, through the experience of noticing that their mapping choices changed the music, and through the process of having to justify each choice to their mentors and to each other. This is one of the most important things that STEAM education can do: create the conditions for genuine intellectual insights to emerge through creative and scientific practice rather than through instruction.

Finally, the school context gave the project a significance that extended beyond its educational outcomes. The Secondary School of Panagia Theoskepasti serves a student population where the majority come from migrant backgrounds and where opportunities to participate in projects of this nature are rare. The fact that these students, with sustained support and genuine creative freedom, produced work that was technically ambitious, scientifically rigorous, and artistically original is itself a powerful argument for the STEAM approach as a tool for educational equity. What they achieved is not explained by exceptional talent or exceptional resources; it is explained by the quality of the pedagogy and the consistency of the support.

Evidence of impact

The project was evaluated at the national showcase event using the STEAM Innovation Festival Evaluation Rubric, achieving the highest scores across all criteria: scientific accuracy and technical quality, STEAM integration, originality and creativity, teamwork and collaboration, communication and presentation, and the music module-specific criterion for the advanced and meaningful fusion of music, science, and technology. The project was selected as one of three Cyprus projects to represent the country at the transnational festival in Matera, Italy, in September 2026.

Post-implementation feedback from teachers noted significant development in students' programming skills, data literacy, mathematical reasoning, and capacity to communicate complex ideas to a non-specialist audience. Students reported, in post-event reflections, that the project had changed how they thought about data, both as a scientific tool and as an interpretive act.

What can be replicated

The most directly transferable element of this practice is the data sonification approach itself: taking a real-world dataset in any domain the students genuinely care about and designing a systematic mapping to musical parameters. The dataset need not be football statistics. It could be climate data, biodiversity measurements, population figures, air quality readings, or any other numerical record of phenomena the students want to investigate. What matters is not the subject matter but the process, the students choose the data, they design the mapping rules, and they produce something audible from something numerical. This process is applicable across age groups, curriculum subjects, and resource levels, making it one of the most scalable practices documented in this report.

Equally transferable is the mapping system design process as a pedagogical tool. Requiring students to justify every mapping decision with both scientific and artistic reasoning, not one or the other, but both simultaneously, is the mechanism through which the data sonification practice becomes genuinely interdisciplinary. This dual justification should be made explicit from the outset of any replication: students should know from the first session that every choice they make will need to be defended on both grounds. That expectation, held consistently, is what prevents the practice from collapsing into either a purely technical exercise or a purely aesthetic one.

A third transferable element is the framing of programming as a creative act rather than a technical obligation. Treating the Python programme, or any equivalent coding tool, not as a means to an end but as the students' own unique instrument for making the mapping happen gives the technical work

a creative identity that sustains engagement through the inevitable difficulty of the programming challenge. Students who understand that the programme is their composition tool, not their homework, approach debugging and iteration with a fundamentally different quality of motivation.

Finally, the philosophical discussion of data objectivity that this practice naturally generates is itself a transferable and valuable pedagogical resource. Using the experience of noticing that mapping choices change the musical output as the entry point for a broader discussion about what data is, how it is interpreted, and what assumptions are embedded in any analysis opens a conversation that is accessible to students of all ages and connects STEAM education to some of the most important epistemological questions in contemporary science and society. Schools attempting this practice should plan for this discussion explicitly, treat it as a learning objective in its own right, and give it the time it deserves.

Lessons learnt

Schools attempting this practice should allow more time for the mapping design phase than they expect to need. The mapping system is the intellectual heart of the data sonification process, and students benefit significantly from being pushed to justify their choices more deeply than their first instinct allows, to go beyond "we chose piano because Messi is smooth" and articulate precisely which data variable maps to which musical parameter and why that correspondence is scientifically defensible. Rushing this phase in order to reach the programming stage sooner produces compositions that are technically functional but intellectually shallow, and that miss the STEAM integration that gives the practice its educational value.

Multiple revision cycles should be built into the timeline from the outset. The Music Pythons team went through several rounds of testing and adjustment before their compositions accurately reflected both the data and the musical identities they had designed, and each revision cycle produced new scientific and artistic insights that the previous version had not. Schools attempting this practice should budget time for at least three full revision cycles between the first working version of the programme and the final composition, treating each cycle not as a correction of failure but as a planned and necessary stage of the learning process.

Perhaps the most important lesson for schools replicating this practice is a question of framing: the programme is not the product; the music is the product. There is a natural tendency, particularly in ICT-led implementations, to treat the successful writing of the Python programme as the primary

achievement and to give insufficient attention to the musical and scientific quality of what the programme produces. Both dimensions matter equally, and the assessment framework used to evaluate the project should reflect both. A programme that runs without errors but produces music that does not accurately or meaningfully represent the data has not achieved what the practice sets out to achieve.

3.3 Learning STEAM Through music:

Il Respiro della Terra — Liceo Artistico Carlo Levi, Matera, Italy

School Profile and Context

School type	Artistic Upper Secondary School (Liceo Artistico Carlo Levi), Matera, Italy
Students involved	Five upper secondary students (Team Power)
Teachers involved	4 Teachers in total involved with this group during the whole process of Implementation. One teacher from the Graphic and Design pathway, 1 from Architecture and Interior Design, 1 music teacher and 1 mentor from Materahub.
School context	Students from Matera and neighbouring rural areas, including students with diverse educational needs and emotional vulnerabilities; a region that is experiencing steady population decline and offering fewer opportunities for young people to engage in interdisciplinary and international projects of this nature.
Module	Learning STEAM Through Music
Scientific theme	Climate change and environmental sustainability (SDG 13 Climate Action - SDG 15 - Life on Land).
Artistic form	Experimental music, sound design and audiovisual storytelling.
Performance title	Il Respiro della Terra ("The Breath of the Earth")
Showcase event	Italian Local STEAM Festival at University of Basilicata, Matera (12 May 2026); selected for the Transnational Festival in Matera (11 September 2026)
Mentorship support	Continuous mentoring provided by teachers and Materahub throughout the creative process, from concept development to the public presentation.

What the school did

Students explored the theme of climate change and environmental sustainability by asking a simple but meaningful question: "Is the Earth breathing well?" Starting from the analysis of environmental

challenges and the SDG's, they reflected on the impact of human activities on natural ecosystems and discussed how these issues could be communicated through artistic expression.

Rather than creating a traditional awareness-raising video, the team developed the concept for *Il Respiro della Terra*, an audiovisual production combining original sound design, visual storytelling and digital editing. The project followed the Feel–Imagine–Create–Share methodology. Students first identified the environmental problem (Feel), then designed a creative concept to represent the Earth's "breath" through sound and images (Imagine). During the Create phase, they developed a precise audiovisual narrative based on the contrast between natural cycles and human interference, using environmental sounds, sound effects and editing techniques to symbolise the disruption of ecological balance. Finally, the project was presented to the public during the Italian Local STEAM Festival as a way of encouraging reflection and discussion on climate change (Share).

Why it worked

The project's main strength was its ability to integrate scientific inquiry with artistic expression through a genuinely interdisciplinary approach. Rather than simply communicating environmental issues, students transformed scientific concepts into audiovisual narratives using sound design, images and digital media, encouraging students to engage with climate change from both scientific and creative perspectives. Working on topics they considered relevant to their own lives increased motivation and encouraged greater ownership of the creative process. Throughout the project, students collaborated to develop and refine their ideas, experimenting with different narrative solutions and receiving continuous feedback from teachers and mentors. This iterative process strengthened both the technical quality of the final production and the coherence between its scientific message and artistic language. Presenting the work to a public audience provided an additional incentive to produce a meaningful and well-developed outcome while reinforcing students' confidence in communicating complex societal issues through creative media.

Evidence of impact

Il Respiro della Terra was presented at the Italian Local STEAM Festival held at the University of Basilicata in Matera, in May 2026 alongside the other projects developed by students participating in the Italian implementation phase. This project was selected as one of the three Italian projects to represent Italy at the Transnational Steam Innovation Ecosystem Festival in Matera in September

2026, where it will be presented together with the other nine projects selected in the other three Consortium Countries (3 per Country). The evaluation committee recognized the project's ability to combine scientific content with artistic expression through an original audiovisual language. Beyond the final product, the project demonstrated students' capacity to interpret scientific evidence creatively. Throughout the presentation, students were able to explain the rationale behind their artistic choices, describing how the repetitive natural soundscape represented the Earth's normal rhythm and how the gradual introduction of human-generated sounds symbolised the disruption of environmental balance. Their ability to communicate both the scientific message and the creative process showed a meaningful integration of STEAM competences. Teachers also observed increased collaboration among students from different artistic pathways, greater confidence in using digital production tools and a stronger ability to communicate complex social issues through audiovisual language.

What can be replicated

This experience can be replicated in schools with different artistic or technical backgrounds by encouraging students to translate scientific concepts into creative narratives rather than simply presenting factual information. The core methodology does not depend on highly specialised or expensive technologies but on an interdisciplinary process where students investigate a real-world issue, develop an original concept and communicate it through artistic media.

The use of sound design, visual storytelling and collaborative project work can be adapted to different school contexts and topics. The Feel–Imagine–Create–Share framework provides a flexible structure that allows students to combine research, creativity and communication while maintaining a strong connection with scientific evidence.

Lessons learnt

One of the main lessons learned was that artistic expression can make complex scientific concepts more accessible and emotionally engaging. Encouraging students to represent environmental issues through sound and visual language allowed them to move beyond a descriptive approach and develop a more personal understanding of climate change.

The project also highlighted the importance of concept development before production. Spending time discussing the message, experimenting with different narrative approaches and refining the relationship between scientific content and artistic expression significantly improved the quality of the final outcome. Finally, presenting the project to a public audience reinforced students' confidence and demonstrated that creative work can become an effective tool for raising awareness within the community.

3.4 Learning STEAM Through making and tinkering:

School Profile and Context

School type	Public school offering regular basic/secondary education and professional education
Students involved	47 students total: grades 6th, 11th and 12th, plus member of the Eco-Escolas club
Teachers involved	Amélia Sebastião (Eco-Escolas), Florbela Ribeiro (ICT/6th grade and Project & Multimedia Production/12th grade), Nuno Monteirinho (Physics/11th grade Multimedia Course), Sílvia Soares (Multimedia Techniques/12th grade and Project & Multimedia Production/11th grade)
School context	Rural, drought-affected area; steadily losing population over the years; fewer opportunities for students to take part in projects like this.
Module	Learning STEAM through making and tinkering
Scientific theme	Water pressure and flow in an automatic irrigation system; renewable/solar energy generation and storage.
Artistic form	3D-printed reservoir, pots, and signage paired with photo and video documentation of the build process
Performance title	"Onde a Tecnologia Faz Crescer o Verde" (Where Technology Makes Green Grow)
Showcase event	STEAM innovation national festival in Portugal, 29th April 2026
Mentorship support	NUCLIO, through training sessions and remote mentoring from January to May 2026

What the school did

The project began in the FEEL phase with a visit to the school garden, where students observed the plants firsthand and discussed the problem of watering during holiday periods, when the region's dry summer climate makes manual care unreliable. This led the team into an investigation of sustainability,

water management, and renewable energy, and to an introduction to the micro:bit and to the basic physics of how water behaves in a system.

In the IMAGINE phase, students ran a brainstorming session and generated a wide range of ideas, from humidity sensors to programmed watering schedules to renewable power sources. After weighing the options, they settled on a night-time automatic irrigation system, controlled by a micro:bit and powered by solar energy collected during the day, a solution that made direct use of the region's long hours of summer sunlight. They then divided the work: the younger and Physics students would take on programming and system assembly, while the Multimedia course students would handle the 3D modelling and printing of the reservoir, pots, and supporting parts.

In the CREATE phase, students split into working groups and moved from planning to building. Physics students studied water pressure and flow to inform the system's design; the micro:bit was programmed to control watering automatically; a solar panel and battery were set up to store daytime energy for night-time use; and the reservoir, pots, and solar panel support were modelled and 3D printed. The system was assembled and tested repeatedly to confirm it watered the garden correctly overnight, with students troubleshooting technical issues as they appeared and documenting each step in photos and video.

In the SHARE phase, students presented the finished system to the school community on Dia da Informática (IDT day), demonstrating how the micro:bit, solar panel, and irrigation system worked together in the garden, and sharing the photos and videos that documented the whole process from first idea to working prototype.

Why it worked

The problem was real and visible to students, and that made it motivating rather than abstract. It was the Eco-Escolas club that first identified the need: the school garden required watering during holiday periods in a region where water is not something to take for granted, and it was through their own investigation into sustainability and water management that the idea of an automated night-time irrigation system emerged. The technical work that followed, learning to programme, testing pressure and flow, modelling and printing components, was therefore anchored to a problem the students had themselves recognised as worth solving.

The solution was built across a genuine diversity of subjects rather than treated as a single-discipline. ICT students learned programming through the micro:bit; Physics students applied hydrostatics and hydrodynamics to explain how water actually moves through the system; the Eco-Escolas group investigated renewable energy and sustainable water use; and the Multimedia course students handled 3D modelling, printing, and documentation. Each class contributed according to its own curriculum.

This project depended on collaboration across ages and course types that would not normally work together. The 6th grade class and the 11th grade Physics students worked together on programming and building the system. Meanwhile, the 12th grade Multimedia students brought skills the others didn't have, such as 3D modelling and printing. This was consistent with the project's approach of guiding students towards collaboration and finding solutions by themselves rather than supplying them.

Finally, the iterative nature of the build, testing the prototype, encountering technical problems, and adjusting through further experimentation, was treated as expected and valuable rather than a sign of failure, in line with the project's stated principle that mistakes are an important part of learning. That gave students room to genuinely work through the engineering challenges of the system rather than simply execute a pre-solved design.

Evidence of impact

A functioning prototype was developed including a solar panel, the micro:bit microcontroller and a complex irrigation system that works at night too, with a battery charged with the solar panel during the day. The development process was iterative, leading students to experiment various methods. The whole process was documented to allow others to replicate it, including the code used to program the microcontrol that controls the irrigation system.

The students presented the automatic irrigation system they developed within the school community and in STEAM innovation national festival in Portugal, demonstrating how the micro:bit, solar panel, and water distribution system worked together in the school garden. They also shared videos and photos documenting the entire development process. This presentation raised community awareness about responsible water use and the potential of technology to create sustainable solutions. For the students, this phase was a moment to see their work valued and to reflect on the skills they had developed throughout the project.

What can be replicated

The whole process has been documented with step-by-step instructions and links to resources, such as code and 3D models, as such, the whole station can be replicated.

A school with similar resources, a micro:bit, a solar panel, and access to a 3D printer, could follow this record to set up an equivalent irrigation system without having to design it from scratch.

The subject-matching is also easy to reuse elsewhere: instead of treating irrigation as a standalone tech project, it was split so that Physics covered the water pressure and flow, ICT covered the programming, and Multimedia covered the modelling and printing. Any school could apply that same logic, take a practical problem and hand each piece to whichever subject already teaches the relevant skill, rather than trying to squeeze it all into one class.

Pairing older students who already have technical skills, here, 3D modelling and multimedia, with younger ones learning to code and assemble things, gives both groups a real reason to collaborate rather than just share a building.

Lessons learnt

When something didn't work during assembly or testing, students had to try things, get it wrong, ask each other, and try again. Schools attempting something similar should expect this to slow the build down and plan the timeline accordingly, rather than treating delays as a sign the project is off track.

Planning the tasks before touching any hardware mattered more than it might seem. With 47 students split across different ages and subjects, without a clear division of who was doing what, the project could easily have become unmanageable. Deciding upfront which group handled which part, before any building started, is what made a project this size workable rather than chaotic.

Finally, the final product wasn't the only thing being evaluated, and schools should be deliberate about that from the start. Teamwork, critical thinking, and environmental awareness were tracked and assessed just as seriously as the working irrigation system itself. If those skills are only mentioned in passing rather than built into the assessment plan, they tend to get squeezed out once everyone's focus narrows to getting the prototype working.

4. Cross-cutting findings and recommendations

Across all best practices and all four national implementations, a set of findings emerge consistently. These are not context-specific observations but replicable insights that apply wherever integrated STEAM education is attempted. They are presented here as recommendations addressed to the three primary audiences of this report.

4.1 Findings for educators and trainers

The Feel phase is the most important and the most consistently underestimated.

In every best practice documented in this report, the projects that produced the strongest outcomes were those in which students spent significant time genuinely identifying a problem, posing their own questions, and developing real ownership over the direction of their inquiry before any tool was introduced or any artistic form was chosen. The daily life of a student became the main story but from inside his body by explaining how our organs operate in several situations that a child is living. Football statistics became music because students were allowed to ask what hearing data might feel like. The noise traffic light was built because students were allowed to say what bothered them about their classroom. Educators who invest in the Feel phase, even when it feels slow, uncertain, or unmappable to curriculum outcomes, consistently produce more engaged, more ambitious, and more scientifically rigorous student work.

The trainer's role is to facilitate, not to instruct.

All best practices depended on teachers and trainers who were able to resist the impulse to explain, direct, and correct, and to replace it with the discipline of questioning, listening, and trusting. This shift is genuinely difficult, particularly for subject specialists with strong content expertise, and it requires sustained support. The mentoring model documented across all four implementations (weekly sessions, school visits, individual feedback) is not a luxury of a well-funded project; it is a structural requirement for supporting teachers through a genuine pedagogical shift.

Functional outputs produce deeper learning than representational ones.

In all three best practices, students produced something that worked in a real context: a performance that made an audience laugh and understand biology; a composition that sounded different from another because the data was different; a device that actually measured sound and actually changed classroom behaviour. This functionality is not incidental to the learning; it is the mechanism of it. Schools should set functional success criteria from the outset and should resist the temptation to accept representational outputs (a poster about the noise problem, a presentation about data sonification) as equivalent to functional ones.

4.2 Findings for school leaders and policymakers

STEAM integration requires sustained time, not additional time.

A consistent concern expressed by teachers across all four national implementations was that STEAM projects require more time than is available in standard school timetables. The evidence from the best practices suggests that this concern, while genuine, misframes the challenge. The most effective implementations did not add STEAM on top of existing curricula; they reorganised existing curriculum time to allow for sustained, interdisciplinary project work. The Portuguese implementation, which used a 50-hour accredited teacher training structure to embed the approach within teachers' professional development, is a model that policymakers could replicate, not by adding hours but by reframing the purpose of existing professional development time.

Inclusion requires design, not intention.

The project's target that at least 60% of participating students come from underrepresented or marginalised groups was met across the implementation. But the evidence from the best practices suggests that this was not achieved by directing the methodology at disadvantaged students; it was achieved by designing the methodology in a way that valued multiple forms of contribution, connected scientific learning to students' own contexts and interests, and created public performances in which every student's role was visible and recognised. Policymakers seeking to use STEAM education as a tool for equity should focus on these design principles rather than on targeting interventions at particular student populations.

Public performance is a policy instrument, not just a celebration.

The national showcase events and the transnational festival in Matera served multiple functions simultaneously. They were pedagogical completions of the learning process. They were community-building events that connected schools to parents, local authorities, and CCI professionals. They were advocacy platforms that demonstrated to policymakers and educational leaders what integrated STEAM education can produce. And they were sources of recognition for students whose achievements are not always visible in conventional academic assessments. Policymakers seeking to scale STEAM education should invest in public sharing infrastructure, festivals, exhibitions, online platforms, as a structural component of the approach, not as an optional extra.

4.3 Findings for educational organisations and networks

The methodology is scalable but requires local adaptation.

The STEAM Innovation implementation across four countries demonstrates that the shared framework of IBSE, Design Thinking, and the incubator model is genuinely scalable, it can operate across 27 school teams in 13 Greek regions, two schools in two Cypriot districts, ten teams in an Italian artistic secondary school, and 56 teachers in 11 Portuguese schools simultaneously. But scalability does not mean uniformity. The Greek implementation worked because it was embedded in an existing network. The Cypriot implementation worked because it designed two distinct methodological pathways for two different age groups. The Portuguese implementation worked because it operated through an accredited professional development structure. Educational organisations seeking to replicate the approach should invest in understanding their specific national and institutional context before adapting the framework to it.

CCI mentorship is a structural requirement, not a supplement.

Across all four national implementations, the mentorship by CCI professionals, scientists, and community stakeholders was identified as a critical factor in the quality of student outcomes. The mentorship programme gave students access to professional knowledge and real-world feedback that teachers alone cannot provide. It also gave students experience of entrepreneurial thinking and of the concept of a product with community value. Educational organisations seeking to replicate the STEAM

Innovation approach should build CCI mentorship structures into their programme designs from the outset, rather than treating external mentorship as an enhancement to be added if resources allow.

Documentation is a professional responsibility, not a bureaucratic one.

The best practices documented in this report were made possible by consistent, structured documentation of implementation activities throughout WP3: teacher observation forms, student questionnaires, project descriptions, festival evaluation data, and implementation reports. Without this documentation, the evidence base for identifying, verifying, and communicating best practices would not exist. Educational organisations running STEAM programmes should invest in documentation systems from the beginning of implementation, treating the collection of evidence as an integral part of the professional practice of STEAM education, not as a reporting obligation to be fulfilled after the fact.

5. Conclusions

This report has documented the methodological approach and four best practices identified across the WP3 implementation of the STEAM Innovation Ecosystem project. The four practices, a junior high school team in Argypoli bringing the human body to life through humorous theatrical personification and live music; a secondary school data science team in Paphos building a Python programme to turn football statistics into original MIDI compositions; an artistic upper secondary school team in Matera transforming climate change data into an emotionally resonant audiovisual narrative; and a multi-age, multi-subject school team in Portugal designing and building a solar-powered automatic irrigation system for their school garden, are different in their disciplines, their age groups, their national contexts, and their technical approaches. But they share the same essential character: they are examples of students who were given a real problem, genuine creative freedom, sustained support, and a real audience, and who produced work of scientific rigour and artistic ambition that surprised everyone, including themselves.

The methodological framework that made all four practices possible, the integration of Inquiry-Based Science Education and Design Thinking within the incubator model, sustained by the five core principles of student agency, genuine interdisciplinarity, cultural heritage and sustainability as content, inclusion by design, and real audiences, is not a fixed recipe but a set of design commitments. What makes it replicable is not the specific activities it contains but the principles that shape every design decision within it. Schools that internalise these principles will produce implementations that are different in form but equivalent in quality.

The STEAM Innovation project has demonstrated, across more than 1,525 students and 198 teachers in four European countries, that integrated STEAM education, when it is well-designed, well-supported, and well-documented, can foster multiple learning outcomes simultaneously, including scientific understanding, artistic expression, digital literacy, collaborative skills, critical thinking, and civic confidence. These dimensions of learning can be mutually reinforcing rather than mutually competing. The four best practices documented in this report provide strong evidence of the potential of this approach across diverse educational contexts.

The practices documented here are ready to be replicated. The lesson plans, facilitation tools, mentorship frameworks, assessment rubrics, and implementation evidence are available in the companion deliverables of this project, D2.3, D4.1, D3.1, and D3.3, and through the project website. Educators, school leaders, policymakers, and educational organisations who wish to adopt and adapt

this approach are encouraged to begin with the practices documented here, to use the documentation tools the project has developed, and to contribute their own implementation evidence to the growing body of STEAM education practice across Europe and beyond.