SENSE.

SENSE. The New European Roadmap to STEAM Education

D3.1 – Report on the STEAM DNA Workshop

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Abbreviations and acronyms

Abbreviation or acronym used in this document	Explanation
STEAM	Science, Technology, Engineering, Arts and Mathematics
STEAM DNA	Unique building blocks of STEAM and STEAM education which are recognizable in Project's outcomes. They reveal the essence of SENSE.
RoM	Return on Meaning
EU	European Union
NEETs	Young people Not [engaged] in Education, Employment or Training

Glossary

Term	Definition used or meaning in the SENSE. project	Reference or source for the definition if applicable
STEAM	Understanding of this concept is still in progress. During the workshop, questions emerged such as: "What does S of STEAM mean? Is it natural science? Which science? And for the A: is it just Art?	From the workshop results

	Suggestions for the A of STEAM as *Attentiveness*, *Act of translating*, *Artistic inquiries* are insights which need further deepening.	
STEAM DNA	Unique building blocks of STEAM and STEAM education which are recognizable in Project's outcomes. They reveal the essence of SENSE.	SENSE. Description of Action
SENSE.STEAM	The SENSE.STEAM methodology, comprising a dedicated educational model and its pedagogy, with i) STEAM inquiry, ii) citizen science and art practices, iii) learner centredness and iv) reflective feedback as its building blocks.	SENSE. Description of Action
STEAM labs	The project's implementation activities will take place as part of a set of STEAM Labs, set out to reach potential change agents and enable them to become advocates for STEAM.	SENSE. Description of Action
STEAM beneficiaries	Stakeholders that should benefit from the new approach to STEAM education and the SENSE. Roadmap	SENSE. Description of Action

The SENSE. project

There is a widespread understanding that the future of a prosperous and sustainable Europe depends to a large extent on the quality of science education of its citizens. A science-literate society and a skilled workforce are essential for successfully tackling global environmental challenges, making informed use of digital technologies, counteracting disinformation, and critically debunking fake news campaigns. A future-proof Europe needs more young people to take up careers in science related sectors.

Research shows that interest in STEM subjects declines with increasing age. This effect is particularly pronounced among girls and young women; even those of them who take up science studies gradually forfeit their motivation. But despite all image campaigns and efforts to remove the awe of science only “one in five young people graduates from STEM in tertiary education” and only half as many women as men, according to the European Skills Agenda.

The disinterest in science is striking and evokes the question of its causes. Stereotypes and lack of female role models seem to be only a part of the explanation. Nor is there a lack of career prospects that could explain a reorientation despite initial interest.

SENSE. has identified two major problems in current science education that need to be addressed: a) A distorted teaching logic that progresses from abstract models to procedural applications (“reverse ontology”) and b) The inability to implement a learner-centred pedagogy linking students’ everyday knowledge to science-based knowledge, thus promoting motivation, self-directed and life-long learning.

SENSE. advocates for the development of a high-quality future-making education that is equally accessible to all learners and promotes socially conscious and scientifically literate citizens and professionals. SENSE. aims at radically reshaping science education for a future-making society. By promoting the integration of all human senses into exploring and making sense of the world around us we will challenge conventional ideas of science and science education. Considering the pitfalls of current science education practices and the advantages of artistic and aesthetic activity, this innovative approach also considers social inclusion and spatial design as core components for a new STEAM education paradigm. With ‘SENSE.STEAM’ future science learning will be moving away from the standardised classroom shapes and furniture layout entering new learning landscapes.

The project seeks to develop an accessible educational roadmap promoting socially conscious and scientifically literate citizens and professionals. It addresses outdated

perceptions of current science education as well as gender stereotypes by integrating the arts, social inclusion, and spatial design as its core components. SENSE. will establish 13 ‘STEAM Labs’ across Europe to develop and evaluate the ‘SENSE. approach’ to STEAM subjects alongside students, educators, teachers, businesses, and other stakeholders.

The ‘New European Roadmap to STEAM Education’ will take the shape of a STEAM learning companion to support tomorrow’s educators and learners – be it in the classroom, in a museum or on a drilling rig. A digital hub will be established, where practitioners from all ages and backgrounds across Europe will be able to access tried and tested educational practices to increase engagement within these subjects.

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Executive Summary

This document describes the work carried out during the STEAM DNA workshop and is meant to give an overview of its main results. The STEAM DNA workshop is part of the activities foreseen in task 3.1 of Work Package 3, which will establish the SENSE.STEAM methodology. It took place at Western Norway University of Applied Sciences (HVL) in Bergen from 15 to 17 November 2022. It was attended by 34 people from partners, associated partners and from the International Advisory Board (IAB). Other persons were invited for their professional contributions on the key issues addressed in this workshop. Its main goals were to harvest participants informal and tacit knowledge of STEAM education and to observe stakeholders' needs.

The design of the STEAM DNA workshop aimed to set up a learning context in which the following priorities could be addressed:

- Explore diversity and richness of STEAM understandings among the participants.
- Explore areas of commonality and difference.
- Explore existing knowledge and practices on STEAM.
- Design and share principles of the SENSE.STEAM (the DNA of SENSE.STEAM) and gather valuable feedback to be implemented in the ongoing work.
- Bring together participants from different backgrounds and levels of experience in the field of STEAM and STEAM education in an active learning/creation process.
- Document the existing informal and tacit knowledge of participants as a basis for structuring the future work and for developing the SENSE.STEAM methodology on existing and ongoing STEAM practices.

The workshop lasted three days and ideally was structured also in three phases closely interlinked one to each other. The first part of the work was dedicated to creating synergies between the participants while exploring areas of commonality and difference on the scope of STEAM and on the project in relation to beneficiaries and stakeholders. The second level was to create collective experiences of STEAM education as a common basis on which to discuss, while outlining interesting insights for the SENSE.STEAM methodology. The third phase was dedicated to work on the insights collected during the proceedings and to deepen them in four "clusters" - STEAM beneficiaries, SENSE.STEAM theoretical model, SENSE. Learning Companion, the SENSE. six topics of Green Deal, Digitalisation, Health, Work-readiness, Space and social inclusion- for outlining working paths for the future work.

Each phase of the work was documented with video and audio recordings, and photos of the key moments and of the main outputs. In addition, participants wrote a personal

journal with a self-reflection feature which has depicted an effective way to collect feedbacks and insights among the participants who decided to share their thoughts.

Outputs of this workshop which will contribute to co-create the methodology of the SENSE. project, STEAM, and its pedagogy, can be summarised as follows:

- A first outlining of the SENSE.STEAM beneficiaries and their needs assessment.
- A preparatory document for the SENSE.STEAM educational model with guiding questions to evaluate.
- A preliminary set of criteria to identify STEAM practices and to envision the educational material.
- A visualization of the ecosystem of interrelationships to guide the response and address Green Deal, Digitalisation, Health and Work-readiness while mainstreaming social inclusion and spatial design and promoting new form of inquiry and reflection.
- The creation of effective synergies among participants which nurture the network, the sharing of perspectives and the increase of awareness of the complexity and scope of STEAM education and thus of the project.

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1. Introduction

1.1 Context

The STEAM DNA workshop is part of the activities planned in WP3 in Task 3.1 to establish the methodology of the SENSE project. Together with the results and outputs of the other tasks of this work package WP3 (Task 3.2 and Task 3.3), the results of the STEAM DNA workshop are meant to contribute to create the praxis informed SENSE.STEAM methodology, to establish the first steps towards the New European Roadmap to STEAM Education. The workshop results will also feed the work in working packages WP4 (Steam Labs), WP5 (Cross-cutting issue: space), WP6 (Cross-cutting issue: social inclusion) and will be incorporated into the Roadmap in WP7 (Consolidation of the STEAM Roadmap and its supporting tools).

The word DNA in the title of the workshop - STEAM DNA workshop - captures its main purpose: just as when we refer to the DNA of a certain organism, we mean those fundamental, heritable characteristics that make it unique, the purpose of this workshop was to characterise the unique building blocks of STEAM and STEAM education to be recognizable in all the project and project's outcomes.

The aim of the workshop was to harvest, at an early stage of the project, the fundamental ideas, practical and implicit knowledge of partners and associated partners about STEAM and STEAM education. The intention was to engage participants in a co-creation process to ground SENSE.STEAM on existing practices, frameworks, and knowledge and to support an effective creative method to envision pedagogies while identifying key elements to be considered in SENSE.STEAM.

The perspectives and points of view of the different participating stakeholders guaranteed to discuss key principles for a methodology that would best incorporate the needs of different target groups, support social inclusion and address the four thematic areas of Green Deal, Digitalisation, Health and Work-readiness.

As a result, this workshop is meant to contribute to the accomplishment of the key performance indicators (KPIs) established to create the praxis informed SENSE.STEAM methodology: in particular for the KPI 1.1 the collection of at least 28 existing practice examples to be reviewed and for the KPI 1.3 the participation to the creation process of at least 50 stakeholders.

1.2 Acknowledgements

This report reflects the invaluable contributions of all the following participants:

- Among partners:
  - Lydia Shulze Heuling, Laura Colucci-Gray, Idar Mestad, Nickolai Birkeland, Felek Mukkader Baran, Xavier Bonete and Hanning Klafstad from HVL.
  - Daniela Conti from CREDA onlus.
  - Michael Riebel and Xuhong Zheng from Hawkins/Brown.
  - Anne Krebs from Musée du Louvre.
  - Raluca Dumitrescu and Gabriel Brezolu from GEYC.
  - Joseph Sturm from Velvet.
  - Silvia Pesini from EFEE.
  - Anna Samwel and Ida Bakhturidze from WECF.
  - Jai Mexis and Theodoris Kostoulos from Odyssea.
  - David Bockstahler from PHW.
- Among associated partners: Nils Petter Hauan, Anna Sandven and Ida Mari Bøe (VilVite), Manuela Re (Trelleborg), Ene Laura Cleopatra (Municipality of Campina).
- From the International advisory members (IAB): André Lepecki (New York University) and Hege Sæbjørnsen (IKEA UK & Ireland)
- Among stakeholders: Edvin Østergaard, Dagmar Shulze Heuling, Aksel Hugo, Elin Flannum, Britt Aslaug Birkeland, Anne Skaansar, Francois Quéré.
- From Return on Meaning (RoM) for the facilitation: Tobias Lessmeister and Karina Janning.

A special acknowledgement is to:

- Anne Krebs and Anna Samwel for the contribution to chapter 4.3 about the work of cluster 1 on STEAM beneficiaries.
- Laura Colucci–Gray for the contribution to chapter 4.3 about the work of cluster 2 on SENSE.STEAM theory development.
- David Bockstahler for the contribution to chapter 4.3 about the work of cluster 3 on SENSE. learning companion.
- Michael Riebel for the contribution to chapter 4.3 about the work of cluster 4 on thematic areas and cross-cutting issues.
- Edvin Østergaard for the contribution to chapter 4.2 and his valuable reflections on the Concert for “singing glasses”.

A particular thanks is also to all the HVL staff for their great hospitality and the excellent organisation of the workshop.

1.3 Purpose of the document and relation to other deliverables

This document offers a summary of the activities, discussions, and insights of the STEAM DNA workshop held in Bergen on 15 to 17 November 2022. It aims to provide an overview of the key elements of SENSE. STEAM from the participants' perspectives.

Together with the next deliverables, 3.2 (Report on the Citizen Science and Art-Practices Workshop), 3.3 (Report on stakeholders challenges and needs for a New European STEAM education), and 3.4 (Report on knowledge and practices for a New European STEAM education), this report will contribute to establish the SENSE.STEAM methodology that will then feed the work of work packages WP4 (Steam Labs), WP5 (Cross-cutting issue: space), WP6 (Cross-cutting issue: social inclusion) and will be incorporated into the Roadmap in WP7 (Consolidation of the STEAM Roadmap and its supporting tools).

This report will also serve as a common ground for understanding, future communication and visualises some of the insights already achieved.

2. Methodology

2.1. Workshop design

The design of the STEAM DNA workshop was developed by a working group consisting of HVL, who coordinates the project and hosted the workshop, CREDA onlus, who coordinates WP3, and Return on Meaning (RoM) who collaborated pro bono in the planning and moderation of the first two project meetings. PH Weingarten and Musée du Louvre contributed to defining the documentation instruments and tools to be used during the meetings.

This working group worked with two considerations in mind. Firstly, the workshop was to be a moment in which the Consortium could consolidate the foundation for working effectively and collaboratively throughout the project. Secondly, it needed to be a critical meeting to maximize the active contributions of each participant in order to define the essence of the STEAM.SENSE methodology.

To address the above reflections, the overarching approach which guided the design of the workshop was based on a learning perspective that links creativity and experience to a shared vision for the SENSE.STEAM methodology and addressed the following priorities:

- Explore diversity and richness of STEAM understandings among the participants.
- Explore areas of commonality and difference.
- Explore existing knowledge and practices on STEAM.
- Design and share principles of the SENSE.STEAM (or, in other words, the DNA of SENSE.STEAM) and gather valuable feedback to be implemented in the ongoing work.
- Bring together participants from different backgrounds and levels of experience in the field of STEAM and STEAM education in an active learning/creation process.

2.2. Documentation

To keep track of participants' considerations and insights and for data collections, different means of documentation were put in place such as traditional videos and audio recordings, photos of posters created during the work in groups and of visualizations of concepts. Sticky notes were used extensively during the activities to make and share comments by groups or individually and to note open questions and insights. Sticky notes facilitated firstly the visualization of the flow of the discussion and, secondly gave the opportunity to collect and analyse participants' key reflections.

Participants described the examples of STEAM practices which were shared during the practical phase of the workshop. For each practice, they filled out ID cards in order to have key information immediately available for the revising and debriefing phase and for the developing of educational material. Texts, whiteboards, posters, models, presentations created for and during the hands-on experiences also enriched the outcomes of the documentation.

Moreover, participants were asked to write personal journals. The primary aim and value of these journals lies in it being a privileged place of self-reflection, allowing to carve out moments of pause and silence within the frenzy which typically characterizes the working moments of workshops, in which participants could reconsider their experience. The personal journal tool makes possible a constant training to thoughtfulness, which assumes a preparatory value to enhance one's

experience and in general the quality of the work of the whole workshop. The second reason for using this tool was its ability to keep track of the experience and of the professional and tacit knowledge of the participants. To this end, those who wished shared their journals at the end of the workshop.

Finally, the facilitators from RoM took notes and photos to react to unexpected results and include open points into upcoming action, debriefing and design.

2.3. Workshop format

The workshop was spread over three days, a time extension that allowed for the structuring and incorporation of a wide range of activities based on different processes that could enhance experience, explore participants' ideas, and trigger reflection processes. The workshop dimension was intended as a learning laboratory for content development to allow insights to be shared based on a common experience giving participants the opportunity to actively contribute to the elaboration of the project's fundamental characteristics and methodology: its DNA or, in other words, its essence. Moreover, the facilitation by RoM's external experts enabled the effective process and communication during group activities, promoting mutual understanding and participation by all.

In the programme, it is possible to identify three phases that are synergistically connected:

1. The first one was dedicated to creating synergies between the participants while exploring areas of commonality and difference on the scope of STEAM and on the project in relation to beneficiaries and stakeholders. Open questions and fields raised during this phase augmented the process and enriched the material to work on in the future.

2. The second level was to create collective experiences of STEAM education as a common basis on which to begin to discuss and interrelate, while outlining interesting insights for the SENSE.STEAM methodology.

3. The third phase was to work on the insights collected during the proceedings and to deepen them in four clusters - STEAM beneficiaries, SENSE.STEAM theoretical model, SENSE. Learning Companion, the six SENSE topics - for outlining working paths for the future work.

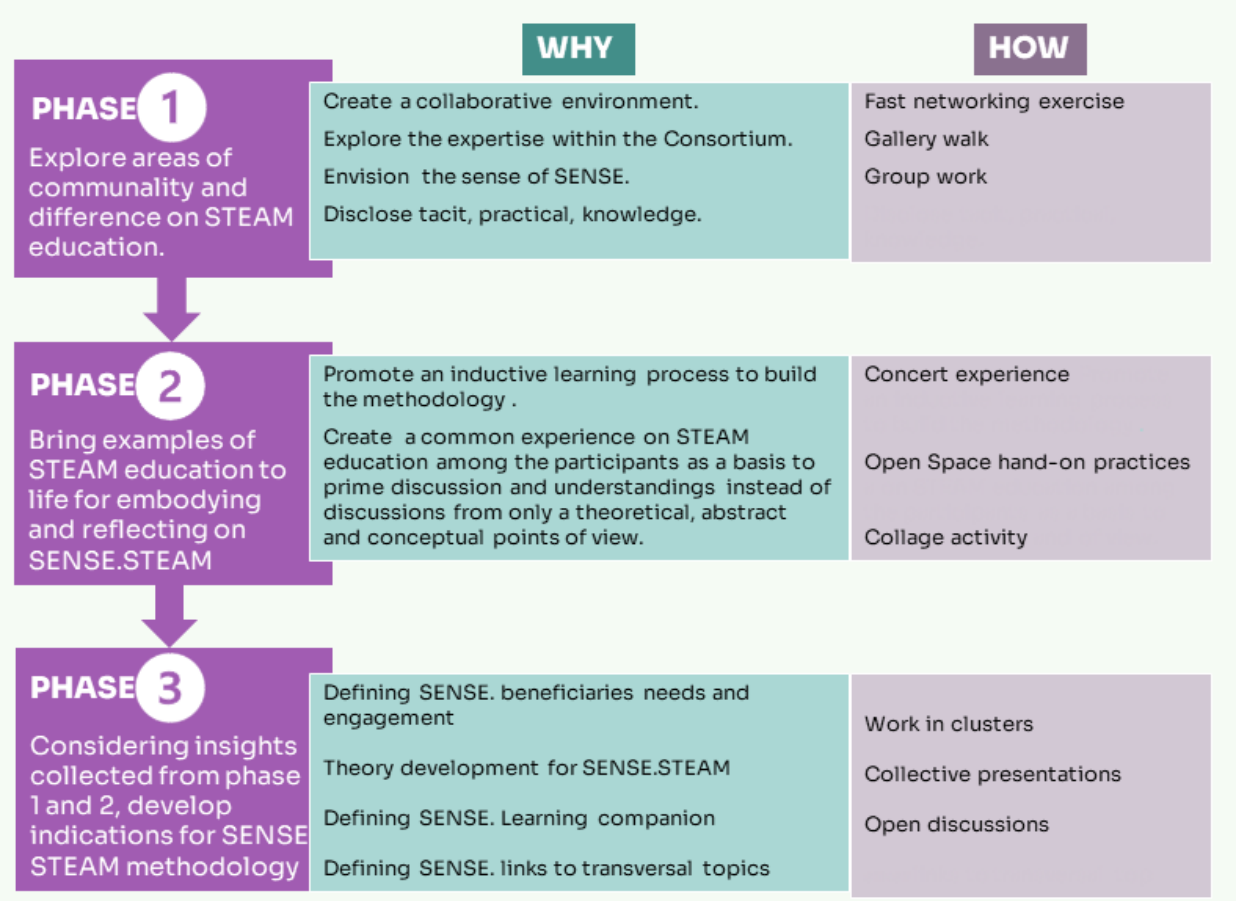

Figure 1: STEAM DNA workshop phases, objectives, and methods.

The detailed workshop agenda and the invitation letter are attached as Annex 1.

3. Participation

Participants were expected from all partners and associated partners and from the SENSE. advisory board. Participation was also open to specially invited guests who contributed with their expertise to topics relevant to SENSE.. Altogether, 42 participants registered, with 2 participants per organization approximately. 34 participants took part in the work, with 1 partner and 2 associated partners unable to attend due to sickness and organizational problems.

3.1. Background and Expertise

Backgrounds and skills present were diversified and complementary. Participants came from all parts of Europe and internationally and from different types of organisations such as higher education institutions, NGOs, private sectors organisations, municipalities, museums, and with diverse professional expertise and viewpoints to put at stake.
This aspect was a central feature and the external facilitators from RoM ensured an effective activation of the transdisciplinary and inclusive perspective as well as co-creation approach during the entire workshop.

In the following charts it is possible to have an overview of participants context.

Figure 2: Participants' type of institutions

Figure 3: Participants' diversification of expertise

4. Contents

4.1. Phase 1 - Explore

The phase 1 coincided in terms of timeframe with the first day of the agenda of the workshop. The aim of this phase, as previously described, was to build a suitable context in which to tune in and encourage exchange and discussion on key issues as a basis for exploring the four SENSE building blocks: SENSE.STEAM inquiry, Learner Centred Pedagogy, Citizen Science and Art Practices, Reflective Feedback. It is possible to have an overview of these core four building block in Annex 2.
A preliminary introduction supported the understanding of the meant type of pathway for the outlining of the project methodology. Rather than an epistemological and ontological path aimed at defining STEAM and STEAM education a priori, the approach will be rooted in experience and the transfer of tacit and experiential knowledge among the participants. The central part of the work saw the participants engaged in two activities and in a final moment of reflective feedbacks. Participants

were given a short overview of the SENSE.STEAM building blocks (Annex 2) and of the SENSE.'s 8 steps towards building The New European Roadmap to STEAM Education (Annex 3).

Divided into small groups, participants consolidated, made connections, organized ideas and inputs which were previously collected with a fast-networking exercise around the following eight core questions:

- Something I know or want to know about STEAM;
- The change I want to induce with STEAM;
- Which criticalities/challenges for STEAM do I see in my current situation?
- Something I wish for the future generations.
- What does the "A" in STEAM trigger for you?
- What does the "S" in STEAM trigger for you?
- Artistic Research – what do you know or would like to know about it?
- Scientific Research – what is the role of the senses?

Each group then visualized their work in explanatory posters. A gallery walk followed, giving everybody the possibility to add insights, questions, and comments directly on posters.

The second activity focused on the essential aspects of STEAM related to the beneficiaries and, potentially, to the four building blocks of the SENSE STEAM methodology.

The following tables sum up the collected feedbacks.

Table 1: Fast-networking exercise

Something I know or want to know about STEAM	What is Art? What kind of art is the art in STEAM. What is the scope of art in STEAM? How to relate to STEM: — interdisciplinary: connecting different disciplines and topics; — long term impact; — skills; — contribution to personal development — gender attention; — implementation (in school, real life, with the curriculum, reaching more people. How does STEAM fit into capitalist society?

The change I want to induce with STEAM.	▪ Bring gender balance. ▪ Make education more contemporary and the young come to be the agent of the change of the world. ▪ Make it relevant in people's day-to-day lives. ▪ More inclusive, more creative, more fun education. ▪ More interesting conversation between students and teachers. ▪ A more holistic society. ▪ Integrating models of being and acting. ▪ Align Arts with STEM in a balanced way.
Which criticalities and challenges for STEAM do I see in my current situation?	Challenges or opportunities? ▪ The challenge is in the seamless integration: ▪ The S in STEAM is seen as dominant, inflexible, abstract. ▪ The A in STEAM: we don't know it; didn't learn it, how do we teach it? How art fits?
Something I wish for the future generations.	▪ More creativity and creative thinkers. ▪ More digitality that is meaningful. ▪ Don't worry too much - your dreams will come true. ▪ Caring for people around you. ▪ Slowness. ▪ Allow new things in your life. ▪ Self-confidence. ▪ Able to adapt to new context. ▪ Believe in a positive future. ▪ Don't stop career development. ▪ Ability to come together. ▪ Care more about gender issues. ▪ School for self-directed learning. ▪ Living in a sustainable, peaceful world.
What does the “A” in STEAM trigger for you?	In STEAM, the closed box which contains Science, Technology, Engineering, Math opens up: it spreads out Science life, Art technology, creative Technology, love Engineering, Math sparks. Art is seen as a transformer, improver, and opener of STEM. The A in STEAM triggers love -creativity - new perspectives - spark. The A in STEAM is perhaps not just Art but *Awareness*, *Attentiveness*, *Act of translating*, *Artistic inquiries*.
What does the “S” in STEAM trigger for you?	On one hand: It triggers technocracy which means boring, competitiveness, locked system, tradition, senseless. For others it triggers a mental state of being systematically curious, senses explorations, problem solving and logical thinking, transformation, passion, empowerment. Are these above social reality or stereotypes? When and why the S turned in Technocracy?

Artistic Research – what do you know or would like to know about it?	What we know: ▪ It is music, theatre, dance. ▪ Similar to design research: learn by doing, it needs to document it. ▪ Artists to be confident in them as researchers. What we would like to know: ▪ What is it? ▪ What is the state of the art? ▪ Which methods are used, and which are not? ▪ How can STEM and STEAM drive a more artistic society? ▪ Where are the overlaps between scientific and artistic research? ▪ How can art enhance inclusivity and productivity of STEM/Science? ▪ How to apply it? ▪ Is there a hierarchy? ▪ What does it look like when it is performed? ▪ How does it help move people into action? ▪ How to integrate it into science? ▪ How to apply it to teachers' education? ▪ Which are the connections between science, art and gender? ▪ How to democratize artistic research to our audience? ▪ How to change capitalistic mindset? ▪ How to find a balance between qualification and quantification aspects of research and give the same importance to both?
Scientific Research – what is the role of the senses?	▪ It connects with the world around us. ▪ Essential but neglected. ▪ Co-create and collaborate. ▪ It is where understanding begins and ends (sight, spell, hand, feel, ear). ▪ Senses are subjective: how to make an individual experiences a collective one? ▪ Trigger and confuse - critical justification.

Table 2: STEAM beneficiaries needs and essential aspects of STEAM and differences from the perspectives of the organisations represented by the participants.

Beneficiaries	▪ Co-workers ▪ Children, teenagers. ▪ Pupils/students ▪ School authorities, local councils/national educational board ▪ Youth workers ▪ Adults (migrants, minorities) ▪ Groups of school students ▪ Families ▪ Teachers and future teachers ▪ Youth workers ▪ Young people not engaged in education, employment, or training (NEETs) ▪ Minorities and vulnerable groups.

	▪ Trainers ▪ private sectors ▪ volunteers ▪ Architects ▪ School management ▪ Public council ▪ Museum audience ▪ Partners of the museum ▪ Activists ▪ Decision makers, change makers ▪ Engineers and professionals ▪ Leaders who need more holistic, embodied, emotional intelligence.
Essential aspects of STEAM	▪ Foster ability to stay with confusion, risk, complexity. ▪ Sustainability and nature leadership is critical to integrate into STEAM ▪ The letter A represents creative, process, adaptive, complex, emotional art in a VUCA world (volatile, uncertain, complex, ambiguous). A for attentiveness. ▪ Available to different formats, context, languages. ▪ Micro-teaching (teachers education technique). ▪ Reflection discussions, listen to the feedbacks of students at every step with a shift to learner centredness and starting from a students' need assessment. ▪ Transformation through self-education. ▪ Accessible to everyone, attention to inclusion and equal representation, breaking down the stereotypes. ▪ Creative freedom, multidisciplinary, practical. ▪ Break the walls between the disciplines, transdisciplinary way of learning, thinking, acting, fluidity both in disciplines and in terms of spatial contexts, embedding arts in the educational offers, open science to different perspectives, including humanities. ▪ Hands-on, inquiry and project/process-based experience, study/context-based learning, opening up sensorial experiences and having confident in sense experience as a primary form of knowing. ▪ Space design to enhance and facilitate the learning. ▪ Participatory. ▪ Mentality shift. ▪ Healing trough making. ▪ Involves everyday practice, endorsing non-classroom learning in the real world. ▪ To be aware of the political decisions. ▪ To criticize and enrich the components of STEAM. ▪ To rethink questions of measurement or evaluation. ▪ Define and guide into STEAM the practitioners/ stakeholders ▪ Promoting STEAM careers.
What is common across STEAM beneficiary needs	▪ We find ways to learn from mistakes to improve. ▪ The attunement. ▪ The way we recognize failure and adjust. ▪ Try to use it as methodology rather than as contents.

	▪ Inclusiveness. ▪ Promotion of STEAM careers. ▪ Lifelong learning. ▪ Volunteering (peer to peer) as a way for STEAM. ▪ Gender balance for STEAM careers. ▪ Cross disciplinary. ▪ Political and mentality shift. ▪ Non classroom learning. ▪ Open sensorial experience for education. ▪ Have trust in sensorial experiences.
What is different	▪ Business is more pressured to change, the education field ignores the need for change. ▪ Different target groups. ▪ Socio-economic background of the organization ▪ Developing attentive learning.

Personal journaling on key insights and discussion on further critical questions to be answered during the proceedings closed this first phase of the workshop. In the discussion, inputs about theoretical concepts and about a historical perspective of STEAM seemed central and critical. More work during the WP3 on this debate will be necessary so that the Consortium feels in accord with some of the epistemological aspects of STEAM and with the pragmatic outlining of the SENSE.STEAM methodology.

The collected key questions and topics for further and future work are listed below:

Table 3: Open questions from Phase 1 of the workshop

Open questions from the debriefing from the fast-networking and Gallery walk activities
What is Artistic research?
What is Art?
How experimental can the art be performed, and STEAM be included?
What is A in STEAM?
Social Sciences and gender studies part of science
What are the working definitions of STEM, of STEAM, ...?
Create a historic perspective on education, STEM, STEAM
What are the problems we are trying to solve?
What is the purpose of education?
What is the end goal, relation, mix of STEM and A?
Do we need/want to take into account other disciplines besides STEAM?

4.2. Phase 2 – Embody

The second phase of the workshop aimed to explore STEAM through shared experiences, furthering the understanding by doing, reflecting, discussing and connecting.
Two types of experiences were organized: the concert "Sounds for Mortal Ear" and an open space for STEAM hands-on practices.

A. Sounds for mortal ear - a Concert for "singing glasses".

Sounds for Mortal Ear was part of a three-fold structure: (i) introduction on the STEAM educational purpose with the work and the concert, (ii) the concert itself held in Tårnsalen, and (iii) discussion on resonances following the concert, structured by questions – What did resonate with you? With which ear were you listening? - and a collective open discussion.

The composition was thought to give rise to a common experience for the workshop participants to reflect the central topic: how to combine the A in Arts with the STEM subjects. The used approach here was suitable with the overall strategy of this workshop: it is impossible to discuss the question purely theoretically; the reflection should be grounded in a common experience.

Building on the rich phenomena of "singing glasses" and acoustics from the concert, this practice invited participants to a visual and auditory encounter and aesthetic experience of a spectrum of phenomena of glass (quarts and silica) from nature and culture. Each phenomena invited participation of the senses, particularly sight, hearing and touch, and the sensory participation invited aesthetic appreciation and inquiry, integrating sensing and reflecting.

Two phenomena side by side evoked the question of their relationship, it asked participants to create an ecology of phenomena that is integrative across the different life sciences (geology, biology, chemistry, physics); and across silica in nature and culture. Each of these phenomena can be viewed as a gateway of stairways into a deepened understanding of glass; the glassblower's way of knowing glass is different than the chemist's and geologist's, but he or she will need to know the material, its origin in relation to its quality, its chemistry in relation to its colours. Integrative aesthetic inquiry will therefore mean different things to the artisan and the geologist or the chemist. But they all have potential of integrating these different modes of knowing in their own professional and personal life. The activity invites the participants to find their personal and professional entry point into glass, as the composer demonstrated how he found his, in the concert.

Following are the composer considerations:
"*As an aftermath I have three considerations. First, the performance of the music in Tårnsalen was difficult to prepare for the workshop participants. It was difficult to decide how much I should verbalize: on the one hand avoid instructions, on the other hand give the audience some mind- and ear-opening clues. Looking back on the event now, I am not sure what I should have done differently. Second, the A in Arts should be disclosed as different and particular practices. I was made aware of the potential of musical practice in the workshop because "music" and "composition" was turned into A as "doing art" and "experiencing art". Such a turn indicates an emphasis on the artistic processes rather than on art as products. Third, I regard audial attentiveness as a core competency in doing music in a STEAM context. Practicing audial attention in STEM education is both possible and desirable. However, doing music should not solely serve the purpose of increased/improved STEM learning. Practicing audial attention is of value in itself.*"

The concert debrief was focused around the two key reflections related to what resonated with the participant through the concert and with what ear did participants listen and perceive the music. The 'singing glass' experience was described by many participants like a choral soundscape with different resonances in different parts of the body till the vibration's perception of own bones and the awareness of the hall space. For others it was a more unpleasant experience, with some waves which were felt to interfere with the heartbeat. The first reflections about the type of elective perception channel to hearing sounds were consistent with own different participants' background. For example, participants with a professional background in physics mentioned that it wasn't possible to prevent thinking about sound and acoustics in a physical way – hearing it as vibrations. Others with either culture or architectural expertise commented that the music, sensory and spatial experience all flew together, while others added that the ear of the educator transformed the experience of sounds in possibilities to discover with students. Someone pointed out that it was surprising to perceive the change in sounds when the singer poured water into a glass and that it was the exact moment where and when science and art met and came together.
Participants also pointed out the importance of the doing and the value for the audience to interact directly with the sound productions. A participatory approach would give the opportunity for people to think with their own hands in order to construct understanding using the body as a mode of cognition.

The concert program is attached as Annex 3.

B. Open Space: STEAM hands-on practices.
Each participant was invited to bring one example of a meaningful STEAM practice to share, with a short hands-on experiential moment to be trialled by the other participants. Also here, the aim was to have an experiential base to prime discussion and encourage participation. Four sessions of STEAM practices were run in parallel, followed by individual reflection on lessons learnt through using material for a collage. At the end participants were invited to explore the collages and to note feedbacks on the open space process in the personal journal. The heterogeneous backgrounds of the participants generated a broad spectrum of approaches to be tested, among which it is possible to recognize activities that aimed at a STEAM subject which use different languages to guide the inquiry process and improve STEM learning performance through illustration or storytelling. An example of this was the practice where the sensorial exploration – a visual inspection - of an ice cube floating in salty compared to a cube in sweet water catalysed the understanding of the concept of the lower freezing point of salt water.

Another category of practices focused on different ways to explore the environment. For example, poems were used to translate an architectural space into words, ropes to explore the two-dimensional and three-dimensional nature of perception, a visual impression was to be translated into a precise geometric language. These practices could be defined as “transformative experiences” as they aim at rehearsing a different form of enquiry.

It was observed that the compressed time of the open space sessions only gave the possibility to have a taste of the practices and not to perceive the frameworks of the learning paths in which they were developed as well as the intention. The possibility to have an overview on all practices was also seen as important for a holistic understanding of the complex process.

In total 16 practices (listed in Table 4) were documented by the proposers who filled ID cards of their practices at the end of the hands-on phase. The ID cards were designed to include descriptive elements such as a description of the activity and its specific elements related to the nature of the inquiry and the task, the developed dimensions of SENSE.STEAM inquiry described in Annex 2 (noticing deeply, embodying, questioning, identifying patterns, making connections, exhibiting empathy, living with ambiguity, creating meaning, acting, reflecting and assessing), and possible links to the topics of the STEAM labs (Green Deal, health, digitalization, work readiness) and cross-cutting issues of space and social Inclusion. An example of ID card for the activity ‘The Tangram Puzzle” is reported in Table 5.

The collected ID cards were examined during the third phase of the workshop in cluster 3 (see chapter 4.3). These practice examples, together with others to be selected and analysed later in WP3, will be reviewed and will form the set of

practices from which at least 28 practices will be selected and developed in WP4 (KPI 1.1). They will be documented in deliverable D3.4.

Table 4: List of the STEAM hands-on practices piloted by participants

A first list of STEAM practice examples to inform and shape the SENSE.STEAM pedagogical model	
Young digital leaders	Participants become digital leaders and reflect on social media and on different filters we have online and offline.
Drawing sounds	Participants get sound out from provide or own material from day-to-day life and depict it in any way.
Architecture and poetry	Participants are asked to write a cinquain poem about the space that they are in.
AlieNation	Participants are invited to behave in a manor they are not supposed to behave where they are at the moment.
Empathy balloons	Participants are asked to make a balloon bouncing in an hand while doing some digital work on their phone. This encourages users to consider the idea of cognition impairments and what effect it has on the users of digital products.
System Constellation	Collaborative discussion involving role playing and sharing of perspectives.
Anchor senses	Practice with a 'anchor senses', making one sense less dominant.
Gender mainstreaming	Participants reflect on the gender mainstreaming in their organisations
Reflect and interact	Participants confront ideas and approach in a inter-cultural environment.
A frame for my story	Participants create a simple mechanical sculpture that lets them bring stories to life.
The Tangram puzzle	Participants challenged themselves at translating a visual geometrical representation into words for others who can't see it in order to draw it precisely on a sheet of paper.
Shadow city	Participants build a city with different materials in order to explore materials in relation to light and shadow.
Fast Fashion	The practice invites participants to attempt to sew a button into a piece of fabric to practice the ability to do basic clothes-mending and to reflect on the effect of fast-fashion on the environment.
Water and sanitation safety planning	Participants map the water and sanitation systems in their community identifying risks, pattern, problems and open questions.
Stairways to glass	This practice invites participants to a visual encounter and aesthetic experience of a spectrum of phenomena of glass.
Melting ice	Participants experiment how the ice melts in fresh and salt water.

Table 5: Example of ID card for the activity The Tangram puzzle.

Title	The Tangram puzzle		
Short description	This activity is based on the Tangram puzzle. People work in pairs and sit back-to-back. One of the persons of the couple has a picture of the form to be realized and the other has the puzzle pieces. The person with the image describes the image but only referring to the geometric shapes and characteristics. It is not possible to state what it shows. The other person needs to listen and can only ask yes or no questions. This rule forced the participants to translate a visual impression into precise geometric language		
Key features	The aim is to develop active listening skills and effective communication.		
Dimensions of SENSE.STEAM inquiry	✓ Noticing deeply ✓ Embodied knowing Questioning ✓ Identifying patterns ✓ Making connections ✓ Exhibiting empathy Living with ambiguity ✓ Creating meaning Acting ✓ Reflecting Assessing		
Links to STEAM labs	TOPICS		*Short explanation*
	European Green Deal		
	Health		
	Digitization		
	Work Readiness	✓	Effective communication is a main and key skill in international organizations
	CROSS-CUTTING AREAS		
	Space	✓	The design of the space might interfere and facilitate the process of explaining and understanding The ability to perceive spatial organisation, translate the perception of space and the relation between objects in that space into words
	Social Inclusion		

4.3. Phase 3 – Develop

The last part of the workshop allowed participants to analyze insights and knowledge produced so far and to deepen them further, addressing

1) the landscape of STEAM beneficiaries using key characteristics from phase 1 and preparing an overview and description of STEAM beneficiaries.
2) the potential construct of SENSE.STEAM inquiry for developing the SENSE.STEAM model.
3) the SENSE. learning companion and learning continuum.
4) the links between STEAM and the four thematic areas as well as the two cross-cutting issues of SENSE.

Participants freely divided according to their own interests and expertise in four clusters along with guidelines to prime discussion (Annexes 5-6-7-8).

Outputs of the work of the 4 clusters were presented and shortly discussed in plenary. The salient points that emerged are presented below.

A. Cluster 1: STEAM beneficiaries

   STEAM implementation implies - at least - three levels of action:

   — Skills and competences
   — Social groups' internal and external constraints
   — Social groups' values, representations, and opinions

   STEAM policies need to define more accurate and precise categories and groups: categories for action (stakeholders, policymakers...) are not similar to socioeconomic categories (social science) and to categories of uses (individuals' social practices).

   Even though the stakeholders are given in the SENSE proposal, the group decided to re-assess if they were complete and analyse and categorize the stakeholders each of the present organizations is working with. Categories were beneficiary, partner, stakeholder. Groups could be in one or more categories, as it is shown in Table 6.

Table 6: Cluster 1 - STEAM beneficiaries

Beneficiaries	All youth includes subgroups such as minorities/migrants, girls and other vulnerable groups: — Youth 13 – 18 years old — Youth 19 – 25 years old — Youth under 12. We know it is difficult to work with this last group and they are not considered in the proposal (legal requirements/GDPR). However, in some countries young children already have to make a choice for their further school career if they want to follow an 'alpha' or 'beta' path, which will determine their chances to get involved in a STEM / STEAM career later on in their life. — Women and girls as group which is currently disadvantaged and will be paid special attention to throughout the project.
Beneficiaries, Stakeholders and Partners	— Teachers: they can improve their teachings and position through STEAM, but we also need their input as partners, and need to cooperate with them as stakeholders. — General public: it is a very vague and ill-defined category. It includes employers, employees, parents, adults as lifelong learners, families, women. Sub-categories need to be more accurately defined in the frame of our project. — Policy makers: Ministry of Education, Ministry of Culture, Local authorities, European Commission, other legal or political bodies who might benefit or might adopt the New European Roadmap to STEAM Education, and or change curricula and support the project. — Journalists and content creators: They are not listed in the proposal, but their cooperation will be helpful to bring across the message of 'STEAM' education to the general public — Educational institutions that decide to do/propose SENSE.STEAM practices and co-implement labs — Scientific Community will be involved to develop STEAM practices and improve learning experiences — Artistic Community will be involved to develop STEAM practices and improve learning experiences — Companies, Industry interested in a skilled and creative workforce

For 3 selected groups of stakeholders a needs assessment was brainstormed and synthesized in Table 7.

Table 7: Cluster 1 - Needs assessment

Stakeholder	Needs	Constraints	Added value
Youth, all categories	- Skills: critical communication, digital education (which includes media literacy, critical thinking, digital safety, digital management), relevant skills to function in society, professional orientation - Personal development: Self-awareness, character development, self-determination, self-directed learning, learning to learn, function independently, empathy, hope, joy, motivation. - Values based needs: Climate and Environmental Justice, they need to be agents of change to act upon their communities' needs and problems, a connection to the natural world that comes with a sense of belonging, and consequently taking responsibility for our planet and their actions.	- Parents' and/or teachers' mentality; they sometimes are opposed to changing education methods or content or have different values. - School curricula are already full and inflexible, they do not allow a lot of change. - Stereotypes about what is means being an activist, stereotypes about young people not supposed to speak up, stereotypes about girls should not fight for their rights - Weak interdisciplinarity can prevent STEAM implementation, as there are no existing structures linking the disciplines that make up STEAM.	- Happy Children - Less dropouts - Inclusion of all learning types - Life paths lead to more satisfaction

Teachers	- Training on teaching methods, how to teach STEAM - Materials and tools, STEAM curriculum - Students that learn well in their subjects - Training and skills in 21st century topics (sustainability, digitalization, critical thinking) - democracy/ participation, - Interdisciplinarity - Community, sharing	- Insufficient recruitment, economic constraints, time constraints / overburden - The education system is old fashioned, and the curriculum is not adaptable/flexible - Value system and mentality of schools/general public/parents are not open for STEAM and/or innovative approaches	- The Roadmap to STEAM will provide guidance and concrete curriculum to implement STEAM, as well as tools to change mentality. - They will be fitter for their jobs, more successful in teaching - More Art in STEM / more STEM in Art
Policy makers	- A good public image in order to be re-elected - Data from the project and the effects of innovation on learning and comprehension - Stable working population with a reasonable level of education and creativity - Not too critical or demanding in terms of environmental, social or economic justice to prevent unrest	- Lack of political will to implement change or innovation due to short re-election terms of 4-5 years. (e.g. climate change goals are set too late, too low to prevent a disaster, stricter chemical legislation is only adopted upon massive evidence of a substance being harmful, instead of using the precautionary principle, serving the interest of the industry instead of the planet and people) - Political agenda - Economical constraint, education is not always prioritized in terms of investments	- Increased popularity when education improves - Creative and critical society - Responsible population

B. Cluster 2: Theory Development

'SENSE. The New European Roadmap to STEAM Education' is a project born under the auspices of the European Union, with the ambition of bringing innovation into the development of the economic, social, and cultural sectors of European countries.

It does so through the medium of education which by its nature of being an intermediate between society and the state, brings with it long-standing debates around its aims and purposes. Education has always been central to the development of a political project, through an educational science - or

‘science of the citizen’ - concerned with the knowledge, skills and competences that are both desirable and required to fulfil the needs of a country at any point in time. So, the development of theory for this project cannot be disentangled from such wider debates around the question of purpose, or in other words, what ‘science of the citizen’ may be underpinning and informing the project’s rationale, research methodology and related pedagogical practices. This means recognising the power of theory to make visible a range of multiple possible perspectives on such an educational project; the extent to which it engages with value dimensions surrounding how such project may be undertaken, and by whom.

The group engaged in theory development was thus clear that there is no one single or one best theory that will inform best practice. But there will be theories in action that will draw upon the needs of people in different contexts. Whatever the ‘dream’ school might be, the development of theory will always push at the edges of the ‘practical’ realities of participants involved.

Such practical realities may be those of curriculum structures and assessment systems, which may differ across countries in their degree of emphasis on knowledge and skills; the working conditions of teachers, and the support available to them to adapt to new practices; the rate of inclusion or exclusion of children from schools etc.

In this conception, theory development may not be understood as something that can be devised a priori, but as an ongoing and dynamic process of theorising in action, and across multiple contexts; it will engage a multiplicity of stakeholders – teachers, students, parents, policy-makers – eliciting, listening to, and drawing on their experiences, needs and perception. It is a process that does not simply measure the impacts of a new educational intervention, and how and when such impacts are occurring; but it is a process that keeps asking whether the theory and the knowledge that is being produced is the right knowledge, one which tells us what we should be doing to address the most inequitable impacts. And how can we make sure that such research, if done, is heeded by policymakers? Particularly in relation to STEAM education, we are concerned with the question of whether such innovation, carried forward under the mantle of a funded European project, can actually help us to advance the cause of justice, by unpicking and reformulating the purposes of education from different perspectives and points of view. In this sense, whatever practices of STEAM we seek to implement, we will need to ask which interests and which needs such practices will serve; and what opportunities such practices can provide to address the practical realities in each given context.

What STEAM: moving between transformation and the status quo
As acronyms go, STEAM in its simplest form can be understood as STEM plus the Arts. Yet, such apparent simplicity is riddled with tensions.

Firstly, the additive proposition appears to limit the role and purpose of the Arts disciplines – as generically defined - to a contributory role, to help extend and drive the agenda of STEM education. Economically driven, STEM education originates as the combination of science and technology for job-creation and economic growth. In this frame, the Arts are also subjected to the same purpose and are called upon to serve the country with the skills of creativity and innovation that are needed to drive the economy within an increasingly competitive planet.

But a second, and perhaps most significant tension with limiting the role of the Arts to such an additive role, is that of concealing their different and particular practices, and failing to account for their equally wider, diverse, and contested roles in society. Thus, by limiting STEAM to an addition of STEM + Arts we seriously diminish and underestimate the transformative potential of STEAM, not only to scientific fields but also to the humanities themselves; it is an approach that remains anchored to extractive mindsets, pushing out the possibility that we need to ask different questions about the knowledge we hold, and the way in which we are being educated, in order to live and thrive on a planet that is increasingly under pressure.

Finally, STEAM in a way that is similar to its STEM companion, operates in a curriculum knowledge system that does not encourage integration.

The reasons are varied:

- STEAM rely on the inclusion of disciplines which may or may not be part of traditional school curricula, such as Craft or Engineering (Brophy et al., 2008).
- Where subjects are present, a re-purposing of curricula has occurred in order to emphasise applied and economically relevant dimensions (e.g., Design and Technology Education turning into Creative Industries; Brown et al., 2011).
- Integrated approaches such as transdisciplinary creative inquiries in STEAM rely on bringing together academic and vocational subjects, but these are traditionally associated with different sets of expertise and knowledge domains; they rely on the separation between subject content and cross-cutting competences (e.g. communication; practical experience etc.), and they point towards alternative routes to

employment after completing compulsory education (i.e. knowledge for University vs. knowledge for work; Colucci-Gray et al., 2019).

It is thus clear that locating STEAM's transformative potential merely with the addition or even integration of the Arts and Humanities simply does not do. A more interesting and radical proposition may lie with understanding how particular practices across the Arts and Humanities - 'doing art' - can help formulate different conceptions of knowledge and expertise; but also, how working across domains can help reframe current assumptions about knowledge and knowing, thus 'expertising' our ability to learn with and learn from others, within an ecology of relations, including the human and the more than human. Under such conditions we propose that the 'A' in STEAM may be an entry point into a plurality of ways of knowing. Shifting from "art" to "doing art" (in addition to "experience art") indicates a turning to the processes rather than the products, and at the same time it may also be understood as a method for pluralistic inquiry, serving to disclose different dimensions of experience with their different facets of inclusion/exclusion.

Reformulating the 'A' in STEAM

For the most part, assumptions about knowledge and expertise remain unrecognised, implicit and go largely unchallenged. Common perception of scientific knowledge for the most part is still anchored to a cumulative idea of 'pyramid of facts', or expertise as universal archive, devoid of culture and history. A characteristic of this approach is that of separating content from medium, and specifically, from the rhetorical process that influences what and how we know.

A more fundamental contribution is that of moving from acquisition (or extraction) to authoring and performance through an approach which more seriously questions the idea of expertise as archive, to move more courageously – and cite Primo Levi - into the 'world of things that change' (p.34). This is a stance that does not separate thinking from doing, and doing from making-with, within an ecology of times, or materials and spaces. This approach may be referred to a 'craft' which – according to Johnson (2010) is "more than the theory of the art (techne): it is also the activity (*poiesis*) of the productive moment (p.679)". Craft is thus linked to the capacity for action; the making of the product is not disconnected from the making of selves and the making of cultures.

Depending on which stance we adopt, knowledge as archive or knowledge as craft, the possibilities for doing STEAM education also change. According to the first conception, the idea of drawing on the Arts to make STEM content more easily accessible or relevant is appealing, and to some extent, even

desirable for some. There are numerous examples of educational practices which rely on artistic devices to do exactly that, to raise interest, engender curiosity, help visualise and retain an otherwise alien and abstract content. Yet, such an additive approach of 'bringing in the Arts' for delivery of content shies away from the question of how we may come to know, who is asking the question of what is worth knowing, how and why. In other words, it does not engage with epistemic justice.

So, if we want to explore the potential of the second conception, the question is how to engage with making, and challenge the archive model of expertise? Addressing this question, inevitably brings up the divide that still exists between brain and body, enshrined within schooling practices which relegate the body to a supporting shelf for the head. Seating arrangements and regimented time routines exclude the body and the lived experiences of different bodies from coming to know.

Reversing this pattern is the equivalent of a rhetorical move, the turning of the tables, which does not simply replace the brain for the body, as it may be the case when we think of practical tasks as being somewhat disconnected from thinking or even from reasoning. Rather, it is an operation which foregrounds the body as the prime mode of experience, the body as being text upon which history and culture make themselves transparent and visible.

Taking the body as the prime mode of cognition thus moves our concerns away from 'what knowledge' to 'how do we come to know'? And such coming to know is profoundly linked to the capacity to attend to something as it enters the realm of somatic sensorial perception: In what way is our attention directed, shaped, filtered? And what happens to our ways of knowing when we change our ways of paying attention?

For example, during the workshop, the experience of the glass concert in Tårnsalen, already described in chapter 4.2, showed the music was neither in the score, nor in the instruments; but it was created somewhat in between the performers, the materials, and the listeners, all engaged in audial attentiveness. The experience of sensing thus changed the framing of STEAM from adding "music" to STEM (that being for example the physics of the glasses vibrating; the shape of the room; the construction materials used) to "doing music" where all those things entered into relation. Practicing audial attention in STEM classrooms (both indoor and outdoor) is at least one such transformation. However, music cannot serve the purpose of increased/improved STEM learning but practicing audial attention is of inherent value.

A theory development for STEAM inquiry will thus take practices very seriously as practices of the knowing and sensing body. In this regard some questions may be offered here as a means to initiate such inquiry into and through the extent to which practices become affordances or space for coming to know. Questions are summarized in Table 8.

Table 8: Cluster 2 - Questions to develop a theory for STEAM inquiry

Guiding question for developing an educational model with STEAM inquiry
Participants: who is at the table? Who is not?
Spaces: in what way is knowledge confined and tied to specialist spaces?
How can we engage design thinking to challenge and question the divide between expert and layman?
How can we design spaces affording possibilities for diversifying and expanding sensorial inquiry, beyond dominant languages and dominant senses of perception?
How do we engage the rhetorical devices of arts and humanities to disentangle theory-driven observation and extend the capacity to attend to the world of things that changes?
How do we engage with performance practices to multiply and expand our capacity to include the range of perspectives and possibilities that are not seen? And those that are not heard?
How do we engage sensorial inquiry methods to question practices of visibility and to make problems visible?
How do we engage making and design practices across the arts and sciences to enable new and different communication practices?
How to facilitate for interdisciplinarity in schools by finding common grounds and mutual benefits for STEM-subjects and creative subjects such as art and craft?
How can we strengthen ability to solve problems and enhance creativity?

C. Cluster 3: Deepening practices

The main goal of the third cluster was to form the examples for STEAM practices that were distributed in the second phase of the DNA workshop into a common ground for implementation and dissemination. As described in the beginning of this chapter the results of the cluster are meant to provide for the SENSE. learning companion and learning continuum. Therefore, the practices were to be analyzed to discover commonalities and differences or identify patterns and relations to eventually characterize STEAM practices and finally build pathways for the implementation of the STEAM labs in the upcoming WP4.
Concerning the SENSE.'s 8 steps towards the building of the New European Roadmap to STEAM Education (see Annex 3) the results are located in the awareness-oriented steps 1 and 2 where the questions of (1) what STEAM

education is and (2) what it means for the persons and organizations are to be answered. Among other things this includes the collecting, selecting, and reviewing of examples for STEAM approaches in educational and non-educational settings. Farther, the results are highly related to the action-oriented steps 4 and 5 that focus on (4) the design of a STEAM educational model and pedagogy including a structured display of practices finally targeted on the needs of various stakeholders and (5) the creation of the learning companion through the implementation activities within the STEAM laboratories. All this will contribute to step 6, where specific strategies addressing different stakeholders will be applied in various European countries.

Concerning the current model of SENSE.STEAM that links *A*rtistic and STEM research and education throughout four interrelated building blocks, these must be kept in mind when analyzing practices. Especially the learner centeredness and the reflective feedback are highly related to the characterization processes of STEAM practices.

Participants & Phases

To keep the magnitude of stakeholders in mind and ensure a variety of perspectives and practices, the cluster assembled a broad number of participants from different organizations and backgrounds. The work process consisted of two different stages.

- Stage 1: At first the characteristics of the STEAM practices from the day (and thus phase) before were sampled and discussed in an open process with the help of the practice-related ID cards completed by the participants' individual notes and impressions. Afterwards the sampled features of a STEAM activity were visualized and summarized within a mind map that served as the common ground for the second stage.
- Stage 2: Each cluster's participant chose to work in one of three different groups to generate presentable content from the deepening of practices:
  - Guiding principles for STEAM (education) practices
  - Missing features / dimensions from stage 1
  - Applicability to beneficiaries / stakeholders

Documentation

As mentioned before the results of the first stage were visualized as an unstructured mind map as a fundament for the second stage. In the second stage each group fabricated a poster with their central findings. These were presented to the whole plenum at the end of the cluster phase. Furthermore, the documentation within the individual diaries still took place during the cluster and presentation activities.

Results

Stage 1: From analyzing and discussing the variety of provided practices an unstructured mind map emerged. To tell the truth, it had more of a brainstorm character and was preliminarily rearranged into four categories to bring some structure into the result.

Table 9: Cluster 3 - Features of STEAM activities

Field*	Collected Features of STEAM Activities
General	-using senses (deeply) -formal and informal learning included -project / problem based and requires active participation/ thinking -transdisciplinary -adds value to and/or represents reality
Content	-artistic and STEM activity can be recognized -artistic and STEM learning outcome (possible) -assesses artistic and STEM outcome -already practiced and reflected upon -involves critical reflection and communication -framework/ guidance/ scaffolding within -reaches from narrative to visual
Openness	-possibilities to complexify / go deeper -creative (and individual) elements -open process / open ended -empower to further questions and/or further action
Individual	-inclusive / open for all -accessible for all (easy entry points) -learner centeredness

*The categories were just used as part of the process and are *no* depiction of a real or final pattern! The four main patterns are depicted below in the results of the second stage's first part.

Stage 2: Based on the collected features from the first stage one group developed guiding principles for STEAM education practices. Therefore, it was necessary to discuss and decide which of the features are essential while others had to be considered optional. The word education is bracketed purposely to allude the usability of STEAM practices outside of pure educational contexts. We summarized the main components into four generic points to make these essential guiding principles for STEAM activities more expressive.

Table 10: Cluster 3 - Features of STEAM activities

Guiding principles for a STEAM (education) practice ...or what makes your practice a STEAM practice	➔ Respect and align *STEM* & *A*rts in learning goals, learning activity, and the assessment of the learning outcome ➔ Promote creativity and active participation ➔ Include sensory experiences and attentiveness ➔ Support individual and collective learning – linked to real life

To double-check the practices with our professional knowledge and experiences the second group examined what features or dimensions could still be missing after our discussions about the practices. The dimensions of SENSE.STEAM inquiry that were missing, were identified as summarized in Table 10. It has to be reported here that this might be due to the short time for the reporting and evaluating phase that participants had for each activity.
In conclusion there still is a necessity for further investigation on SENSE.STEAM inquiry in terms of generating and analyzing more practices.

Table 11: Cluster 3 – Dimensions of SENSE.STEAM inquiry in analyzed practices

The 11 dimensions of SENSE.STEAM inquiry	Less represented features/dimensions
• Noticing deeply • embodied knowing • questioning • identifying patterns • making connections • exhibiting empathy • living with ambiguity • creating meaning • acting • reflecting • assessing	➔ Making connections ➔ Creating meaning ➔ Assessing ➔ Embodied knowing

The third group aimed on a general analysis of which beneficiaries the provided practices apply to and which not – to eventually estimate where further specification or generalization is needed:

Table 12: Cluster 3 – Practices analysis in relation to beneficiaries

+ (beneficiaries that are highly addressed = where practices can be easily applied)	- (beneficiaries that are slightly addressed or not addressed at all)
• Students aged from 13 to 18 years • Schools, teachers, educators in formal and informal settings • Businesses, employers • Cultural / artistic institutions • (politics & public → indirectly)	• Students aged 19-25 • Girls who are afflicted by gender stereotypes • Parents who are involved in education and decision-making • Academic staff / researchers

The linking to the different beneficiaries varies highly. In conclusion the demonstrated practices need further development or new particular practices have to be generated to suit determined users. It is not effective or even reasonable to try to characterize and frame single STEAM practices as universally as possible, because this would only mean a loss of applicability. The activities and especially the guiding principles should rather be used as framework to enable the beneficiaries, stakeholders or finally STEAM labs to design STEAM practices fitting to their needs and target audience.
The challenging of designing STEAM practices is on the one hand to make them not too specific so that they can be useful for different contexts, but, on the other hand, to give enough guidance to ensure its applicability. This legitimates the value of the ID cards that were created to describe and classify the practice examples within the DNA workshop, as explained below.

Importance of the ID cards
An important step towards the applicability and transferability was already done in designing the ID cards for the STEAM practice examples. Besides the descriptive elements such as title, an activity description, and a short depicting of key features the ID cards also contain space for further connections. First, the facilitator of the practice must select three of the key dimensions of SENSE.STEAM inquiry (see Annex 2*)* that the practice contributes to the most. Second, the ID cards provide the opportunity to think about links to the four key thematic areas of the implementation within the STEAM labs (WP4): European Green Deal, digitization, health, and work-readiness as well as the cross-cutting areas Space and Social Inclusion that will be focused on in the work packages WP5 and WP6.

By using the provided information inside identity cards in combination with the guiding principles and the investigation of the respective beneficiary's needs, STEAM practices can hopefully be assessed and therefore modified to apply to the context depending on the target audience and the distributor.

Example Practice: Drawing Sounds

To depict a possible categorizing scheme and further applicability thoughts the practice example "Drawing Sounds" will be discussed exemplarily.

Table 13: Cluster 3 – Categorizing scheme and its applicability for STEAM practices

Title	Drawing Sounds
Description	- Create sounds using different materials from day-to-day life to instruments - Make the sounds visible in an open form of own preference, for example pictures, drawings, boards, models and so on - Get insights in each other's ideas and further uses of the deployed material by discussing, sharing, presenting and maybe even draw scientifical approaches out of your results
Task's natures	Making of and listening to sounds; collaborate, share and discuss; explore material and relations; develop ideas and designs; make sensorial and artistic approaches to open results
SENSE.STEAM inquiry dimensions	➔ Embodied knowing ➔ Making connections ➔ Creating meaning
Links to the STEAM Labs' areas	❖ European Green Deal: Usage of day-to-day material to explore acoustics without unnecessary costs or waste ❖ Health: find joy, peace, distraction, relaxation or motivation in simple things ❖ Digitization: pictures, slow-motion videos or else as visualization technique
Cross-cutting areas	❖ Space: Stimulating environments provide ideas for exploring science and arts in an engaging, natural way ❖ Social inclusion: easy access to participate, contribute and engage no matter the level, gender or experience
Guiding principles: STEAM practice?	✓ Allows aspects of STEM & Arts in goals, activity and outcome ✓ Promotes creativity and active participation ✓ Includes sensory experiences and attentiveness ✓ Supports individual and collective learning – linked to real life
Suitability/ easy applicability to beneficiaries: (see *Annex 5*)	A: Students aged from 13 to 18 years old: YES B: Students aged from 19 to 25 years old: Maybe (entry level?) C: Girls who are at risk to be afflicted by gender stereotypes: YES D: Parents involved in education and decision making: NO E: Schools, teachers, educators in formal and informal settings: YES F: Academic staff and researchers: Maybe (as starting point?) G: Employers and businesses: Maybe (team building?) H: Cultural and artistic institutions: YES I: Policy makers, decision makers: NO J: General public: Maybe (citizen science activities?)

D. Cluster 4: Thematic areas and cross-cutting issues

The cluster aimed to use the experience from the first two phases of the workshop to have a closer look at the four thematic areas Green Deal, Digitisation, Health and Work readiness, and the project's cross-cutting issues, Spatial Design and Social Inclusion. The key problem the group discussed at the beginning was that the six fields the research wants to address are difficult to categorise. Green Deal, Digitisation, Health and Work readiness are particular policies of the European Union (EU) with defined targets, albeit with varying degrees of detailing and time scales. In contrast, spatial design and social inclusion are treated as overarching principles that should inform all STEAM experiences across the other four thematic areas.

However, each EU policy area could also be considered an abstract, overarching principle. Sustainability, work readiness, health and digitisation are surely issues intrinsic to almost any field of society. It was understood that the structure of the themes resulted from a pragmatic decision to respond to EU needs and, by doing so, to stay relevant. The research must live with this.

To resolve or "soften" these contradictions, the team discussed splitting the suggested STEAM experiences into a "pragmatic" branch that aims at specific outcomes to meet the targets of the four policy areas and an "experimental" branch that promotes a new form of enquiry in a more abstract way without obvious policy targets to facilitate a change of consciousness. Experimental experiences will improve the results of the pragmatic experiences by training participants to be open for different perceptions. This will also allow us to treat all six thematic areas in their own right with sufficient space for methodological self-reflection to create a baseline for the more targeted measures.

In reflection, we would be tempted to label the two sections "applied STEAM" and "basic STEAM". A roadmap might need to integrate both approaches in a balanced way. It would also allow including STEAM experiences that use "ART" in a more illustrative way if those experiences are accompanied by exercises that aim at a reflected learning process. Space and social inclusion aspects will be used as "enabling questions" (such as "What space do I need" or "Is this experience accessible for everyone") or "reflective questions" (such as "How does change alter my perception" or "What is my relationship to other people"). Base STEAM should also contain experiences with lessons that will deal only with space or social inclusion to facilitate a changing in the social and environmental awareness of the participants.

5. Conclusion

The main goal of the STEAM DNA workshop was to discuss the essence of the project and to identify and share those red threads to be kept in mind and to be developed during the WP3 to create the praxis informed SENSE.STEAM methodology and its pedagogy. Consequently, this will then support and inform the shaping of the New European Roadmap to STEAM education which will provide resources and materials produced through STEAM labs and the STEAM Academy. Namely this workshop was the first step, and its footprint gives guidance for the development of future work.

The proposed work strategy – that is, an empirical approach for sharing practices, experiences, intuitions and knowledge among participants and an inductive approach to build the methodology – was intended to support a truly creative process that could go beyond what has already been experienced in the field of STEM and STEAM education, reconfiguring methodological approaches, and taking forward educational innovation.

This modality has shaken things up and led participants to discuss the main issues and big ideas raising foundational questions on the ecology of knowing such as “what is worth knowing, how, why and how do we come to know’ or ‘what is the ultimate goal of education’, or ‘what connections can be glimpsed between artistic and scientific research in the educational field’ and again ‘what meaning and what balance to give to the additional A in STEAM”.

Sometimes the discussion remained in its initial phase or stayed at the surface, which seemed to be due firstly to the lack of time which this type of insights exchanges might require – for example some reflections from personal journals suggested that discussion would have benefited by providing more time for sharing results between groups. Secondly, as reported by some participants, the lack of some specific theoretical inputs also seems to have led the discussion at times to fail to go beyond some stereotypes such as, for example, those according to which STEM are rigid and boring disciplines, and that the role of art is to simplify and make accessible complex scientific concepts somehow unreachable to the most or that the prevalent purpose of art in STEAM is to arouse curiosity, engaging a diverse audience. The possibility to experience some practices at the second phase of the workshop, rather than simply discussing while imagining STEAM activities through their oral or visual description, helped to “embody” this ontological discussion and to support the clusters works in the last part of the workshop giving insight to be deepen, for instance on the next workshop on Citizen science and art practices.

The indications emerging from the final work in the clusters, although still preliminary, depict the first requirements for practical implementation of the SENSE STEAM educational methodology, outlining the needs ecology of our audience (see the needs assessment and STEAM beneficiaries in table 5 and 6), providing guiding questions to lead us in the elaboration of the SENSE.STEAM model and its pedagogy (see Table 7), identifying a set of criteria to envision SENSE STEAM experience (see Table 9), and, finally, visualizing an ecosystem of possible interrelationships to respond to the program objectives (addressing Green deal, Digitalisation, Health and Work-readiness) while mainstreaming social inclusion and spatial design and promoting new form of enquiry and reflection.

In conclusion, the STEAM DNA workshop represented a unique co-creation landscape in which all participants were called upon to imagine new approaches to both STEM and STEAM education. It appears clearly that the role of the A in STEAM is crucial as participants reflections indicate the requirement to go beyond the limitation of a STEAM as an interpretation of STEAM + Art. In this way SENSE.STEAM will reveal the transformative potential of STEAM, not only in relation to scientific fields but also to the humanities themselves.

Next steps for further work should focus on the exploitation and the deepening of the preliminary results of the four clusters discussions:

- The needs assessment of beneficiaries will need further investigation to precisely map the wide range of STEAM beneficiaries and to identify the value added by SENSE.STEAM for each of them. This work will constitute the foundation of the deliverable 3.3 on stakeholders challenges and needs.

- The SENSE.STEAM theory development will benefit from the insights of the next workshop on citizen science and participatory art intervention as well as from new existing practices analysis and from available literature investigation, desk research and additional elements of other Horizon and Erasmus + projects. All this work will flow into the development of the SENSE. STEAM methodology and be reported in deliverable 3.5.

- To imagine the SENSE. learning companion, it will be crucial to develop and categorise further pedagogies and practices guided by the deepening and improving of the feature created within Cluster 3. The results of this research will also be described in the deliverable 3.4 on knowledge and practices for New European STEAM Roadmap. From this work at least 28 practices will be selected and documented as learning sequences (KPI 1.1) to be developed in WP4.

- The first outlining of the interrelations and the added value of SENSE.STEAM in addressing the four societal challenges of the Green Deal, Digitalisation, Health and Work readiness while tackling the two cross-cutting theme of spatial planning and social inclusion will be taken into account and further developed in WP4 on Steam labs, in WP5 on space issues and of WP6 on social inclusion.

- The presence of 7 external stakeholders constituted a central and strategic element of the STEAM DNA workshop in order to identify needs and requirements on STEAM and STEAM education. The work described in the previous points will have to be further shared with an enlarged audience in order to enrich the elements to be taken into account to define the SENSE.STEAM methodology and pedagogy as indicated in KP 1.3 (50 external stakeholders to co-create the SENSE.STEAM methodology).

6. References

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7. Annex 1

7.1. STEAM DNA Workshop Agenda

Høgskulen på Vestlandet, campus Bergen, Norway
15.11.2022 – 17.11.2022

Day 1, Tuesday 15. November: Building SENSE.STEAM together (11:30-17:00 CET)

09:30-11:30	Open optional drop-in for those who arrive the day before or earlier in the morning - Room M160- We think of organising interviews with some of the participants if you wish to contribute. This will be used for communication and dissemination activities for the project (videos, etc.). More information will come later.
11:30-12:30	Lunch – Room: Cafeteria
12:30-13.45	Building SENSE.STEAM together Part I – Room: Learning Lab
13:45-14:00	Coffee break
14:00-16.15	Building SENSE.STEAM together Part II – Room: Learning Lab
16.15-16.30	Short break
16:30-17:00	Debriefing – Room: Learning Lab
17:00	End of meeting
19:00 - 20:15	Concert, Tårnsalen – this concert is also part of the workshop, everybody is warmly invited and expected to participate. Location: Museum of the University of Bergen

Day 2, Wednesday 16. November: Sharing STEAM practices and knowledge (08:30 – 17:00 CET)

08:30-08:45	Introduction to the second day - Learning lab
08:45-09:30	Activity related to Concert - Learning lab
09:30-11:30	Share STEAM examples and practices Part I – Learning Lab and Room M130/131 Everyone brings a practice to the workshop for sharing, reflecting, exchanging.
11:30-11:30	Lunch – Cafeteria
12:30-16:30	Share STEAM examples and practices Part II – Room M130/131 – Coffee breaks on the spot as needed.
16:30-17:00	Debriefing – Learning lab
17:00	End of meeting
19:00	Project Dinner organised by HVL, Location: MatGal, Håkonsgaten 24, Bergen

Day 3, Thursday 17. November: Building our SENSE.STEAM Model (08:30 – 15:00 CET)

08:30-08:45	Introduction to the third day - Learning lab

08:45-11.30	SENSE.STEAM topic clusters Part I - Learning lab In this session we will work in clusters to liaise our work from days 1 and 2 to specific contexts and content (e.g. stakeholder needs, GreenDeal, Digitisation...)
11:30-12.30	Lunch – Cafeteria
12:30-14:30	SENSE.STEAM topic clusters Part II - Learning lab
14:30	Debriefing – Learning lab.
15:00	End of meeting

7.2. Invitation to SENSE.STEAM DNA Workshop

Invitation to SENSE. STEAM-DNA Workshop

SENSE. The New European Roadmap to STEAM Education

Dear SENSE. partner, associate partner and member of the international advisory board,

it is our pleasure to invite you to the **STEAM-DNA workshop** within "SENSE. The New European Roadmap to STEAM Education", funded by the European Union within the framework of Horizon Europe. This is the first time that partners, associate partners, advisory board members and invited guests will meet in person.

The STEAM-DNA workshop is hosted by Western Norway University of Applied Sciences (HVL), Bergen.

We begin on Tuesday, 15.11.2022, 11.30 hrs CET, and continue until 17.11.2022, 15.30 hrs CET.

The aim of this meeting is to bring about two critical milestones of our project – the specific SENSE.STEAM methodology and the collection of STEAM practices currently implemented by each one of you. We set up the format of an intense workshop with lots of space for sharing, co-creating and informal collaboration to harvest the fundamental building blocks of STEAM (the STEAM-DNA), to put forward the discussion of the specific SENSE. approach towards STEAM and to live the multi-stakeholder perspective we desire SENSE.STEAM to embrace.

Considering the pitfalls of current STEM education practices SENSE. sets off to create art-integrative STEM education, grounded into sensory inquiry, innovative feedback techniques, STEAM citizen science and public performances. As a unique feature, SENSE.STEAM mainstreams social inclusion and spatial inquiry at its core, by acknowledging humans' diversity and the role of spatial design in shaping the ways in which we may approach and sense a problem, as well as how we find ways to address it in our own contexts. Inclusion and spatial design are thus core elements for a new paradigm for STEAM education.

The objectives of the workshop are to share practices, identify the needs of stakeholders, bring forward the formation of the SENSE.STEAM model, to relate it to practical examples and to create common ground for implementation and dissemination. We are planning a live concert for Tuesday evening and a workshop dinner for Wednesday evening as integral parts of the workshop.

More details and preparatory work needed to be done by you will be discussed within a preparatory meeting for work package three. If you already wish to inquire for hotels, the once located near Danmarks plass are within walking distance to the workshop location. A family run hotel is Klosterhagen hotell and we are currently inquiring special prices for Zander K. If you are a partner travel expenses are part of your project budget. If you are an associate partner or advisory board member, details will be discussed individually with Lydia.

Funded by the European Union

SENSE. STEAM-DNA Workshop 15. – 17.11.2022

What you need to bring is a maximum of two characteristic examples of how STEAM, or aspects of STEAM, are a part of your professional activities. This can be, for example, a piece of music or an educational sequence. Prepare to share your example at the workshop. Please bring the equipment needed or let us know by 31.10.2022 what equipment we should prepare for you.

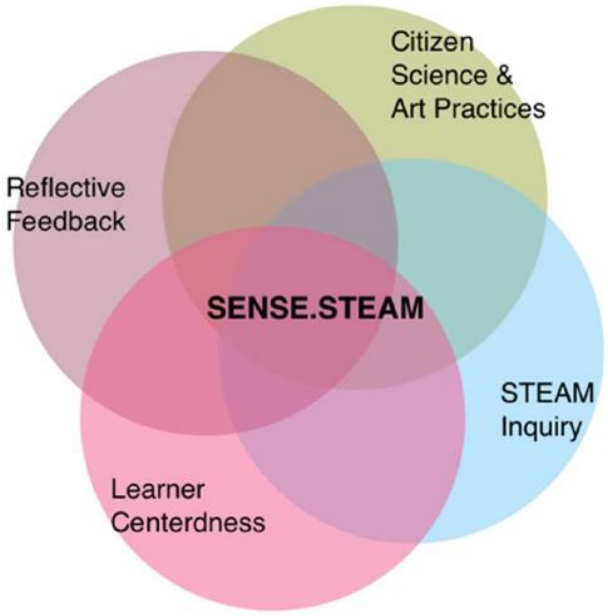
Please reply to hvl-sense@hvl.no with how many delegates of your organisation you are going to participate no later than 20.10.2022.

We look forward to hearing from you.

The organising committee

8. Annex 2

8.1. Aesthetic Inquiry - Linking science and aesthetic epistemologies through STEAM education



SENSE. proposes an educational model that has the ability to link Artistic and STEM research and education through four interrelated areas: STEAM inquiry, Learner Centredness, Reflective Feedback and Citizen Science and Art Practices.

We propose that the renewal of science teaching can be achieved by consequently integrating the Arts into STEM. Building on extensive background research conducted by lead members of the project team, the SENSE.STEAM methodology, comprising a dedicated educational model and its pedagogy (short: SENSE.STEAM) will deliver a change-making approach to both STEM and current STEAM education in a radically new fashion. Based on the current state of the art, SENSE.STEAM is grounded into four building blocks (Fig. 1):

1) SENSE.STEAM inquiry: Developing SENSE.STEAM, we look at the inquiry processes of the individual disciplines forming STEAM. This integrated inquiry approach incorporates methods from Science, Technology, Engineering, the Arts, Artistic

research, and Aesthetic education, as well as Mathematics, creating a truly transdisciplinary starting point for a highly adaptive pedagogy, that can be transferred into national curricula, provides a methodological background for a learning continuum, and is responsive to societal and business needs.

We call this inquiry SENSE.STEAM inquiry which is built on nine capacities: noticing deeply, embodying, questioning, identifying patterns, making connections, exhibiting empathy, living with ambiguity, creating meaning, acting, reflecting, and assessing. This inquiry framework has been applied in the arts as well as STEM research. For example, physicists have identified five of the nine capacities (noticing deeply, embodying, questioning, identifying patterns, and making connections) as directly relevant to their research and educational practice. SENSE.STEAM inquiry focuses on the multisensory perception and thus assigns each human being its place as an experiencing subject.

2) Learner Centred pedagogy: The new SENSE.STEAM methodology adheres to learner centred rather than authority centred approaches, making a radical shift from viewing learners as knowledge receivers to active creators of their own knowledge, promoting self-directed learning and empathy with others.

3) Citizen Science and Art practices: As third pillar we integrate citizen science and art practices into the methodology. With citizen science including art-interventions, SENSE.STEAM inquiry enables school students to liaise directly with the public, as both science makers and science users. An Art-based Citizen science approach will facilitate engagement with both, scientists and artists, science labs and art places to explore, discuss and reflect together on matters that are important to the community.

4) Reflective Feedback: The fourth building block of SENSE.STEAM is reflective feedback. This is necessary because the perspective that STEM is a social undertaking has not found inroads into STEM education and reflection is crucial to produce understanding. The arts offer additional entry-points (e.g., the DasArts feedback and Barbican Creative Learning feedback techniques) for informed reflective feedback to assist learners in improving their knowledge, skills, attitudes and understanding of STEAM and its practices.

SENSE.STEAM is informed by a range of educational theories research reports. We are dedicating this workshop to co-creation and sharing tacit knowledge.

9. Annex 3

9.1. SENSE.'s 8 steps towards building The New European Roadmap to STEAM Education

	Steps	Roadmap planned content	Methodology
1	Awareness: What is STEAM education?	Portfolio of STEAM approaches, mapping of Education practices, art practices and citizen science activities related to STEAM	Collection, review and selection through workshops, desk review and implementation and evaluation activities
2	Awareness: What does STEAM education mean for me and my organisation?	Evidence-based information on the added value of STEAM education with real life examples from education, research, and business; assessment tools for stakeholders to identify implementation strategies and evaluate the impact of SENSE.STEAM	Collection, review, and selection through workshops, desk studies and implementation and evaluation activities
3	Awareness: STEAM for a future-making Europe?	Demonstrating added value of STEAM in addressing four societal challenges (Green Deal, Digitisation, Health, Work-readiness)	The project will address these four areas explicitly in the implementation phase, and will apply well established frameworks (e.g., DigComp) to monitor the competence growth of participants in the respective area
4	Action: What educational model and pedagogy for STEAM?	A new STEAM educational model and pedagogy, bringing together conceptual, sensorial, and enactive dimensions, called SENSE.STEAM, with four building blocks	A structured display of existing practices, frameworks, inquiry and feedback methods and other knowledge from all disciplines constituting STEAM including research results on effectivity and pitfalls of specific inquiry undertakings and external validation by experts. Enrich this review with tacit knowledge and local understandings of STEAM education as well as policy and practice gaps to identify key elements which have not been

			considered yet. Finally, ground SENSE.STEAM on the needs of the various target groups (students, business, education providers, etc.)
5	Action: How to move from the educational model to practice?	An intuitively to use Learning Companion with demonstrations and a user guide	Co-creation of the learning companion through the implementation activities, and refinement during the two real-world pilot implementations in Norway and Italy
6	Action: How to apply and evaluate SENSE.STEAM	Proven strategies specifically addressing different stakeholders showing them how to raise awareness, take action and advocate for STEAM education among their peers.	Application of the STEAM educational components in 13 European countries, evaluation of the implementation activities, transforming evaluation tools as self-assessment instruments, development of support tools for implementation guidance and impact measurement
7	Advocacy: How to promote STEAM?	The STEAM Academy and STEAM Labs as network and nodes connected via the digital hub, equipped with knowledge, supporting tools and policy recommendations for implementing the STEAM Roadmap, addressing both European Education and European Research Areas	Running STEAM dissemination activities coordinated by our STEAM Labs, deriving policy recommendations and strategies for stakeholders, and tailored to the different target groups
8	Advocacy: How to engage with other STEAM actors?	The STEAM Academy and STEAM Labs as network and nodes connected via the digital hub as part of an open community, supporting networking, knowledge and experience sharing, peer learning, etc.	Expanding the network of STEAM Academy and Laboratories that will support the uptake and sustainability of our Roadmap for STEAM education in Europe, linking with other initiatives, Erasmus+, H2020 and Horizon Europe projects and with the new European Bauhaus initiative; two physical nodes in Norway and Italy as a result of the real-world pilots

10. Annex 4

10.1. The Earing Ear Concert program

I' VIDI in terra angelici costumi
E celesti bellezze al mondo sole;
Tal che di rimembrar mi giova e dole;
Ché quant'io miro par sogni, ombre e fumi.
E vidi lagrimar que' duo bei lumi,
C'han fatto mille volle invidia al Sole;
Ed udii sospirando dir parole
Che farian gir i monti e stare i fiumi.
Amor, senno, valor, pietate e doglia
Facean piangendo un più dolce concento
D'ogni altro che nel mondo udir si soglia:
Ed era 'l cielo all'armonia sì 'ntento,
Che non si vedea 'n ramo mover foglia;
Tanta dolcezza avea pien l'aere e 'l vento.

I ONCE beheld on earth celestial graces
And heavenly beauties scarce to mortals known,
Whose memory yields nor joy nor grief alone,
But all things else in cloud and dreams effaces.
I saw how tears had left their weary traces
Within those eyes that once the sun outshone,
I heard those lips, in low and plaintive moan,
Breathe words to stir the mountains from their places.
Love, wisdom, courage, tenderness, and truth
Made in their mourning strains more high and dear
Than ever wove soft sounds for mortal ear;
And heaven seemed listening in such saddest ruth
The very leaves upon the bough to soothe,
Such sweetness filled the blissful atmosphere.

F. Petrarch (1304-1374). *Sonnet*, English trans. T. Wentworth Higginson, 1903

... the hearing ear ...

SENSE workshop

Tårnsalen, University of Bergen, 15. November 2022

Tone Elisabeth Braaten – Soprano

Ebba Rydh – Mezzo Soprano

Per Kristian Amundrød – Tenor

Geir Strande Syrrist – Glass Harp

Edvin Østergaard – Composer

AUS DER ERSTEN DUINESER ELEGIE for three Voices (2019)

... ei meir inderleg flukt...
Hiv alt det tome du held om ut i dei roma vi andar; kanhende vil fuglane feire si utvida luft med ei meir inderleg flukt. / Wirf aus den Armen die Leere zu den Räumen hinzu, die wir atmen; vielleicht daß die Vögel die erweiterte Luft fühlen mit innigerm Flug.

... slike store gåter ...
Men vi, vi treng slike store gåter, som gjennom sorg så ofte er kjelda til åndeleg vekst - : ja, kunne vi vore dei utan? Aber wir, die so große Geheimnisse brauchen, denen aus Trauer so oft seliger Fortschritt entspringt -: *könnten* wir sein ohne sie?

... om eg skreik ut ...
Kven, om eg skreik ut, høyrde vel meg høgt i englanes rangordning? Og sett så at ein av dei plutseleg tok meg til hjarta: eg ville forgå av hans overveldande liv. For det vakre er bare det forferdeleges grense, som vi så vidt held ut, og vi beundrar det, av di det storslåtte avstår frå å leggje oss øyde. / Wer, wenn ich schriee, hörte mich denn aus der Engel Ordnungen?

Höre, mein Herz ...
Stimmen, Stimmen. Höre, mein Herz, wie sonst nur Heilige hörten: daß sie der riesige Ruf aufhob vom Boden; (...) *So* waren sie hörend. Nicht, daß du *Gottes* ertrügest die Stimme, bei weitem.

... ist es seltsam ...
Freilich ist es seltsam, die Erde nicht mehr zu bewohnen, kaum erlernte Gebräuche nicht mehr zu üben, (...) Seltsam, die Wünsche nicht weiterzuwünschen. Seltsam, alles, was sich bezog, so lose im Raume flattern zu sehen. Und das Totsein ist mühsam und voller Nachholn, daß man allmählich ein wenig Ewigkeit spürt. / *Javisst er det underleg, ikkje å bu meir på jorda, (...) Underleg, ikkje meir ynske seg noko. Underleg å sjå alt som høyrde i hop, flagrande laust i romet. For det er strevsamt å vere død, så mykje å hente inn...*

O und die Nacht .../Ja og så natta ...
O und die Nacht, die Nacht, wenn der Wind voller Weltraum uns am Angesicht zehrt –, wem... / *Ja og så natta, natta då vind fylt av verdsrom tærer vårt andlet - , kven blir ikkje ho til del, som trufast ventar på svalt å få svike kvart einskilt lengtande hjarta.*

Høyr, mitt hjarta ...
(Røyster, røyster.) Høyr, mitt hjarta, det elles bare helgenar høyrde: (...) Men høyr den dulde susen, det nye som utan opphøyr stig ifrå stilla.

***Die erste Duineser Elegie*, Rainer M. Rilke, *Duineser Elegien*, 1923; Norwegian trans., Åsmund Bjørnstad, *Første elegien, Duino-Elegiane*, 2002**

SOUNDS FOR MORTAL EAR for three Voices and Glass harp (2022)
Eight Sketches for STEAM laboratory

PROLOGUE
... HEAVENLY BEAUTIES I
LOVE, WISDOM
I' VIDI IN TERRA
... STIR THE MOUNTAINS
AMOR, SENNO
WAS IST EIN TON?
ED ERA 'LCIELO
... HEAVENLY BEAUTIES II
EPILOGUE

"Zuerst, was ist ein Ton? Schon die gemeine Erfahrung lehrt uns, dass alle tönenden Körper in Zitterungen begriffen sind. Wir sehen und fühlen dies Zittern, und bei starken Tönen fühlen wir, selbst ohne den tönenden Körper zu berühren, das Schwirren der uns umgebenden Luft. Specieller zeigt die Physik, dass jede Reihe von hinreichend schnell sich wiederholenden Stössen, welche die Luft in Schwingung versetzt, in dieser einen Ton erzeugt. Musikalisch wird der Ton, wenn die schnellen Stösse in ganz regelmässiger Weise und in genau gleichen Zeiten sich wiederholen, während unregelmässige Erschütterungen der Luft nur Geräusche geben." (S. 58/59) "Die musikalische Höhe des Tons hängt nur von der Zahl der Luftschwingungen in der Secunde ab, nicht von der Art, wie sie hervorgebracht werden." (S. 60)

"Wenn Sie Paradoxen lieben, können Sie sagen, die Luftzitterung wird zum Schalle, erst wenn sie das hörende Ohr trifft." (S. 64)

H. v. Helmholtz: „Über die physiologischen Ursachen der musikalischen Harmonie", 1857

11. Annex 5

11.1. Cluster 1: STEAM Beneficiaries

With SENSE. we seek to address a wide range of STEAM beneficiaries. The challenge for you is to carve out central needs of the beneficiaries with respect to SENSE.STEAM, to identify the value added by SENSE.STEAM for each particular beneficiary and lastly to project the input from Day 1 and Day 2 on your findings in order to map the relations between SENSE.STEAM and the STEAM beneficiaries.

A. Students aged from 13 to 18 years old, who need to make decisions on their future studies.
B. Students aged 19-25, who need to decide about further study and/or choose a professional career.
C. Girls who are afflicted by gender stereotypes limiting their access to science-related studies and professions
D. Parents, who are involved in supporting the education and decision-making processes of their children at various stages of the educational life-course.
E. Schools, teachers, educators, in formal and informal settings as well as science museums who need to be equipped with hands-on pedagogical tools to implement STEAM in curricula.
F. Academic staff in higher education and research, to promote and integrate STEAM inquiry and research methodologies in PhD programmes and research projects including Horizon Europe.
G. Private and public sector employers and businesses who need to have work ready and creative students matching new job profiles related to digital and green transitions.
H. Cultural and artistic institutions as spaces for the learning of science in relation to society. We want to bring to the fore and make explicit their role as legitimate and powerful informal learning spaces where science and the arts can productively meet.
I. Policy makers and decision makers who derive education policies and curricula embedding STEAM throughout the learning continuum.
J. The general public: The development of a scientific literate citizenry is a fundamental goal of SENSE. that believes that social challenges are best dealt

with by informed and scientifically literate citizens who have made lifelong learning their way of life.

12. Annex 6

12.1. Cluster 2: The SENSE.STEAM Model

With SENSE. we seek to develop an educational model with STEAM inquiry as a unique and novel key feature. SENSE.STEAM inquiry should consider artistic practices as epistemic practices being equal to science practices.

The work in this cluster begins to map the potential construct of SENSE.STEAM inquiry as an amalgam of artistic and scientific research.

STEAM inquiry
Learner Centredness
Science and Art practices
Reflective feedback

13. Annex 7

13.1. Cluster 3: Envisioning the SENSE. Learning Companion

With SENSE. we seek to develop educational material that can serve as a learning companion for STEAM practitioners in all kinds of areas of education. In other words, the educational material we seek to develop needs to promote an integrated learning continuum between second and third level education and between education and business.

Your task is to map STEAM practices to the different learning stages, to address what makes a practice suitable for younger, or older practitioners, to eventually also address how practices can be adopted in order to serve different abilities or desired results of the intervention. You are challenged to address pedagogical freedom, formal, informal and non-formal learning sites.

You can use the input from DAY 1 and the ID Cards from day 2 to map selected STEAM educational sequences as a series of variations from awareness through training to education or application.

14. Annex 8

14.1. Cluster 4: Linking SENSE.STEAM to six Key topics

With SENSE. we seek to develop educational material that will be able to address the four thematic areas Green Deal, Digitisation, Health and Work Readiness as well as the project's cross cutting issues Spatial Design and Social Inclusion.

Your challenge is to develop links between the input from Day 1 and Day 2 by using the notes and ID cards and the six key topics mentioned above.

GREEN DEAL. Climate change and environmental degradation are an existential threat to Europe and the world. To overcome these challenges, the European Green Deal will transform the EU into a modern, resource-efficient and competitive economy, ensuring:

- no net emissions of greenhouse gases by 2050
- economic growth decoupled from resource use
- no person and no place left behind

DIGITISATION. Digital technology is changing people's lives. The EU's digital strategy aims to make this transformation work for people and businesses, while helping to achieve its target of a climate-neutral Europe by 2050.
The Commission is determined to make this Europe's "Digital Decade". Europe must now strengthen its digital sovereignty and set standards, rather than following those of others – with a clear focus on data, technology, and infrastructure.

HEALTH. EU health policy focuses on protecting and improving health, giving equal access to modern and efficient healthcare for all Europeans, and coordinating any serious health threats involving more than one EU country. Disease prevention and response play a big part in the EU's public health focus. Prevention touches many areas such as vaccination, fighting antimicrobial resistance, actions against cancer and responsible food labelling.
Health is achieved through the interaction between people and their environment. Therefore, health promoting schools have a broad understanding of health and reflect how both individual and environmental factors are influencing health and well-being. There is no single definition of health. However, health can be described as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO 1946)

WORK READINESS. An apprenticeship or an in-company learning period, as part of a vocational education and training (VET) programme, helps young people prepare for working life. Employers expect learners to show motivation and commitment, as well as certain behaviours and attitudes. Learners may be in client-facing situations which requires a certain degree of maturity and self-control.
This is a significant change when compared to a school environment. Many learners, in particular those who are younger and those with a history of absenteeism or discipline issues, may not be sufficiently prepared. Insufficient work readiness can be a reason for early apprenticeship contract termination, or for learners' disengagement and drop out.
The vocational education and training system can support learners to ensure a successful transition into in-company training.

SPATIAL DESIGN. We understand "Space" as a multisensory environment that impacts human behaviour in a variety of forms. Soft or hard surfaces modulate sound in different ways, light reflects specific to materials, each place has a distinct smell, the tactility of touch matters, etc.; there are infinite forms of spatial perception and interaction through a broad spectrum of sensory impulses. The "space" of the European classroom has not significantly changed since the 19th century: a simple, slightly oblong box with rows of chairs and tables directed towards the teacher are still commonly found in many educational settings. While there have been attempts in recent times to move away from the "teacher-centred box", by changing classroom shapes and furniture layout, formal education environments tend to reinforce standardized spatial typologies, promoting formalised exchanges of knowledge.

SOCIAL INCLUSION. To identify how structures and organisations can practically support best the inclusion of minorities or groups in a vulnerable situation; to provide inputs to other WPs to incorporate social inclusion as a key aspect in the SENSE.STEAM educational model; to transversally analyse, explore and discuss how inclusion issues shape STEAM and vice versa; To collect and elaborate tools, methods, strategics policy recommendation that contribute in diminishing social and educational segregation and in further enhancing gender dimension.

During implementation four partners will cooperate together and link their activities to the following topics:

- ✓ The European Green Deal: Creda (Lab#1) ODY (Lab#2), Vilvite (Lab#3) with EFEE as supporting member for the three labs.
- ✓ Digitisation: Velvet (Lab#4), PHW (Lab#5) and GEYC and PMC (Lab#6)
- ✓ Health: UEdin (Lab#7), WECF (Lab#8), UB and FBofill (Lab#9) and SHE (Lab#10).
- ✓ Work readiness: H\B (Lab#11), Trelleborg and HVL (Lab#12), and Louvre (Lab#13)