

SENSE. The New European Roadmap to STEAM Education

D2.3 - Design principles for the digital hub STEAM Academy and Laboratories

November 2023



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Statement of intent

The design principles shape input from the STEAM Labs to the roadmap to make it useful for creating a digital hub.

The digital hub is a repository to disseminate educational materials created for the SENSE.STEAM roadmap.

This deliverable intends to cut through the formalities and bring the SENSE. methodology directly to the people. It is a direct challenge to top-down educational models, and sets in place three clear principles which place learners at the centre of creating, using, and growing the digital hub steam academy by:

Enabling creativity and generative activities

Demanding inclusiveness

Pushing educational materials beyond the digital

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1. Introduction

1.1. Purpose of the document

The purpose of this document is to document the design principles to be used in the SENSE.STEAM project for the STEAM academy digital hub and labs as well as describing the underlining process and context.

1.2. Intended readership

The intended readership of this document is all partners of the SENSE. consortium, and in particular those involved with creating the digital hub, STEAM academy and STEAM labs.

1.3. Structure of the document

This document is structured in three more sections:

- Section 2 sets out the background, place the design principles in the context of the project.
- Section 3 describes the design principles in context and proposes guidelines for their use.
- Section 4 draws conclusions and outlines next steps.

1.4. Relationship with other deliverables

The digital hub is part of the Work Package for Dissemination and Sustainability of the Results of the project. The Roadmap (WP7) is made based on the methodology (WP3) with activities and practices to be tested in the labs (WP4) while considering the cross-cutting issues of Space (WP5) and Social inclusion (WP6).

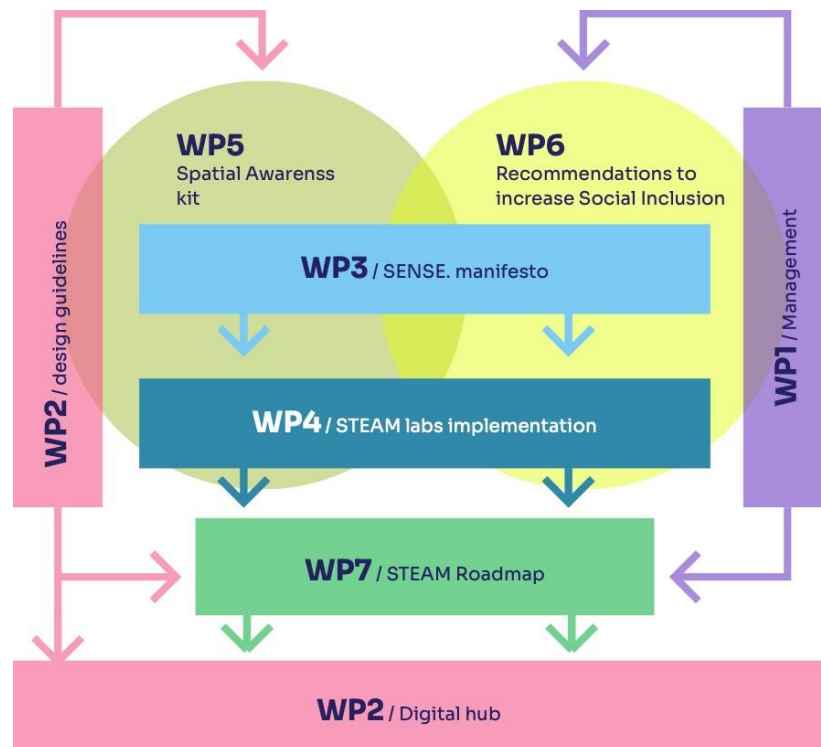


Figure 1: placement of the digital hub in relation to work packages of the SENSE.STEAM project. Source: adapted from Visual Identity by Velvet DP OÜ

This deliverable sets out principles which will be used and built upon in D2.6 STEAM Academy Digital Hub. It also provides input for *D4.3 SENSE.STEAM evaluation of the four specific areas* and *D4.4 Recommendations for the Roadmap and the learning companion*.

Additionally, this deliverable makes extensive use of materials produced in Work Package 3, in particular *D3.4 Report on knowledge and practices for a New European STEAM education* and *D3.5 The SENSE.STEAM educational model and pedagogy*.

This deliverable is informed by principles and approaches documented for the cross-cutting issues in *D5.1 Scoping report on STEAM spaces* and *D6.1 Scoping report on social inclusion and gender in STEAM*. The design principles should continue to be refined as the tools from these scoping reports are further developed and finalised in *D5.3 Self-experimentation toolkits and design principles for STEAM spaces* and *D6.3 Toolkits for social inclusion and gender awareness through and for STEAM education*.

D7.1 First outline of the New European STEAM Education Roadmap has informed and further aligned the design principles and will provide a key input for further work on the roadmap in Work Package 7, as well as indirectly influencing via other work packages.

2. Context for setting of the design principles

Design principles are value statements that describe the most important goals that a product or service should deliver for users and are used to frame design decisions. For design principles to be relevant they must come from within the context of the organisation that will use them. For SENSE. this means taking into account the objectives of the project and work already completed in achieving them.

The SENSE. manifesto

As well as documenting a working version of the project's values and principles, the manifesto also sets out characteristics and values to be used for creating new practices. These have been documented with input from across the consortium, and directly inform the creation of practices – which the digital hub is to share. In this, the manifesto must be considered as part of the context and can serve as a valuable foundation for creating design principles.

In practice: the three levels of SENSE.

Work Package 3 defines three levels of SENSE. Practices:

- Level 1: Arts & Sciences as disciplinary bodies of knowledge
- Level 2: Art-infusion
- Level 3: Future-making

The three levels, while also considering arts and sciences, sensing and the cross-cutting issues of space and social inclusion also gives specific mention to *guiding questions for design*. For design the first level asks about the combination of outcomes from different disciplines, the second considers how artistic practices can be embedded within the science-education pedagogy, while future-making considers the use of arts for space and social inclusion.

These questions serve as valuable guidance for creating design principles that both align and enhance the SENSE. methodology, with a continual reflection of the living manifesto.

Cross-cutting issue: Space

As part of work in Work Package 5: *Space a Spatial Awareness Kit* was created to allow consideration of the topic when creating STEAM labs. The kit is based on four lenses of spatial reflection: *Function*, *Appearance*, *Space* and *Environment* and are documented in Deliverable 5.1.

Cross-cutting issue: Social inclusion

As part of Work Package 6 *Social Inclusion*, a preliminary scoping report (Deliverable 6.1) set out 20 points addressing practical aspects to effectively guide the STEAM Labs in their task in considering social inclusion. Broadly, inclusion is achieved through user-centred, collaborative, and participatory means aligned with the manifesto and methodology and thereby overall objectives.

The 20 recommendations to increase social inclusion, cover topics such as addressing bias, ensuring access to learning resources and ensuring all sections of society are included. These are further addressed on a wider level in terms of community engagement and consideration of learning activities themselves.

First version of the SENSE.STEAM roadmap

As part of Work Package 7 *The New European SENSE.STEAM Roadmap* a preliminary vision of the Roadmap and discussion of how it will be disseminated digitally were completed as part of a consortium workshop held in Tbilisi, Georgia in October 2023. This was set within the context of ongoing work on preparing for STEAM labs as part of *Work Package 4*, a workshop on space and reflecting on the completed methodology including three levels. This is significant, as it is the first time the methodology and other work packages have been combined while also considering the roadmap and questions of design.

From the visions and first iterations of the roadmap produced, the following common themes emerged:

- Sensing and experience should take precedence over 'right' or 'wrong' answers.
- The importance of personalisation.
- Encouraging and empowering collaboration.
- Don't lose sight of the fun! the whimsical! the play!

3. The design principles

This section states the chain of logic for arriving at the design principles for the digital hub STEAM Academy and labs. Each principle will be described and linked back to the SENSE. methodology via the Manifesto. Proposals for their use in other work packages are presented.

3.1. Steps for creating and applying the principles

Drawing on the context from other work packages outlined in section 2, the following steps have been used to arrive at the design principles.

1. Putting the user first: The design principles have been created with the end user – anyone aiming to create, share, use and apply SENSE.STEAM educational materials – in mind.
2. Starting from the methodology The principles set out from the three levels of SENSE. using the *guiding questions for design* as a starting point for applying the working version of the SENSE. manifesto.
3. Incorporating Space and Social Inclusion: The principles incorporate the cross-cutting issues of Space and Social inclusion through preliminary tools and guidelines created for the STEAM labs.
4. Using the labs and creating the roadmap. The principles will be first applied through ongoing dialogue during the STEAM labs and creation of the SENSE.STEAM roadmap.

Three layered principles were created:

1. Firstly, the principle to be generative uses the manifesto to bring in the practices.
2. Secondly to be inclusive pushes what is created to share and bring people with it, and to use multiple senses.
3. Thirdly the principle of going beyond digital provokes thinking about the relationship with physical space.

The principles are outlined in the following pages.

Design Principles

For the SENSE.STEAM digital hub academy and labs

PRINCIPLE 3

Go beyond digital

PRINCIPLE 2

Be inclusive

PRINCIPLE 1

Be generative

Principle 1: Be generative

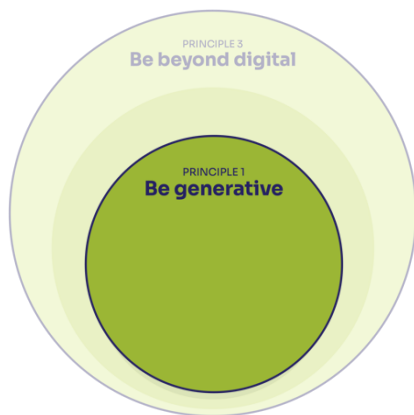


Figure 2: first layer of the design principles - the generation of ideas and practices

In terms of being a call to hands on action for making and creating, creative inquiry, new practices, and techniques. We should be rooted in practice, and our actions should be generative. This design principle should instil a sense of curiosity and empower action. It values experimentation, practice, and applied learning.

Proposals for using the design principles:

WP4 STEAM labs:

1. Setup of the labs should favour doing, creating, and experimenting.
2. Analysis of the results should seek ways of applying new methods generatively.

WP7 Roadmap:

3. While creating the roadmap, we must provide the opportunity to be practical.
4. Users should understand how they can apply the information they are receiving.



WP2 The digital hub:

5. Learning materials on the digital hub should encourage activities that go beyond mere replication. Users should be able to expand, experiment, and add their own creativity to discover.
6. The structure of the hub itself should encourage exploration of activities.

How the principle applies and incorporates other work packages

WP3 Methodology

Related principles from the manifesto:

- Make!
- Relate and Connect!
- Coproduce & Act!
- Set off to find out!

Principle 2: Be Inclusive



Figure 3: second layer of the design principles - ensuring ideas and practices are inclusive.

In terms of being collaborative; including all social groups; using multiple senses to be accessible and avoid issues of language. This design principle embraces the strong focus on inclusivity across the project in the broadest possible terms. It encourages use of the senses in tandem with accessibility and universal design.

Proposals for using the design principle:

WP4 STEAM labs:

1. In dialogue with recommendations for social inclusion identified in WP6.

WP2 The digital hub:

2. The hub should not be prescriptive in which activities are best for whom.
3. The hub must use WCAG standards, go beyond minimum requirements and strive for best practices in digital accessibility.
4. The hub should follow principles of universal design.
5. The hub should address issues of linguistic inclusiveness (not assume a high level of English) and give room for other languages as well as using means of communication other than words.
6. The hub should make use of all the senses and avoid being visually dominated.
7. Visual elements should consider people using screen-readers.

How the principle applies and incorporates other work packages:

WP3 Methodology

Related principles from the manifesto:

- Sense!
- Involve!
- Imagine!
- Relate and connect!
- Discipline switch!
- Coproduce & Act!
- Be diverse and inclusive!

WP6 Social inclusion:

1. Draw from the 20 guidelines for increasing social inclusion.
2. Remain in dialogue with further work and allow the principle to evolve – and become more specific as it progresses.

Principle 3: Go beyond digital



Figure 4: third layer of the design principles - pushing the ideas and practices shared on the digital hub beyond the digital

in terms of recognising the role of physical space, considering that material presented digitally is used in a particular space, that the practices shared are also often created offline, that there are varying levels of digitisation and access to devices. This design principle builds on the cross-cutting issue of space to give a strong push to incorporate and consider non-digital aspects and place digital tools in a wider real-world context.

Proposals for using the design principles:

WP2 The digital hub:

The user interface and experience of the digital hub must allow for educational materials that have been created with physical space in mind.

The digital hub should enable new ways of considering and pushing the boundaries between physical and digital space.

digital learning materials should be platform and device agnostic - including allowing for desktop, mobile or tablet use.

digital learning materials should recognise varying levels of digitisation and access to devices.

How the principle applies and incorporates other work packages:

WP3 Methodology

Related principles from the manifesto

- Involve!
- Be diverse and inclusive!
- Work with space, place, and time!

WP5 Space:

1. Draw from the Spatial Awareness Kit and four lenses of spatial reflection.
2. Remain in dialogue with further work and allow the principle to evolve – and become more specific as it progresses.

4. Steps for implementation

The STEAM Labs

The design principles serve as a useful input for using the STEAM labs to gather relevant and appropriate input for creating the digital hub. They should be referred to when designing, carrying out and reflecting on the lab activities. This will be achieved by:

1. Sharing the design principles in an information session with all consortium members
2. Being easily accessible by making the principles and associated visuals available on the website
3. Creating and maintaining additional guidance as the inputs and learning materials evolve through the project, including in the wiki.
4. Dialogue across the consortium as the results of the labs are being gathered, analysed, and synthesised.

The digital hub

This goes hand-in-hand with creation of the roadmap and as the roadmap is finalised, the design guidelines will ensure the digital hub provides a generative, inclusive and spatially aware means of creative dissemination. This will be achieved by:

1. Aligning the first version of the roadmap with the design principles through ongoing dialogue within the consortium
2. Creating the SENSE.STEAM wiki (Deliverable 7.2) which should serve as a participatory tool for gathering learning materials from across the consortium as they are created and tested throughout the labs and generating the roadmap. If possible, this could be expanded beyond the consortium to members of the public.
3. Forming a more concrete design brief for the digital hub by creating specific design guidelines for User Interface Design and User Experience Design (UI and UX) as well as design of educational materials. This should incorporate the project's Visual Identity.
4. The real roadmap and its world-application (task 7.4, 7.5 deliverable 7.5) at physical manifestations of the STEAM academy in Norway and Italy to test the notion of going beyond digital.

In conclusion, building on the wider context of the project, the SENSE manifesto has been used as a key means for compiling and aligning guidelines, practices and principles already defined by the consortium's work on the project. These are further linked back to the four primary objectives of SENSE. The three design principles ensure application of the manifesto and achieving of the objectives via the STEAM academy, digital hub and STEAM labs. They will continue to live and grow along with the context in which they have been created.

5. Formalities

Project information

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Grant agreement:	101058507
Programme and call:	Horizon Europe, HORIZON-WIDERA-2021-ERA-01
Project coordinator:	Lydia Schulze Heuling, Western Norway University of Applied Sciences
Contact:	HVL-SENSE@hvl.no
Project duration:	36 months (1 September 2022 - 31 August 2025)
Project website:	www.sense-steam.eu

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Work Package:	2 Uptake and Sustainability
Lead Beneficiary:	Velvet

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Revision History

Date	Version	Author	Comment
13/10/2023	V0.01	Joseph Sturm, Velvet	Creation of document outline
22/11/2023	V0.02	Joseph Sturm, Velvet	First draft content of Section 1 and 2
22/11/2023	V0.03	Anne Krebs, Musée du Louvre	First review
22/11/2023	V0.04	Joseph Sturm, Velvet	First draft content of sections 3, 4 and 5
23/11/2023	V0.05	Anne Krebs, Musée du Louvre	Second review
26/11/2023	V0.06	Joseph Sturm, Velvet	Restructuring to increase the role of the principles
27/11/2023	V0.07	Rebekah Breeding, UB	Third review
27/11/2023	V0.08	Joseph Sturm	Final version
28/11/2023	V0.09	Risk and Quality Manager, HVL	Next to final check and approval for submission

29/11/20203	V1.0	Coordinator, HVL	Final check and submission to the granting authority
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Abbreviations and acronyms

Abbreviation or acronym used in this document	Explanation
STEAM	Science, Technology, Engineering, Arts and Mathematics
UI	User interface design
UX	User experience design
WCAG	Web Content Accessibility Guidelines

Glossary

Term	Definition used or meaning in the SENSE project	Reference or source for the definition if applicable
Design principle	value statements that describe the most important goals that a product or service should deliver for users and are used to frame design decisions	Section 2.1 of this deliverable
Design process	A process to guide understanding of design issues and effective communication of solutions.	www.designcouncil.org.uk

<p>Recommendation to increase Social Inclusion</p>	<p>points addressing practical aspects to effectively guide the STEAM Labs in their task in considering social inclusion</p>	<p>D6.1</p>
<p>Roadmap</p>	<p>Roadmap is a strategic planning technique that helps to communicate to all the stakeholders of STEAM education the SENSE. project's goals, and their respective major deliverables over time which also supports them in defining their respective action plans</p>	<p>DoA</p>
<p>STEAM labs</p>	<p>A specialized learning environment for the implementation of SENSE.STEAM, featuring diverse participant panels and addressing specific needs in varied social, cultural, geographical, and economic contexts.</p>	<p>D4.1</p>
<p>SENSE. Manifesto</p>	<p>A living document that succinctly articulates the partners' shared principles, values and goals, serving as a guiding framework that unifies members' efforts and communicates their distinctive perspective or transformative vision to a broader audience. This manifesto provides a clear direction that fosters cohesion and resonance within the collective, while signalling its distinctive contribution to STEAM to the larger discourse.</p>	<p>D3.4</p>

STEAM Stakeholder	STEAM stakeholders encompass a broader range of entities such as students, companies or policy makers. Each of these groups has distinct interests and roles in the success of a STEAM initiative. For example, educators contribute to the design and delivery of STEAM curricula, while policymakers influence funding and educational policies related to STEAM education.	D3.3
three levels of SENSE	moving beyond a mere juxtaposition of art and science to explore, understand the world around us and to facilitate changes towards a more inclusive and sustainable life.	Sense-steam.eu

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.

The SENSE. consortium

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Annex 1: Alignment to the SENSE. project objectives

For SENSE. setting the wider context for creating design principles means beginning with the objectives set for the project. As per the *Description of Action* the project has four main objectives:

1. To create the praxis informed SENSE.STEAM Methodology
2. To establish the requirements for practical implementation of the SENSE.STEAM Educational methodology across Europe
3. To transform current STEAM educational practices by mainstreaming social inclusion and spatial design as cross-cutting issues.
4. To consolidate and disseminate findings into a Roadmap for Science Education

Each objective is further described and in addition is connected to number of KPIs (Key Performance Indicators). The following section will briefly consider the objectives and their KPIs to draw relevant input for creating the design principles.

Objective 1 aims to gather practices, which are used to prepare the methodology. Given the methodology is the key underpinning of the project, informs creation of the labs and ultimately roadmap and practices to be shared in the digital hub, this is an important input. The method's four building blocks of *STEAM.SENSE inquiry*, *Learner-Centred Pedagogy*, *Citizen Science and Art Practices* and *Reflective Feedback* can be used to inform the design principles. The building blocks are described extensively in Deliverable 3.5.

Objective 2 refers to the STEAM Labs as a key means for implementation activities.

Objective 3 seeks for space and social inclusion to be considered as cross-cutting themes, and therefore by definition both must be considered when preparing the design principles.

Objective 4 relates most directly to creation of the design principles with KPIs referring directly to the digital hub and academy.

KPI 4.1: Digital hub (STEAM Academy) including a repository of tools and reports, a STEAM Wiki, and interactive spaces with a sustainability plan in place for at least five years after the project

KPI 4.2: two STEAM Academies physically implemented in Norway and Italy.

Creation of the design principles is a necessary step in achieving this objective.