SENSE. The New European Roadmap to STEAM Education

D5.2 – Report on Evaluation of Space Strategies for the STEAM Roadmap

June 2024

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Abbreviations and acronyms

Abbreviation or acronym used in this document	Explanation
EU	European Union
SAK	Spatial Awareness Kit. See Delivery 5.1
STEAM	Science, Technology, Engineering, Arts and Mathematics
STEM	Science, Technology, Engineering and Mathematics

Glossary

Term	Definition used or meaning in the SENSE. project	Reference or source for the definition, if applicable
Affordance	Affordance is a term developed by J.J.Gibson and describes the dynamic relationship of individuum and physical environment. An affordance of an object or space defines the action possibilities it offers to the user.	(Lobo, Heras-Escribano, and Travieso 2018), (Norman 2013)

Pattern Language	Pattern language is a concept developed by Christopher Alexander to describe the built environment through a system of modular, spatial components ("Patterns") that evolved through social and cultural practice. Alexander sought to create a kind of architectural "grammar" as a base for a language that everyone could "speak", understand and apply.	Alexander 1978
Spatial literacy	Spatial literacy describes the awareness and knowledge of the complex relationship between the various components of the 3-dimensional physical environment and how it relates to human behaviour and perception.	Montello, Grossner, and Janelle 2014
Spatial agency	Spatial agency describes the ability to interact with the physical environment purposefully using the knowledge gained through spatial literacy.	Awan, Schneider, and Till 2011
Traditional classroom	A "traditional classroom" is a spatial typology that evolved in the 19th century. It describes a rectangular space within a school building, a group of students and typically one teacher. It features a display (for example, a blackboard) on the far end with rows of chairs and desks for the students directed towards it. It evolved from the need to support teacher-centred pedagogies spatially.	Gislason 2011

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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Executive Summary

This report summarises and evaluates the implementation of the Spatial Awareness Kit (SAK, D.5.1.) with the help of a range of primary data sources, comprising the activity reports of the STEAM labs (WP4), notes from "Spatial Surgeries" (interviews and work sessions with the STEAM labs), reflections of the research partners and a more detailed study of Hawkins\Brown's STEAM lab activities.

The report does - and cannot - constitute an empirical study of which environments are most suited for the SENSE methodology, i.e. it is not the aim to establish the ideal "STEAM space". The report represents a moment of stock-taking and reflection on the outcomes of the STEAM labs with a closer focus on the Hawkins\Brown lab in the UK and Ireland.

The workshops and exchanges with the research partners were essential for implementing the SAK, as its categories and terminology were not always clearly understood. One of the reoccurring discussion points was that some facilitators did not always distinguish clearly between describing the environment indiscriminately and analytically evaluating each component's relevance for SENSE-specific objectives.

However, from the overall analysis and feedback, it can be seen that all labs actively engaged in thinking about the physical environment and its impact on the activities. A general increase in the ratings between pre and post-activities showed a rising awareness and recognition of the relevance of the physical environment for the STEAM approach.

The most common spatial typologies used in the labs were outdoor spaces and adaptable classrooms with flexible furniture. Especially the latter represents the spatial bedrock of STEAM education. Familiar appearance ("sense of belonging") and spatial flexibility were rated highly by most of the facilitators. Especially the importance of appearance came as a slight surprise to the research team.

Using the experience gained from the STEAM labs, the report revisits the two overarching categories, "supportive" and "explorative" spaces, highlighting that these are not exclusive descriptors but represent two poles on a sliding scale without positive or negative connotations. While a "supportive" space creates the right conditions for a STEAM activity, an "explorative" use of space turns the physical environment into a purposeful tool to achieve STEAM-specific objectives.

While most labs used environments the research team classified as "supportive", roughly a quarter of the activities triggered a more active use of space. The Hawkins\Brown lab demonstrated how studying light and shadow effects could lead to a range of explorative behaviour patterns, depending on the type of environment in which the activity was carried out. For example, large spaces without much environmental control led students to create their own virtual space as a micro-world.

In some cases, the participants used light sources to transform the environment into a new, explorative space. However, it needs to be noted that the outcomes for explorative use were less predictable than presumed.

Moving forward, the report suggests clarifying and simplifying the language of the SAK for the “Spatial Self-Experience Kit” (D5.3) and considering replacing the four categories with a set of targeted questions to avoid confusion.

To make the methodology usable for the roadmap, the report suggests adopting Christoper Alexander’s concept of spatial “patterns”, which he conceptualised as a system of modular “spatial strategies” to provide non-architects with design agency. A similar approach could be used to create a collection of spatial STEAM patterns as an inspiration for the SENSE. roadmap users.

The ultimate aim of the “Spatial Self-Experimentation Kit” will be to raise awareness for the spatial conditions of STEAM education and inspire a wide range of stake holders to engage more actively and experimentally with their physical environments, with the overall aim to increase spatial literacy and agency.

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1. Introduction

1.1. Purpose and Limits of the Document

This document aims to harness the research partners' experience regarding best practices in STEAM education, with a particular focus on spatial aspects.

Following the scoping report and several workshops with the research partners to rehearse and test the spatial awareness kit (D5.1), all STEAM Labs were asked to fill in feedback documents describing the setting of the STEAM practices and asses how the spatial setting influenced the outcomes of their activities. The base for the feedback was the "Spatial Awareness Kit", which was part of Delivery 5.1. Delivery 5.2 analyses the submitted activity reports, critically reflects how the methodology was applied within the STEAM labs, and describes the spectrum spatial approaches used within the research consortium.

It is important to acknowledge the complexity of the subject and the diversity of the STEAM labs across Europe. With this in mind, this evaluation report will and cannot establish a guide that provides highly defined recipes for the spatial arrangements of STEAM.SENSE environments. The conceptual impossibility of such a normative aspiration has been sufficiently explained in D 3.5. The idea was to provide the research partners with a template for discussion and reflection. The report will present the outcomes of this process. In the last ten months, we gathered and analysed a significant amount of data. This report can only outline a high-level summary of the findings.

Although we asked the STEAM labs for feedback in a standardised and quantifiable form, it is understood and intended that our primary data is essentially a collection of qualitative assessments across widely different contexts and target groups.

Ultimately, this report is only an interim step towards integrating spatial aspects into the SENSE.STEAM roadmap. In this sense, we are in a moment of stock-taking and reflection on the original premises, its implementation and "collision" with the reality of a diverse array of STEAM labs. As the methodology is a prototype, the evaluation will highlight areas for improvement and clarification.

1.2. Intended readership

The report will be publicly available and, as such, be accessed by the stakeholders and beneficiaries, as outlined in Deliverable 3.3. However, as a background document, it is predominantly directed at the consortium members in general and at the facilitators

and organisers of the STEAM labs, in particular, to help reflect the spatial setting of their STEAM practices.

1.3. Structure of the Document

The report is divided into three parts. The first part presents the data sources that informed the analyses in the second part. This is followed by a third and last section where we discuss how we will use the findings for the Spatial Self Experience Kit (D 5.3) and the Roadmap (WP7), including a deeper dive into the case studies of the Hawkins\Brown STEAM lab in England and Ireland.

1.4. Relationship with other Deliverables

Similar to the cross-cutting delivery "D6.2 - Report on Evaluation of Social Inclusion Strategies for the SENSE Roadmap," this report analyses the STEAM lab feedback. Here, we look at the first results of the reported activities from within the SENSE.STEAM Labs and analyse the self-reflection exercises and lessons learned. These insights will feed into the Spatial Self Experience Kit (D5.3) as part of the SENSE. Roadmap.

The base for the feedback from the labs is the „Spatial Awareness Kit" (SAK), part of delivery 5.1, which established the core terminology used throughout the WP4 implementation. While we will refer to the Toolkit and use its terminology consistently, we will not reflect its methodology at length and will refer the reader to delivery 5.1. While we clearly understand the many overlaps between the different evaluation metrics of WP4, 5 and 6, this report will focus mainly and almost exclusively on evaluating the completed SAK reports and spatial aspects. Future deliveries will aim at a higher degree of integration with the various evaluation metrics developed across the work packages.

Finally, the report will not contain in-depth explorations of the SENSE Methodology in general or spatial theory in particular. These themes have been explored and summed up in deliverables 3.4 and 3.5.

2. Primary Data Collection

2.1. General Comments

The primary data source for the impact of learning environments consists of the activity reports in which the STEAM labs ranked the four categories (Function, Appearance, Environmental control and Space) of the Spatial Awareness Kit (SAK), with individual ratings by activity and space (with some underlying aggregations where multiple activities took place in one location). In addition, we conducted interviews and workshops with research partners and collected written statements from the facilitators.

Hawkins\Brown's STEAM lab focussed on studying the impact of the learning environment. It developed tailored activities to test how physical environments influence the behaviour and experience of the participants.

Although the research team aimed to standardise and quantify the evaluation to a certain degree by giving a ranked scale to the facilitators, the collected primary data needs to be seen as a predominantly semi-structured qualitative source, giving us an impression of the spectrum of conditions, opportunities and viewpoints across the different STEAMlabs.

The evaluation is and cannot be an empirical study that recommends and rates particular learning environments and spatial arrangements as "ideal" for STEAM education. Given the diverse contexts, facilitators and audiences, this would be impossible. As we pointed out in D5.1, the fundamental problem in evaluating educational spaces is that the indicators for "success" are often unclear (or implicit), with frequently declarative knowledge metrics dominating. From our point of view, this was of secondary importance as the SENSE methodology focuses on processes and reflected feedback – mirroring the dynamic relationship between human perception and the physical environment.

The central objective of the SAK was, therefore, to initiate a structured discussion, raise awareness and collect a broad spectrum of approaches that will feed into the Spatial Self Experience kit that – as the name suggests - is not a normative compendium either but will serve as inspiration for educational practitioners across Europe to continue and adapt the experiments which our research started in a reflected - and hopefully - creative manner.

2.2. The Spatial Awareness Kit

The Spatial Awareness Kit (SAK) is the centre-piece of the data collection and our "Guideline" for a reflected conversation about the physical environment. For this, we

suggested segregating the condition or the physical environment into four categories, which should guide a reflection on the learning environment.

Function	In this section, you should reflect on **what kind of equipment** is necessary for the activity and its users. • What equipment is required to run this activity smoothly (Tables, chairs, blackboard/whiteboard, digital tools, etc.)? • Requirement of specific supplies like- power, gas, specialist goods, etc.? • Does it require storage, washroom access, showers, a kitchenette, etc.? ....
Spatial Configuration	In this section, you should reflect on the types of spaces where this activity could be carried out. Think about their internal and external configuration. Space doesn't necessarily mean a room in a building. It can also be an outdoor location or public place, such as a market square, a park, etc. • The dimensions of the space • Would you need one or more spaces? • Is this an indoor, outdoor or mixed-space activity? • What is the selected space's height, type, shape, and size? • What is its spatial configuration (for example, is it a row-based classroom, an open plan situation, follows activity-based learning, or just an empty room)? What about the flexibility of furniture • Does this space require disabled access, or does it need multiple entrance/exit points? • Does this need an area for performative activities (like a stage)? How would this manifest spatially? • Does the activity require modification of the space? .....
Environmental Control	In this section, you should reflect on the environmental conditions of the space, such as air, light, temperature, noise levels etc. Will these parameters need to be controlled? • Type of light – Natural or artificial? • Do the windows need blackout curtains? • Does it need natural ventilation or air conditioning?

	• Would windows need to be glazed and soundproofed to control temperature and noise levels? • Would the sense of smell enhance the activity? • What about noise? ….
Appearance	In this section, you should reflect on what the physical environment looks and feels like. What kind of emotions does it instil? • Is it a space that looks familiar to the participants? • Materials used for furniture. • Will the colour scheme of the space and the furniture impact the activity? • Are there any visual stimuli around? ….

The STEAM labs were asked to analyse (or better dissect) the learning environment and rank each category on a scale from 5 = “very important” to 1 = “not important at all” in terms of relevance for achieving the activity objectives. Each category was rated before and after the activity.

The emphasis in this context is on a three-step process:

(1) Define the STEAM-specific objective of the activity
(2) Analyse and determine the components of the activity for each category.
(3) Come to a reflected rating for each element in light of their relevance to the overarching objective.

The success of this method hinged on a clear understanding of the objective and the ability of the facilitator to move beyond a descriptive approach to the physical environment.

It is needless to say that analysing and categorising something as complex as the physical environment and relating it to a similarly challenging methodology like SENSE sometimes produced mixed results and some confusion. However, the Hawkins\Brown research team always emphasised that understanding and analysing the learning environment can only happen through discourse, and from that point of view, the SAK was successful.

2.3. Spatial Surgeries

After the “Spatial Awareness Kit” (SAK) was introduced in Georgia, the research team at Hawkins\Brown initiated a series of “spatial surgeries” with the research partners, during which the setting an location of the STEAM lab activities were discussed, and suggestions were made. These meetings were also helpful for practising the terminology developed in the SAK.

As one might expect with this complex and context-dependent topic, we encountered a variety of challenges during those discussions regarding the understanding and use of the suggested categorisation:

Questions raised	Answers
What is a learning space? Some research partners defined learning environments as purposely designed spaces, with the school building as the key example. They felt that the “Spatial Awareness Kit” would not be relevant for some activities in random, improvised spaces, for instance, outdoors or in alternative locations that were never intended to be used as learning environments.	**Everything is a space!** It was highlighted that the SAK treats the physical environment in a neutral way. There is no methodological difference between “designed” and “improvised “ spaces. It is not so important how we “shape” the physical environment but what decisions we make, where we are, and how we relate to our surroundings. Space is always there, like the air we breathe; it is more a question of how we use and relate to the environment. Decision-making and selecting are more impactful than shaping.
Limited agency and resources Some research partners pointed out that they felt “they had no choice” and were given spaces very limited in their adaptability, bare and neutral. Often, the problem was solely ”getting the spaces” to work “somehow”, just to get on with the job. Functional considerations become an overwriting factor and are perceived as limiting more sophisticated spatial strategies due to lacking resources.	**Agency needs no resources**. It was acknowledged that external conditions often limit choices that might not be conducive to STEAM activities. However, it must be highlighted that every space can be modified and changed, no matter how limited the means are. The idea behind the analytical concept of the SAK is to develop “spatial literacy” skills that help to identify and prioritise the relevant elements of the learning environment for targeted interventions. This can range from the creative rearrangement of furniture to simply

	deciding to leave an unsuitable space and look for an alternative, maybe improvised setting, whereby the decision to leave already establishes strong spatial agency and empowers the participants.
Categories are not clear. In many conversations, it was pointed out to us that the differences between the four categories were unclear, with research partners often confusing functional and environmental control components.	**Ask the right questions**! The confusion was expected and only natural as the segregation of the physical environment into specific categories is, to a certain degree, artificial and arbitrary. It is impossible to avoid overlaps. To mitigate this, we always encouraged the research partners to return to the SAK's original questions. For example, instead of attempting to define what "function" might mean, simply ask: "What equipment do I need to get this activity to work?". The SAK was not intended to be a universal system but a set of guided questions relating to the physical environment. Notwithstanding the confusion, the discussion "Is this a functional relevant item?" is very productive in itself. It helps to understand the relevance and potential of the physical environments. In this sense, the attempt and reflection on the categorisation was already part of the process to raise awareness, even if it was born out of confusion.
What to do with multiple spaces? Some STEAM labs combined and connected a range of spaces for their activities. For example, the University of Edinburgh used a classroom in combination with a garden and a greenhouse—a range of other partners combined indoor and outdoor spaces for some of the activities. However, the SAK tends to focus on singular environments.	**Use the SAK flexibly.** It is acknowledged and a lesson to be learned that there are limits to fragmenting the physical environment. In this case, we encouraged the research partners to "zoom out" and look at the combination of spaces as "one spatial system", which could be ranked and analysed in a similar way to the single spaces it contains.

	The combination of spaces was identified as a powerful spatial strategy with much STEAM potential and should be included in Delivery 5.2. However, the research team also concluded that there are limits to the SAK, where it will be helpful to develop broader, more comprehensive approaches that can capture larger spatial systems.

The conversations with the research partners were instrumental and demonstrated how important the analytic discourse is in raising awareness. This discourse is often missing in traditional learning environments.

The research team at Hawkins\Brown took notes of the conversations and created a set of spider diagrams that were returned to the research partners with annotations to give advice and ask for clarifications. Figure 1 is an example of one of those diagrams. These graphics were useful communication devices, and it should be considered to use them for the Spatial Self-Experience Kit (D.5.3), too.

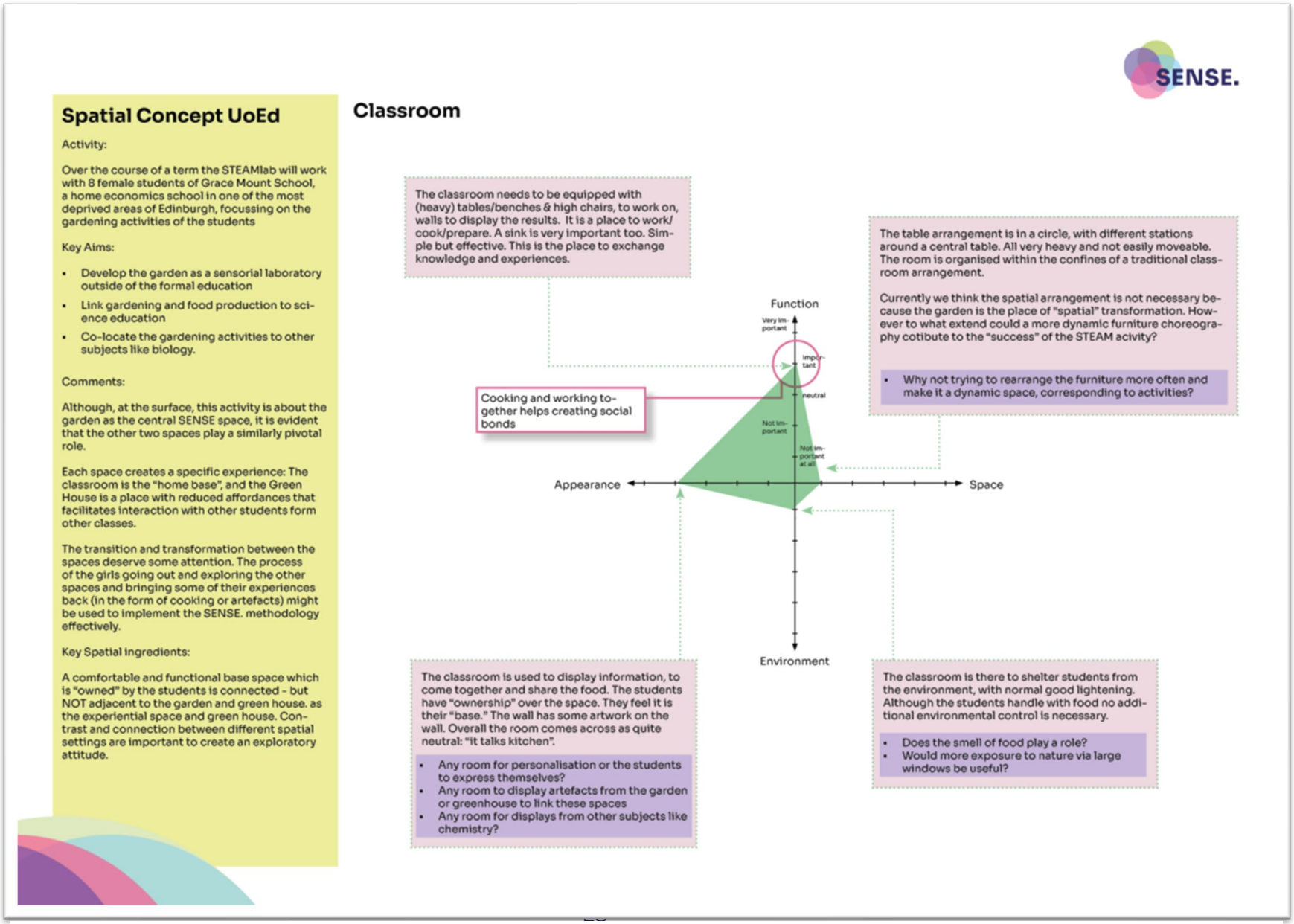

Figure 1: Sample outcome protocol from a spatial surgery discussion.

2.4. Focussed Labs

Within the research consortium, Hawkins\Brown takes on a double role. On the one hand, Hawkins\Brown is responsible for monitoring spatial strategies across the labs. On the other hand, the labs in London and Kinsale were designed to test the methodologies developed in D5.1 more in-depth. The Hawkins\Brown STEAM lab, therefore, carried out a limited number of activities ("Letter from the Future" and "Light and Shadows") within a range of different spatial settings.

List of activities and workshops (Activity descriptions in the Appendix)

Lab	Actvity	Space typology	Age groups
Parliament Hill / London	Light & Shadow	Maker Space	15-17
Parliament Hill / London	Light & Shadow	Large Assembly Hall	15-17
Highbury Grove / London	Light &Shadow	DT Lab	15-17
Highbury Grove / London	Light & Shadow	Science Lab	15-17
Highbury Grove / London	Light & Shadow	Foyer	10-16
Highbury Grove / London	Light & Shadow	Art space	10-16
Kinsale Community School	Light & Shadow	Corridor	15-17
Kinsale Community School	Light & Shadow	Theater Stage	15-17
Kinsale Community School	Light & Shadow	Maker Space	15-17
UCL Academy Group 1	Mapping the Neighbourhood/ Letter from the Future	Small classroom (Both sessions)	16-17
UCL Academy Group 2	Mapping the Neighbourhood/ Letter from the Future	Large classroom/ Outdoors (schoolyard)	16-17

As noted in Chapter 2.1, these field tests need to be heavily caveated. The Hawkins\Brown research team could see some impact of the different learning environments; for example, it was noted that the outdoor setting influenced the group work output significantly; the other labs also contributed a few insightful surprises, which we will discuss in more detail in Chapter 3.4. However, these findings cannot be generalised. The test sample was too small for any significant statistical analysis, and the institutional and spatial contexts differed widely. Nevertheless, the activities helped test some of our early hypotheses and opened up a spectrum of possible interventions to inform the Spatial Self-Experimentation kit.

3. Findings

3.1. The SAK in Action

3.1.1. Implementation

When the Hawkins\Brown research team developed the methodology, it was meant to become the structural backbone for the activities, evaluation, and – later - roadmap. The methodology was based on existing research into educational spaces but was adapted to the context of STEAM education. In addition, the method was used by a wide range of stakeholders outside of the architectural research spectrum.

With this in mind, it is unavoidable that the adoption of the SAK was not always without challenges. While overarchingly, most labs applied the SAK efficiently to reflect spatial aspects of their STEAM activities, it was not always fully understood as intended.

A reoccurring – and slightly unexpected - misunderstanding was that many research partners used the rating system too descriptively instead of weighting the identified factors against the activity objectives. A typical example of this is that facilitators conducted activities outdoors and rated the category space as low ("not so important"), as there "was no space used". However, we would have pointed out that using the outdoors as a learning environment (as opposed to the traditional classroom) is an essential spatial strategy and more than relevant for the activity's success.

In other cases, facilitators described standard classrooms as "bland" and, as a consequence, rated them low on the appearance scale. However, it could be argued that – on reflection - a more pleasing-looking classroom with bright colours might have had a desirable energising effect on the activity by stimulating the senses.

In some cases, the Hawkins\Brown research had the impression that the confusion in ranking the efficiency of the learning environment was a consequence of missing or at least unclear definitions of STEAM-specific objectives. It goes without saying that if the STEAM-specific objective of an activity is not fully clear, an assessment of the physical environment tends to be guided by predominantly performative aspects ("Was the space suitable for a smooth execution of the activity?")

The Hawkins\Brown research team provided feedback and held various workshops and discussions with the STEAM labs, which helped to rectify some of the confusion. This led to improvements, but overall, it needs to be noted that the 3-step mechanism: (1) *Define the STEAM objective*, (2) *Analyse how the environmental conditions relate to those objectives and* (3) *Decide on priorities*, will need to be made clearer for Delivery 5.3.

Another ambiguity noted is how the term “space” was used. While the SAK defined “space” as a geometric category,i.e., the description of the cartesian relationship between elements, many STEAMlabs used it more generally – as an umbrella term for what we usually describe as the physical environment. It is understood that space is often used as an overarching category, and this report uses it sometimes in the same way, acknowledging that both uses are possible. However, the distinction between physical environment and geometric space is important for the analysis and will need to be more precisely defined for the Road Map resources.

Overall, the SAK triggered a wide range of observations and reflections, as seen from the many long comments in the activity reports. The research partners widely acknowledged that the environment has an impact on the outcomes of the STEAM activities, as can be seen from the increase in ratings between Pre- and Post assessments (see Chapter 3.2)

Being aware of the slightly heterogeneous interpretation of the SAK we asked the STEAM labs to write a short essay summarising what they considered the main factors for the learning environment they observed (See Appendix) This qualitative feedback added more depth to our understanding of what kind of spatial typologies and elements were considered to be most beneficial for the SENSE methodology.

3.1.2. Preferred Spatial Typologies

The flexible, generous seminar room with functional support for making (sink, etc.) dominated the activities in the STEAM labs, either as a flexible classroom or a maker space/ fab lab. As the success of many STEAM activities relied on efficient group work and interaction between the participants, many facilitators preferred a flexible space with decent environmental controls and adaptable furniture settings. Simplicity was essential to avoid the affordance traps of traditional classrooms. As already noted in the scoping report, the generous open-plan space with decent environmental control and flexible furniture is the bedrock, the “lingua franca” of STEAM education.

An interesting aspect raised in many of the feedbacks was that many facilitators noted the positive impact of appearance on a feeling of familiarity, trust, and comfort, which was especially relevant for those dealing with marginalised participants. Many lab reports emphasised the importance of the “look and feel” for the activities, instilling a sense of belonging. While none of the STEAM labs experimented with unusual appearance features, one STEAM lab noted that a possible strategy might be to “defamiliarise” specific spaces to counteract an institutionalised language.

> *The appearance of some of the rooms made a bigger difference than anticipated, for instance, there were cosy rooms with floor-to-ceiling windows and a lot of greenery outside, which made us feel like we were working from outside, even though we were inside. (STEAM lab UB)*

Another group of activities used outdoor spaces to create a multi-sensory stimulating environment and/or raise awareness for the endangered eco-system and ongoing climate crisis. While the stimulating connection to nature is an apparent aim for many STEAM activities, outdoor environments were also be used as a place of spatial agency (for example, the garden in the Edinburgh STEAM lab or CREDAs outdoor activities) or as a statement against institutionalised places of education (like the citizen science activities of the University of Barcelona). It is worth highlighting that using the outdoors as a learning environment – including seating and other equipment – fundamentally differs from using the outdoor space as a deliberately improvised setting (see also comments in Chapter 3.4.2). The feedback from the SAK showed how versatile outdoor spaces could be included, with the potential to be used extensively within STEAM curricula.

STEAMlabs rarely integrates performance spaces (such as stages) into the activities. Similarly, random, non-traditional locations were not chosen for activities.

One new typology that evolved is what we might call the “spatial eco-system”, consisting of a combination of locations which the participants regularly use. The contrast and regular transition between the locations have the potential to create an impactful dynamic. For example, the STEAM lab of the University of Edinburgh developed a spatial eco-system consisting of a garden, classroom and greenhouse,. The transition between the two spaces, moving from the classroom to the garden and vice versa, has made these environmental aspects more felt or visible (e.g., experience of natural light and temperature).

3.2. Activity Reports Analysis

		Function			Appearance			EnvironmentalControl			Space			Space Typologies	
Lab	Activity	Function Pre	Function Post	Average Increase	Appearance Pre	Appearance Post	Average Increase	Pre Env. Control	Post Env. Control	Average Increase	Space Pre	Space Post	Average Increase	Supportive space	Explorative space
CREDA	In-Visible	5	5	no change	2	2	no change	1	1	no change	1	1	no change		yes
	In-visible	1	3	up	1	3	up	4	4	no change	5	5	no change		yes
	Activity for students (15-21 years old)	4	4	no change	3	5	up	2	5	up	4	4	no change	yes	
	A shared hydroponic vegetable garde	5	5	no change	2	2	no change	4	4	no change	5	5	no change	yes	
	In*Visible – Photovoice Project - Court	1	1	no change	5	5	no change	3	3	no change	4	4	no change		yes
	In*Visible – Photovoice Project - Class	1	1	no change	2	5	up	2	5	up	3	5	up	yes	
	uture Workshop/Spatial Geometry/Scr	3	3	no change	2	2	no change	2	2	no change	5	5	no change	yes	
GEYC	Bucharest- Today and in the Future	3	5	up	3	4	up	1	3	up	3	4	up	yes	
	Gender Roles 2 Bucharest	4	5	up	3	5	up	1	3	up	1	4	up	yes	
	Gender Roles 2 Timmisora	1	4	up	1	5	up	1	3	up	1	4	up	yes	
	Reclaiming our bodies (Campina)	2	3	up	3	4	up	2	3	up	3	3	no change	yes	
	Skin of the world	3	5	up	3	4	up	2	3	up	3	3	no change	yes	
	Crashtest your institution	3	3	no change	3	4	up	3	3	no change	4	4	no change	yes	
	The 'Miracle & Wonders	4	4	no change	3	4	up	3	4	up	4	4	no change	yes	
	D.I.N.E.	3	5	up	5	5	no change	1	2	up	4	4	no change		
	A house for the fairy	3	5	up	3	5	up	2	4	up	1	1	no change		yes
	Gender Portraits	5	5	no change	4	5	up	1	4	up	2	5	up		
	A small survey on destruction	3	4	up	4	5	up	3	3	no change	3	4	up	yes	
Hawkins\Brc	Light&Shadow 1 Parliament Hill DT Lat	3	5	up	1	1	no change	3	5	up	5	3	down	yes	
	Light&Shadow 1 Parliament Hill audito	3	5	up	1	1	no change	3	5	up	5	5	no change		yes
	Light&Shadow 2 Highbury Grove DTLa	3	5	up	1	1	no change	3	5	up	5	3	down	yes	
	Light&Shadow 2 Highbury Grove Lab	3	5	up	1	1	no change	3	5	up	5	3	down	yes	
	Light&Shadow 3 Highbury Grove Foye	3	5	up	1	1	no change	2	5	up	5	3	down		yes
	Light&Shadow3 Highbury Grove Roun	3	5	up	1	1	no change	2	5	up	5	3	down		yes
	Kinsale Community School Corridor	3	5	up	3	3	no change	2	4	up	5	3	down		yes
	Kinsale Community School Stage	3	5	up	3	4	up	2	5	up	5	5	no change		yes
	Kinsale Community School Lab	5	5	no change	1	1	no change	4	4	no change	3	5	up	yes	
	UCL academy Group 1	3	3	no change	2	2	no change	1	1	no change	4	5	up	yes	
	UCL academy Group 2	3	3	no change	2	2	no change	1	1	no change	5	5	no change		yes
HVL	01 House of the Fairy	4	5	up	4	4	no change	4	4	no change	4	4	no change	yes	
	Soil Taxonomy activity at the Skapersk	3	4	up	2	2	no change	3	3	no change	2	2	no change	yes	
	Sequence and training with VilVite staf	4	4	no change	4	4	no change	2	2	no change	3	4	up	yes	
Louvre	Louvre_LAB1_Botanical Drawing	4	4	no change	3	5	up	2	3	up	1	4	up	yes	
	Louvre_LAB2_Toolmaking & Botanical	5	5	no change	1	3	up	2	3	up	2	4	up	yes	
	Louvre_LAB3_Shaping Herbariums	4	4	no change	3	5	up	2	3	up	2	4	up	yes	
	Louvre_LAB4_Expanding Botanical Po	5	5	no change	4	5	up	4	4	no change	5	5	no change	yes	
	Louvre_LAB5_Bearing Walls	3	4	up	3	4	up	2	3	up	1	3	up	yes	
	Louvre_LAB6_Lighting Ambiences	3	4	up	3	4	up	3	2	down	1	3	up	yes	
	Workshop on the Art of Measuring	4	4	no change	3	3	no change	3	3	no change	2	3	up	yes	
Odyssea	1st Lab - Gender portraits & bios	2	4	up	2	3	up	5	5	no change	2	3	up	yes	
	4th Lab - Gender Portraits & bios	4	4	no change	4	4	no change	3	4	up	5	5	no change	yes	
	5th Lab - Gender Portraits & bios	4	4	no change	4	4	no change	3	4	up	4	3	down	yes	
	6th Lab - Future neighbourhood and g	4	4	no change	4	4	no change	3	4	up	2	3	up	yes	
PHW	2024_04_25 Boys' Day - 1	2	3	up	1	3	up	4	5	up	2	1	down	yes	
	2024_04_25 Boys' Day - 2	4	5	up	4	2	down	2	4	up	3	3	no change	yes	
	2024_05_02 PHW Mapping	2	5	up	4	5	up	3	3	no change	3	4	up	yes	
	2024_05_09 Article from the Future	2	3	up	2	3	up	3	3	no change	3	4	up	yes	
UB	Airmapping on the Besós River	5	5	no change	1	1	no change	1	1	no change	5	5	no change		yes
	Citizen Science for Mental Health in Cl	4	5	up	2	3	up	1	3	up	2	3	up	yes	
	Citizen Science for Mental Health in Sy	3	3	no change	4	5	up	3	5	up	3	5	up	yes	
	Citizen Science for Mental Health in Ur	4	5	up	4	5	up	3	5	up	3	5	up	yes	
	Heat Chronicles in La Ribera - inside	3	3	no change	1	1	no change	3	3	no change	3	3	no change	yes	
	Heat Chronicles in La Ribera - outside	5	5	no change	1	1	no change	1	1	no change	5	5	no change		yes
	Heat Chronicles in Montcada i Reixac	3	3	no change	1	1	no change	3	3	no change	3	3	no change	yes	
	Heat Chronicles in Sant Vicenç dels He	3	3	no change	1	1	no change	3	3	no change	3	3	no change	yes	
	Heat Chronicles in Sant Vicenç dels He	5	5	no change	1	1	no change	1	1	no change	5	5	no change		yes
Uedin	Garden (aggregated)	5	5	no change	3	5	up	3	4	up	4	4	no change		yes
	Classroom (aggregated)	5	5	no change	3	4	up	3	4	up	4	4	no change		yes
VELVET	Workshop 1_Building a snow city	4	5	up	4	5	up	4	5	up	5	5	no change	yes	
	Workshop 2_Creating a prototype of a	5	5	no change	5	5	no change	4	5	up	5	5	no change	yes	
Vilvite	Launch	4	4	no change	4	4	no change	4	4	no change	4	4	no change	yes	
	Extraterestrial Life	4	4	no change	4	4	no change	4	4	no change	4	4	no change	yes	
WECF	Sequence 2_Article from the future	5	5	no change	3	3	no change	4	4	no change	5	5	no change	yes	
	Sequence 3_Bodyclock architecture	5	5	no change	3	5	up	5	5	no change	5	5	no change	yes	
	Sequence 4_A house for the fairy	5	5	no change	5	5	no change	4	4	no change	5	5	no change		
	Sequence 5_Gender roles	4	4	no change	5	5	no change	4	4	no change	5	5	no change		
	Sequence 7_Drawing Sounds	5	5	no change	4	3	down	5	5	no change	4	5	up	yes	
	Sequence 8_Building Bridges	5	5	no change	3	3	no change	4	4	no change	5	5	no change	yes	
	Average Ratings	3.6	4.3	0.7	2.7	3.4	0.7	2.7	3.6	0.9	3.6	3.9	0.3	49	15
	Average Change (Proprotion of increased activity ratings)			43%			46%			52%			34%	73%	22%

On the left is the analysis of the activity reports. The green headigs represent the ratings given by the facilitators.

The pink headings contain the (subjective) assessment by the Hawkins\Brown research team of whether the space was used in a supportive or explorative manner.

The green cells indicate a higher rating of the post-activity evaluation, while the red markers indicate a decrease.

The ranking scale is from 1 = „not important at all“ to 5 = „very important“.

Figure 2: Aggregated activity reports (Hawkins|Brown) See also Appendix.

The Hawkins\Brown research team aggregated all activity reports in one table to allow for an overarching, more quantitative analysis. As noted before, the widely differing contexts of the labs and the – unavoidably diverse interpretation of the four categories – make a deeper analysis difficult to important. For example, the aggregated data cannot be used to demonstrate that "space" and function are the most impactful categories because both indicators achieved the highest average ratings. The quantitative analysis is even more difficult as, in some cases, facilitator teams combined several activities in one report because they all took place in the same location within the same physical environment.

Still, there are significant observations worth highlighting:

- Hardly any post-activity rating was lower than the pre-activity assessment. From a total of 268 ratings, only 12 (4.5%) post-activity ratings were lower.
- The majority of the ratings increased in value, i.e. were considered more important in hindsight (see Figure 4)
- On average, the ratings increased by 0.65. While "space" showed the lowest pre-post difference, "environmental control" seems to be the most underrated factor. 52% of the environmental control ratings increased in the post-activity assessment.

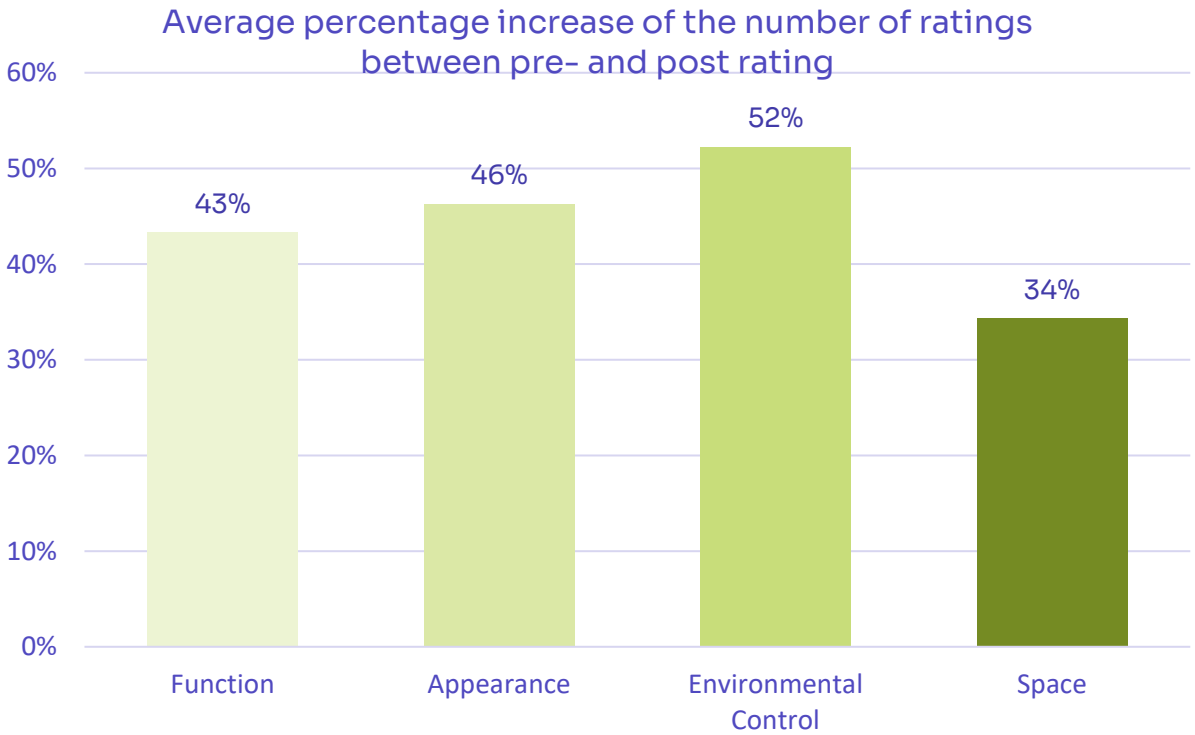

Figure 3: Percentage of the number of assessments that increased in the post-activity assessment. The percentage does not reflect the amount of increase, just the number of increased assessments.

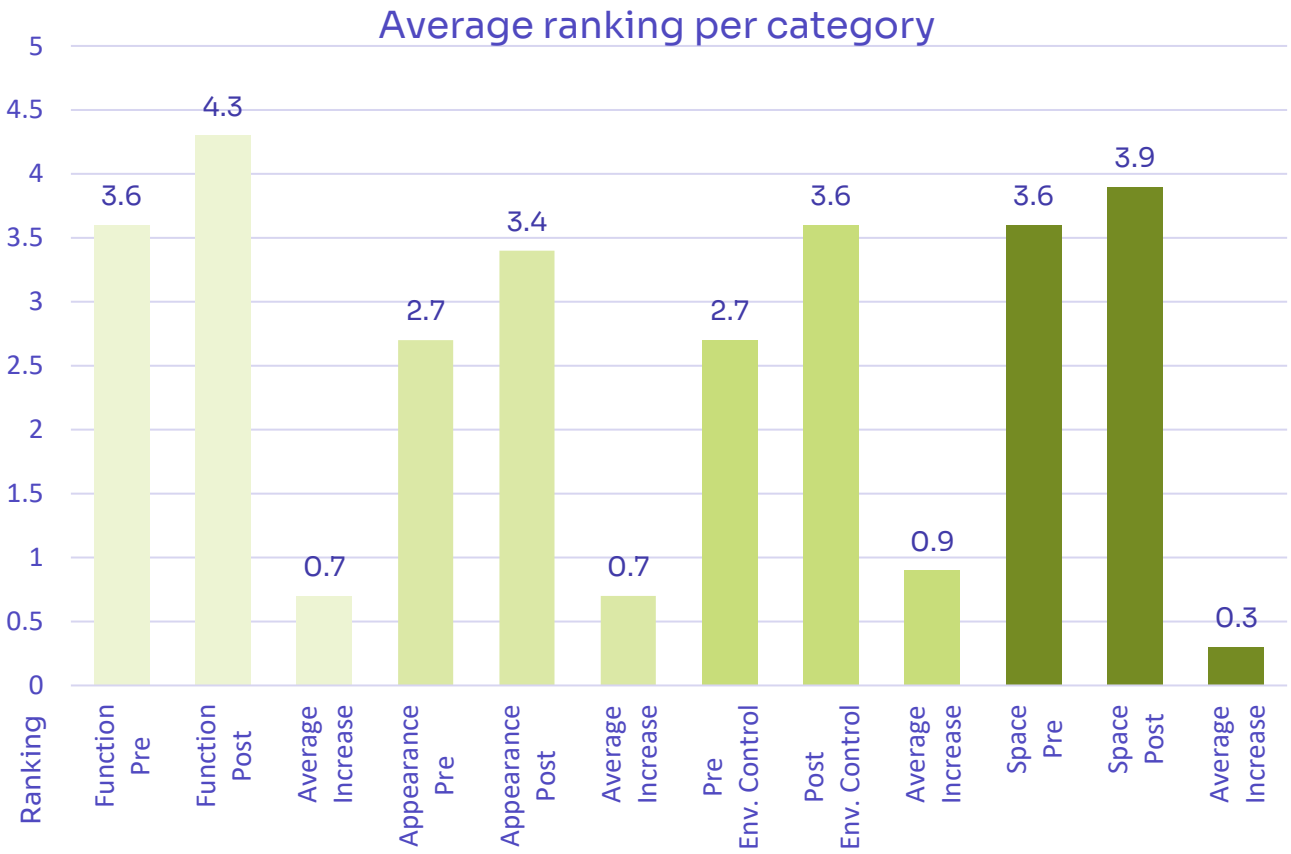

Figure 4: The above diagram shows each category's average pre- and post-rating, including the average increase between the two values. The ranking scale is from 1 = „not important at all" to 5 = „very important".

The rating increases show that facilitators often underestimated the importance of the physical environment at the outset of the activity and, on reflection, corrected the values in hindsight, as many of the comments on the activity reports show. This corresponds to the many discussions the design team had during the "Spatial Surgeries" and other workshops. In this sense, the objectives of the SAK, i.e. to raise awareness, were fully achieved. The following quote gives a good impression of how the SAK acted as a catalyst for reflection.

> *This activity was the first STEAM method implemented by us. So, in the beginning, we didn't understand these indicators very well because we didn't know how to relate to them and their impact on the activity. The fact that after the activity, their score is very different shows that we realised their importance in the results of the activity and that we have understood how to look differently at their contribution to our activity.* (GEYC comments on the SAK)

3.3. Supportive & Explorative Environments

The second part of the SAK suggested recombining the four affordance categories and placing them onto a scale between two poles, with “supportive” or “passive” environments on the one side of the spectrum and “explorative” or “active” environments on the other end. This synthesis is essential, as the segmentation – yes fragmentation - of the physical environment into categories often felt artificial. Clear-cut lines between the categories were frequently difficult to establish or agree on, with many ambiguities and overlaps. The analytic split into categories can only be seen as a (necessary!) catalyst towards a more holistic terminology.

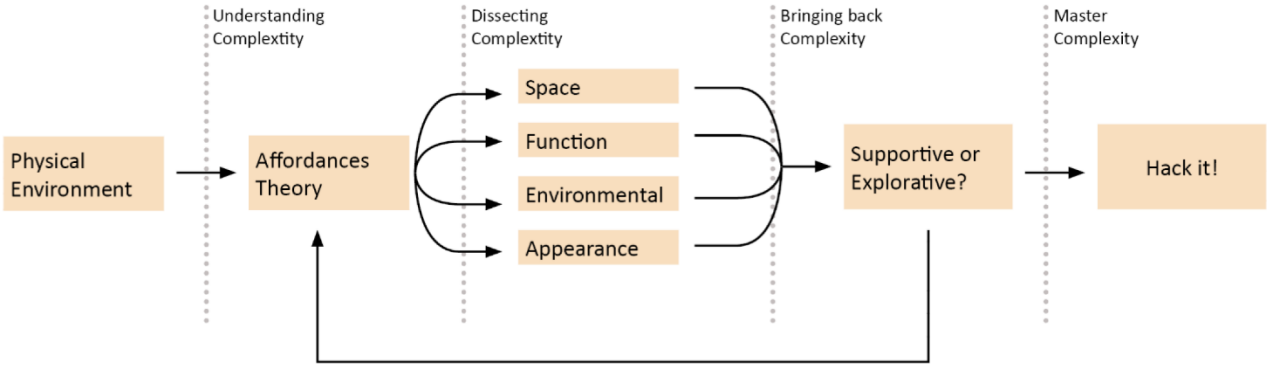

Figure 5: Sketch from the SAK showing the underlying analytical process

We defined a “supportive“ or „enabling“ environment as a passive space that supports an activity functionally but does not play an active part within the STEAM enquiry. In an „explorative space“, in contrast, the environment turns into an interactive tool. i.e. it plays an active, indispensable role in the enquiry process. For our methodology, the link to the STEAM enquiry is quintessential for categorising a space as „explorative“. Explorative spaces are not constituted by any random interaction with the environment but evolve from purposeful intent within the STEAM enquiry, turning a space from a neutral container into a catalytic tool.

For example, in one of the STEAMlabs in Bergen, the activity „Soil Taxonomy“ was enabled indoors through tables and trays that could hold (and contain) the earth that was brought in from the outside. The trays were necessary to protect the space and keep it tidy. It was the right functional equipment to „enable“ the activity. If we were to turn this „supportive“ setting into an „explorative“ one, the participants could have been encouraged to use the soil to resurface the floor or the walls, to convert the room into an interactive earth atlas by coating it with brown dust, spread the soil, start painting with it, etc. and other spatial interactions between soil and room, which, of course, was prevented by the social rules of the location.

Another example of this was the use of outdoor spaces. In the “letter from the future” activity in the Hawkins\Brown STEAM lab (see chapter 3.4.2), the outdoor space, in this case, a schoolyard, was used to stimulate the students’ senses and inspire their creative future-making reflection. Here, the schoolyard acted as a “supportive” environment. In contrast, the University of Barcelona went on a walk along the Besos River, actively exploring the various natural elements and recording sounds in close contact with nature. Similarly, the participants used the garden of the Edinburgh STEAM lab to “explore” their relationship to nature.

Figure 6, “Besos River Walk”, STEAM Lab University of Barcelona (Left) and the School Garden of the University of Edinburgh STEAM Lab

It is important to understand that the two categories are poles on a sliding scale. And it is equally important to emphasise that neither category carries any positive or negative connotations. Both are two different strategies to operationalise the physical environment for STEAM activities. As with many categories, the distinction is never clear-cut. To a certain degree, any environment has active and passive components, and passive elements can be turned into active elements (or vice versa). A chair, for example, is a supportive element as it enables a particular working style. However, the moment it is turned into a stage or a sculpture, it converts into an active ingredient in the enquiry process. The chair becomes a tool to shape and explore space.

In this sense, the term “explorative” evokes a higher degree of active input from a participant, meaning they “own” a space comfortable. Understanding and using a space actively fosters the development of “spatial literacy” and, consequently, “spatial agency”. While these terms are used differently in different contexts, within the framework of WP5, we define them as the facilitators' and participants' ability to understand, reflect and use environmental settings.[1] The ability to actively manipulate

[1] There is a wide range of literature on „Spatial Literacy and Spatial Agency“. The key sources used in this context was (Montello, Grossner, and Janelle 2014) and (Awan, Schneider, and Till 2011). The question of active and passive spaces within society has been part of an ongoing discussion since Lefebvre’s seminal work on the „Production of Space“ (Lefebvre 1991) published in 1974, which provides the intellectual backbone of our research approache.

and integrate the physical environment into the STEAM enquiry process is central to the SENSE methodology.

Figure 7: Photos from the Light & Shadow activity (Hawkins\Brown STEAM lab, Kinsale), showing how supportive equipment (chairs on the left and toilet paper on the right) becomes a tool of enquiry

There is, however, a limit to what can be achieved with specific components. A chair, to stay within the above example, has its limitations. Certain environments, equipment, conditions etc. lend themselves more to a more passive use, such as the traditional classroom or schoolbench, which, at its core, is designed to mute agency and optimise aural and visual knowledge transfer. Others, in contrast, such as outdoor settings, tend to instil more explorative uses.

However, any limitation can be overcome, at least to a certain extent. Any affordance can be "hacked" – to use the term popularised across the labs -i.e. turned into the opposite. One of the more famous historical examples of this is the use of 19th-century school benches for gymnastic practices by the German teacher Erich Fischer (Figure 8) to enable physical exercise for students, thereby turning the affordances of the school bench, i.e. the normative body posture, into its opposite.

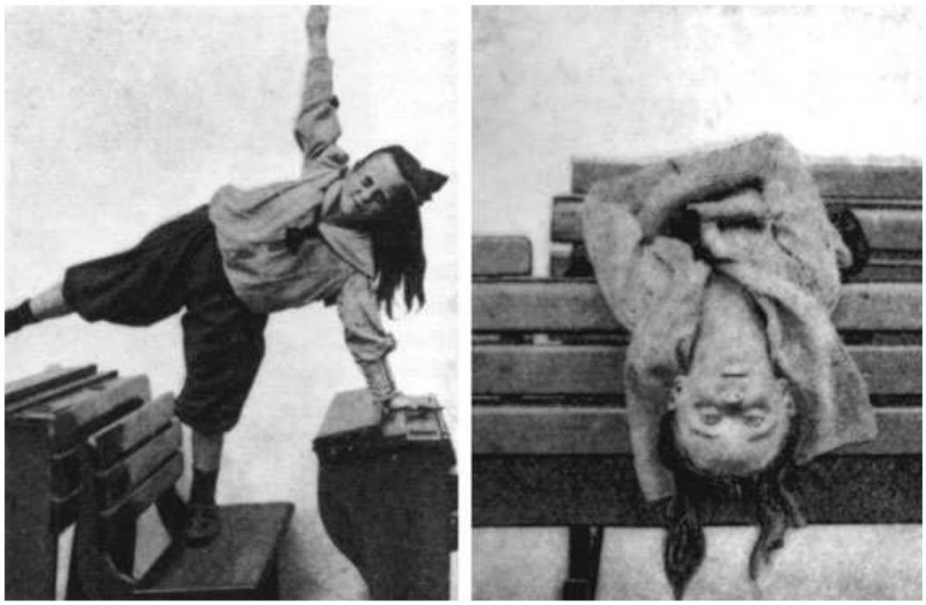

Abb. 13: Schulbank als Turngerät nach Fischer (1910)

Figure 8: "Hack" the affordances: the traditional school bench becomes a gymnastic apparatus. (Hnilica 2010)

"Hacking the space" often requires the transgression of social norms, mostly only slightly but sometimes more extremely. And that requires social courage. In the labs Hawkins\Brown carried out, the first half an hour was often spent in an awkward atmosphere, while the facilitator tried to activate the participants to behave outside of the learned spatial and social norms. Most of our physical environments represent the materialised expression of social norms, and it takes varying degrees of social courage or permission to violate deeply rooted conventions.

The Hawkins\Brown research team rated and analysed all activity reports, categorising each as either supportive or explorative. Overall, 22% of the reports were classified as "explorative" and 78% as "supportive". The supportive space category mainly contained the outdoor activities and the labs by Hawkins\Brown that aimed to create active spaces.

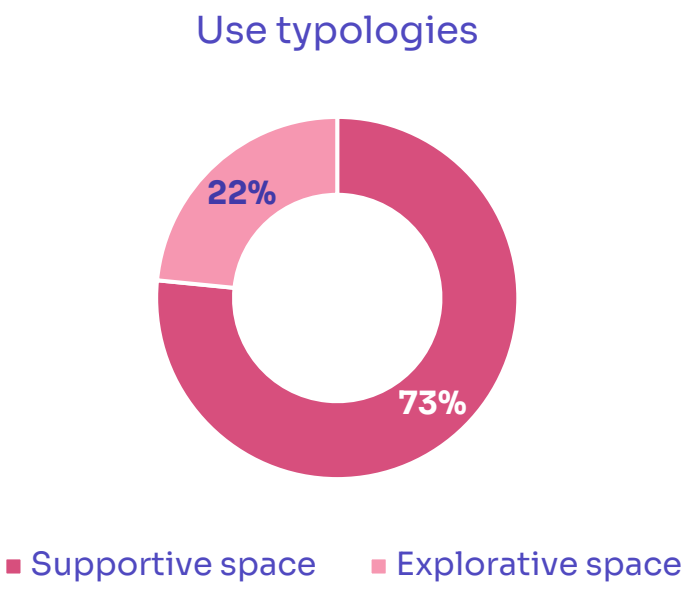

Figure 9: Proportion of supportive and explorative spaces across all labs (as assessed by the Hawkins\Brown research team

These figures demonstrate that most of the activities took place in – more or less – conventional teaching spaces with flexible furniture, which were designed to support a variety of educational events, and it would take a substantial amount of social energy to turn them into active spaces. As noted before, the labels "supportive" or "explorative" are neutral. Some activities simply do not need or benefit from explorative spaces. Or even worse, this type of environment might distract from the desired educational objectives. However, a more balanced statistic might have been more desirable. While it is and cannot be the aim to exclusively promote an explorative use as part of the SENSE methodology, a bolder and more conscious utilisation of space should be encouraged.

3.4. Focussed Labs

3.4.1. Explorative Environments: Light & Shadow

The Light & Shadow activity was developed to be tested in a range of different spaces to compare the impact of varying environmental conditions. (see List in chapter 2.4) In this activity, the participants were given a range of translucent and reflective materials and a light source (either natural light, central spotlights or individual torches) to create and study shadow and light effects, which were documented with photos or drawings. The motto for this activity was "journey over destination" to emphasise that its objective was about playfully experimenting with lights and objects without normative instructions or predefined outcomes. Each participant was encouraged to find their own way of discovering light and shadow phenomena,

guided only by close observation of the visual phenomena. In follow-up conversations, the facilitators discussed the results and possible further investigations into the observed phenomena with the students.

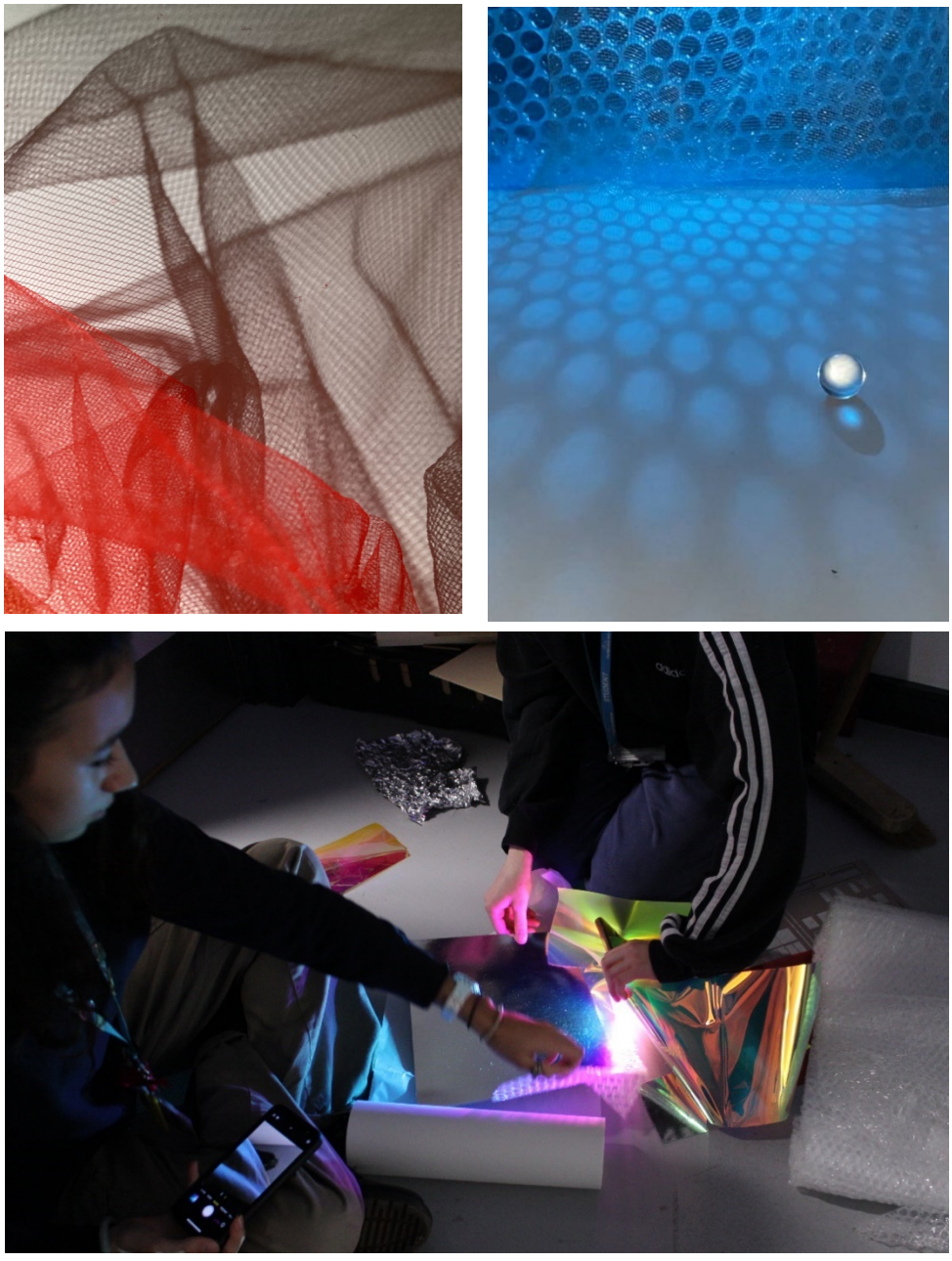

Figure 10: Hawkins\|Brown Steam lab, "Light and Shadow" activity.

The Hawkins\Brown research team assumed that participants would actively explore their environment to find exciting reflection and shadow phenomena and speculated that the larger and more complex a space was, the more experimental and explorative the creative investigations of the students might become. As shadows and light effects are relatively simple to produce and observe, we did not pay too much

attention to the props, i.e. the provided light sources and materials. In two instances, we even deliberately reduced the available materials to encourage the participants to work harder to find more subtle effects.

However, this hypothesis proved wrong. To start with, the students found it challenging to begin an activity without a predefined learning outcome – something they had never done before. On top of this, they were asked to detect light and shadow effects without any tools that created a strong and engaging impact. To overcome this initial threshold, we provided the participants with more potent light sources and "flashy" materials. This proved essential for raising their interest as the experimental results were more stimulating – and relatively easy to achieve. However, with brighter light sources and more "colourful" materials came the need to control the environmental light sources better, i.e. to exclude natural light. While this was feasible in the smaller classrooms, it was impossible in the larger and more expansive locations like the school foyer or the double-height assembly hall. In these spaces, students had to develop more inventive strategies to create exciting and engaging light and shadow phenomena.

The students reacted in two ways:

1. **Creating micro-environments**
   Many student groups improvised a kind of "raree show cases" that allowed them to set up a micro-stage, giving them enhanced environmental control over the light sources. Within these "mini-lab environments", students were able to systematically test different materials, reflections, etc., with some even creating animations or abstract visual stories. Once the students had set up "their space", they became entirely focused and drawn into their new world.

   While the selected environments themselves were not the object of active exploration, they catalysed – together with the used equipment – intense explorative behaviour and spatial agency, all driven by the need for environmental control. Instead of one large explorative space, many microspaces were created to cope with the macro conditions.

   The facilitators quickly noted that the strategy of creating a controlled micro world bears similarity to scientists setting up a lab bench for controlled observations. While the outcomes of both activities might differ, the process itself, i.e., the controlled enquiry into phenomena, is similar, making the link between artistic and scientific enquiry evident.

Figure 11: Hawkins\Brown Lab, students creating a controlled micro space to test a range of different materials and light sources

2. Transforming the macro space

In some – but not many - cases, participants actively explored their environment with more expansive projections. In the large assembly hall, the intense sun through the windows inspired the participants to utilise the environment in its entirety as a 3-dimensional projection screen, like a giant light sculpture, thereby creating a joint experience for all participants. The students transformed the macro space and created an intense moment of shared experience – an excellent example of an explorative use of the environment.

However, and interestingly, when the facilitators met the participants for feedback after the activity and asked them to show their favourite images, none of the students chose the moment when the large-scale light installation lit up the space. All students preferred their "personal" microworlds.

In another activity event – in a middle-sized maker space – students purposefully explored the dimensionality of the existing space. They used a strong light projection "to open up" the ceiling by creating the illusion of a much larger world outside their confined space – (similar to effects the artist James Turell used). The participants explicitly noted the fascinating oscillation between the 2d shape and the 3d illusion.

Again, the active interaction between light and the physical environment created an explorative moment that transformed the larger space

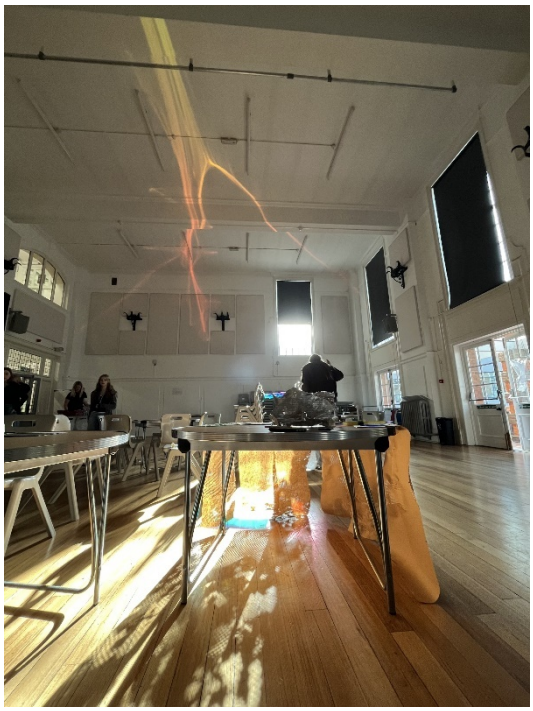

Figure 12 Hawkins|Brown Steam Lab. A large space transformed through light.

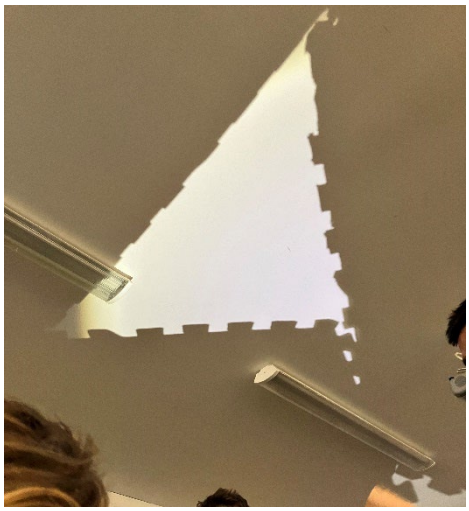

Figure 13: Hawkins|Brown Steam Lab: A new space in the ceiling opens up.

To test the ability of the students to adapt and explore, the research team increased the spatial complexity of the activity environment and, in one case, selected a school foyer with stairs, a large atrium and an irregular shape providing intense spotlights and large pieces of fabric in the hope that the participants would engage with the space more actively, for example, spanning the fabric across floors etc. However, in this case, the spatial setting became too complex, and the students quickly gave up and chose an adjacent, empty classroom for the experiment, cutting down the fabric and using the torchlights of their phones to create a more controllable environment. It seemed as if the double complexity, engaging in a creative, non-linear enquiry and the complex spatial conditions overstretched the students' ability.

In conclusion, the lab experiments demonstrated that “explorative spaces” are challenging to plan (or predict) and depend on many – often unexpected - factors. The research team expected that the spatial setting would directly afford explorative behaviour patterns. However, this was only indirectly the case and depended much on the equipment and environmental controls provided. Nevertheless, the principle of spatial affordance was confirmed: the learning environment catalysed explorative behaviour. Interestingly, in the “Light and Shadow” activity, the less complex environments were the better “explorative” spaces, enabling more opportunity for spatial agency.[2]

One of the key lessons we learned was that there is not necessarily a direct link between “explorative environments” and “explorative behaviour”, i.e. spatial agency. While some environments are more likely to foster explorative behaviour, this is by no means an automatism. Any space can become “explorative” through interaction. In this respect, the Light and Shadow activity was very insightful.

3.4.2. Supportive Space

The second Hawkins\Brown lab was carried out at the UCL academy in London. The task for the students was to reflect on the school environment by describing their sensory impressions on the way to school, identifying favourite spots, and combining those findings on a sizeable collaged map. In a second session, the same students recapped their findings and developed ideas on how the school and its environment would look in an imaginary future. Finally, the students presented their “letter from the future” to their peers.

The first session took place with one group in a large and another group in a smaller classroom equipped with the typical school furniture, i.e. chairs, tables and displays. Both spaces provided enough space and flexibility to accommodate the task. Students first discussed in pairs and then continued to work in groups to create larger collaged maps of the area. The facilitators did not observe much difference between the outputs from the groups in the large and small rooms. However, it was noted that the smaller room created a more collaborative atmosphere, leading to a more joined discussion.

For the first step, the reflection exercise, the existing tables and chairs were suitable. The mapping activity, in contrast, needed a larger area to work on, so some groups removed the tables and used the floor to create a more fitting space.

[2] It needs to be highlighted that due to operational constraints of the collaborating schools the Hawkins\Brown research team only engaged once with the participants and did not carry out multiple sessions across the term, which might have brought different results assuming that students would have become increasingly spatial literate.

As the UCLAcademy is a secondary school with a large catchment area, it became evident that most students were more interested in their way to school and the places they came from – often far away. The maps were extended with strings to reflect this, and again, the flexible classrooms were easy to adapt to meet these needs.

Figure 14: Hawkins\Brown STEAM lab. Mapping the school environment activity

For the second session, in which the participants had to come up with their thoughts on the future of the school environment, the students were split into two cohorts; one stayed inside the small classroom while the other group went into the large schoolyard, thereby creating a fundamentally different spatial experience. The indoor groups stayed in a typical group work mode around tables. The schoolyard workgroups, in contrast, started immediately roaming the area freely, choosing mobility over a static setting. The facilitators noticed that the students felt more comfortable being in an open space, specifically smaller “corners” of the schoolyard, which they chose to occupy. In all four outdoor groups, the students were more open to one another, and the conversation seemed to flow more naturally, without preconceptions or too much care about what they said and how it would be perceived by other peers (as none apart from their immediate peer could listen or take part in the conversation). The fresh air lightened their mood as well. It was fascinating to see how differently the students used their bodies and senses to connect with the environment outside, using walls as improvised whiteboards for notes, freely gesturing and being constantly on the move.

When the two cohorts congregated to present their thoughts to each other, the

Figure 15 Hawkins\|Brown STEAM lab, "Letter from the Future" activity. Students are roaming freely in the schoolyard while they develop their thoughts on the future of the school environment.

results were tangibly different. While the indoor groups talked about technology like public transport, social themes like poverty, tax revenues or teaching, i.e. more abstract themes, the outdoor groups used more concrete descriptions, covering a broad range of subjects like how the rain will change the buildings' appearance in the future, about trash in the streets, nature, specific places around the school and so forth. The vocabulary was more emotional and poetic. In fact, one group even

composed a poem, which they presented to the fully assembled group, with much giggling and to the slight bewilderment of their indoor peers.[3]

In this activity, the physical environment supported its objective well, albeit in different ways, leading to different outcomes. Both environments provided the conditions for the reflection but were not activated to achieve the activity's task at hand, i.e. creatively imagining the school's future. The open, multi-sensory outdoor environment led to more diverse and unexpected outcomes. The emotional feedback of the outdoor students was also more positive.

As a next step, it could be imagined that the whole school could be turned into a map that visualises the future, with the students creating lines of new connections across the existing geography, thereby moving from an enabling to an active, explorative use of space.

It might be argued that the active use of the schoolyard constitutes a form of spatial agency (which in turn would be true for any movement), and the active use of – for example – the school wall as a whiteboard is moving towards an explorative use. This might be justifiable to a certain degree, but this kind of oversophistication might take the distinction – between the two concepts a step too far. Again and in conclusion, it must be noted that the two terms are not necessarily clear-cut and represent two poles on a sliding scale; they should not be treated with normative precsion.

[3] This matches experiments carried out by behavioural research that shows how different the brain works in spaces with different dimensions. See: Vartanian et al. 2015

4. Next Steps

4.1. Revisit the Methodology

After a year of experimentation, it is now the moment to take a step back and reflect on the lessons learned. The central question is: How do the SAK and its underlying assumptions need to be modified and adapted in a way that will be productive for future deliveries? This reflection will continue with the ongoing research, but here is a list of initial thoughts:

- Simplify and clarify the language and give more examples. While the four categories developed in the SAK were good in helping the STEAMlabs, it might be beneficial to replace them with a set of questions and remove some prominence from the category titles. A more visual “guide to reflection” might be more valuable for dissemination than insisting on terminological precision.
- The same applies to the diagrams that represent the various factors of the physical environment.
- Be more explicit about why “space”, i.e. the learning environment, is important. While this has been discussed in delivery 3.3 it should be clarified that space and spatial literacy is relevant in two ways:
    - It supports and enables the multi-sensory educational approach of SENSE
    - A reflected use of and interaction with the physical environment fosters a creative understanding of complexity, central to the SENSE methodology, with spatial agency and literacy as crucial ingredients.
- Encourage more experimental thinking. A lot of the feedback from the STEAMlabs was descriptive and less interventionist, accepting the status quo of the environment. The roadmap output should stipulate a more experimental mindset. We should encourage facilitators to be more courageous and play with the elements of the activity environments in more extreme ways, challenging the participants' perceptions.
- Clarify that environmental conditions and the interaction with the environment are different things. An enabling space might be transformed through explorative behaviour.
- Develop the idea of spatial eco-systems further. The SAK is too focused on single locations and does not cover a network of spaces, which might provide opportunities for a variety of STEAM epistemologies.

4.2. Towards a Toolkit

One of the central deliverables of Work Package 5 is the "Spatial Self Experimentation Toolkit", which aims to inspire STEAM practitioners. While the SAK was instrumental in establishing a methodological framework for the analysis and support of the STEAM labs, it has to be acknowledged that it is not always easy and feasible to implement by non-specialists. What is needed is a format that is based on the methodology but allows for a more accessible implementation by practitioners who do not have the time or resources to engage deeply with the theory

In the 1970s, Christopher Alexander developed a classification system for architecture called a „Pattern Language" (Alexander 1978). His objective was to make architectural design more accessible for „lay people" outside the architectural industries. For this, he undertook an empirical analysis of the built environment and defined a system of what he called„timeless patterns", which, in essence, is a system of modular design strategies that can be used as universal building blocks for the built environment. These patterns range from concrete design tasks („the bathroom") to abstract principles („the private room"), from small elements („staircase as a stage") to general categories („the countryside"). For Alexander, these patterns form a universal „grammar" underlying the language architecture. This „grammar" has been shaped by cultural and social practice and, therefore, tried and tested and can be used as a blueprint for anyone to create new elements in the built environment. In short, Christopher Alexander was the first architect to propose an accessible toolkit for the built environment rooted in social and cultural practice, as opposed to modernist systems that were solely based on technology. His „patterns" are not mere neutral descriptions of form but always address a specific social theme. Alexander saw his patterns as elements of an universal language spoken by human beings and, as such, suitable to serve their needs adequately and effortlessly.

Christoper Alexander is attractive to our research because his idea of patterns – „spatial formulas" or „spatial grammar" linked to human behaviour- represents an accessible way to communicate complex configurations. Its modular and pragmatic character makes it versatile. Using this approach, we suggest developing a similar collection of patterns that captures the experience gained from the STEAMlabs.[4] Encapsulated in the identified patterns, we would still apply the metrics developed in the SAK to facilitate a deeper understanding of the underlying mechanisms. However, the „patterns", we might call them „spatial scenarios", will allow for easy adaptability by STEAM practitioners. Strategies could range from „The spatial eco-systems" to „The stage" to „Total control of the environment" or „Hack the space", etc.

While this is not the place to discuss Christopher Alexander in-depth, it must be noted that his model is based on a notion of universality. If a change occurs, i.e. new patterns evolve, it is rather evolutionary than radical experimental. Orthodox pattern

[4] A similar attempt has been made by Nair, Fielding, and Lackney 2020.

theory relates more to the manifestation of the existing rather than the progressive. However, if freed from these limitations – and there is no need to adopt Alexander's belief in universal systems – it can provide the right format and inspiration for a toolkit that can serve as a modular blueprint for creative experiments supporting and promoting the spirit of the STEAM.SENSE approach.

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6. Appendix

6.1. Reflective Feedback from the Research Partners

6.1.1. Creda

'KEY SPATIAL MOVES'
Please provide us with a clear idea on what you think your key spatial moves might be.
6/05/2024

In CREDA's Lab, we worked in different spaces with varying objectives and participants. It's challenging to generalise because what's important in one case may not be in another.
In this such heterogeneous experience, the key isn't specific characteristics or moves but rather certain approach suggestions. For example, during planning, it's essential to maintain an open and investigative outlook on spaces by asking some spatial questions, such as:

- Are the spaces welcoming for our group of participants?
- Would I go to that space to enjoy a cup of tea during a moment of relax?
- Are the spaces we're considering suitable for our work's purpose?

If the answers to these questions are mostly negative, it might be suggested to seek compensation or even consider modifying the activity or changing the program.
Similarly, for post-activity considerations, it's essential to note any changes in the activity, space, or its organisation for future reference. Nevertheless, another consideration is that participant learning may occur inversely, where users learn from a less-than-ideal spatial situation, whether due to functionality, spatial organisation, environmental parameter control, or even just the overall feel. Therefore, having a "perfect" space may not be what we're aiming for.

Additionally, we also utilised outdoor spaces, sometimes urban and others more natural (although there isn't much truly natural left in our context; all spaces have been more or less modified for human needs or desires). In this case it is difficult, or even not what we are looking for, to plan and control all the spatial parameter.

Also, when considering real-world learning situations, it's necessary to deal with non-ideal or possibly inadequate spatial conditions or some unexpected contingencies. Hence, it's crucial to always have an idea or tool in mind to change the program, to adapt an activity, or change the approach so that participants can work optimally. This is often the case in school classrooms (at least in our context), which may be too small,

too hot, or too already fixed, requiring facilitators/teachers to have a creative and flexible approach.

If we would imagine a general type of “good” indoor space for our lab, this learning space could be a flexible one, with enough room different type of activities, for relax and for sharing/discussing. It should have a good illumination (natural or artificial) and could be also easily darkened. It should provide enough comfortable seats and tables easily to move and to reorganise. The walls could be also a learning space (with screen or for papers, to draw and write) and it would be helpful to have smart ways to pull ropes in order to divide the space or to hang sheets and posters up high. Electricity should be easily provided, with mobile cabinets with removable drawers where to have easily materials needed. Near it should also have a restroom and an easily place to fill a water bottle.

If we could imagine a general type of “good” outdoor space for our lab, this outdoor space should be meaningful for the aim of the activity. Somewhere near the place we are exploring/working in/ investigating/sensing, we would like to find a spot where each participant could stay in a circle, maybe sitting on the grass or on the pavement or on the asphalt (perhaps with each participant bringing their own small waterproof cushion to sit on). It would be lovely if this space could be under some trees in summer or basked in warm sunlight in winter or near a rain shelter in case of a heavy rain.

Most important, before planning/running the activity, for our lab we also need to have clearly in mind the real participants' needs, whether physical, spatial, related to health, or special needs, to have enough time to organise the space and the activity. This is also why it is unlikely that the generalised and artificial description for a learning space described above might work in reality.

6.1.2. GEYC

Given the fact that we chose methods with a heavy humanities accent, there were a couple of space related aspects that proved to be important while facilitating the activities.

First and foremost, having a space that is flexible and can be adjusted to best fit the activity while clearly delimiting it from a conventional class led by a teacher, was one of the most important elements for us. Working mainly with conventional classrooms- over 50% of our Lab activities being delivered in this kind of space (benches on 7 rows and 3 collums and the teacher desk slightly elevated or further away), working with classrooms where the furniture could be moved around, facilitating a more genuine interaction among the participants, that wasn't constrained by the traditional classroom space was ideal. Liberated from the constraints of a fixed layout, our discussions flourished.

When not delivering the activity in a classroom, but in an NGO office, youth center or even outside, having the flexibility of moving furniture around and creating a new, more adapted space, was still one of the most important aspects, as modular rooms helped easily divide the group when needed,

offering privacy, or a room big enough for the participants to stroll through when thinking about ideas facilitated the dialogue and thinking process.

Although function proved itself very important especially for some of the methods that required very specific tools (like DINE or even A house for a fairy), I think our second most important aspect remains appearance.

Appearance played a crucial role especially for methods needing more dialogue and storytelling, as we have strived to provide spaces that would promote sharing, empathy, innovation and availability. For example, even if at some points we have worked in classrooms, we have made sure to choose some with a rather neutral color, well balanced height and welcoming decor. Even if, in some cases, decor wasn't available, we made sure to decorate the walls with elements that offered the space a homey feeling, like paintings, quotes or pictures.

When running methods in spaces that we had more control over, like our own office or spots that could access the previous day (youth center, other NGO office), making the space welcoming was a priority. Since most of the methods we approached were heavily relying on interaction, dialogue, storytelling and role playing, we felt a welcoming space was crucial for the ideas to flow.

6.1.3. Louvre

Based on the experience of setting up the labs and considering the analytical orientation proposed on their spatial dimension, we have identified some lines of reflection that can be articulated as research questions to be explored in greater depth.

One of the objectives underlying the design of the labs was to obtain some elements of comparative analysis of the effects of implementing a similar activity in two spaces that are embedded in very different institutional contexts and, as such, have their own configurations, working rhythms, dynamics of use and more or less explicit rules of behaviour. The exercise of comparing a nineteenth-century classroom with a fablab workshop may seem a somewhat biased choice since, as spaces for the transmission of knowledge, they could be situated at the extremes of a spectrum and hinder a nuanced context-sensitive reflection. How can we compare two such different fields of application without falling into a certain binarism? What specific parameters can we extract to rigorously assess the impact of two spatial configurations on the smoothness, the operability or the sensory experience of the activity? What is the degree of transferability of certain practices and what dimensions are lost or gained when shifting from one context to another? On the one hand, setting up the workshops has shown us that even when they take place in a strongly historically and ideologically marked learning space such as the French school, it is possible to imagine creative strategies for readjusting the parameters that determine the pedagogical experience. On the other hand, even if the spatial features of the fablab (open-plan layout, accessible outdoor area, multifunctional spaces, flexible and modular furniture) make it suitable for the development of innovative learning

modalities, making effective use of this potential is complex and requires rethinking the expectations and the dynamics of interactions that take place in this specific space. Another salient aspect that emerged from our observation practices was the variability in the way participants used their bodies during the activities. Even in the context of a learning device that did not directly solicit the learners' bodies, we were able to get a clear picture of the bodily impact of the school's culture. The embodiment of its codes of conduct is visible in gestures, postures or bodily schemes, which also allowed us to become aware of its multiple micro-overflows and diversions. These phenomena can occur when, within a known frame of reference, new elements are introduced, such as an unusual pedagogical rhythm, a different way of addressing the pupils, a responsive listening to the dynamics of the activity itself, the use of non-conventional materials or a renewed attention to them. Focusing on the case of the school workshops, both the evaluation system and the design of the content of the activities were conceived with the aim of increasing awareness of the learning space. Although the classroom is a familiar space whose presence is often concealed by everyday use, by mobilising a certain strategy of defamiliarisation and re-sensitisation, the purpose was to create new perspectives and make explicit the emotional dimension of spatial interactions. Linked to the corporeal dimension of the spatial experience of an educational device was the attention paid to the materials used in the activity. In this sense, we believe that providing tools to increase material sensitivity can have an impact on enhancing bodily and sensory interactions with space. Reorienting attention and cultivating sensitivity to materials also implies the possibility of rematerialising the relationship we can develop with the learning space that surrounds us, in which we evolve, and which shapes us as learning bodies.

6.1.4. University of Barcelona

Key Spatial Moves

We categorised our activities into 4 different categories: artistic walks, workshops, school/civic centers, streets.

For the Artistic walk, our activity included a walk along the river Besós, where the participants explored the public space along the river. The key spatial elements of this exercise were function and spatial configuration. When planning the exercise, we knew that the functionality was going to be high, as we wanted to consider the use of the river and surrounding space, and discuss amongst the group how it has been used and has transformed over the past decades, and consider the possibilities of the space in the future. Post-activity, we still considered function to be high, as we would not have been able to do the activity without physically being at the river, as we recorded sounds and videos of the river to try and capture our collective perceptions. Our key objectives for this were to really explore the outdoor space and see how each of us feel individually and interact with the river- our goal was to then have a group discussion of these feelings and body sensations, and how being in nature (and in the city) affects our perceptions of our surroundings.

For the workshops (Syddansk, Twente, Charm), pre-activities, we didn't necessarily have high expectations on the space in general, because often we were entering into a space that we were unfamiliar with – but also, we knew that they would be pretty standard classrooms. Therefore, in all of our post-activities the number increased (most often from a 3 to a 5). We found especially that if we were able to move around the room (environmental control), and "hack the space" by moving tables and chairs, hanging stuff on the walls, then we were able to engage with each other more, which greatly shifted how the participants were able to get involved. The appearance of some of the rooms made a bigger difference than anticipated, for instance, there were cozy rooms with floor to ceiling windows, and a lot of greenery outside, which made us feel like we were working from outside, even though were inside. Our key objectives for these workshops were to familiarise participants with the potential of citizen science, and how it can be applied in different settings and with different tools.

For the schools/civic centers (L'Hospitalet de Llobregat, Sant Viçen dels Horts, Moncada i Reixac and La Ribera): pre-activity, we had fairly low-mid expectations of the space overall, as we knew we would be in lower socioeconomic public school/civic buildings. Pre/post for appearance were both rated as 1. We didn't have a lot of environmental control, which we thought would have been ideal – being able to move the furniture for our own purposes helps the participants to feel more engaged. Regarding space, we felt like we had the most limitations in these settings. We didn't have much agency or control over what kind of rooms we would be in, therefore we had to use the space provided. Sometimes we, as facilitators felt a discomfort in the space that we were, but I realised that the participants probably didn't share the same discomfort, as they were accustomed to the spaces that we were using. Therefore, they weren't bothered by hot and crowded, no windows, poor acoustics, or intense lighting. Our objectives in these activities were to speak with participants about current issues that occur within their own communities, and to see how community members can learn about climate change/heat/public spaces/and how to get involved in addressing the problem.

When we moved to the streets (La Ribera session 2, Sant Viçen dels Horts session 2) to perform the heat walk activities, the function and spatial configuration of the space pre/post activity was a 5, as without the outdoor space we wouldn't be able to perform our objectives. We wanted to interact with the outdoor space and explore it through our sensations of the heat. The appearance and environmental control of the space were both rated as 1 pre/post activity, as we were observers of the space, and we didn't have much flexibility and adaptability within the space. The objective of this activity was to explore the streets and public spaces, and to engage with them by measuring the temperature with sensors and with our own perceptions of the body.

6.1.5. University of Edinburgh

Key Spatial Moves

Instructions from HB:
Find a storyline again – what was most relevant? From the four categories, what was most important? How would you explain it to someone? What are the key spatial moves?

University of Edinburgh STEAM Lab

Spaces in focus: school garden; home economics classroom; greenhouse (limited)

A key consideration for our STEAM Lab was that schools, and school grounds, are not always the most welcoming spaces for young people, their families, and the community. The school curriculum is set centrally and delivered though separate subjects with little or no connection with the history and diversity of heritage, culture, and lives of pupils in the community. This can particularly be the case for secondary schools. Also notable is the relative lack of social spaces in the local community for young people. The area of the school lies next to the bypass around the city; it has featured urban expansion in recent years with the creation of new housing estates which have replaced the existing farmland; despite the influx of new families the area lacks amenities such as parks or playgrounds for young people to congregate freely. As such, it was important to promote and develop the spaces of our STEAM Lab as places where young people feel a sense of belonging and find opportunities to be creative and enact agency. This was also a space where young people could make new encounters with the world other than human, with its dynamics, cycles, and changes through the year and through the seasons. The concept of the STEAM Lab at Gracemount school was therefore imagined as a space of happenings and a space of doings, where it was possible to imagine a different way of being educated in schools: not as a process of being inducted into set behaviours, knowledge, and protocols, but as the experience of leading and being led out into the world of the things that change.

We found all the categories for space to be important and significant. For example, the Function of both spaces – the classroom and the garden space – in terms of resources, and access and availability of resources, has been a key issue. In the garden, the group have noticed that the tools available to them are old and rusting (and of course the need for a bin given the large amount of litter). This has led to conversations about the ways in which the garden space is valued by the school, with the group discussing how to raise awareness and obtain better quality resources for the garden. There are also clear challenges for the teacher, who has applied for further resources but often waits months for a response and has resorted to bringing some of her own tools from home. Access to the resources in the classroom is also an issue, with most utensils and ingredients kept locked away in cupboards or in resource rooms. This is partly for reasons of health and safety (e.g. knives), but also means

pupils do not have easy access to plates or containers, or for a range of ingredients for cooking. This adds constraints and elements of control around creativity and obstacles for the pupils taking the initiative or enacting agency in the space.

The Configuration of the space is generally fixed, especially in the classroom which is laid out as a mock kitchen for the delivery the home economics curriculum. However, the activities of the group have played into a sense of openness. They have separate counters for cooking which means that in some cases they break off into separate groups, but the central table acts as a focal point to gather, discuss, and collaborate. In the garden, the range of areas and open nature of the space also provides opportunities for different activities and for the pupils to follow their interests. For example, the three large planters and six small planters allow for planting and tending to plants and vegetables, while the sculpture garden allows for weeding, clipping, and reimagining of the space. There is also the possibility of pupils moving around the space in their own time, which is important for certain members of the group.

There has been some change in terms of Environmental Control, as in the garden the cutting back and weeding of the sculpture area has allowed more natural light into the space. It has also become apparent that there is a lack of 'control' of the environment of the garden space, which can be changeable due to the weather and due to the intervention of others that use or exist in the space (human and more than human). The school has a greenhouse on the top floor which regrettably was damaged during the winter storm and was never repaired. Due to the bad weather, gaining access to the greenhouse would have increased sense of environmental control; lacking that resource, new seedlings were planted in two propagators (one of which was also partly broken and repaired with sticky tape) that were kept in the textile room under the ongoing care and maintenance of the teacher. In the classroom, the cooking and baking activities change the environment of the space – sometimes it can be very hot and the smell of the room changes. Sometimes this is change that is enacted by the group in their activities, and sometimes it is out of their 'control' – there may be a class in the room beforehand that has been cooking, for example. The transition between the two spaces, moving from the classroom to the garden and vice versa, has made these environmental aspects more felt or more visible (e.g. experience of natural light, of temperature).

Perhaps the most significant category which has seen the most change or evolution during the Lab activities is the appearance of the spaces, in the ways that both the classroom and the garden have changed – albeit temporarily – the way they appear – but more importantly they changed the way they feel. The conventional classroom has emerged as a safe and calm space; this was in contrast to the chaotic space of the corridor where pupils wait before entering the classroom but also in remarkable contrast with the time-pressurised classes taking place just before and after the elective module, during which older kids are busy preparing for their home economics performances as well as exams. During the elective module, an attempt was made each time to delve into the sensorial elements of cooking thus prioritising the making as opposed to the end results, with cooking often being subservient to the wider

purpose of forging participation, involvement, and inclusion. In that space we have observed a visible change in the children's body language as they enter and as they leave the room (relaxed in the room vs tense when leaving). Cooking and artistic activities have been progressively merged and blended with visits to the garden space bringing the opportunity to collect specimens from the garden as well as carrying the inevitable lumps of mud under the shoes and fingernails. But over the course of the year the home economics classroom has emerged as a dialogic space (student-student; student-teacher; teacher-researcher; student-researcher; student-artefacts; student-more-than-human) where the students feel a freedom in enacting agency. The feel of the space has therefore been transformed, and in turn the interaction in and with the space has looked and felt different (though the physical appearance has not necessarily been altered).

In the garden, physical appearance and feel of the space can change naturally, sometimes without intervention of humans. But through the actions and interactions of the group, the space has begun to acquire a purpose, for example in reworking and reimagining the sculpture garden, and planting in and decorating the planters. Furthermore, seeing students get protective of the cleanliness of the garden incites a sense of ownership. In this way the appearance of the garden is both a catalyst and an indicator of how the group sticks together, and a means through which to take an active role in the life of the school and the community. The feel of space was also transformed by a recent visit by parents, who had been invited by the pupils to see and help in the garden after school. Children walking through, exploring, and working together with their parents in the garden saw the space emerge as shared, communal, and welcoming space, with a growing sense of community. The parents were able to see how the space was valued by their children, and their growing sense of belonging in the space.

Therefore, we feel that, while all categories are important, the 'key spatial moves' have involved the appearance of the space, which has occurred through a repurposing of the given set up from a narrative of delivery to a narrative of exploration, which was often tentative and characteristically unfinished as the children approached and explored the affordances of the materiality. These were also physical and more subtle embodied changes in the classroom and garden which transformed the meaning and significance of being at school to the pupils, the teacher, the parents, and others.

6.1.6. WECF

The WECF lab is located in Kakheti, Georgia, based in an innovation center. We conduct lab activities with girls aged 12-19 there, and we are already working on diversifying our target audience, as well as conducting activities at other schools outside the center. However, the main space is the Innovation Center, a local municipality-owned building, and we use a meeting room that has a high ceiling, and wide windows and is equipped with desks, chairs, bean bags, and a bookshelf.

With the Lab's activities focused on community building and co-creation, function and spatial configuration are two of the most important spatial elements for us as we work with young people. It is important to us that those participants can work individually and in groups, while also feeling a part of a larger group, which is why we selected these two elements. By arranging desks, the big room can be divided into smaller spaces, giving participants privacy for group work, while also interacting, exchanging ideas, and sharing materials. In addition, the informal setting of desks allows students to feel they are not at school and allows them to move around easily when tired, stand, jump, and leave the room if needed. There is a space with soft pillows where the children who came early hang around and wait for the activity to start. It is arranged so that they can hang out together.

However, I think our key spatial elements will change as we plan to implement most of our future activities outdoors, and environmental controls will probably come to the forefront as the outcome of many activities will depend on the weather. Perhaps function and spatial configuration will again play an important role, as the implementation of activities will also depend on the materials collected in the environment and how the participants will use these materials.

6.2. Lesson Plans of the Hawkins\Brown STEAM labs

6.3. Activity Report Table