STEAM LEARNING ECOLOGIES

THE STEAM LEARNING ECOLOGIES METHODOLOGY – FINAL VERSION

Deliverable 2.3

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D2.3 The SLEs Methodology – Updated Version			
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Lead Partner	Ellinogermaniki Agogi (EA)		
Author(s)	Georgios Mavromanolakis (EA), Sofoklis Sotiriou (EA), Pavlos Koulouris (EA)		
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Executive Summary

The SLEs Methodology – Final Version is the third deliverable of Work Package 2. The First Version was delivered on Month 6, an updated one on Month 21, and this Final Version on Month 34. In this document we lay out a comprehensive methodological framework of guidelines and proposed actions to enable and guide the development of SLEs in accordance with the main foundational concepts in our SLEs Concept White Paper. The work that is presented in this document is based on the one hand on the outcomes of four co-creation workshops that were organized and coordinated by EA and in which all partners of the consortium participated, and on the other on the qualitative and quantitative feedback collected during stakeholders' co-creation and reflection workshops and surveys of the pilot and mature implementation phases. The co-creation workshops were focused on particular themes, which were: 1. Understanding SLEs concepts and dimensions, 2. Learning by example, analysing an example SLE, 3. Focusing on SLE prototype development and processes, 4. Consolidating overall methodology. The main objectives of this series of workshops were on one hand to bring together all partners' insights, views, ideas, expertise, and experience towards a co-created constructive methodology, and on the other, to simulate and facilitate a similar process of co-creation that each partner can initiate and implement at local level. The stakeholders' co-creation and reflection workshops and surveys of the pilot and mature implementation phases were conducted from Sep 2023 until Jun 2024, and from Sep 2024 until Jun 2025 respectively. Collected feedback, insights, observations and concluding remarks based on quantitative analysis contributed to refining and updating the initial methodology document.

We start by briefly presenting the SLEs that were developed and implemented during the mature phase of the project in sixteen different countries around Europe and beyond, namely in Ireland, Germany, Greece, Italy, Norway, Spain, Cyprus, Malta, Serbia, Portugal, Romania, Slovakia, Sweden, North Macedonia, Turkyie, and Israel. Their main characteristics clearly give an overview of the variety and diversity of ideas, subjects and partnerships that the SLE concept can encompass. Then the initiators' pilot phase survey is discussed along with its consolidated results and concluding remarks for each of its focus areas.

We then discuss our suggested step-by-step development process that can facilitate and guide the development of a generic SLE. The proposed SLE development process is divided in four main steps, which are: 1. Initiation and Getting Started; 2. Preparation and Establishment of Partnership; 3. Co-creation and Implementation; 4. Reflection and Sharing of Results. For each step, we give a general description, discuss its main objectives, and present the main actions, conditions or prerequisites needed, supplemented with general recommendations on how to successfully complete it. We also include a list of key indicative questions to be thoroughly considered or addressed which can assist the successful completion of each step.

To enhance the readability of the document, we first finish discussing the whole sequence of proposed steps of development and then proceed with accompanying sections that complement them by elaborating on certain key aspects based on the synthesis of partners' insights and recommendations derived from the co-creation workshops. On partnership establishment and stakeholder engagement, and on living lab co-creation practice. As co-creation is being a core and very significant element of the SLEs perspective and development process we revisit the open schooling model and the living labs practice as first discussed in our White Paper. We synthesise and adapt their subsequent steps in our generic development process to produce an easy-to-follow elaborated version, which at the same time we believe will be more appealing to learners and in general to partners of an SLE. It consists of the

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main stages of “Feel and Imagine” as part of the initiation phase, which then lead to the stage of “Co-create” and its iterative subsequent steps of “Explore, Experiment and Evaluate”, and finally concludes with the stage of “Reflect & Share”. This is the main model process we propose to partners, educators, and other stakeholder participants in the SLEs project to adopt and implement during the mature phase.

We finish by discussing our facilitation methodology and guidelines. Therein we suggest to plan and offer a comprehensive facilitation programme, encompassing multiple modalities, online or in-person, that include hands-on practice workshops, that will not only help teachers, educators and all actors involved to explore, adopt, implement and improve an already developed learning ecology but also assists them to gain confidence and experience towards developing their own ones individually or in collaboration with other teachers, educators, stakeholders or partners of the consortium. We propose the main design considerations along with general and specific recommendations of features that such a general facilitation programme can incorporate. Partners can further adapt it depending on local needs and circumstances.

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Introduction

In our SLEs White Paper we put forward the concept of learning ecologies to offer a powerful new way to envision and develop impactful local open schooling partnerships as science learning continuum for all. We invoke pathways as a metaphor for thinking about ways to provide structure to learning experiences, about how they are inter-connected and inter-related and about how they allow or help learners to build upon them to pursue goals requiring extended engagement across multiple contexts and learning opportunities. The vision of SLEs is practically manifested in fusing STE(A)M approach, open schooling environment and living lab practice within an empowering partnership based on local-level collaboration between formal, non-formal and informal science education providers, enterprises, and civil society. In our view of a committed local partnership, we want it to resemble a real ecological system in nature, which has the potential to initiate and generate in time a rich and robust complex system of relationships, interactions, pathways and opportunities of collaboration and development, which was neither prescribed nor predefined. In this respect when designing learning ecologies, we should consider that natural ecosystems both provide and require diversity, efficiency, adaptability and scalability. Ensuring that these features are present in the SLEs to be developed and implemented during the piloting or mature phase of the project calls for a comprehensive and flexible methodological approach to guide and assist the overall development process.

SLEs methodological work, which started at conceptual level with the SLEs White Paper, was first documented in D2.2 “The SLEs Methodology – First Version” (delivered on Month 6 and updated on Month 21) and is finalised with the current document. It focuses on the practical and procedural aspects regarding the design and development of an SLE as a whole or of its accompanying learning activities.

The document is divided into four main sections. The first one presents the SLEs that were developed and implemented during the mature phase of the project in sixteen different countries around Europe Then the initiators’ survey is discussed along with its consolidated results and concluding remarks for each of its focus areas.

Then follows the second section where our suggested step-by-step development process of a generic SLE is discussed. Elaboration and further guidance on key aspects of the development process is provided in the subsequent section. Partnership establishment and stakeholder engagement, living lab co-creation practice, and inquiry-based pedagogical design are the key aspects in focus. In the fourth section the facilitation methodology and guidelines are described. The document closes with the summary.

Methodology and guidelines

The work that is presented in this document at conceptual and procedural levels is based on the one hand on the outcomes of four co-creation workshops that were organized and coordinated by EA and in which all partners of the consortium participated, and on the other on the qualitative and quantitative feedback collected during stakeholders’ co-creation and reflection workshops and surveys of the pilot implementation phase. The four workshops took place during May 2023 (Month

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5), and each workshop was focused on a particular theme. The themes were: **1. Understanding SLEs concepts and dimensions, 2. Learning by example, analysing an example SLE, 3. Focusing on SLE prototype development and processes, 4. Consolidating overall methodology**. The main objectives of this series of workshops were on one hand to bring together all partners' insights, views, ideas, expertise, and experience towards a co-created constructive methodology, and on the other, to simulate and facilitate a similar process of co-creation that each partner can initiate and implement at local level.

Visual highlights of the online sessions are shown in Figure 1 below.

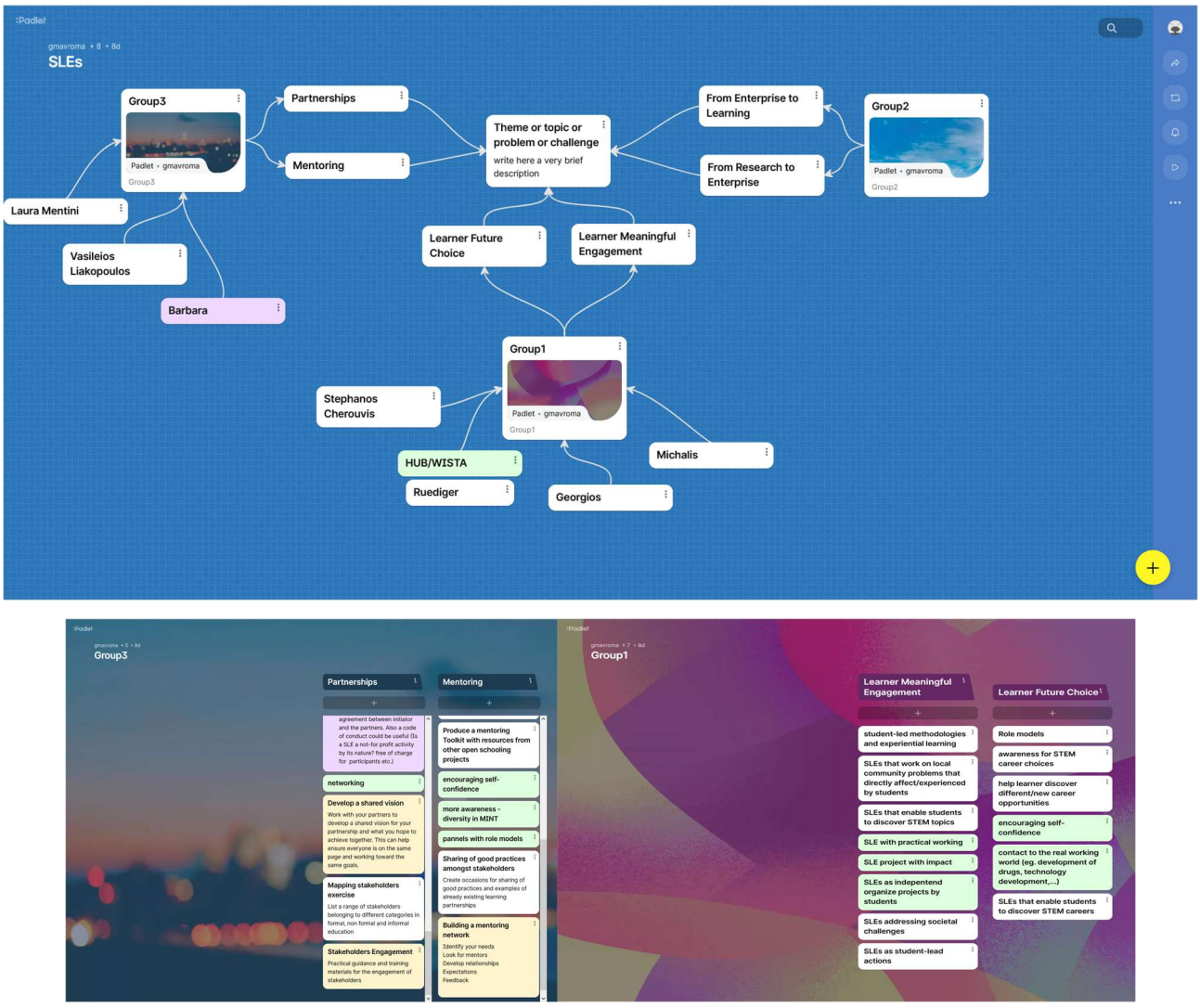

Figure 1: Screenshots from the online co-creation workshops. Highlights include grouping of participants and concepts, contribution of ideas and insights

The stakeholders' co-creation and reflection workshops and surveys of the pilot and mature implementation phases were conducted from September 2023 until June 2024, and from September 2024 until June 2025, respectively. Collected feedback, insights, observations and results from the

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quantitative analysis of the initiators' phase survey presented herein in the following sections contribute to refining the initial methodology document.

In the following sections we first give an overview of the SLEs that were developed and implemented during the mature phase of the project and then present the initiators' survey main results. We then describe in detail our suggested step-by-step development process. The generalized methodological steps are then followed by separate accompanying sections that complement them by elaborating on certain key aspects. These focus on partnership establishment and stakeholder engagement, living lab co-creation practice, and, guidance on inquiry-based learning.

1.1 STEAM Learning Ecologies

1.1.1 Mature phase SLEs

The mature implementation phase of the project started in September 2024 and lasted until June 2025. During that period 109 SLEs were initiated, developed and implemented in 16 different countries around Europe and beyond, namely in Ireland, Germany, Greece, Italy, Norway, Spain, Cyprus, Malta, Serbia, Portugal, Romania, Slovakia, Sweden, North Macedonia, Turkyie, and Israel. In Appendix II – Mature Phase SLEs the full list of SLEs per country of implementation is tabulated. A general title and a brief description accompany each entry, allowing for an initial understanding of the breadth and diversity of ideas, themes, topics, and partnerships encompassed by the SLE concept and framework.

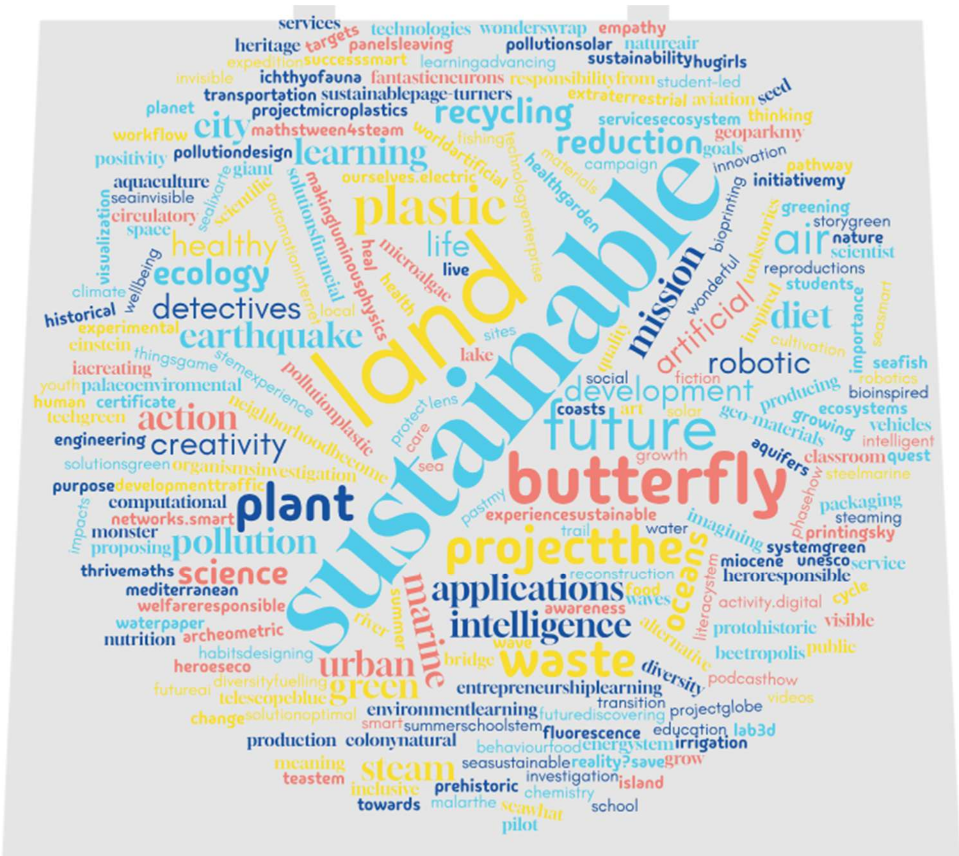

Figure 2: An illustrative word cloud generated with the titles of SLEs implemented during the mature phase

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A quick visual overview can be given with the image above which displays a word cloud generated with the titles of the various learning scenarios implemented during the mature phase of the project. The most prominent word, sustainable, appears at the center in large, bold letters, emphasizing its frequency of use and consequently its importance. Surrounding it are various related terms such as future, land, waste, plastic, recycling, and green, reflecting themes of environmental education, responsibility, and innovation. Words like plant, pollution, climate, ecology, robotic, applications, and artificial intelligence indicate the integration of natural sciences and technology in sustainable practices. Additionally, creative and educational concepts or terms such as creativity, learning, STE(A)M, and entrepreneurship are included, highlighting a holistic and interdisciplinary approach incorporated across the mature phase SLEs. In a nutshell, the overall message one gets by this illustration is that SLE's learning scenarios and educational activities promoted awareness and action towards a more sustainable and informed future.

The following table outlines the primary thematic areas of focus identified during the mature phase of SLE implementation.

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Table 1 : Key thematic areas of interest for SLEs at the mature implementation phase

Interest Area	Description
Environmental & Sustainability Fields	The most represented category, indicating strong emphasis on ecological, climate, and sustainability themes.
Technology & AI	High interest in modern tech, digital tools, AI, and innovation.
Science & Health	Includes natural sciences, life sciences and health related or focused activities.
Education & Social Development	Covers empathy, youth leadership, gender equality, and STE(A)M education.
Engineering & Innovation	Focused on practical applications in design, transport, energy, and infrastructure.
Business, Policy & Global Development	Involves financial literacy, global citizenship, SDGs, and policy.
Art & Communication	Emphasizes creativity, science communication, illustration, and storytelling.
Mathematics & Statistics	Involves math-based projects and quantitative reasoning.

The distribution of SLEs' educational activities across thematic areas reveals a strong emphasis on environmental and sustainability topics. Closely following are activities focused on technology and artificial intelligence, reflecting a growing interest in digital innovation and future-ready skills. Science and health-related themes also feature prominently, covering subjects such as physics, biology, chemistry, and wellbeing. Education and social development activities show a meaningful presence, emphasizing empathy, gender equality, and youth empowerment. Engineering and innovation, along with business, policy, and global development, share a balanced representation, highlighting the relevance of practical problem-solving and global citizenship. Art and communication, though less prevalent, demonstrate the value of creative expression in scientific contexts.

1.1.2 SLE survey and results

The goal of the survey is to facilitate the evaluation of the pilot SLEs which were implemented in various countries and settings. The survey template is composed of a list of statements categorized in a sequence of templated forms/questionnaire that focus on different dimensions of an SLE. The survey is addressed to initiators and educators/lead teachers or to the whole group of stakeholders who can utilize it for guidance or as a preliminary list of indicative statements that can help them to characterize their observations from the overall educational activities, they tried out during the mature implementation phase. The survey statements, remarks and observations are also relevant for initiators, educators/lead teachers and stakeholders participating in future SLEs as these can give insightful guidance and food-for-thought on various key points to consider while preparing and developing their SLEs.

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There are ten focus areas with several subsequent questions or statements in each. The focus areas are listed below whereas the complete survey questionnaire is included at the Appendix III – SLE Survey Questionnaire.

1. General Aims and Objectives: Towards which skills or transversal competencies are students oriented in the SLE?

2. What have students actually learned or what are they able to do after completing the educational activities of the SLE?

3. How is the group of stakeholders involved in the SLE is facilitating learning?

4. Where and with whom or how are students learning in the pilot SLE? E.g. are they better learning individually, in small groups, or whole class?

5. How are learning activities in the SLE increasing female participation and deconstructing gender stereotypes?

6. What have educators learned or what are they able to do after completing the educational activities of the SLE?

7. Is the current policy framework helping or restricting the implementation of the SLE?

8. Which of the following challenges have you encountered in implementing your SLE?

9. How effective were the collaborative efforts between stakeholders (e.g., educators, administrators, policymakers, community members, industry partners) in planning and implementing the SLE?

10. To what extent did partnerships with external organizations or institutions (e.g., universities, businesses, NGOs) contributed to enriching the students' learning opportunities and engagement?

The analysis of responses to the mature phase survey reveals a high level of agreement regarding the development of key transversal skills through participation in SLEs. Learners consistently demonstrated growth in creativity, critical thinking, collaboration, digital literacy, and leadership, alongside increased motivation towards science-related studies and careers.

There is also strong consensus on the learning outcomes achieved through SLEs. These include enhanced interdisciplinary and problem-solving abilities, deeper content knowledge in STE(A)M subjects, and increased learner confidence and autonomy.

Stakeholders within SLEs are widely seen as mentors and facilitators who promote creativity and reflective thinking, while taking into account learners' prior knowledge, competences, attitudes, and learning preferences. Learners benefit most in environments that support collaboration in small groups and offer flexible learning pathways tailored to individual interests and skills.

To increase female participation and address gender disparities, effective strategies include focusing on competences rather than gender roles, promoting collaborative rather than competitive activities, forming gender-balanced teams, and introducing same-gender mentors and role models.

Educators also benefit significantly from the implementation of SLEs, which contribute to their professional development through the adoption of innovative pedagogies, peer collaboration, and access to shared resources and expertise.

While national and local policy frameworks differ across countries, there is a general shift toward supporting interdisciplinary, STE(A)M-based, and multi-stakeholder educational initiatives. Common

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challenges, such as curriculum constraints, limited time, and resource shortages, remain prevalent in some cases, though issues related to stakeholder engagement, teacher training and STEAM understanding are less frequently cited.

Overall, collaborative efforts among stakeholders and partnerships with external organizations have played a pivotal role in the successful planning, implementation, and sustainability of SLEs. These partnerships enriched learner experiences by providing mentorship, access to real-world contexts, and specialized facilities, while also strengthening long-term institutional capacity and engagement.

1.2 SLE step-by-step development process

In this section, we focus on the methodological process that can facilitate and guide the development of a generic SLE. The recommended process as documented below is based on the synthesis of partners' insights and recommendations derived from the co-creation workshops; consultation of relevant methodologies in EU funded projects, such as SALL, OSOS, MakeItOpen and others as discussed in the White Paper; stakeholders' collected feedback, observations and survey results during the pilot and mature implementation phases.

Our proposed SLE development process consists of four main steps, these are: **1. Initiation and Getting Started; 2. Preparation and Establishment of Partnership; 3. Co-creation and Implementation; 4. Reflection and Sharing of Results**. Each step can be divided into multiple sub-steps. For each step, we give a general description, discuss its main objectives, and present the main actions, conditions or prerequisites needed, supplemented with general recommendations on how to successfully complete it. Although the whole process usually can be visualized as a linear path from start to end, often in practice there may be situations that parts of the process need to be iterated or revisited or different pathways may emerge that lead also to successful outcomes. Still suggesting and adopting a step-by-step plan with enough flexibility helps us to provide a constructive and efficient process towards the achievement of our goals.

To enhance the readability of the document, we finish discussing the whole sequence of proposed steps of development and then proceed with accompanying sections that complement them by elaborating on certain key aspects. These focus on partnership establishment and stakeholder engagement, living lab co-creation practice, pedagogical design and framework, and also facilitation methodology and guidelines. For better usability and reference purposes the key elements of the step-by-step development process are consolidated in flash cards which are included in Appendix IV – SLE Methodology .

1.2.1 Step 1. Initiation and Getting Started

The very first step in establishing a SLE is **initiation**. It is done by an initiator in broader sense, meaning an initiator can be for example an individual person, a partner from the SLE consortium, a schoolteacher, or a group of students. An initiator can be also an organization such as a public authority, a school, a research institute, a community, or an enterprise. At the heart of initiation is an idea in relation to a problem or a challenge and the willingness to act upon it. Either a problem or an idea that can provide solution to an existing or new problem lie at the core of one's ambitions to initiate a SLE. The problem or idea can be related to initiator's personal needs and aspirations, the needs of the local community or may have broader societal impact. In other words, there is no imposed constraint with respect to topics or focus areas on which SLEs must aim for.

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In the former case, when starting from a problem, the actions lie first in identifying and studying the problem and then finding partners that agree on collaborating in solving this problem to initiate a SLE. In this case an idea or ideas for a possible solution can follow at a later stage, for example, following rigorous research and brainstorming phases.

In the latter case, from an idea to a problem, an idea even at a very initial form can also serve as a starting point for a SLE. An idea can emerge naturally or subconsciously in relation to a new experience or event or from serendipitous search for a solution to a problem. Making the connection between the idea and a relevant problem is key in this case. Based on an initial idea which will then be further worked on and refined, a SLE with other interested stakeholders can be set up.

In both cases the next step to follow is to start seeking for partners. It is up to the initiator coming up with the idea, e.g., a user or group of users, private or public organizations or educational institutes, to find partners who are interested in collaborating on elaborating on the main topic related to a problem or idea. The initiator must search for and contact potential partners with the aim to form a partnership with the capacity to set up a collaborative project that accommodates the key dimensions which form an SLE.

Below we include a list of key indicative questions to consider in advance and think about thoroughly which can assist the successful completion of this step.

- What do we find bothering or problematic in our everyday life?
- What possible solutions can we think of to improve it?
- What is feasible or what we can do to address the challenge identified?
- Has any idea or solution been tried before?
- Can we think of a new or improved one?
- What are the issues and needs of our community at local/regional level?
- What is community well-being? How is affected? How can we impact it?
- What are the societal challenges we are interested in, or we are aware of?
- What do we find interesting to be engaged with?
- From a list of problems or challenges we have identified which one is worth tackling first?

Action Hint: *to initiate a SLE, begin by identifying a problem or idea that inspires action—this could stem from personal needs, community issues, or broader societal challenges. Whether you're an individual, a group of students, a teacher, or an organization, take the first step by clearly defining the challenge or concept at hand. If starting from a problem, analyse and research it thoroughly before seeking collaborators. If beginning with an idea, explore its relevance and refine it through discussion and feedback. In both cases, the next crucial step is to search for and engage potential partners who share your interest and can contribute to building a collaborative project. To guide this process, consider reflective questions such as: What problems do we face in daily life? What solutions are feasible? Has this been tried before, and how can it be improved? What does our community need most? Prioritize challenges that matter and are worth addressing through shared effort.*

1.2.2 Step 2. Preparation and Establishment of Partnership

The main goal for **creating a comprehensive partnership** in the form of interconnected knowledge ecosystems is to give to all actors, space, opportunities, and motivation to take initiative and central roles in mutual learning and benefit. Bringing together stakeholders from various backgrounds and

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expertise, the development of new partnerships and collaborations is encouraged that can lead to new opportunities to create and promote a more dynamic and engaging learning environment for all involved (Hazelkom et al. 2015). Thus, envisaging and realising impactful local open schooling partnerships which will involve in and bring together a diverse set of actors from formal, non-formal and informal education, as well as enterprises and the civil society is one of the most difficult tasks in the whole process of developing a SLE.

Therefore, in this step, preparation work is crucial to accomplish and establish a partnership. Preparation consists of first identifying and then approaching stakeholders. The starting point to identify potential stakeholders is to make a comprehensive list of all possible stakeholders one can think of. Drawing up selection criteria can also help to make a thorough analysis and finally to select a shortlist of stakeholders to contact.

When in contact, it is the task of the initiator to convince the potential partners to collaborate on the topic of the suggested idea or problem. Although intrinsic interest and motivation is necessary for commitment in a fruitful collaboration, however at the early stages of the development of a partnership it is preferred to aim for an informal agreement rather than a formal commitment. When approaching potential partners to collaborate it is also crucial to have a clear view on how they can contribute to and benefit from the partnership. At this point, it should be noted as well that it is not unusual that an established and promising collaboration fails because the proposed problem is not specific enough or an idea is not concrete enough and clear to all.

Below we include a list of key indicative questions to consider in advance and think about thoroughly which can assist the successful completion of this step.

- Who has direct or indirect interest or motivation to participate?
- Who will be impacted, positively or negatively?
- Who will be affected directly or indirectly?
- Who will be benefited?
- Who do we need?
- Who do we know?
- Who is already in our network of contacts that could make a useful contribution, have interest to participate or introduce/recommend potential partners?
- Who has already been part of a similar project about the issue/problem/idea we have chosen?
- What knowledge, experience or authority is needed?
- Who within our local community or contacts could possibly have similar knowledge, experience or authority?
- With whom have we collaborated in the past?
- What is the level of their availability of learning resources?
- What is their willingness and ability to provide support to learners along their learning pathways?
- What role do we envisage for each potential partner?

Action Hint: *to establish a strong and effective partnership for a STE(A)M Learning Ecology, begin by identifying and engaging diverse stakeholders from education, business, civil society, and beyond. The goal is to create a collaborative knowledge ecosystem where each participant has space, motivation, and opportunities to contribute meaningfully. Start by compiling a broad list of potential stakeholders and apply clear criteria to narrow it down. When reaching out, focus on informal engagement first—highlight the shared problem or idea and clarify how each partner can contribute*

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to and benefit from the collaboration. Be aware that vague or underdeveloped ideas may hinder progress, so ensure your proposal is specific and relevant. Use guiding questions such as: Who is affected or interested? Who do we need or already know? What knowledge, experience, or resources are essential? Who has participated in similar initiatives? Clearly define each partner's potential role and contribution to increase the chances of building a successful, committed partnership.

1.2.3 Step 3. Co-creation and Implementation

In SLEs perspective, the key to creating a vibrant and thriving learning ecology is to work across all levels of the learning ecosystem, with educators, organizations, and policy makers, and to start by establishing local partnerships as the driving force of learning ecologies in which everybody contributes and benefits. In SLEs all participants share a common intention of embracing the complexity that surrounds an individual's experience of learning and development in the various systems and environments (Pritchett 2013). This emphasizes the value of meaningful **co-participation and co-creation of activities**, mutual respect, and responsiveness from the entire environment. It suggests that both young students and lifelong learners are capable of being relatively independent and self-directed when they are given freedom and sufficient opportunities to participate meaningfully in authentic activities across the learning continuum (Baker 1999). This also entails educators in all types of settings within a learning ecology recognizing young learners' interests, skills, and personal areas of expertise, building on what they bring to the learning experience, supporting them in integrating these into their learning and helping them find a way to deepen them, explore and see how these can extend into the future by following relevant studies and careers. It crucially involves building on one's prior knowledge or making seamless connections between e.g., the science curriculum and science in the broader world, across time and settings throughout the day and across the lifespan (Hannon 2017).

Creating a project that entails all the above is the next step to follow in the development process. Namely, having established a partnership and decided to develop the idea of a solution to the selected collective problem, the partners have then to take the action of co-creating. This can be done either by following an existing initiative or process as the one proposed in the living lab co-creation practice or by setting up a new one that better suits their needs and objectives.

Whether a project is set up or connected to an existing one, it is important that all stakeholders in the partnership are included from the start to meaningfully contribute at the co-created and integrated solutions. This requires the initiating partner or partners to actively invite stakeholders to participate in the process as early as possible. It should be considered also that other stakeholders relevant in the context of the envisioned problem or solution can be involved. This includes the end users with which prototype solutions can be tried and evaluated.

Creation and initiation of a project practically mean to develop an overall plan. A living lab approach implies that also the plan development process is one of co-creation. In the first step, stakeholders jointly work toward a shared vision for the project. A shared vision, being an integrated result of the joint effort of all stakeholders, fosters satisfaction and commitment among the participants. A precondition for this commitment is that all actors are intrinsically motivated to participate. If one of the stakeholders cannot be convinced that the project is in their interest, the project will not yield integrated solutions and long-term sustainability. This intrinsic motivation to participate should be consolidated in the shared project vision, be it by providing added value in terms of the educational or commercial or social responsibility objectives of stakeholders.

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The best chance of reaching mutual agreement and making optimal use of the means, capabilities, and strengths of the various actors, is created when both interests and solutions to be explored are aligned in the development plan. This implies that, if necessary, the aims should be reformulated until all stakeholders' interests are included, which should be part of the plan development process and to which the initiator should be open and accommodative. Thus, it is crucial that all stakeholders of the partnership jointly form an integrated vision and jointly define the problem statement, goals, ambitions and expected outcomes.

Commitment of the participants to be open to adopting an attitude that might be different from their traditional way of working should be part of the shared vision underlying the project in partnership. An open and transparent attitude is needed with regards to expertise, knowledge, interests, and objectives of all involved. Further to being open-minded, flexibility and willingness to adapt may be required before all participants realize how others can help them find new or better solutions to problems.

After having developed a shared vision the next step to follow in the planning is the organization of the various activities that are required to bring initial idea or ideas to final solutions. The activities include iterative phases of exploration, experimentation, and evaluation. Exploration work aims at turning ideas into use case scenarios and rough prototype solutions to be tried further. Experimentation involves testing on real-case situations or conditions to gather further insight and deeper knowledge by collecting useful data that will feed into evaluation. Evaluation is the analysis of collected valuable information during experimentation, the results of which will guide the selection/adoption, rejection or improvement of a particular solution.

The implementation of this iterative process of solution or product development usually referred in industry as "from conceptual designs to prototypes" or prototyping, requires one to actively seek inclusion of useful resources and skills. This usually involves interaction with the people who have, or have access to, these skills and resources or who are willing to develop them through learning. These interactions often take place through a recurring pattern of awareness, action, and interest, leading to better connection and engagement of these people to the project. Therefore, as already mentioned a co-development and co-creation-oriented mindset is crucial to be instilled in the partnership at all levels to encourage the diffusion of resources, skills, expertise, and capabilities.

The aim to ensure that all capabilities and resources necessary for the development process and that all corresponding actors are included in it implies the need for efficient organisation and distribution of tasks, roles and responsibilities. It should be clear that not all partners can contribute to an equal extent or have the capacity or expertise to do so. Hence, it is better if participants first on their own initiative indicate where they can contribute and then altogether jointly work toward the allocation of all required roles, responsibilities and resources.

During the allocation of roles, responsibilities and resources, it should be clear to all what the planned tasks, activities, and expected outcomes imply, and what exactly is expected of each actor. Actors usually need to contribute to the tasks of others as well. Creating awareness and agreement on the commitments, dependencies, and implications of tasks up front increases the chance that actors will adhere to their commitments. However, at the same time it should be noted, that in general a development process can be dynamic and may deviate substantially from initial plans. In this respect being prepared for processes taking unexpected turns or being proactive to avoid so calls for agility, adaptability, flexibility, and resiliency.

Further on this, we should always keep in mind that a learning ecology is being a metaphor of a natural ecosystem which by default is a dynamic, diverse, self-organised system. In other words, the dynamic

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and unpredictable character of its development and evolution is an inherent feature of the whole concept. Nevertheless, some management structure is needed to track and ensure progress, to monitor the performance of the scheduled activities, and to organize the tasks, people and resources to achieve results as planned. The structure does not need to be strict and hierarchical in a conventional way given that most participants may have joined the partnership on a voluntary basis.

Usually, the initiator of a partnership can take the leading role to manage the project and to do so it is needed not only to coordinate and guide the other partners but also to motivate and inspire them.

At the same time, keeping things simple, clear, open, and transparent is key to effective management in partnership. In this direction, organising frequent results-oriented meetings so that all partners get informed about progress or are aware of deviations from expectations helps to maintain the momentum, to remain focused and motivated to contribute. Keeping a positive mindset and active participation of all involved is also crucial in the whole process. As this is greatly depending on or being affected by the sense of accomplishment of results one has also to be prepared for situations where the route to accomplishment may not be smooth or continuous. Periods with ups and downs are not uncommon in exploration and experimentation or in general in any development process. Unexpected problems may arise, and setbacks may occur, however these may be a great source of insightful learning about what caused them or how to overcome them instead of being a reason to abandon the effort.

Below we include a list of key points and indicative questions to consider in advance and think about thoroughly which can be useful in the preparation and successful completion of this step.

- Creating a project in partnership is done by following or adopting a process such the living lab co-creation practice. Is this process clear to all participants?
- Are all relevant stakeholders included in the process or is their active participation ensured?
- Is a shared vision co-created that is jointly defining the problem statement, goals, and ambitions of all in the partnership?
- Does it clearly embed all stakeholders' interests?
- Co-creation in practice may require participants to commit to a more open, transparent, and flexible attitude and way of working. Are all aware and committed to this?
- Is an overall plan of activities co-created?
- For the plan to succeed, are the committed resources adequate or well-foreseen?
- Is it well divided in tasks or iterative phases of exploration, experimentation, and evaluation?
- Are the expected outcomes or results in each task or phase clearly defined? Are they understood by all?
- Are division and allocation of roles, responsibilities and resources clear to all partners?
- Is allocation based on interest, expertise and capability of each partner?
- Are all aware of and do agree on associated commitments, dependencies, contributions, and implications?

In concluding this step, we would like to emphasise that given the importance of co-creation in the whole development process we dedicate further methodological guidance on it. This is based on the living lab co-creation practice and is presented in the next section.

Action Hint: *with a partnership in place, the next step in developing a SLE is to collaboratively co-create and implement a project rooted in shared vision and mutual interest. Begin by involving all stakeholders early and meaningfully, ensuring they help define the problem, co-design the goals, and contribute to shaping the solution. Consider using a living lab co-creation approach or similar*

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participatory processes to encourage experimentation, iteration, and learning. Develop an overall project plan that includes cycles of exploration (generating ideas and early prototypes), experimentation (testing in real-life conditions), and evaluation (analysing and refining based on feedback). Clearly define roles, responsibilities, and tasks based on each partner's strengths and interests, and ensure alignment with available resources. Foster open communication, flexibility, and a willingness to adapt, recognizing that the development path may be non-linear. Use regular meetings to maintain momentum, monitor progress, and address challenges proactively. Above all, promote a culture of mutual respect, shared learning, and collective ownership to ensure long-term commitment and impact.

1.2.4 Step 4. Reflection and Sharing of Results

The last step in the process is **reflection and sharing of results**. Both actions in this phase consist of an integral and essential part of the whole process. Their importance should not be undermined by considering them a formal obligation as part of completing the project or reporting about it outside the partnership. On the contrary, it is an opportunity for all involved to openly think about and discuss the accomplishments, articulate the findings from each participant's own perspective through communicating them to others and collectively reflecting upon all or some of the stages of the followed process.

Reflection on the partnership's overall work, results and processes give rise to new thoughts on what went well or not according to plans, how common mistakes or setbacks could have been avoided, what can be done differently and more efficiently, which were the key elements that accelerated progress or led to better than expected results, what are the overall lessons learned. Reflection includes also rethinking about how the proposed solutions or product prototypes were received by the target population, whether they managed to reach the goals they were intended for and whether any adaptation is required. Thus, reflection can immediately result into reigniting the co-creation process for a new iteration.

As all participants reflect on their own understanding but also compare with each other's assessment and views they strengthen their sense of ownership and at the same time subconsciously consider how to sustain their achieved results or solutions. It is not uncommon that participants focus most of their attention on delivering a solution within certain constraints, and much less on making sure that this need to be a successful solution also over a longer period. Thinking or laying out a strategy about this point of "now-what-next" can actually be initiated in the reflection phase.

Effective sharing of results contributes along this line. Sharing with a wider community of stakeholders is a committing obligation of all in the partnership. It aims at both informing about the tangible outcomes and encouraging and inspiring others to follow a similar approach of action. Various methods and digital or conventional means accessible to the partnership can be utilised such as publications, announcements, participation in conferences, exhibitions, public outreach and awareness campaigns, innovation publicity and networking hubs etc.

Below we include a list of key points and indicative questions to consider in this phase.

- Thinking about the whole project, including its objectives, its participants, their roles and actions, its processes, and its outcomes, what did go well and what not?
- Are all relevant stakeholders included in the reflection process or is their active participation ensured?

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- What was the main element or elements behind successful outcomes or what was the main cause of any problems?
- Was it process related; people, institution and attitudes related; conditions or resources related?
- What can be done differently, and how?
- What are the main lessons learned?
- How the lessons learned can be best shared and with whom?
- How achieved outcomes or proposed solutions can be sustained or replicated at wider scale?

Action Hint: *the final step in developing a SLE is dedicated to reflection and sharing of results—a crucial phase for learning, improvement, and sustaining impact. Rather than treating this step as a formal closure, use it as an opportunity for all stakeholders to openly evaluate what worked, what didn't, and why. Encourage honest dialogue about key successes, challenges, and lessons learned—considering both the process and the outcomes. Reflect on whether the goals were met, how the solutions were received by end users, and whether adaptations are needed for future iterations. This phase also offers a chance to think ahead: How can the outcomes be sustained or scaled up? Equally important is sharing results with the broader community—through reports, events, digital platforms, publications, or outreach activities. This not only communicates achievements but inspires others to adopt similar collaborative approaches. Effective reflection strengthens a sense of ownership among partners and often sparks new ideas, making it a vital link back to the beginning of the co-creation cycle.*

1.3 Elaboration and further guidance on key aspects of the development process

In the previous section we discussed the proposed steps of development. In this accompanying section we complement them by elaborating on certain key aspects. These focus on partnership establishment and stakeholder engagement, living lab co-creation practice, and finally, inquiry-based pedagogical design.

1.3.1 Partnership establishment and stakeholder engagement

In today's rapidly evolving educational landscape, collaboration between schools and companies, universities and other stakeholders is of paramount importance. The vision of SLEs blends the STE(A)M approach, open schooling environment and living lab practice within an empowering partnership based on local-level collaboration between formal, non-formal and informal science education providers, enterprises, and civil society.

These partnerships have the potential to enhance teachers' teaching practices, enrich the learning experience of students, bridge the gap between academia and industry, and ensure that educational institutions are equipping students with the skills and knowledge needed in the professional world. The various stakeholders can also benefit from collaborating with schools by gaining access to

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emerging talent, contributing to the development of future professionals, and fostering innovation through academic research.

To ensure a bottom-up approach in the creation of the project partnership, it would be optimal for the initiator of an SLE to be a primary or secondary school. Furthermore, we consider an SLEs partnership to be composed of at least three actors: a school and two other actors belonging to different stakeholder groups among those mentioned above. In this section, we will explore a structured approach for schools to establish and navigate collaborations with external stakeholders effectively.

Identifying Shared Objective(s)

The foundation of any successful collaboration lies in the identification of shared objectives between the school and the other stakeholders which are part of the project partnership. All parties must align their goals and values to create a meaningful partnership. For instance, a shared objective could be to enhance students' employability through practical experience and exposure to industry practices. Another objective can be even more specific and focus on a specific sector or skills that the company introduce to the students. By identifying these shared objectives, schools and stakeholders can work together towards achieving common goals and maximizing the benefits of their collaboration. For example, in the portfolio of twelve pilot SLEs presented earlier on, the goals of the majority of SLEs are to lead to increased motivation and offer incentives for students to develop deep content and concept knowledge, critical and creative thinking, and problem-solving skills through exposure to real-life community challenges. This alignment ensures that the collaboration is purposeful and relevant, benefiting both students and the stakeholders.

Useful Hint: *Align goals between schools and stakeholders to define shared objectives that ensure purposeful, relevant, and mutually beneficial collaboration.*

Needs & Resources Assessment

Before initiating a partnership, it is crucial to conduct a thorough needs and resources assessment. This assessment allows both the school and the stakeholders to understand each other's specific requirements, resources, and areas of expertise. An assessment may involve evaluating the school's curriculum, facilities, and student demographics and, for instance, a company's industry focus, skill requirements, and corporate culture. Open and transparent communication during this process ensures that all involved have a comprehensive understanding of each other's needs, laying the foundation for a successful collaboration. It also helps identify potential areas of synergy and opportunities for joint initiatives.

To emphasize the importance of having a clear view of what is needed, what is available, what can/should be committed for a successful SLE we include below some representative transcripts from the feedback received during the implementation phases survey: *… The project-based activities in schools are done on the basis of volunteer work of teachers but also by research organizations and researchers. This makes the process not sustainable in the long run, if there were the necessary economic and time resources allocated to these activities and formal recognition of this work, this would be radically different …* (APRE, SLE Initiator and National Coordinator in Italy); *… Even though the topics of the project were integrated into the curriculum, we faced challenges related to time and curriculum constraints. Additionally, the lack of budget for materials and field trip expenses was overcome with the help of parents …* (SLE Initiator in Romania); *… Lack of resources: Inadequate resources, including materials, equipment, and funding, can limit the scope and quality of educational*

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activities in the SLE, impacting the overall learning experience for students … (CPN, SLE Initiator and National Coordinator in Serbia).

Useful Hint: *Assess and align the needs, resources, and capacities of all partners to ensure a realistic, sustainable, and mutually supportive collaboration.*

Collaboration Models and Activities

Collaboration between schools and external stakeholders can take various forms, depending on their objectives and available resources. A school can engage in a diverse range of activities with a company, university, museum, or local authority to enhance the educational experience of its students. Collaboration with a company can involve career-oriented activities such as internships, job shadowing, or guest lectures/chats, providing students with practical industry exposure and insights. Partnering with a university opens avenues for research projects, joint academic initiatives, academic mentorship programs, and access to specialized resources and expertise. Museums can offer field trips, guided tours, or interactive workshops, enabling students to explore and appreciate art, history, science, or culture. Engaging with a local authority allows schools to organize activities that directly benefit the local community, civic engagement programs, or environmental initiatives, fostering social responsibility and active citizenship. These collaborative efforts between schools and external organizations enrich the learning experience, provide valuable real-world connections, and broaden students' horizons.

Useful Hint: *Design diverse, goal-driven collaboration activities with external partners to enrich learning through real-world experiences and community engagement.*

Access to support mechanisms

To ensure the success of partnerships between schools, industry, universities, and public authorities, various support mechanisms, accessible by all stakeholders, aremade available via the SLEs project. Access to resources including templates, partnership ideas, guidelines and frameworks already developed within previous Open Schooling projects, are organised, and made available via the SLEs website. On both European and local level, online and face to face workshops addressing various aspects of the SLEs methodology, were organised, providing all stakeholders with abundant opportunities to learn from existing good practices, exchange with other stakeholders, ask questions and receive guidance.

In particular, support materials included detailed project guidelines based on the current methodological framework, a thorough checklist that summarizes its main points, a more detailed version of the guidelines to design and collect learning artefacts, a toolkit on how to create inclusive and gender equal SLEs, and information on how to look for funding opportunities to support the SLEs implementation. Additionally, materials produced by SLEs initiators, such as learning scenarios and resources for replicating activities other projects, were also shared to inspire new SLEs.

In more detail, the checklist was planned to be fully aligned to the current methodology and contains a step-by-step guide to the implementation of an SLEs. Each step includes references to support materials which guide participants in gaining a better understanding of that phase. By doing so, the checklist became a guide to accessing learning resources, and a map along the whole implementation process. Additionally, by asking participants to report when a certain step has been completed, the

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checklist was also used as an indirect monitoring tool, which could alert National Coordinators if certain SLEs were lagging and allowed them to promptly ask for assistance or offer guidance to others.

At the same time and within the partnerships, mentoring programs in the form of a peer-to-peer support system have been established, allowing students but also teachers to benefit from one-to-one support and guidance from industry professionals, university faculty, or public authority representatives. This helped students gain valuable insights, build networks, and navigate their educational and career pathways effectively. Additionally, capacity-building workshops, training sessions, or knowledge-sharing platforms were organized within the partnership to enhance the skills and expertise of teachers, industry personnel, and university staff, fostering effective collaboration. Open communication channels and regular meetings facilitate ongoing dialogue, problem-solving, and the exchange of ideas among all stakeholders. By having access to these support mechanisms, stakeholders can foster strong and sustainable partnerships, maximizing the benefits for all involved parties.

Documenting and sharing knowledge among partners are key elements of the project. To facilitate SLEs development, the consortium created and applied two schemes:

- Ideas and methods to facilitate research-industry-learning synergies, promoting and supporting integrated SLEs projects combining science and innovation application in industry with lifelong learning. To do so, the project leveraged on the SLEs projects to formulate communities of practice bringing together all those concerned or passionate for science education. This included a dual focus on identifying and enacting opportunities for: a) the application of R&I results in business, including different genres of enterprises (start-ups, SMEs, entrepreneurs); and b) in this industry-based context, providing lifelong learning experiences to various actors (students, teachers, researchers, professionals, etc.)
- Mentoring across the different groups involved in the SLEs to take full advantage of the learning, personal and professional development opportunities generated in the context of the evolving synergies of education, research, innovation, and industry in the local partnerships. Depending on the specific challenge, the right mentor was identified and provided advice at development stage, reviewed actions, and suggested activities and improvements. In each implementation country, the SLEs project partners acting as National Coordinators supported the local stakeholders and facilitated the development and implementation of the respective ecologies. The facilitation of SLEs included regular planning, support and reflection meetings (online or face-to-face), and training activities. Methods used, knowledge and experiences gained through the SLEs co-creation and facilitation in the early stages and up to the completion of pilot implementation activities, informed the mature implementation cycle of SLEs.

In each implemented SLE, the stakeholders, with support from the National Coordinator, implemented the methodology provisions for facilitation and mentoring and for learner meaningful engagement in ways relevant to the local context.

The “Ecologies co-creation and facilitation methods and learning” (project deliverable D3.2) includes a detailed description of the SLEs methods for mentoring as well as framework a set of guidelines drawn from pilot experiences and recognised good practices. This document offers broad suggestions for content to be built upon by the SLEs implementing entities that they can test and adapt during the implementation phase.

The SLEs coordinators, initiators and participating stakeholders were encouraged to experiment with what worked best for their context and to share reflections on their experience toward an effective and

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innovative mentoring methodology. The local contexts, and participants individual characteristics and needs must always be taken in consideration to implement an effective mentoring activity.

Useful Hint: *Leverage available support tools, mentoring, and training resources to strengthen collaboration, build capacity, and ensure sustainable SLE implementation.*

Establishing Partnerships

Once the school and external stakeholders have identified shared objectives and explored collaboration models, the next step is to establish partnerships. Schools can begin by identifying potential organisations that align with their goals and values. Networking events, industry connections, and online platforms can be valuable resources for finding suitable partners. Parents employed within a specific company/university and/or sector, can also help by making that first contact.

When reaching out to potential partners, clear and effective communication is crucial. Schools should articulate their objectives, propose collaboration models, and discuss potential mutual benefits. Emphasizing the value and unique opportunities that the partnership can offer is essential for engaging the interest of prospective partners. Building a strong foundation of transparent communication, trust and mutual understanding from the beginning is key to establishing successful long-term partnerships.

As already mentioned and emphasized earlier an important aspect to be considered when establishing partnerships for SLEs projects is to consider the pedagogical resources that each stakeholder can offer to the SLE.

Useful Hint: *Build trust through clear communication and mutual benefit to form strong, lasting partnerships aligned with shared goals and resources.*

Enhancing Gender Equity, Inclusiveness and Diversity

Meaningful and impactful stakeholder engagement comprises of gender equity, inclusiveness and diversity. These should be reflected in partnerships' composition, roles and responsibilities allocation, but also in tasks, educational pathways and activities to be implemented with learners. Therefore, it is of high importance to highlight same-gender role models along with providing career aspirations and mentorship towards increasing female participation and engagement. Of equal importance is to promote also perspectives of diversity, gender equity and inclusiveness. Deconstruction of stereotypes can be achieved as well by encouraging collaboration rather than competitiveness among individuals or groups of learners, by offering learning activities that put emphasis on skills and competences and not on gender, ethnical, cultural or socioeconomic backgrounds. The following transcripts from the implementation phase survey, interviews and workshops give a literal highlight of above aspects: *… During this process, all those who worked with the students in leadership roles were female – scientists, teachers, workshop leaders, librarians, artists etc. This was a conscious decision to use the principle of ' See it – Be it'…* (CURAM, SLE Initiator and National Coordinator in Serbia); *… During the pathway, stakeholders presented the list of five Italian excellent female scientists who are on the list of the 100 most influential female scientists. Contrary to other situations where the male component tends to strive more to be in the spotlight and impose itself on the female component, in this context instead boys and girls worked on a parity basis …* (APRE, SLE Initiator and National Coordinator in Italy); *… Female Role Models: By highlighting female spokespersons from stakeholders as role models, the SLE provides examples of successful women in STEM fields, inspiring female participants and*

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breaking gender stereotypes. Equitable Opportunities: The SLE pilot aims to provide equal opportunities for female engagement by designing activities and topics that appeal to both males and females, fostering a supportive and inclusive learning environment. Highlighting Diversity: By showcasing female role models and emphasizing the importance of collaboration and diverse perspectives, the SLE pilot promotes a culture of inclusivity and empowerment among all participants challenging traditional gender norms in STEAM education. … (CPN, SLE Initiator and National Coordinator in Serbia).

Useful Hint: *Foster inclusive partnerships by promoting diverse role models, equitable opportunities, and collaboration to challenge stereotypes and empower all learners.*

Building Trust and Maintaining Relationships

Building trust and maintaining strong relationships are vital for the long-term success of collaborations between schools and external stakeholders. Regular communication, meetings, and feedback mechanisms help nurture these relationships. Initiators, schools and stakeholders should establish channels for open dialogue and the exchange of ideas, allowing for a continuous flow of information and insights. Sharing successes, challenges, and lessons learned promotes transparency and strengthens the partnership. Confidentiality and accountability should be prioritized to protect sensitive information and maintain professional standards. By actively investing in relationship-building efforts, schools and external stakeholders can foster a collaborative environment that leads to sustainable and impactful partnerships.

Useful Hint: *Nurture partnerships through open communication, transparency, accountability, and continuous relationship-building efforts for lasting collaboration.*

Assessing the impact of collaborative activities

Schools and external stakeholders can establish a comprehensive evaluation framework to assess the impact of their collaborative activities. Stakeholders will be collecting and describing artefacts ("learning products") to be created by students along their learning paths within the partnership focusing on comprehensive learner engagement and reflection on scientific knowledge, skills, and competences necessary for their construction. These learning products will enable an insightful stakeholder dialogue to help assess and redesign learning trajectories and activities provided by the SLEs. The assessment can also focus on specific topics like for example female engagement in the SLEs implementation and female career prospects in STE(A)M reflected during the various learning trajectories. From this process, specific artefacts will lead to the identification of learning paths and activities that will be used as good practices by the wider SLEs community. In the context of overall assessment, the initiators' survey questionnaire which is included in the Appendix III – SLE Survey Questionnaire and the results of which were discussed earlier on can also furnish as a starting template for the evaluation of an SLE.

Useful Hint: *Use learner-created artefacts and stakeholder feedback to evaluate and improve the impact of collaborative learning activities.*

Below we provide some useful resources.

For teachers and educators

- Advice from the industry: How can teachers get engaged with the STEM professionals?

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- Professionals go back to school: Guide for schools
- Methodology for the engagement of School Living Labs with stakeholders
- A guide to ethics and student engagement via partnerships

For companies

- Professionals go back to school: Guide for companies
- InGenious code: School – industry collaboration
- Guidance for schools and businesses collaborating in curriculum-based projects

1.3.2 Living lab co-creation practice model

In this section we elaborate on the living lab co-creation practice. Although parts of this practice were already presented and discussed in the White Paper, we include and highlight its main elements in this document for completeness. This section concludes by proposing a practical step-by-step model in the context of SLEs project.

In our White Paper we have discussed in detail how we envision STE(A)M's inherently integrated and interdisciplinary nature can facilitate the development of innovative ideas and creative solutions that emerge at the interface between disciplines and can involve different societal actors to bring in or link to diverse experiences, needs and problems. We mentioned that it can also involve different learning settings as learning can happen in formal, non-formal and informal spaces, at home, in the community and in activities linked to enterprises.

This naturally leads us to the core element of the open schooling concept which within SLEs is generalized as being an environment that promotes partnerships between different societal actors and the local community with a view to engaging them in the teaching and learning processes but also to promote education as part of local community development. An open schooling learning environment helps and engages learners to apply learning to real-life problems and find effective solutions. They are inspired to be responsive, innovative, and entrepreneurial in their approach to learning, to generate ideas and applying them to solve problems and to create sustainable responses to community's and in general to society's challenges (Price 2013; Covay 2010; Mueller 2015).

Essential elements regarding the creation and establishment of an open schooling environment in school education were firstly developed in the "Open School for Open Societies" (OSOS) EU funded project, implemented between 2017 and 2020 (https://cordis.europa.eu/project/id/741572). The project succeeded in introducing and testing an open schooling model with 1000 schools across Europe. The proposed facilitation model is the four-step process "Feel-Imagine-Create-Share", as it was first developed by the "Design for Change" movement and has been accordingly adapted. The main purpose of each step is as follows:

- Feel: Students identify problems or challenges in their local communities. They can also select topics related to global challenges that may affect their communities in the future. Students observe problems and try to engage with those who are affected, discuss their thoughts and ideas of solution in groups, and make a plan of action, based on scientific evidence.
- Imagine: Students envision and develop creative solutions that can be replicated easily, reach the maximum number of people, generate long-lasting change, and make a quick impact. They are meeting external actors, they are looking for data to support their ideas, and they are proposing a series of solutions.

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- Create: Students are implementing the project and they are interacting with external stakeholders to communicate their findings.
- Share: Students share their projects with other schools in the local or wider community.

A representative example of a school project focusing on road safety and its relation to community well-being that was developed based on this generic four-step approach is the following: 1. Feel: teachers and students make a survey of their local area and observe that bicycle riders are exposed to increased risk of accident when they need to turn, 2. Imagine: they propose a solution that if riders or bicycles are equipped with automatic flashing indicators then the following car drivers will be better alerted to expect a turn, 3. Students collaborate in groups with the physics, informatics and electronics teachers and design a vest with a wearable device, with tilt or inclination sensor, control unit and led lights, that bicycle riders can wear, 4. Students show their creation in school exhibitions and share online their design documents, source code, photos, videos etc. This example demonstrates well some of the core elements of a learning ecology as we envision it in SLE, however it needs to be complemented e.g., to better incorporate the dimension of a partnership where a diverse set of actors are involved in co-design and co-creation of potential solutions.

An enabling methodological practice to either initiate, support, or complement an open schooling learning environment is the concept of Living Lab. In general, “living lab is a diverse partnership driven by innovation methodology for co-creation acting in an environment for co-creation and user engagement” (Millet et al. 2015). In this way Living Lab may simultaneously refer to and encompass three different dimensions: partnership, methodology and environment. As already discussed, a partnership is established and focused on the collaboration of different actors from diverse sectors. In SLEs we aim at having partnerships that comprise actors that include schools, informal educators, local public authority, enterprises, and the end-users themselves, who may be involved as individuals or through a civil society organisation. These actors should commit to engaging the project in a co-creation process.

In addition to partnership, a Living Lab can be defined as a practical methodology to develop innovation through a user-driven process of co-creation. This process emphasizes the central role of the user in the Living Lab approach. Instead of being the target of an innovative solution, the users will be its co-creators, so the solution can be driven by their needs, values, priorities, and ethical concerns. This approach is a real commitment for all involved as they are required to deeply participate into a project and really contribute to its development. The methodology in practice emphasizes the idea of development cycles comprising prototyping, testing, and redesigning phases, in a way that is related to or resembling engineering design processes (see Figure 3).

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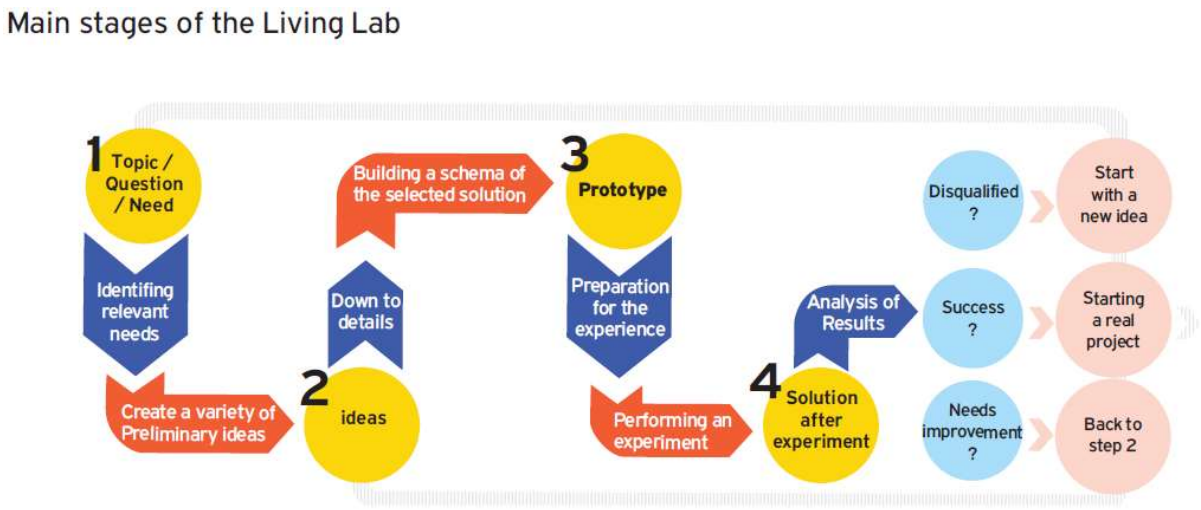

Figure 3: Main stages of the Living Lab methodology as proposed in SALL project (Aguirre, 2021).

In this framework the key principles and main steps of development of a Living Lab project are:

- Start from a real issue with a goal to study, develop and propose a real solution, making use of the participants' personal experience. This principle ensures that the project focuses on an issue and not only on a general idea, and that the main driver of the project will be to look for solutions, and furthermore to have those solutions implemented.
- Actively involve all societal actors in co-creation. Those can be local actors, individuals or institutions that have some common direct or indirect interest with the school, and that are benefited or affected by the process or the project's outcomes.
- Conceptualize, design, and propose solutions using all the perspectives that are present in the partnership, thus maximizing the various levels and types of expertise from different actors. The school students would generally be the core team to generate ideas, but those ideas would have to be discussed, shared, and built with the other actors.
- Aim to put in practice and test early and quickly preliminary solutions with users. By prototyping initial versions of possible solutions, the learning value of a project is coming both from the study of an issue, but also from the transformation of an idea into prototype and the testing with real users.

A living lab approach has been widely implemented throughout the SALL ("Schools as Living Labs") and GenB ("Informing and educating young people on more sustainable behaviours and choices to build a future generation informed and interested in bioeconomy") projects in both of which partners of the SLEs consortium participated. Similar to these projects' practice, we suggest adopting and implement a staged living labs process as follows (Leminen 2012; Millet et al. 2015):

- Co-creation/co-design: This is the ideation stage where participants develop a portfolio of possible ideas that they could implement to reach their desired goals.
- Exploration: at this stage the participants explore the ideas in more detail and together come into a consensus on which ideas they would like to produce and experiment on. In this stage, they develop prototypes of the ideas or bring them to life so that they can deploy them to the target population in the next stage.

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- Experimentation: At this stage, the participants test the developed prototypes or products with the target population.
- Evaluation: At the final stage, the participants of the living labs reflect on how their product or products were received by the target population, whether they managed to reach the goals they were intended for and whether any adaptation is required.

The following transcript from the initiators' survey highlights clearly the importance of the living lab methodology, *… The living lab methodology was extremely effective in supporting the inclusion and teamwork of the children. Working together for common ethical goal allowed them to develop soft skills (e.g. overcoming conflicts, problem solving, team building, collaboration) and to increase their sense of belonging to the community …* (APRE, SLE Initiator and National Coordinator in Italy).

An overall synthesis and adaptation of above-mentioned processes in accordance with the generic open schooling model and the living labs practice leads to the following step-by-step model as depicted in Fig.4. It consists of the main stages of Feel and Imagine as part of the initiation phase, which then lead to the stage of Co-create and its iterative subsequent steps of Explore, Experiment and Evaluate, and finally concludes with the stage of Reflect & Share. Figure 5 visualises better its correspondence and accordance with the overall development process discussed in the previous section. This is the main procedural model we propose to partners, educators, and other stakeholder participants in the SLEs project to adopt and implement during the mature phase. It is worth noting that its efficacy and flexibility was proven during the piloting phase.

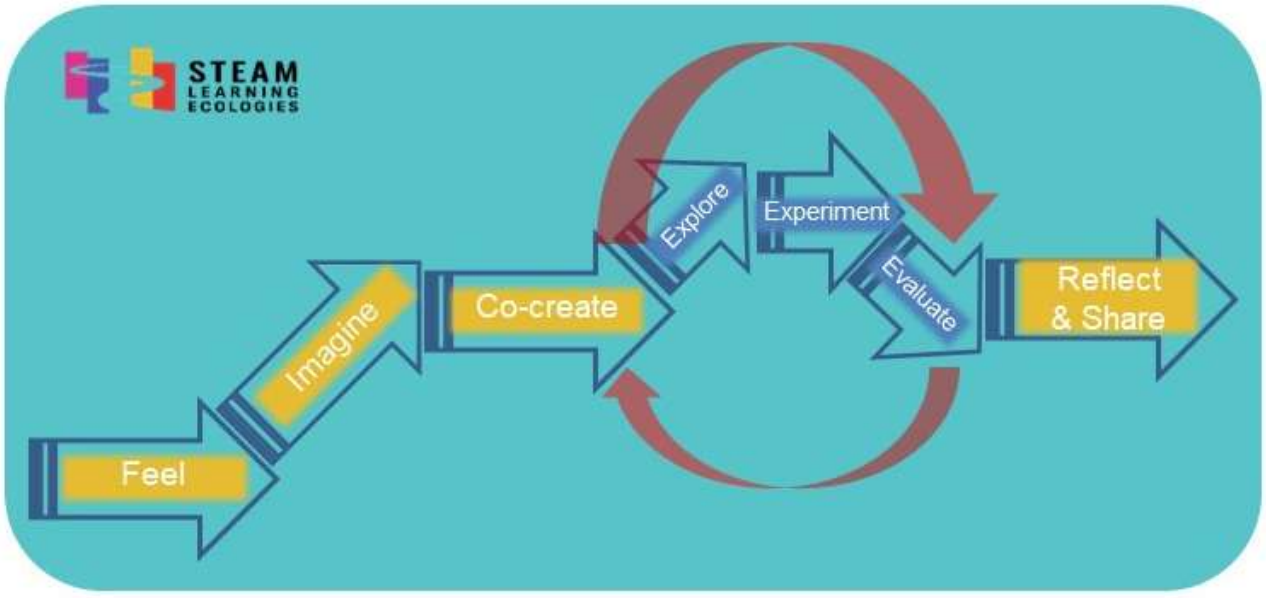

Figure 4: Main stages of the integrated living lab co-creation practice

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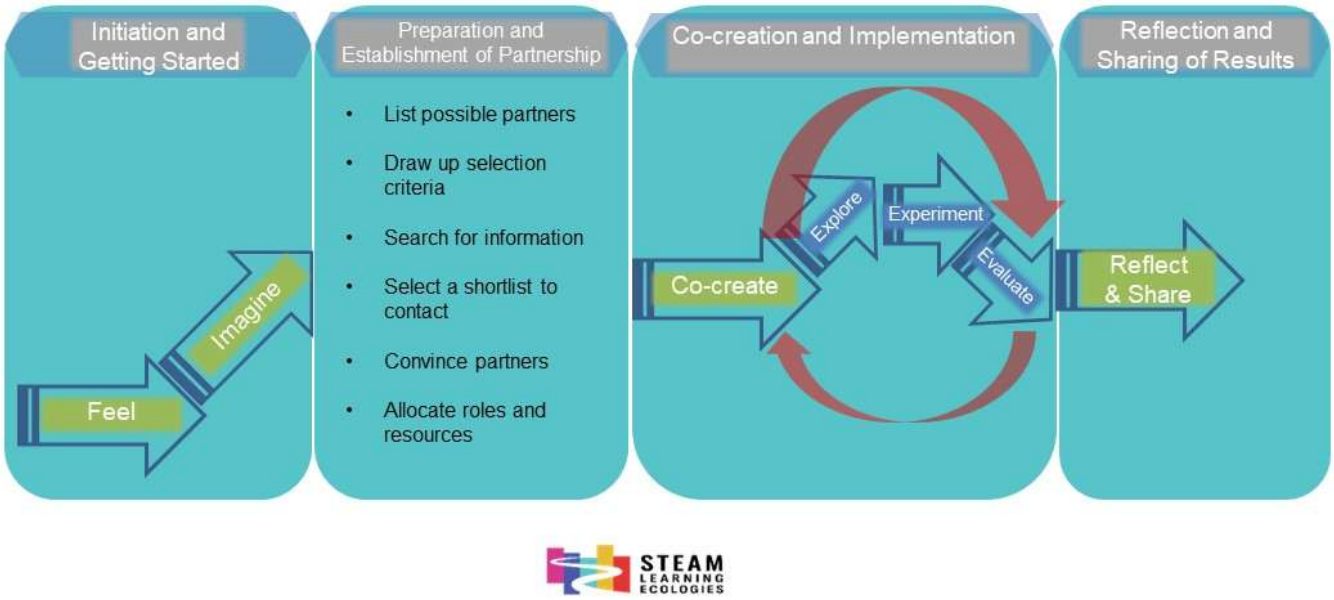

Figure 5: Main stages of the integrated living lab co-creation practice in accordance with the SLE step-by-step SLE development process

In the appendix of this document, we also propose a template to facilitate the process of development and reporting of an SLE or its initial concept and envisaged activities. This can be utilised by partners, schoolteachers, and educators in collaboration with other stakeholders involved to document an example SLE or a complete one developed in partnership. In addition, sharing proto-SLEs or mature ones through a standard template allow others to easily adopt, adapt and replicate them. In the Appendix IV – SLE Methodology we provide a concise set of flashcards that consolidate the key elements of the step-by-step development process.

1.3.3 Guidance on inquiry-based learning

An SLE invokes and encourages the nurtures of pathways as a metaphor for thinking about ways to provide structure to learning experiences, about how they are inter-connected and inter-related and about how they allow or help learners to build upon them to pursue goals requiring extended engagement across multiple contexts and learning opportunities. Further to this, along pathways the living lab practice inherently induces abundant opportunities for investigation and experimentation, i.e., see Explore-Experiment-Evaluate in Figure 4. In other words, scientific inquiry is a core element of an SLE, therefore we adopt a pedagogical framework that greatly encompasses it. The main approach we adopt and suggest is project-oriented inquiry-based methodology for effective teaching and learning.

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We emphasise the fact that this focuses on tasks within an SLE so that learners are better guided or supported. For instance, in an SLE students can be split in smaller groups to investigate and experiment on various aspects of prototype solutions. These micro-projects can follow an inquiry-based methodology so that better guide learners through the process of postulating a research question, plan an experiment, gather evidence by data collection, analysis and finally conclude to results. The whole procedure does not have to be overwhelming or over constraining, it is up to the teacher or educator or the partners involved to decide how to better implement it or simplify it to better match the learning needs of the students.

One may draw distinctions between project, inquiry or problem-based learning, however in reality the differences are minor. School students and in general learners found them highly engaging because they are conducting work that is meaningful to them and can connect to real life problems and challenges. Learning begins with a problem to be solved, and the problem is posed in such a way that learners need to gain new knowledge before they can solve the problem. Rather than seeking a single correct answer, they interpret the problem, gather needed information, identify possible solutions, evaluate options and present conclusions. The whole process gives many opportunities to connect to real-life and real-world challenges, work across disciplines, learn to function and collaborate in teams, communicate their findings and solutions, engage with their peers, experts and communities.

In the following we first present in detail a generic inquiry-based model based on five phases (Orientation, Conceptualization, Investigation, Conclusion and Discussion) that is suggested for teachers to follow in the design of interdisciplinary educational activities. A variation of this can be also adopted and integrated not only in the structure of STEM related projects but also in the features of creativity focused ones. At the end of this section, we also discuss in brief types of inquiry to better understand how inquiry-based methodology can be adapted in accordance with different levels of learners' self-direction.

Project and inquiry-based pedagogy

Inquiry-based learning (IBL) is an educational flexible strategy with phases that are often organized in a cycle and divided into subphases with logical connections depending on the context under investigation (Pedaste et al., 2015). This framework entails five general phases (Orientation, Conceptualization, Investigation, Conclusion and Discussion) and seven sub-phases (Questioning, Hypothesis Generation, Exploration, Experimentation, Data Interpretation, Reflection, and Communication). It can be used by teachers in order to conceptualize a structured way to implement inquiry activities and develop multidisciplinary educational projects in their classroom and beyond.

IBL is not a linear procedure (see Figure 6) and learners should be involved with various forms of inquiry, going through different combinations of the phases, not all of them necessarily. For example, if the data analysis is not satisfactory enough, students can return to the conceptualization phase and reconsider their question and/or their experimental design. When students come to a conclusion, new questions can be generated, and the process starts again in a progressive fashion. A description of the processes that each phase encompasses is provided below and the connections between these processes are presented in 6 (Pedaste et al., 2015).

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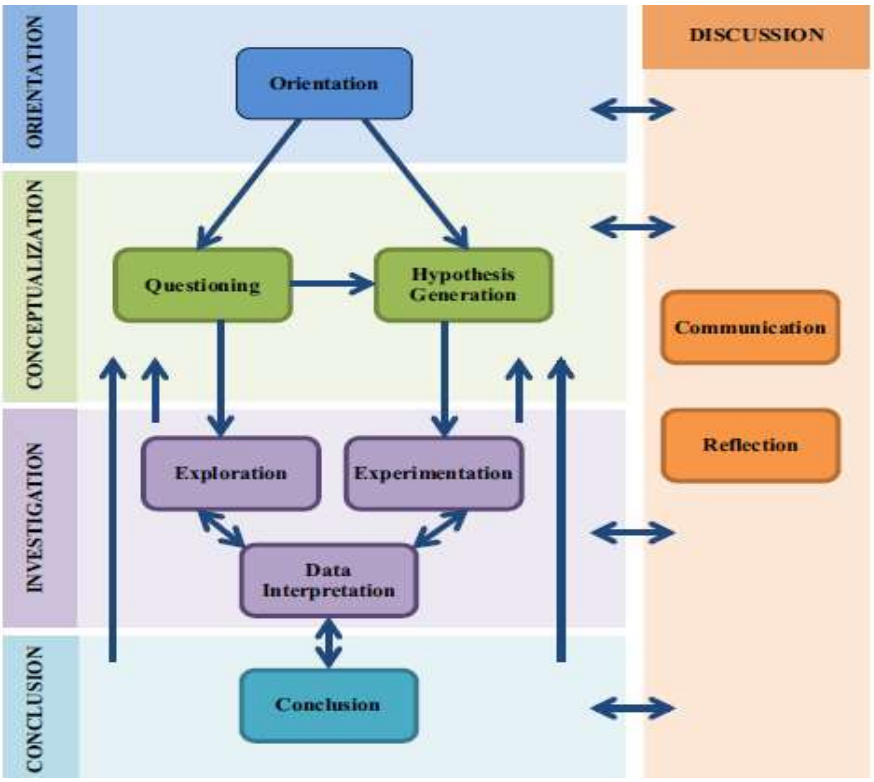

Figure 6: Phases and subphases of inquiry-based learning and their relations as described in Pedaste et al., 2015

Phases and subphases of inquiry activities

Orientation: Orientation is the phase where the identification of the problem occurs. The topic to be investigated is presented and interest about a problematic situation that can be answered with inquiry is stimulated. The topic under investigation must be relevant to students' daily life, interests, and prior knowledge. The teacher's role in this phase is to encourage students to express ideas, prior knowledge, and questions about the topic, while promoting interaction and communication between them. For example, students can create concept maps of what they know, do not know or want to know about the topic under investigation. These kinds of activities can also be useful for the next phases of inquiry.

Conceptualization: Conceptualization refers to the understanding of the concept, which relates to the problematic situation presented in the previous phase. It is divided in two sub phases (questioning and hypothesis generation) that lead the learner to the investigation phase. Now the teacher's role is to help students understand how they can formulate questions and/or hypotheses that can lead to an investigation. If students are not familiar with the questioning and hypothesis generation sub – phases, the teacher can choose a structured type of inquiry at first and then progress in more open types of inquiry in order to provide the appropriate guidance.

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- **Questioning subphase:** Questions are formulated in order to design an investigation that produces answers. As this skill is developed through inquiry, students can gradually understand which question can lead to investigation and which one is more generative and might lead to different or richer processes.
- **Hypothesis Generation subphase:** A hypothesis is generated through providing explanations of how the identified variables relate (Pedaste et al., 2015). It explains how and why phenomenon functions based on former experiences and prior knowledge (National Science Foundation, 2000).
- **Investigation:** Investigation is the phase where students collect evidence to answer their questions and/or test their hypothesis (National Science Foundation, 2000) and includes the sub – phases of exploration, experimentation, and data interpretation. The teacher provides materials that the students might need and keeps them on track so that the process they choose to follow is a process that answers the investigative question. Students should determine what constitutes evidence and collect it. If they are not familiar with this process, a structured type of inquiry can be chosen. The teacher can provide or encourage students to create means (e.g., tables, charts etc.) that can help them organize, classify, and analyse the data.
- **Exploration subphase:** Exploration is an open process which generates mostly data concerning the identification of a relation between the variables. It is chosen typically when the question that was formed in the previous phase was generative, because students do not have a specific idea of what to explore or how the identified variables relate to each other (Pedaste et al., 2015).
- **Experimentation subphase:** Experimentation includes the design (e.g., choosing the materials and means to measure) and performing of experiments taking into consideration the variables that need to change, remain constant and be measured. The products of this subphase are data or evidence that can be used later for analysis and interpretation.
- **Data Interpretation subphase:** According to the National Science Foundation (2000), data interpretation "includes finding a pattern of effects and synthesizing a variety of information" (p. 57). Depending on the concept under investigation and the inquiry procedures that were chosen, finding relations between the variables is sometimes the key for getting the desired outcome (answering the investigative question). Organizing and classifying the data (with graphs, charts, tables, pictures etc.) can benefit this process.
- **Conclusion:** In this phase students draw conclusions based on the investigative question and the interpretation of the data. The teacher's role during this phase, a comparison between the interpreted data and the predictions and initial ideas (that students expressed during the orientation phase) can be stimulated. This process can also lead to new hypotheses and questions about the topic under investigation (as shown in Figure).
- **Discussion:** During the discussion phase students articulate their findings through communicating them to others and/or reflecting upon all or some of the stages of inquiry during the process or by the end of it (Pedaste et al., 2015). The teacher's role is to encourage collaboration so that students can present their findings and ideas, provide arguments and

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give feedback to others. If they are not familiar with these practices, the teacher can provide guidelines that will help them to communicate during all the phases of inquiry.

- **Communication subphase:** Communication includes discussion with others and representation of results in a manner that is understandable to all (National Science Foundation, 2000). It can be applied to a single phase or the whole cycle of inquiry and is usually an external process (Pedaste et al., 2015).
- **Reflection subphase:** In this subphase students reflect on their work, their results and the concept under investigation. Reflection can even give rise to new thoughts regarding the inquiry cycle or a single phase.

Types of inquiry

The types of inquiry vary so that students are actively involved in the process to the extent that they are competent and able to do so. The type of inquiry a teacher may choose to follow is highly depended on the objectives of the lesson, the age of the students, their previous involvement with inquiry and the scientific skills they have already acquired. As shown below in Figure , the more responsibility the student has, the less direction is provided and more open the inquiry becomes (National Research Council, 2000).

Essential Features	Structured	Mixed	Guided	Open
1. Learner engages in scientifically oriented questions	engages in question provided by teacher, materials, or other source	sharpens or clarifies question provided by teacher, materials, or other source	selects among questions, poses new questions	poses a question
2. Learner gives priority to evidence in responding to questions	given data and told how to analyze	given data and asked to analyze	directed to collect certain data	determines what constitutes evidence and collects it

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3. Learner formulates explanations from evidence	provided with evidence and how to use evidence to formulate explanation	given possible ways to use evidence to formulate explanation	guided in process of formulating explanations from evidence	formulates explanation after summarizing evidence
4. Learner connects explanations to scientific knowledge		given possible connections	directed toward areas and sources of scientific knowledge	independently examines other resources and forms the links to explanations
5. Learner communicates and justifies explanations	given steps and procedures for communication	provided broad guidelines to use sharpen communication	coached in development of communication	forms reasonable and logical argument to communicate explanations

Figure 7: Types of inquiry and their features regarding questions, evidence, explanations, connection of the explanations to scientific knowledge and communication. Adapted from Inquiry and the National Science Education Standards, National Research Council (2000) p. 29

The variations of inquiry types concern the increasing or decreasing involvement of the teacher and student in the process. Structured inquiry is directed from the teacher so that students reach a specific result, whereas in mixed inquiry students are more involved during an investigation with the teacher guidance still being the most dominant. These forms of inquiry usually are chosen when students are first introduced to inquiry practices and when there is a focus in the development of a specific skill or concept. Open inquiry provides more opportunities for developing scientific skills, given that during open inquiry the students work directly with the materials and practices in a way that resembles authentic scientific approaches (National Research Council, 2000).

For example, if students lack previous experiences with designing investigations and collecting data, a more structured or guided form of inquiry should be chosen. When students acquire the skills needed, they can progress to more open inquiry activities. Students should at some point participate in all the forms of inquiry, while gradually moving from one form of inquiry to another with the simultaneous progression of complexity and self-direction.

1.4 Facilitation methodology and recommendations

Although SLEs is not an explicit school-based initiative, nevertheless it highly aims at attracting the participation of schoolteachers and educators from informal and non-formal education providers as key initiators or contributors to a learning ecology. Teachers, and in general educators, develop practices of teaching with which they feel comfortable and confident. When they mature it is usually

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difficult to change them, or they feel insecure to adopt innovative methodologies, technologies or practices such as the educational approach and activities to be developed and proposed in SLEs. However, when asked in surveys, most teachers express the willingness to adopt new methods and models of teaching that lead their students to better results in terms of concept understanding, content knowledge and behaviour or attitude change. A required condition is that they are thoroughly introduced in practicing these new methods before applying them to their everyday teaching or setting. In this respect, we plan in the SLEs project to offer a comprehensive facilitation programme, encompassing multiple modalities, online or in-person, that include hands-on practice workshops, that will not only help teachers to explore, adopt, implement and improve an already developed learning ecology but also assist them to gain confidence and experience towards developing their own ones themselves individually or in collaboration with peers or partners of the consortium.

In general, our facilitation approach aims at being inductive and practical with its participants focusing on gaining a better understanding of a learning practice or achieving a real change or improvement in the practice context. It involves actively participating in a change situation, assisted, or guided by peers, with the aim of improving their strategies, practices, and knowledge of the environments within which they practice. Furthermore, it should be interactive, collaborative, and reflective so that it can enable work with others to propose a new course of action to help their community improve its work practice. Generally training or facilitation by action is a form of development, intervention, and change. In this context, the overall facilitation of change induction can be implemented as a cycle with planning, acting, observing, and reflecting phases wherein educational practices or methods are first developed, then tried-out in real settings and finally are further improved based on reflection of observations and findings.

Herein we discuss and propose the main design considerations along with general and specific recommendations of features that such a general facilitation programme can incorporate. Partners can further adapt it depending on local needs and circumstances.

1.4.1 General recommendations

In general, when developing a learning ecology and considering its educational activities, a facilitation or training programme or a curriculum in partnership it should be emphasized that alongside the process of how an overall learning activity is developed, key aspects of the activity itself like aims, learning outcomes, content, teaching and learning methods and assessment methods also need to be considered. Usually in literature (for example see Plomp 2009 and van den Akker 2007), an extended version of key aspects of an activity, and in general of a curriculum in the broader sense of a learning continuum, is shown in the shape of a spider web, thus metaphorically illustrating that placing additional focus on one of the key aspects this would inevitably influence the shape and the strength of the whole web. The key aspects as depicted in the following figure (Figure 8) are: rationale, aims and objectives, content, learning activities, teacher role, materials and resources, grouping, location, time and assessment. We adopt this spider web model, and we suggest that all these dimensions should be clearly defined, be in balance and be addressed in the programme. We believe this will strongly assist and facilitate teachers in better embracing the SLEs concept and its objectives.

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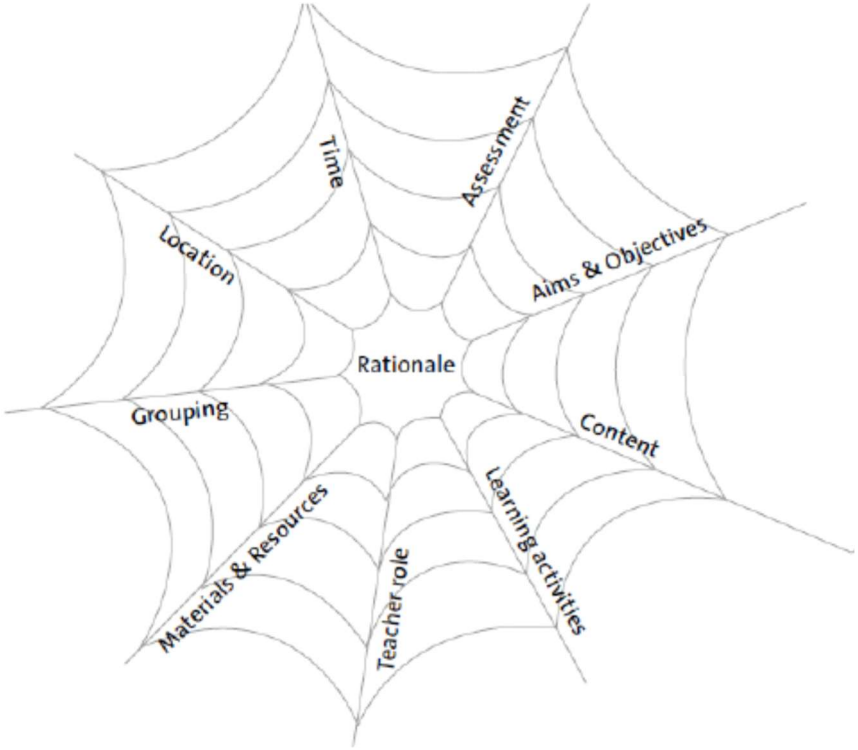

Figure 8: Curricular spider web as proposed in van den Akker, J. (2007).

Regarding the general process of facilitation, we follow a phased approach where participants are first introduced to an example, they practice it taking the role of learners and analyse it in a reflective and collaborative way. Then, they envisage how to implement it in a real setting, taking the role of action researchers and critical observers, and finally discuss their findings and also collaboratively reflect on the results and outcomes. The whole process is implicitly of iterative nature and provide a well-founded overall framework for progressive and gradual acquisition of, for example, suggested and already-made best-practices to start with or the development of new ones. These phases may not be explicitly imposed or practiced, for example in the mode of separate distinct workshops, but they can be implicitly infused in a single session of a hands-on workshop with different groups working on different aspects that will finally be wrapped up at the end.

In this context, we recommend offering teachers and other stakeholders dedicated workshops to help them to pre-practice by following examples, develop further and reflect on their practices, their understandings, and past experiences, and collaboratively reflect on the proposed processes and models. These workshops can be offered in parallel or within the framework of existing professional development programs, or even better in synergy with other similar projects and initiatives. They can also be grouped into consecutive cycles in line with the school year schedules in each country where workshops of training activities are implemented first in a small number of participants, feedback is collected, and findings are shared with other partners in different countries.

In conclusion, in the framework of SLEs and complementary to its main objectives, the facilitation programme is recommended at furnishing, touching upon or strengthening the following general educational objectives:

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- To enable primarily teachers but also other stakeholders involved in a SLE trying new ideas in practice as a means of improvement and as a means of increasing knowledge about the curriculum, teaching, and learning opportunities within a SLE.
- To raise their level of critical thinking about teaching and learning, and in general about their everyday practice.
- To engage them in collaborative and reflective implementation and development of SLEs.
- To facilitate the adoption of the SLE concept and approach in teaching and learning.
- To emphasize the importance of sharing experience, expertise and valuable outcomes with other teachers and stakeholders in their community and beyond.
- To empower them in engaging in similar approaches to SLE that affect their communities and well-being and for their particular needs or interests.
- To strengthen their capacity to become educational content creators or opportunity explorers to overcome standard curriculum constraints.

1.4.2 Specific recommendations

In the following we list together also a main set of specific features and characteristics that we recommend that such a facilitation programme should emphasise and incorporate.

- Overall inclusive approach. The programme and its activities should attract and involve teachers and educators of all disciplines, levels of experience, gender, social or ethnic backgrounds. Specifically: Gender balance. Training examples, proposed educational activities, projects or ideas should attract the interest of teachers and students of both genders avoiding common stereotypes. Social inclusiveness and integration. Similarly, they should be accessible and attract the interest of teachers or students of social or economic disadvantaged areas or in rural or distant sites.
- Multidisciplinary/interdisciplinary collaborative approach. The programme and its activities should address or involve teachers of multiple scientific fields.
- Modular structure. The programme and its materials should be modular and staged so that it can be followed by teachers with different level of needs, expertise, experience etc.
- Replication potential. The proposed approach, programme and activities should be easily transferable to other European countries.
- Low-threshold use of ICT technologies. Proposed online resources, e-learning platforms or tools should enhance and complement traditional teaching and learning and promote digital literature of both teachers and students without any prerequisites of prior technical knowledge, requirements for pre-installed software packages etc.
- Open and online modes complementary to in-person workshops. This will greatly facilitate the participation of schools and teachers from rural or distant areas thus greatly enhancing the diversity and inclusiveness aspects of the facilitation programme itself but also of the SLEs project overall.
- Scientific and technological correctness. Training modules or accompanying materials, including links to online resources, public video instructions etc, should not create gray areas or matters that may create misconceptions to teachers or students, promote pseudo-science etc.
- Emphasis on experiential aspects, practical hands-on training and do-it-yourself implementation.

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Summary

The SLEs Methodology – Final Version is the third deliverable of Work Package 2. The First Version was delivered on Month 6, an updated one on Month 21, and this Final Version on Month 34. In this document we have laid out a comprehensive methodological framework of guidelines and proposed actions to enable and guide the development of SLEs in accordance with the main foundational concepts in our White Paper. The work that is presented in this document is based on the one hand on the outcomes of four co-creation workshops that were organized and coordinated by EA and in which all partners of the consortium participated, and on the other on the qualitative and quantitative feedback collected during stakeholders' co-creation and reflection workshops and surveys of the pilot and mature implementation phases. The co-creation workshops were focused on particular themes, which were: 1. Understanding SLEs concepts and dimensions, 2. Learning by example, analyzing an example SLE, 3. Focusing on SLE prototype development and processes, 4. Consolidating overall methodology. The main objectives of this series of workshops were on one hand to bring together all partners' insights, views, ideas, expertise, and experience towards a co-created constructive methodology, and on the other, to simulate and facilitate a similar process of co-creation that each partner can initiate and implement at local level. The stakeholders' co-creation and reflection workshops and surveys of the pilot and mature implementation phases were conducted from Sep 2023 until Jun 2024, and from Sep 2024 until Jun 2025 respectively. Collected feedback, insights, observations and concluding remarks based on quantitative analysis contributed to refining and updating the initial methodology document.

We started by briefly presenting the SLEs that were developed and implemented during mature phase of the project in sixteen different countries around Europe and beyond, namely in Ireland, Germany, Greece, Italy, Norway, Spain, Cyprus, Malta, Serbia, Portugal, Romania, Slovakia, Sweden, North Macedonia, Turkyie, and Israel. Their main characteristics clearly give an overview of the variety and diversity of ideas, subjects and partnerships that the SLE concept can encompass. Then the initiators' pilot phase survey is discussed along with its consolidated results and concluding remarks for each of its focus areas.

We then discussed our suggested step-by-step development process that can facilitate and guide the development of a generic SLE. The proposed SLE development process is divided in four main steps, which are: 1. Initiation and Getting Started; 2. Preparation and Establishment of Partnership; 3. Co-creation and Implementation; 4. Reflection and Sharing of Results. For each step, we gave a general description, discussed its main objectives, and presented the main actions, conditions or prerequisites needed, supplemented with general recommendations on how to successfully complete it. We also included a list of key indicative questions to be thoroughly considered or addressed which can assist the successful completion of each step.

To enhance the readability of the document, we finished discussing the whole sequence of proposed steps of development and then proceeded with accompanying sections that complement them by elaborating on certain key aspects based on the synthesis of partners' insights and recommendations derived from the co-creation workshops. On partnership establishment and stakeholder engagement, and on living lab co-creation practice. As co-creation is being a core and very significant element of the SLEs perspective and development process we revisited the open schooling model and the living labs practice as first discussed in our White Paper. We synthesised and adapted their subsequent steps in

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our generic development process to produce an easy-to-follow elaborated version, which at the same time we believe will be more appealing to learners and in general to partners of an SLE. It consists of the main stages of Feel and Imagine as part of the initiation phase, which then lead to the stage of Co-create and its iterative subsequent steps of Explore, Experiment and Evaluate, and finally concludes with the stage of Reflect&Share.

We finished by discussing our facilitation approach and guidelines. Therein we suggested to plan and offer a comprehensive facilitation programme, encompassing multiple modalities, online or in-person, that include hands-on practice workshops, that will not only help teachers, educators and all actors involved to explore, adopt, implement and improve an already developed learning ecology but also assists them to gain confidence and experience towards developing their own ones individually or in collaboration with other teachers, educators or partners of the consortium. We proposed the main design considerations along with general and specific recommendations of features that such a general facilitation programme can incorporate. Partners can further adapt it depending on local needs and circumstances.

The document is complemented with the following appendices: Appendix I - SLE Template, Appendix II – Mature Phase SLEs, Appendix III – SLE Survey Questionnaire, Appendix IV – SLE Methodology Flash-cards.

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References

Aguirre, C., et al. (2021). The Schools As Living Labs Methodology. Available at: https://www.schoolsaslivinglabs.eu/

Baker, B.K. (1999). Learning to Fish, Fishing to Learn: Guided Participation in the Interpersonal Ecology of Practice (1999). Clinical Law Review, Vol. 6, No. 1, pp. 1-84, 1999, Available at SSRN: https://ssrn.com/abstract=2104109

Covay, E. and William, C. (2010). After the Bell: Participation in Extracurricular Activities, Classroom Behavior, and Academic Achievement. Sociology of Education 83(1):20–45.

Hannon, V. and Peterson, A. (2017). Thrive: Schools Reinvented for the real challenges we face, Innovation Unit Press, London, http://www.innovationunit.org

Hazelkom, H., et al. (2015). Science education for responsible citizenship, European Commission: Directorate-General for Research and Innovation – Science with and for Society, 2015, ISBN:978-92-79-43637-6.

Leminen, S., et al. (2012). Living Labs as Open-Innovation Networks. Technology Innovation Management Review 2012 2(9):6-11.

Millet, F., et al. (2015). Living Lab, a new form of relationship with the public. Inmédiats Handbook (www.inmediats.fr).

Mueller, S. and Toutain, O. (2015). The Outward Looking School and its Ecosystem: entrepreneurialism 360. Thematic Paper, OECD and European Commission.

National Science Foundation (2000). Foundations: A monograph for professionals in science, mathematics, and technology education. Inquiry: Thoughts, Views, and Strategies for the K-5 Classroom. Arlington, VA: National Science Foundation.

National Research Council (2000). Inquiry and the National Science Education Standards. Washington, DC: The National Academies Press.

Pedaste, M., et al. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. Educational Research Review, Volume 14, February 2015, Pages 47-61.

Plomp, T. (2009). Educational design research: an introduction, in T. Plomp and N. Nieveen (eds), An introduction to Educational Design Research, Enschede, The Netherlands: SLO

Price, D. (2013). Open: How we'll work, live and learn in the future. Crux Publishing. ISBN:978-1-909979-02-4.

Pritchett, L. (2013). The Rebirth of Education: Schooling Ain't Learning. Center for Global Development Books. ISBN:978-1-933286-77-8.

van den Akker, J. (2007). Curriculum design research, in T. Plomp and N. Nieveen (eds), An introduction to Educational Design Research, Enschede, The Netherlands: SLO

Stringer, E.T. (2013). Action research, ed. Thousand Oaks, California, ISBN:978-1-452205-08-3.

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Appendix I – SLE Template

SLE development template

General Information	
Title	
Initiator	
Partners	
Brief description of main idea or concept	
Learning objectives	
Age range of learners	
Links to curriculum	
Description	
“Feel”	

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Describe here any actions, activities, outcomes related to this stage
“Imagine” Describe here any actions, activities, outcomes related to this stage
“Co-create” Describe here any actions, activities, outcomes related to this stage including also details about the substages of Explore-Experiment-Evaluate Explore Experiment Evaluate

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“Reflect&Share” Describe here any actions, activities, outcomes related to this stage
References or additional resources Mention here any references or additional resources related to this SLE
Appendix Attach or include here any additional items such as example worksheets, spreadsheets, instructions, web-links to audio-visual materials that accompany the SLE

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Appendix II – Mature Phase SLEs

Index	Country	Title	Description
1	CYPRUS	The Butterfly Project	This SLE involved first year Lyceum students in a biodiversity monitoring project focused on butterflies, using the eBMS mobile application. Conducted primarily with female participants, the initiative emphasized taxonomy, observation and peer supported learning. Students were engaged in recording data digitally, created small-scale presentations, and practiced basic research skills, including data collection, recording, and analysis. The project fostered scientific confidence that allowed the communication of findings to a wider public audience, reinforcing both academic content and scientific skill-related competences.
2	CYPRUS	The Butterfly Project	this SLE engaged first- and second-year Lyceum students in butterfly monitoring using the eBMS app, following a EU standard methodology to record butterfly species and promote biodiversity awareness. Observations were mainly focused on species observation, photography and data entry. Students became more observant and engaged with nature, collected data, and contributed in research that tracks biodiversity trends over time.
3	CYPRUS	The Butterfly Project	1st and 2nd year gymnasium students were engaged in biodiversity observation and species analysis using the eBMS app as well as excel. Students recorded butterfly sightings, analysed trends, and explored the conditions under which different species appeared. They used photography skills and research methods to study and present butterfly life cycles as well as connecting species presence with scientific evidence. Despite time limitations, students were highly engaged, and the activity was enriched by contributions from stakeholders.
4	CYPRUS	The butterfly ecology project	This SLE invited 1st and 2nd Lyceum students as well as 3 Erasmus+ visitor students to explore biodiversity in their local environmental through collaborative citizen science activities. The project integrated butterfly monitoring with broader ecological awareness, including plant observation and environmental literacy. Despite limitations in student initiative and time, learners engaged with environmental data, conducted research, and participated in joint activities with Erasmus visitors. Artefacts included biodiversity photos and an activity worksheet.
5	CYPRUS	The butterfly project	This SLE engaged 2nd and 3rd grade lower secondary gymnasium students in biodiversity research using the eBMS mobile application to monitor butterflies. The activities included scientific observation, data collection and reflection on ecological matters. Students participated in experimental fieldwork and created learning products including photographs, and species records that contributed towards the finalisation of a national school network database. The project contributed to the national Science Fair.

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6	CYPRUS	The Butterfly Project	1st and 3rd grade Gymnasium students explored butterfly biodiversity through hands on field research, supported by the EBMS app and environmental data collection. The students focused on taxonomy, recording data in excel based databases, and learning about adopting the scientific method with awareness on variables like temperature and wind. Learners collaborated to gather, process and present data using digital tools, and communicated with local stakeholders including community councils. Outputs included a student-generated database, PowerPoint presentations and real lie application of scientific and mathematical concepts.
7	CYPRUS	The butterfly Project	The activity engaged students from a rural lower secondary school in Cyprus, in scientific observation and biodiversity monitoring through butterfly recording. Students explored local environments, collected butterfly data, and examined the relationship between species and environmental variables such as temperature and weather. Their work was presented as a group presentation. Despite modest levels of student autonomy and enthusiasm, the SLE contributed to the development of environmental and scientific literacy.
8	Cyprus	The butterfly project	The group focused on biodiversity and climate change through the lens of butterfly observation and ecosystem interdependence. Students in lower and upper secondary (1st and 3rd grade Gymnasium) engaged in field observation, collaborative gardening, and scientific data analysis. The project integrates biology, environmental education and ICT to produce learning artefacts such as scientific posters, plant markers, PowerPoint presentations, and digital photographs. Students were engaged with the community and learned how to be environmentally responsible.
9	Cyprus	Microplastics detection using fluorescence. Investigation of samples from Coasts and Marine Organisms	Microplastic (MPs) contamination became a critical environmental challenge posing a threat to all living organisms, including humans. Cypriot students (16-17 years old) detected MPs in marine and freshwater sources in Cyprus, showing their entry in the food chain from the oceans and finally to our tables. The goal was to raise pollution awareness as well as fostering environmental stewardship through hands-on experience. Local tap water, sand samples and the digestive systems of shrimps were analysed by using the fluorescent dye Nile Red which makes them fluoresce and for sample analysis students constructed a cost-effective fluorescent stereoscope (Glowscope) by modifying a basic stereoscope. Students collaborated with teachers, researchers, parents, local fishermen, private water filter companies and the local community to perform their research. Therefore, this project empowered students as actively participating citizen scientists and educators of the community, enhancing their critical thinking and problem solving in an 'open school' learning environment that nurtures 21st century skills. Findings were shared through public events to raise environmental awareness among the community, contributing to initiatives like 'Plastic Pirates-Go Europe' and supporting the Mission "Restore our Oceans and Waters by 2030", as well as promoting similar pedagogical lesson models for other schools to follow.

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10	Cyprus	Investigation of the Miocene ichthyofauna and palaeoenviromental reconstruction of Cyprus Island	This open school project allows students to study fish otoliths as indicators of marine life during the Cenozoic Era, focusing on reconstructing fish fauna in the Levantine Basin from the Miocene and Pliocene epochs. By analysing fossil otoliths from the eastern Mediterranean, particularly around Cyprus, students will investigate past ecosystem conditions, including temperature, salinity, and oceanic circulation. They will be exploring fish evolution and the impacts of climate change. Aligned with Mission Ocean priorities, the project emphasizes scientific analysis, problem-solving, and technology literacy, while promoting EU values. It engages students from diverse backgrounds, fostering climate awareness and environmental responsibility. Collaboration with the national university ensures effective open schooling methods and supports our participation in the EU Blue School Networks, increasing our school's impact on the wider community.
11	Romania	Fuelling our future - Healthy food in a sustainable community	The SLEs aimed to enhance healthy food literacy among nine-year-old students, helping them understand the importance of nutrition and sustainability. Through learning-by-doing activities, the young learners explored the benefits of healthy eating with the close guidance of nutritionists and food industry engineers, gaining early insights into potential career paths in STEM-based fields. Following the most important learning path of the project, grandparents, parents and elder students shared their knowledge about traditional healthy foods, broadening the children's perspectives beyond modern eating habits. A key outcome of the project was the creation of a cookbook featuring healthy traditional alternatives to junk food, encouraging better eating habits among students and their families. By combining scientific expertise with cultural traditions, the initiative not only promoted healthier lifestyles for the school community but also provided an early career orientation for both girls and boys in food-related professions that can make our city glow in a sustainable future.
12	Romania	The city of the future – smart, green and sustainable	This Learning Scenario (SLE) aims to develop key competences related to sustainability, technology, and innovation by designing a 'City of the Future'. Students will work in teams, analyse real problems and create innovative solutions. The final product will be a portfolio including sketches, models, and prototypes of the city.
13	Romania	Page-Turners for Life	This SLE aims to reignite students' interest in reading and the open expression of their creativity by combining various hands-on, interdisciplinary learning experiences. Partnering with a library, two museums (one on-site national museum and one European virtual museum), an IT training centre, and a publishing house, the initiative provides students aged 11–17 with opportunities to explore and create multi-modal texts that connect science, history, culture, and storytelling. Through carefully designed reading and writing activities, field trips, workshops, and discussions, students discover that studying and creativity serve as gateways to exploring and understanding the wonders of our world. By integrating the school subjects of Language Arts, Science, History, and Computer Studies, the project seeks to foster the students' love for learning, improve their critical thinking, cultivate their creativity, and develop their growth mindset.

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14	Romania	STEAMing Up with Nature's Wonders	In this mature phase of our Romanian SLE project, STEAMing Up 2 with Nature's Wonders, 7- and 8-year-old students deepened their understanding of natural habitats and the impact of human activity on the environment. Building on last year's exploration of the Buila Vânturarița National Park's flora and fauna, this year's focus shifted toward student-led inquiry and action. Learners examined how local human behaviour contributes to climate change and biodiversity loss, analysing how everyday choices within their community influence the surrounding natural ecosystems. Through hands-on experiences such as mapping green spaces in the county, investigating sources of pollution and changes in weather patterns, visiting a tea factory that uses mountain flora and engaging with biology experts from a medical analysis laboratory, students connected theory with real-world observation. They further explored optimal conditions for plant growth, developed digital projects through coding, and constructed a model of a sustainable urban city. With the support from experts, students designed and carried out their own initiatives, sharing thoughtful reflections on environmental protection and climate action.
15	Slovakia	WRAP - Materials & Alternative Packaging	This STEM Learning Ecology (SLE) Learning Scenario focuses on renewable materials for everyday use, specifically wrapping material. Following a visit to a wrapping making factory and observation of traditional bio-farm products, students will design and create their own disposable wrapping material using renewable resources and incorporating their own unique designs with the help of AI. The learning product is the new, renewable, and disposable wrapping material prototyped by the students, drawing inspiration from old methods
16	Turkyie	Innovation Bridge – Future Technologies on the Trail of the Past	Innovation Bridge SLE leverages technology to empower students in museum and science centre environments, enabling them to explore natural and historical events as well as the key figures who have prompted the technological advancements of the past. The project emphasizes how historical innovations have shaped modern technology, inspiring students to merge this knowledge with contemporary tools to design innovative products and future-forward projects. Through hands-on activities, students explored aviation, renewable energy, car and furniture-making processes, and they were challenged to merge innovation and technology with creativity and design, to devise the innovations of tomorrow.
17	Romania	My wonderful UNESCO Geopark	Buzau Land was awarded the title of UNESCU Geopark in 2022. Buzău Land is located in a space of confluence, both of distinct natural areas and of provinces with different historical evolutions. Thus, over time, it has acquired common features to the areas of influence, but also the specificity resulting from interference. The proposed territory, although not entirely corresponding to what was called, at various historical moments, the "Land" or "Buzău Land", includes the essential elements: faith, cultural traditions, specific natural resources, continuity of spirit. The idea pf the project came from the students' need to know their own roots, to get to participate in the rebirth of communities, to feel attached to traditional values, to learn about their history and meet the people living there, so that they can hear their stories. We wanted students to feel enriched by what they have found. But, at the same

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			time, to realise how special their hometown or village really is, because it's different and unique in its own way.
18	North Macedonia	My Health and Wellbeing through Data and Science	In this dynamic, hands-on project, students aged 12–14 explored how science and technology can help us to take care of our health. Blending biology, math, physics, and digital tools, the journey began with a deep dive into real medical check-up reports and a visit to a preventive healthcare center. Students discovered how everyday choices and technology shape our physical and emotional wellbeing. They became young health researchers—tracking personal habits, creating health journals, building measuring tools with Micro:bit, and analysing real data about their bodies and minds. From digital detox challenges to visualizing emotional patterns, the activities sparked curiosity and critical thinking. The project wrapped up with a peek into future careers in health and science, inspiring all students—especially girls—to see themselves as tomorrow's scientists, doctors, and innovators.
19	Romania	The Buzz of learning: Beetropolis and the Quest to Save Nature	This STE(A)M Learning Ecology (SLE) program focuses on the theme of bees and their vital role in sustaining life on Earth. Preparatory grade students aged 6-7 experienced a multidisciplinary learning journey, exploring bee anatomy, pollination and environmental conservation through hands-on activities, digital technologies, museum learning, robotics, artificial intelligence tools and community partnerships. The project stood out by creating a model city - "Beetropolis"- to physically and virtually support bees. Learning products include 3D bee models, observation diaries, posters, robotic simulations, AI-generated city designs and a collaborative digital exhibition. The activity was officially disseminated through the Facebook page of one of the most important partners: the Science Museum of Oltenia.Aim of the SLEs.
20	Israel	Air Pollution in the school area: Fiction or Reality?	This SLE examines Air Pollution in and around the students' school. The school is situated in a heavily trafficked area, bordered by Israel's main railway station, the main highway and several roads under construction. Even before the school was built 5 years ago, parents and students had protested at the Municipal offices against the designated location of the school, claiming that air pollution in the area could affect children's health. Parent-led research provided them with evidence of poor air quality. One the other hand, the Municipality claimed that according to their results, the quality of the air adhered to the official Ministry of Environmental Quality standards. The main purpose of this SLE was to find out which assessment was correct. During the activities, students conducted their own air quality assessment around the school, interviewed a paediatrician about air pollution's effects on adolescents' health, researched the issue with the help of AI tools, and presented their findings using posters and presentations. Students' findings were mixed. Some days recorded high air pollution, while others fell within acceptable limits. At the end of this SLE students had "a taste for more" and drafted a letter to the local Ministry of the Environment outlining their findings and inviting officials to visit the school for a discussion over the issue.

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21	Sweden	Save Lake Malar	In this SLE, 'Rena Mälaren' experts helped students become aware of the environmental obstacles that Lake Malar and the Baltic Sea face. The lake near the school has become a dumping ground for many unwanted things that disturb the ecosystem of the water body. The main goal is to develop consciousness about sustainability and sustainable choices. This cross-curricular project will involve working with ecosystems in NO lessons, sustainable goals in SO lessons/English lessons, and making posters on Sustainable Lake Malar in science/ Art classes during the Noble Week celebrations. Students worked in-depth with water-based ecosystems, their changing dynamics, and the environmental impact of human activity, and will also devise preventive measures to preserve them.
22	GERMANY	Discovering STEM	Learning path that combines STEM skills and career guidance at the Adlershof campus. We invited 30 students from the Waldorf School to get to know the Adlershof Technology and Science Park and its resident institutions. A presentation of the campus is planned, followed by a 3D printer workshop to engage students with technology. Afterwards, the high technology education and training network will also be presenting internship opportunities in the STEM fields.
23	GERMANY	Experience Chemistry @ HU	Students visit the university and attend lectures on various topics in chemistry. Additionally, they conduct experiments in the laboratory related to these topics. On this day, students gain insights into research and science, could interact with experts, and get a glimpse into scientific careers.
24	GERMANY	Girls in Tech	The *Girls in Tech* SLE encourages girls to discover their passion for technology and supports them through hands-on training. The focus is on understanding technical and mathematical concepts, exploring academic and career opportunities in STEM, and gaining inspiration from female role models. To further engage participants, there will also be an electrical engineering and soldering workshop. By fostering enthusiasm for STEM, the initiative aims to bridge the gender gap and contribute to a more innovative and diverse future.
25	GERMANY	Green Steel	This SLE focused on topics related to green chemistry. It addressed the following questions: What is green steel? What is green hydrogen? What is the current state of research and industry in this field? The students went through various stations over a total of three days, where they acquired both theoretical knowledge and practical skills.
26	GERMANY	Marine Plastic Pollution	Students explore the global challenge of plastic pollution in the ocean; they deepen their understanding of plastics and actively apply their knowledge by developing and producing a sustainable bioplastic alternative.
27	GERMANY	Solar energy	The learning unit deals with topics in solar energy research. Students receive a theoretical overview of the construction and functioning of solar cells. Additionally, problems and possible alternatives to the technology are discussed. In a practical section, students build dye-sensitized solar cells and conduct various experiments.

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28	GERMANY	STEM Future Literacy	This SLE aims to equip students with future skills in STEM through targeted training. Participants will explore different future scenarios in STEM, strengthen their Futures Literacy, and develop their own visions of the future in areas such as mobility and communication. The learning path encourages openness and adaptability, empowering students to actively shape the world of tomorrow. Students will also develop mathematical skills, including coordinate systems and data analysis, to enhance their understanding of STEM concepts.
29	GERMANY	STEM Summerschool	A three-day STEM summer school for STEM students who are researching a scientific idea and developing it into a product or business. This gives them the opportunity to move from theory to innovative and creative practice Goals: Creative thinking, design thinking and problem solving, financial and mathematics education.
30	GERMANY	STEM Experience	In a practical workshop, students learned about high technology and materials used to build microchips and even had the opportunity to explore laboratories. The goal of this initiative was to enhance STEM skills and provide young people with valuable insights into scientific and technical careers, supporting their professional orientation.
31	GERMANY	Sustainable Urban Greening and Plant Diversity	The students investigate plant diversity at different locations and gain insights into the planning of sustainable urban greening.
32	GREECE	Computational thinking applications – Visualization of earthquake activity.	High school students in collaboration with experts focus on how they can easily visualize the activity of earthquakes, demonstrating in practice applications of computational problem-solving. Students first familiarize themselves with the phenomenon of earthquakes, understanding how earthquake activity is measured through dedicated instruments, seismometers, and how data collected through them can be utilized to extract various characteristic parameters of an earthquake event. They then formulate an idea on how they can easily extract information from a series of seismographic data and visualize the development of the earthquake activity for a period of time. In doing so they implicitly form the hypothesis that their visualized results are related to the energy that is released during earthquake phenomena. They can test their hypothesis by collecting, processing and analyzing data from different periods or locations as if conducting an experiment in order to acquire evidence and draw conclusions. They may need to change or refine their hypothesis and methods of analysis along with the computational solutions they propose in the form of computer code and thus embark into an iterative cycle of building and debugging of their algorithms or processes.

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33	GREECE	Digital creativity and entrepreneurship	This STEAM Learning Ecology focuses on digital creativity and entrepreneurship. It is implemented in the junior high school of Ellinogermaniki Agogi in Pallini, Greece, as an extracurricular activity with about 10 students of age 12-15. A group of teachers, researchers and experts are also participating in the learning activities. The main objective of this SLE is to combine various subjects such as maths/geometry, informatics, computer science, digital tools, arts/creativity and entrepreneurship into an interdisciplinary learning pathway of diverse activities. Through a series of brainstorming and co-creation sessions with teachers, principals and the students involved it gradually evolved into a more concrete plan and subsequent steps required and tasks to be completed emerged. In a nutshell students start working in small groups and practice and experiment with various digital applications trying to harness their creativity and imagination by designing abstract but beautiful geometrical patterns and motives. Through various creative sessions they share, present and discuss their creations with peers, teachers, experts and then select a subset of patterns that they best like or represent them. In the next step they brainstorm on finding objects from their everyday life which they can use as basic canvases on which their creations can be projected. These plain objects could be clothes, shirts, ceramics, home ornaments, furniture, artefacts etc. Going into the process of designing them, decorating them, visualizing them they soon realise that this can be products which they can produce and sell themselves in shops, art galleries, museums etc. Having realized this potential, they start seeking guidance from experts on entrepreneurship, marketing, sales etc. Thus, students along with the teachers, researchers, experts and other stakeholders are finally into the process of establishing a real commercial enterprise, with brand-name, logo, intellectual property rights just like a real company! They run a campaign on social media to disseminate their creations and products to a wider audience outside the school community. In practice, they have allocated tasks and responsibilities among them like in a real business partnership and their ambition is to contact and attract the interest of industrial partners so they can proceed into actual production of their creations.
34	GREECE	Learning about what an earthquake is and what to do to protect ourselves.	Primary school students and teachers in collaboration with experts study the phenomenon of earthquakes. They learn about curriculum topics such as tectonic plates, inner structure of Earth, characteristics of an earthquake, seismic waves, seismometers, etc. They then focus on how to increase awareness about protection measures during the event of an earthquake. During the activities they build a model of a seismometer with simple materials to demonstrate its operational principle. They also make a variety of posters in the Greek and English language with easy to memorize instructions of what to do and do-not-do in case of an earthquake. They present what they learned to younger children and also to parents and the public during a special event in the school.
35	GREECE	Electric vehicles and robotic solutions	Junior high school students collaborate with experts to study and propose various electric vehicle solutions to solve problems or tackle challenges that local communities face. During the activities students learn about the fields of programming, robotics, multi-terrain electric vehicles/rovers and their applications, they collaborate with experts to present

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			and discuss their ideas and propose potential solutions to problems that attract their interest. All above were conducted as afterschool extracurricular activities of junior high school – first grade.
36	GREECE	Green city – sustainable urban environment	Junior high school students and science teachers in collaboration with experts study how to make greener and more sustainable the neighbourhoods or areas of their city. They consider various solutions including green spaces, pedestrian areas/vehicle-free areas, roof top gardens, heat absorbing vegetation, roof top solar panels, improvements for public transport services etc. They also focus on the cost and benefit of such initiatives by gathering real-life data and assessment schemes. Then they utilize the knowledge they acquired by proposing and evaluating solutions for specific neighbourhoods or areas in their city with the purpose of influencing or assisting the urban planning efforts of local municipalities.
37	GREECE	Learning about the Mediterranean diet – acquiring healthy diet habits	Primary school students and teachers in collaboration with experts explore the various aspects of the traditional Mediterranean diet, from its main ingredients and products to its important nutritional values and significant health benefits.
38	GREECE	Designing a mission to another planet to establish an extraterrestrial human colony	Primary school students and teachers in collaboration with experts focus on the design of a future space mission to another planet, e.g. Mars, with the aim to found an extraterrestrial colony for humans. Students have to consider and study various interdisciplinary subjects related to such a mission such as what resources are needed, how to design a rocket/spaceship to carry them, how to sustain a human base in another planet etc. subjects the phenomenon of earthquakes. During the activities they design model rockets using CAD software and then build them in 3D printers. They also build habitable bases and study their properties which are essential for humans to live in such as heat insulation, UV radiation protection, structural strength etc. At the final stage they present what they learned, studied and built to parents and the general public during a special event in the school.
39	GREECE	Natural robotics – proposing a bioinspired robotic solution	Junior high school students and English language teachers collaborate with experts to study and propose various bioinspired robotic solutions to solve problems or tackle challenges that local communities face. During the activities students learn about the research field of natural robotics and its applications, they communicate with experts to present and discuss their ideas and propose potential solutions to problems that attract their interest. All above activities were conducted in English and were incorporated in the English language curriculum of junior high school – first grade.
40	GREECE	Optimal transportation networks.	High school students collaborate with experts to study and propose optimal transportation solutions for various cases including school bus itineraries, public transport services, logistics/courier companies etc. They assess different prioritization strategies such as serial-stack, random-order, sorted-by-distance and minimal-path, which can be incorporated accordingly in algorithms and programs. They specifically focus on studying bioinspired solutions such as the so-called ant colony optimization algorithms which are based on mimicking the behavior of ants and how they transport food in their colonies.

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41	GREECE	Smart solar panels	Junior high school students collaborate with experts to develop smart solar panels to increase their light collection efficiency. During the activities students first learn about the major societal challenges of climate change and transition to more sustainable energy sources like solar panels. They then focus on developing innovative solutions so that they increase public awareness around renewable sources of energy and especially about solar panels. They build a prototype of a smart solar panel with sensors and a robotic stand, and they program them so that it tracks the sun during the day to maximize light collection and electrical energy generation. Finally, they show their solution to students, parents and the public during the annual school fair. All above activities were conducted as part of afterschool extracurricular program of junior high school – first grade.
42	IRELAND	Leaving Certificate Applied (LCA)	Galway Community College identifies a challenge in how young audiences engage with STEM particularly on their Leaving Cert Applied (LCA) programme. The Leaving Cert is the final stage of secondary school education for teenagers, and the applied programme offers more practical and alternative options for teenagers – this SLE allowed these students access to more STEM-related content. Students created science engagement tools for younger audiences at the National Aquarium in the form of a Marine Medtech Quiz.
43	IRELAND	Empathy Detectives	Empathy Detectives aims to increase awareness and understanding of diabetes amongst teenagers through the creation of empathy toolkits which are aligned with the Junior Cycle curriculum. The project is divided into 2 phases: pilot and live. The pilot phase will test out the toolkits on students who will provide feedback to develop kits further for their peers during a live phase.
44	IRELAND	Waves of Positivity	The initiative sought to highlight the great things happening around ocean conservation, offering a refreshing counterbalance to the often anxiety-inducing news about the challenges facing our planet. The primary school class promoted hopeful and positive actions around climate change via a social media takeover of both Galway Atlantaquaria's and CÚRAM's platforms. During the takeover, positive news stories and ocean-focused content reached an impressive 44,000 people on Facebook and 5,525 on Instagram.
45	IRELAND	Empathy Detectives - Live Phase	Empathy Detectives is a workshop developed in collaboration with CÚRAM Research Ireland Centre for Medical Devices, The Ideas Lab and PPI Ignite Network, all based at the University of Galway, and a group of people living with or caring for somebody with diabetes. The workshop is aimed at junior cycle students and includes a series of interactive 'empathy experience' activities that focus on creating a better understanding of diabetes and the additional challenges that diabetes self-management can bring. Empathy Detectives focuses on the development of key skills and increasing awareness of STEM education and careers. The National Council for Curriculum and Assessment (NCCA) Wellbeing Guidelines (2017) identified a need to provide out-of-school STEM learning opportunities to further deepen learners' knowledge (2017). Empathy Detectives workshops take place in the Galway City Museum, therefore engaging students in learning how the skills learned in the classroom are applied to solve real-world health problems. The project is divided into 2 phases and 2 SLEs: pilot and live. The pilot phase will test

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			out the toolkits on students who will provide feedback to develop kits further for their peers during a live phase.
46	IRELAND	How Exercise impacts the Circulatory System	The SLE was created as part of CÚRAM's Teachers in Residence programme. The SLE aimed to encourage exercise amongst teenagers by enhancing their understanding of the circulatory system. A Secondary School partnered with CÚRAM to create a curriculum linked project which supported Junior Cycle students in this DEIS School. The Junior Cycle caters for students in the first three years of their post-primary education. The main learning product was CPR mannequins.
47	IRELAND	Green Lab	The SLE was created as part of CÚRAM's Teachers in Residence programme, where primary and secondary teachers from across Ireland attend a 3 x month online course to learn about current scientific research and how to bring that into the classroom. The SLE aimed to increase students' understanding of energy consumption specifically around energy use in science labs. A Secondary School partnered with CÚRAM, which was awarded the first Green Lab* in Europe in 2019 and the Rediscover Centre*, Europe's first circular economy demonstration centre, to create a curriculum-linked virtual Green Lab which the students could use to illustrate how energy could be conserved in labs.
48	IRELAND	3D Bioprinting and Podcast	The Youth Academy at University of Galway works with high ability young people to support their learning and academic development and to get experience of learning in a university about subjects outside of the school curriculum. The Academy wanted to offer courses in medtech subjects and collaborated with CÚRAM to create a course looking at cutting-edge 3D bioprinting. Students created 2 and 3D printed items and made a podcast about their experience. Ultimately the aim is to encourage teenagers to choose these subjects at third level.
49	IRELAND	How Science and Engineering can Heal our Bodies	The Youth Academy at University of Galway works with high ability young people to support their learning and academic development and to get experience of learning in a university about subjects outside of the school curriculum. The Academy wanted to offer courses in medtech subjects and collaborated with CÚRAM to create a course looking at cutting-edge research into biomaterials. Students took part in mock crime scene investigation and extracted DNA and peformed electrophoresis. Ultimately the aim is to encourage teenagers to choose these subjects at third level.
50	IRELAND	Protecting our Oceans against Plastic Pollution	Students learned about the effects of plastic pollution on our oceans and how to mitigate these effects by creating their own mini ocean.

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51	IRELAND	Plastic is Not Fantastic	The initiative sought to highlight the increasing amount of plastic pollution in our environment. The secondary school students came up with solutions to combat plastic pollution and presented their ideas as posters. The project culminated with a plastic and litter clean-up event around the school which was arranged by the students.
52	IRELAND	Neurons Behaving Badly	The initiative sought to highlight the high prevalence of Multiple Sclerosis (MS) in women living in Ireland. The teacher and secondary school students developed a 'Brain Activity Kit' to be shared during Brain Awareness Week to raise awareness of MS in Irish women. Brain Awareness Week is an annual initiative, led by the Neurological Alliance of Ireland (NAI), which aims to raise awareness about neurological conditions and the need for investment in research and services. The week encourages participation from various organisations, including patient groups and research institutions, to promote understanding of the impact of living with a neurological condition.
53	ITALY	Nature and Art: Nature Drawing for the Development of Scientific Communication	The project approaches the world of science and art in a synergetic way, developing skills in the visual arts for better communication. The simultaneous practice of scientific and artistic disciplines, such as the natural sciences and visual arts, allows both sides of the brain to be exercised at the same time. The student will thus be facilitated to develop his or her communication skills in science, not only through traditional verbal and writing means, but also through 'artistic languages' such as Drawing.
54	ITALY	Water and US	The project aims to address issues of applied ecology in order to better understand the topic of water resources and environmental monitoring. In cooperation with the literature and science teachers, work will be done on the emotional aspects that contact with water environments arouses. Lessons, excursions and field work will be carried out. At the end of the project, the participants, divided into groups, will be invited to present the results of their work in a round table discussion and to propose ideas for future developments.
55	ITALY	Food Waste Reduction and Sustainable Behaviour	Knowledge of new solutions to reduce food waste, while stimulating young people to undertake curricular studies in research and technological innovation, highlighting future opportunities and careers. Promoting Italian agri-food products, the fundamental principles underlying a healthy and sustainable diet for a more appropriate and conscious use of resources (against food waste) and some principles of circular economy (reuse of food waste), to highlight the importance of actions - including individual ones - to be taken in the context of achieving the Sustainable Development Goals as set out in the UN 2030 Agenda and the European green deal.
56	ITALY	Food Waste reduction and Sustainable Behaviour	Causes of food waste and corrective actions: from knowledge of the state of the art (ethical, economic, social and technological reasons related to the overall theme of food waste) to the shared planning between researchers, teachers and students, to the need for cooperation in the realization of products, which are validated and effectively disseminated with specific actions on the regional territory and in the social multimedia circuit and verifiable by means of appropriate indicators. Use of the SPAIC Toolkit, which is to be intended as a Manual/Guidelines for the replicability of the SPAIC Project in its methodological structure and operational tools, aimed at supporting students and teachers who intend to

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			experiment this project within their own Higher Education Institute. This Toolkit, therefore, intends to prepare teachers, to support all the actors involved in the new experimentation of this project, but mainly aims to inspire and motivate students and classes that will be sensitized on the theme of food waste, to the diffusion of sustainable development messages in their territorial reality.
57	ITALY	GEO-LOCALISATION OF PILOT SITES AND GEO-MATERIALS USEFUL IN A PREHISTORIC - PROTOHISTORIC AND HISTORICAL CONTEXT. EXPERIMENTAL REPRODUCTIONS AND ARCHEOMETRIC ANALYSES	The project encourages students to approach STEAM subjects promoting responsible research and innovation through teaching methods that refer to "Science Education for Responsible Citizenship" and reconstructing the relationship between man and the environment with a specific territory through geolocalization, analysis of useful raw materials and transversally through the operational chain of the prehistoric-protohistoric craftsman. In this way, in a transdisciplinary context the student participates by becoming an active protagonist by identifying with the researcher's activity. Furthermore, the topic of women in science will be addressed considering the contribution of women to human evolution from both a technical and cultural point of view to overcome gender stereotypes and encourage young female students to also consider scientific disciplines. With an interactive multidisciplinary approach, the students will be protagonists both during the visit and afterwards, in the realisation of a product that they will present to their peers during the week dedicated to the European Researchers' Night 2025.
58	ITALY	Everything has its own story	This project is designed to educate primary school learners on product life cycles, emphasizing play and theatre as learning tools. The project fosters creativity and emotional involvement while teaching complex concepts in an accessible way. The goal of the project is the hope that understanding these concepts from childhood will help children to grow up as aware adolescents and adults, respectful of the environment around them. The outcome of the project is the creation of a short sketch about the project's themes, using colored cubes as scenery to simulate a puppet theatre.
59	ITALY	Green Transition and Gender	The pilot aims at promoting the awareness on the importance of STEAM disciplines and their opportunities beyond gender paying special attention to sustainability and green transition. Starting from the relevance of STEAM sectors and their opportunities for all, the learners are guided to discover scientists (especially female ones) that have contributed to significant achievement in different STEAM areas. The path focuses also on characters and scientific experiences from the local territory (such as the Ancient Salerno Medical School). Starting from these aspects, the training path connects to the theme of medicine and health in terms of well-being through nutrition and the Mediterranean Diet and therefore to the typicality of local products, to Km0 productions and to local production chains based on the circular economy, as well as to the broader theme of sustainability.

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60	ITALY	BYE – Build Your Einstein Telescope	The project is a project of scientific dissemination and informal teaching of physics aimed at promoting and spreading scientific culture, the physics of the Einstein Telescope (ET) and its deep connection with the territory in which it will hopefully find a home, that is, the territory between Lula, Bitti and Onanì, Sardinia (Italy). The project moves within the dissemination activities of the Cagliari section of the National Institute of Nuclear Physics and the Universities of Cagliari and Sassari promoted by the ET Italia collaboration. The project is aimed at schools, with the aim of establishing a deep connection between science and society, increasing scientific literacy, the professional development of the teaching class and the skills of individuals. To develop a physical identity, stimulating curiosity, creativity and providing key skills for the future through a STEAM approach.
61	ITALY	BLUE MISSION: OUR SEA IS OUR HEALTH	This pilot SLE offers an active and creative learning path focused on sustainability of human activities in marine-coastal environments from a One Health perspective. Through creative activities, active learning and outdoor experiences, participants will develop new skills and will collaborate in the creation of educational resources and artistic products, such as educational short films on selected topics (plastic marine litter, ecological beach, sustainable aquaculture)
62	ITALY	Garden care: a space to grow and thrive	The aim is to educate young people in an engaging way to protect biodiversity and raise awareness of the objectives of Agenda 2030. Students create innovative educational resources that can be replicated in other contexts, such as 1) a school garden; 2) documentation on the topics addressed through the selection of texts for a Green Library; 3) photographic documentation.
63	MALTA	Maths Camp – Our Heritage through Maths	The *Maths Camp – Our Heritage through Maths* which was held at the Malta Maritime Museum from 15th to 19th July 2024 was organized by the Directorate for STEM and VET Programmes, STEM and VET Curriculum Hub, Pembroke. The 5-day camp aimed at promoting Mathematics among 12–13-year-old participants. The participants were involved in worskhops consisting of different mathematical tasks that target various aspects of the maritime heritage of Malta. They worked in groups on data collection and interpretation, discussed ways of preserving our seas, and used Mathematical skills and games to investigate our maritime heritage and increased their knowledge on aspects related to this heritage.
64	MALTA	Tween4STEAM Summer Camp	The Tween4STEM Summer Camp, held at the University of Malta, from August 26th to August 30th, 2024, was organized by the Directorate for STEM and VET Programmes, STEM and VET Curriculum Hub, Pembroke. The camp aimed to promote STEM engagement among students aged 11-12 years and address gender disparity in STEM education. Through collaborative, hands-on activities, participants explored various STEM fields. A key element of the camp involved structured learning events such as a workshop on electromagnetism where students worked with magnets and explored magnetic fields. The learning product for other activities included presentations based on data collected from fieldwork at Wied Għollieqa.

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65	MALTA	The Plant Irrigation Experiment	Under the guidance of personnel from EcoGozo, students will grow plants on the school grounds. One group of plants will be watered through conventional drip irrigation and another through the use of SLECI which are currently undergoing field testing. The SLECI technology is a self-regulating subsurface irrigation system that uses the actual suction force of the surrounding soil for regulation of the system's water release. Students will take note of the amount of water given to both samples of plants. They will then compare the growth of both samples of plants and fruit production. Following the growth of the fruit production, students will cook Maltese traditional food in a cooking session together with their parents. This will be followed with a special assembly during which students will explain to their peers their findings by presenting a PowerPoint presentation. Finally, this will all be documented in a television programme.
66	MALTA	*Clear the Air: A Student-Led Climate Action Project*	"Clear the Air" engaged 11-12-year-old students in a five-month STEM initiative to investigate air quality at their school using low-cost sensors, experiments, and real-time data analysis. They identified traffic as a key contributor to elevated PM2.5, PM10, and NO_2 levels, collaborated with stakeholders (health experts, tech firms, local councils) for technical guidance, and proposed solutions like green walls and traffic reforms. Integrating gamification (*TreeWorld*) and hands-on learning, the project fostered scientific literacy, environmental responsibility, and student-led advocacy, bridging classroom science with actionable community impact. This STEM Learning Ecology explored real-time air pollution levels with low-cost monitors, combining experiments, gamification, and community collaboration to **link local and global climate issues**. The findings showed a strong correlation between traffic volume and elevated PM2.5, PM10, and NO_2 levels, underlining the need for urgent local action. Students **proposed practical solutions** like green walls and better transport systems, highlighting the effectiveness of student-driven initiatives in addressing climate challenges.
67	MALTA	GLOBE Air Quality Campaign as a STEAM Learning Ecology	The GLOBE Air Quality Campaign is a year-long STEAM Learning Ecology (SLE) designed to empower students through citizen science. It enables students from ten schools in Malta and Gozo to investigate air pollution, monitor air quality using sensors and GLOBE atmosphere protocols and propose actions for cleaner air. Students collect data on NO2, VOCs, CO2, PM and weather parameters, share findings with their communities and present final artefacts such as research posters, videos or reports.
68	MALTA	Scientist in the Making	The 'Scientist in the Making' project was organised by the St Nicholas College Rabat Middle School science department. It ran throughout the whole scholastic year where the STEM careers were promoted and collaborations amongst professionals were fostered. The idea behind the project is to guide students through an independent research project where they follow the scientific investigation method. They were all the time mentored by the science teachers and 21st century skills were targeted through workshops and tailor-made interventions. The main skill we wished to address and poster in the students was the communication skill, how to interact with an audience and pass their message effectively. We believe that to be able to make a difference in this world is largely based on the next generation's ability to communicate and stir change. We worked in collaboration with the Science communication department at the University

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			of Malta and with the science communicator and animators at ESPLORA science centre. The project was a huge success and the positive impact it left on the students was clearly visible when they presented their final research to school mates and parents.
69	MALTA	Luminous	The 'Luminous' project was organised by the St Nicholas College Rabat Middle School science department. During this project, students work with professionals from the performing arts. The STEAM project consisted of a collaboration between the science department, theatrical personnel and dance choreographers to create an unforgettable learning experience for our students. They had to explore a scientific theme, namely 'light' through an artistic lens. The project aimed at creating poems using various aspects of the theme light. These poems were recorded at a professional studio and passed on to the choreographers. These, together with the students, created dance pieces for every poem. The end result was an event where we celebrated science and arts in an original fashion. These were performed during a science event held during the Science Week, in front of the rest of the school and the parents of the students who participated in the SLE.
70	MALTA	Animals360	The main aim of this project was to empower students to obtain communication and oracy skills, work in teams and share knowledge, activities and adventures together. The Theme for this year was Animals360. During the first part of the project, students helped to raise awareness about caring for animals, the responsibility of having a pet and collected food for abandoned animals. This activity reached its climax during the animal awareness day, where the students' pets were blessed and students together with their parents attended several, varied talks about different aspects related to animals. Meantime, students started preparing scripts, researching and rehearsing to put up a literary evening focusing on animals. Here the focus spread from the life of animals, their adaptations to their use in history and languages.

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71	MALTA	Thematic STEM Debate	The Thematic STEM Debate is an initiative designed to foster critical thinking, debate skills, and scientific literacy among students. Students are given a specific STEM-related theme - in this case 'Artificial Intelligence' - to research. To get participants started, they are provided with academic papers, reports, research prompts, and policy documents. They then prepare and present arguments, analyse ideas, evaluate evidence, identify strengths and weaknesses in opposing viewpoints, and strategically communicate their positions in a debate format. Debates are judged by a panel of professionals who assess criteria such as organization and clarity of arguments, scientific validity, use of evidence, cross-examination and rebuttal skills, and presentation style. The Thematic STEM Debate is organized for students across different educational levels: Primary Schools: Specifically targets Year 6 students (typically around 10-11 years old). Middle Schools: Engages students in the middle school years (e.g., Year 8, around 12-13 years old). Secondary Schools: Includes students in secondary years, particularly Year 10 and Year 11 (typically around 14-16 y.o).
72	NORWAY	Artificial Intelligent (AI) Solutions	The "Artificial Intelligent (AI) Solutions" SLE provided students with the opportunity to develop practical software engineering skills while solving real-world challenges using cutting edge technology, such as Artificial Intelligence (AI). The SLE brought together three student-led projects that explored the application of AI technologies to improve digital platforms across education, onboarding, and public administration. Students collaborated closely with stakeholders to develop and deliver three distinct AI-driven solutions: **Group 1** enhanced the FaceitTools.com platform by integrating AI-generated learning materials (e.g., quizzes and recommendations) to support adaptive and personalized features. **Group 2** created an AI-powered onboarding assistant for Metaito's Factsplat platform that dynamically reorganizes user dashboards based on behavior and preferences, improving accessibility and user experience. **Group 3** contributed to the KartAI initiative by building AI tools that assist caseworkers in summarizing and analyzing documents in the Norwegian building permit process. Through iterative development, co-creation workshops, usability testing, and agile sprints, students produced MVPs (Minimum Viable Products), technical project reports and formal presentations. These projects address real world problems while allowing students to gain hands-on experience with AI solutions, agile project management, and customer-focused problem-solving. This SLE successfully bridged academic learning with real-world impact, preparing students for future careers.
73	NORWAY	Financial Education through Technology	This SLE challenged students to address an existing societal issue, children's financial literacy in an increasingly cashless society, through a real-world software engineering project. In collaboration with Tietoevry company, the students designed and delivered a Minimum Viable Product (MVP) for a cross-platform mobile app aimed at children aged 9–12, which includes gamified tasks, savings goals, parental dashboards, and financial education modules. The app's primary goals

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			were to: Empower children with tools for managing finances, including features such as chore-based rewards, saving goal tracking and educational content. Support parents in supervising their children's financial activities through a dedicated dashboard offering transaction monitoring, spending limits, chore assignment and allowance management. Students worked collaborative using the Scrum methodology, engaging with external stakeholders to gather feedback, align on goals, and improve the product. The SLE enabled students to apply their theoretical knowledge in practice, develop user-center design and development skills, and gain insights into ethical, inclusive, and secure technology solutions for real-world use.
74	NORWAY	Enterprise and Workflow Automation	The "Enterprise and Workflow Automation" SLE explored how emerging technologies can address critical challenges in professional settings. Focused on enterprise and workflow automation, and guided by agile methodology and stakeholder collaboration, students developed two innovative digital solutions. The first group created a mobile onboarding app, streamlining employee integration. The solution included secure login, a responsive user interface and integration with company systems. The second group worked to improve a Virtual Reality (VR) based career guidance platform. They developed an Artificial Intelligence (AI) virtual assistant that allow users to ask career-related questions in multiple languages. Both projects followed an iterative development process and addressed important aspects such as accessibility, sustainability, and digital security. Deliverables included MVPs, project report, and stakeholder presentations.
75	NORWAY	Internet of Things	The rapid growth of the Internet of Things (IoT) has created a strong demand for scalable and reliable testing frameworks. The SLE focuses on developing an accessible, open-source platform for IoT quality assurance, giving students hands-on experience in real world setting. Students created a web-based solution that allows users to set up and execute tests between mobile phones and IoT devices. The outcome included a functional MVP (Minimum Viable Product), a detailed report, the platform's user interface and designs, and a formal customer presentation. This SLE addressed a real-world industry challenge in collaboration with an industry partner, a startup producing pet tracking devices. This learning experience provided students with practical insight into agile workflows, usability, and technical integration.
76	NORWAY	Game development	The "Game Development" SLE engaged 10th-grade students in an interactive and creative introduction to programming, using the Scratch platform to design and build their own digital games. Implemented within the Kodeløypa initiative, the learning activity emphasized hands-on learning, problem-solving, and collaboration. Students explored key programming concepts through visual coding and applied them in personally meaningful projects. The process encouraged experimentation, iteration, and storytelling. The final step was presenting their games to classmates, giving students the opportunity to share their work.
77	NORWAY	Traffic and air pollution	The SLE engages students in addressing the real-world problem of traffic congestion and related air pollution in Trondheim (Norway), particularly during wintertime. Through the application of Design Thinking methodology, students collaborate to develop an interactive educational game using the ChoiCo platform. The resulting game aims to raise

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			awareness about road safety and environmental issues, while students engage in inquiry, empathy, creativity, and peer evaluation throughout the learning process.
78	NORWAY	Design a better neighborhood	"Design a better neighborhood" SLE invites students to address the problem of hyper-urbanization by collaboratively designing their ideal neighborhood. Through hands-on workshops, learners apply the Design Thinking methodology to create a simulation game using the GearsBots platform. The final product is a robot-navigated digital map that raises awareness about sustainable urban planning, the need for green spaces, and the importance of inclusive public areas. The process promotes creativity, empathy, digital skills, and responsibility.
79	NORWAY	Become a sustainability hero	The "Become a sustainability hero" SLE addresses sustainability challenges by engaging students in designing interactive, narrative-based games using an online game development platform. Students identify real-world sustainability issues and simulate their impact through "choice and consequence" gameplay. The final learning product is a playable digital game prototype that demonstrates how personal and societal decisions influence environmental and social well-being.
80	NORWAY	Responsible AI and Welfare	The SLE "Responsible AI and Welfare" addressed the social and technical complexities of sick leave management within Norway's welfare system. Three interdisciplinary student groups collaborated to investigate how responsible Artificial Intelligence (AI) could enhance communication, coordination, and fairness in handling long-term sick leave cases. Students mapped the stakeholder landscape, developed ethical design frameworks, and conceptualized digital solutions. The SLE concluded in detailed project reports that included stakeholder analyses, personas, scenarios, and system mockups. Through team-based, experiential learning, stakeholder engagement, and reflective exercises, students developed critical skills in ethical technology design, interdisciplinary collaboration, and social innovation.
81	NORWAY	Responsible AI for Inclusive Public Services	The "Responsible AI for Inclusive Public Services" SLE focused on enhancing communication and user engagement within Norway's public services. Two interdisciplinary student groups deal with real-world challenges related to unemployment benefits and student financial aid services, with a shared objective of promoting trust, transparency, and user empowerment. Using an experiential learning model and guided by design thinking and project-based methodologies, students investigated problem contexts through research and stakeholder feedback. They developed user scenarios and conceptual Artificial Intelligence (AI) driven solutions. While each group targeted a different agency, Group 1: NAV's unemployment services and Group 2: Lånekassen's student financing system, the SLE provided a unified structure for learning about system design, ethical AI, and digital innovation in public services.
82	PORTUGAL	ECOSYSTEM SERVICES OF THE AQUIFERS - FROM LAND TO SEA	A group of 4th-year students (ages 9–10) participated in a week-long STEAM learning experience focused on environmental compartments and sustainability. Held at Centro Ciência Viva do Algarve, the program included activities aligned with the UN Sustainable Development Goals (SDGs). Highlights included a session with scientist Paula Robalo from Centro Ciência Viva Alviela, discussing aquifers

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			and bats, emphasizing ecosystem services and SDGs 6 and 12. The week culminated in teacher and students presenting action proposals related to their chosen SDG in relation to the aquifers aquifers.
83	PORTUGAL	WHAT ARE MICROALGAE, THEIR DIVERSITY, IMPORTANCE IN ECOSYSTEMS, APPLICATIONS, AND PRODUCTION? - FROM LAND TO SEA	A class of 4th-year students (aged 9–10) engaged in a week-long STEAM educational initiative at the Centro Ciência Viva do Algarve, exploring themes related to environmental systems and sustainability. The program was structured around the UN Sustainable Development Goals (SDGs), encouraging students to make connections between global priorities and local action. A standout moment was a hands-on session delivered by PhD researcher Sofia Navalho, supported by Fátima Pereira from the outreach team, which explored the topic "Being a Microalgae Scientist – understanding their nature, diversity, ecological roles, applications, and how they are cultivated." This interactive session opened students' eyes to the vital function of microalgae in maintaining ecological balance and their innovative uses, particularly in relation to ecosystem services and SDGs 12 and 14.
84	PORTUGAL	FISH FEEDING AND NUTRITION IN AQUACULTURE - FROM LAND TO SEA	A group of 4th-year students (ages 9–10) took part in a week-long STEAM educational program centered on environmental systems and sustainability. Hosted at Centro Ciência Viva do Algarve, the experience featured activities aligned with the UN Sustainable Development Goals (SDGs). One of the key moments was a session led by scientist Gabriella Pereira from the company SPAROS, focusing on fish nutrition and feeding practices in aquaculture. The discussion highlighted the importance of ecosystem services and linked directly to SDGs 2, 9, and 14. The week concluded with students and their teacher presenting action plans connected to their selected SDG, emphasizing the importance of proper nutrition in sustainable fish farming.
85	PORTUGAL	INVISIBLE MARINE POLLUTION PATHWAY - FROM LAND TO SEA	A group of 4th-year students (ages 9–10) participated in a week-long STEAM educational program focused on environmental systems and sustainability. Held at the Centro Ciência Viva do Algarve, the experience featured activities aligned with the United Nations Sustainable Development Goals (SDGs). One of the week's highlights was a session led by scientist Vânia Sousa from the University of Algarve, focusing on chemical and organic water pollution. The discussion highlighted the critical importance of protecting water quality—issues directly related to SDG 6 (Clean Water and Sanitation) and SDG 14 (Life Below Water). The program concluded with students and their teacher collaboratively creating a panel showcasing their chosen SDG. Their project demonstrated practical ways people can contribute to preserving marine water quality throughout the entire water cycle.

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86	PORTUGAL	SUSTAINABLE FISHING - FROM LAND TO SEA	A group of 4th-year students (ages 9–10) participated in a week-long STEAM educational program focused on environmental systems and sustainability. Held at the Centro Ciência Viva do Algarve, the experience featured activities aligned with the United Nations Sustainable Development Goals (SDGs). A highlight of the week was a session led by scientist Pedro Lino from the Portuguese Institute for Sea and Atmosphere, which focused on sustainable fishing practices. The discussion emphasized the importance of reducing waste and integrating both traditional and innovative fishing technologies—topics directly linked to SDGs 4 (Quality Education) and 14 (Life Below Water). The week concluded with students and their teacher developing an awareness campaign centered on their chosen SDG. Their initiative underscored the importance of respecting fish life cycles and avoiding the overuse of natural resources.
87	PORTUGAL	LIXARTE A GIANT WAVE TO SAVE THE OCEANS - FROM LAND TO SEA	A group of 4th-year students, aged 9 to 10, took part in a week-long STEAM learning program focused on environmental systems and sustainability. Hosted at the Centro Ciência Viva do Algarve, the program included a variety of hands-on activities aligned with the United Nations Sustainable Development Goals (SDGs). A key moment of the week was a session led by Ana Paula Burnay, a technician from the Europe Direct Algarve Center, which explored the impact of marine plastic pollution through the lens of art. The session emphasized the vital role of plastic recycling and active citizen involvement in achieving SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), SDG 14 (Life Below Water), and SDG 15 (Life on Land). To conclude the experience, students worked alongside their teacher to design and build a plastic identification panel related to their selected SDG. The project showcased practical ways to identify the human activities that contribute to marine plastic pollution, encouraging greater awareness and responsibility.
88	PORTUGAL	FROM THE INVISIBLE TO THE VISIBLE LIFE IN WATER - FROM LAND TO SEA	A group of students from 1st to 4th grade, aged 6 to 10, participated in a week-long STEAM learning program focused on environmental systems and sustainability. Hosted at the Centro Ciência Viva do Algarve, the program offered a variety of hands-on activities aligned with the United Nations Sustainable Development Goals (SDGs). A highlight of the week was a session led by Tiago Gomes, an aquarist from Centro Ciência Viva do Algarve, which explored the life that exists in aquarium water — from the invisible to the visible. Students learned about the microorganisms and larger life forms typically found in aquariums, sparking discussions around SDG 12 (Responsible Consumption and Production) and SDG 14 (Life Below Water). To conclude the experience, students worked with their teacher to investigate how to measure water salinity and understand its impact on aquatic life, linking their discoveries to their selected SDG. The project provided a practical and engaging way to explore the importance of salt in our lives and its role in the environment.

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89	PORTUGAL	FRESHWATER CHALLENGE ON A SAILING BOAT - FROM LAND TO SEA	A group of students from the 4th grade, aged 9- 10, participated in a week-long STEAM learning program focused on environmental systems and sustainability. Hosted at the Centro Ciência Viva do Algarve, the program offered a variety of hands-on activities aligned with the United Nations Sustainable Development Goals (SDGs). A highlight of the week was a session led by Ricardo Barradas, skipper and president of the Association for Ocean Study and Conservation – For a better Sea, which shared the challenges and risks to be a delivery skipper. Students learned about the life onboard and the main differences form being on land and on the sea for everyday's life, sparking discussions around SDG 6 (Water quality), SDG 12 (Responsible Consumption and Production) and SDG 14 (Life Below Water). To conclude the experience, students worked with their teacher to investigate how to spare freshwater and use it in a sustainable way for everyday needs on a sailing boat, linking their discoveries to their selected SDG. The project provided a practical and engaging way to explore the importance of freshwater in our lives and its role in the environment.
90	PORTUGAL	PROTECTING MARINE LIFE - FROM LAND TO SEA	A group of 4th-grade students, aged 9 to 10, participated in a week-long STEAM learning program focused on environmental systems and sustainability. Held at the Centro Ciência Viva do Algarve, the program featured a range of hands-on activities aligned with the United Nations Sustainable Development Goals (SDGs). One of the week's highlights was a session led by Alfredo Rodrigues, a cetacean-watching tour operator who engages tourists with the lives of dolphins and raises awareness of their crucial role in marine ecosystems. His work also helps support ongoing research on cetaceans. During the session, students learned about local dolphin and whale species and the importance of observation for their conservation. These discussions tied into SDG 14 (Life Below Water) and encouraged reflection on SDG 4 (Quality Education). To wrap up the experience, students collaborated with their teacher to investigate the importance of protecting marine life, linking their findings to the SDG they had chosen. The project offered a dynamic and meaningful opportunity to explore the significance of the marine food web and our impact on ocean ecosystems.
91	PORTUGAL	FISH CAN ALSO BE FARMED - FROM LAND TO SEA	A group of 4th-grade students, aged 9 to 10, took part in a week-long STEAM (Science, Technology, Engineering, Arts, and Mathematics) program centred on environmental systems and sustainability. Held at the Centro Ciência Viva do Algarve, the program engaged students in a series of interactive, hands-on activities aligned with the United Nations Sustainable Development Goals (SDGs). One of the program's highlights was a session led by Florbela Soares, a marine biologist from the Portuguese Institute of the Sea and Atmosphere (IPMA). She introduced the students to the topic of aquaculture, explaining how fish are raised in controlled environments and why this method can provide a healthier, more sustainable source of food. The discussion connected directly to SDG 12 (Responsible Consumption and Production) and SDG 14 (Life Below Water). To wrap up the experience, the students collaborated with their teacher to investigate the benefits of aquaculture. They created posters using the AEIOU framework to share their findings, linking their insights to a specific SDG of their choice. This final project gave students an opportunity to reflect on their

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			learning in a meaningful and creative way, reinforcing the significance of sustainable practices in preserving our planet.
92	SERBIA	Smart recycling: From plastic bottle to 3D printing	This SLE (STEAM Learning Ecologies) project addresses the challenge of recycling PET packaging through the development of an innovative device for processing plastic bottles into filament for 3D printing. Students investigate environmental issues related to plastic waste and apply STEAM principles in developing a practical solution. Through the process of designing, testing and optimizing devices, students develop technical, engineering and analytical skills, while also gaining knowledge about the circular economy and sustainable technologies. Learning products include a functional recycling device, recycled 3D printing filament, educational materials, and hands-on products made with 3D printers. In addition to the technical aspect, the project encourages teamwork, cooperation with local environmental institutions and the organization of public workshops and presentations, whereby students actively contribute to raising environmental awareness in the community. Through this interdisciplinary approach, the school becomes a place for innovation and sustainable production, while students develop key competencies for the future.
93	SERBIA	Sky heroes	This STEM Learning Ecology (SLE) emerged from the need to promote meaningful, high-quality leisure activities in the local community of Zaječar. The project engaged high school students—exclusively female participants—in a wide range of multidisciplinary activities that combined environmental awareness, digital literacy, and social responsibility. Through drone-assisted fieldwork, students mapped local picnic areas and illegal dumping sites, documented environmental challenges, and proposed solutions through digital media production. The results include the creation of educational video reports, campaigns on social media, and collaborations with community stakeholders such as hiking societies, museums, and science centers. The SLE empowered young women with technical skills, deepened their environmental consciousness, and encouraged active citizenship through storytelling and scientific exploration.
94	SERBIA	Eco Cycle: From Waste to Growth – A Local Green Initiative	This SLE engages students from different disciplines in an interdisciplinary ecological project aimed at collecting and processing natural biological waste, fallen leaves, twigs, grass, and turning it into natural fertilizer. The ultimate goal is to teach students about the circular flow of natural matter, to develop environmental consciousness, and to contribute meaningfully to their local community. Through practical work, multimedia creation, and public engagement, students not only learn the science behind composting and sustainability, but also how to communicate its importance using modern technology. The project culminates in a public eco-quiz, reinforcing key concepts and celebrating creativity and knowledge with community recognition.
95	SERBIA	My cup of tea	This SLE promotes healthy lifestyle habits, especially among young people. Through spring workshops, students explored local medicinal plants, created a bio-garden, experimented with drying and candying fruit, studied traditional and global tea cultures, and made their own tea blends. The activities culminated in product presentations and sales. The project encourages long-term behavior change and community engagement.

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96	SERBIA	STEM Expedition: The River is Not Just Water	As part of the STEM Learning Ecology (SLE) program, students investigate the water quality of the Ibar River in the Kraljevo area through physical-chemical and microbiological analyses, as well as by studying the biodiversity of the aquatic ecosystem. Activities include field sampling, laboratory testing, data analysis, and visualization. The project is carried out using a multidisciplinary approach and involves collaboration between students, biology, chemistry, and microbiology teachers, and experts from relevant institutions. The main goal is to develop students' research skills, critical thinking, and environmental awareness, while promoting science through practical and socially responsible work.
97	SERBIA	Paper with a Purpose: Recycling, Creativity, and Social Responsibility	This SLE was designed to address an everyday issue in the school environment—excessive paper waste. The project "Paper with a Purpose" empowered students to take initiative in both environmental conservation and social engagement. Through a structured learning path, students participated in workshops on paper recycling, crafted usable and decorative items from recycled paper, and applied entrepreneurial skills by organizing a charity fair. The final products (bookmarks, cards, and aromatic decorations) were sold at a humanitarian bazaar, with proceeds donated to the NURDOR foundation supporting children with cancer. The project not only raised awareness of environmental protection but also cultivated empathy, responsibility, and creativity, all while reinforcing STEAM skills and linking formal education with real-world impact
98	SERBIA	FROM SEED TO SUCCESS	Students apply their acquired knowledge at regular lessons by creating a garden where they grow aromatic herbs and spices. They collaborate with local producers and small entrepreneurs who use these herbs in their production, raising awareness of the importance of organic and sustainable products. Also, they use the herbs in the school canteen, during school celebrations and similar occasions. Also, we use these herbs to promote healthy lifestyles and organic food. Petro Kuzmjak school, located in a rural area, fosters cooperation with local agricultural cooperatives and healthy food producers. Through biology lessons, project-based learning, and visits to local farms, students learn about plant cultivation, processing, and marketing. After planting herbs in the school park and classrooms, students harvest, dry, and package them, and organize a final promotional event where they serve tea made from their herbs and share information with the local community about the project's goals and impact. During this process they learn about entrepreneurship, marketing, package and promotion of the products.
99	SERBIA	Smart Growing: Controlled Plant Cultivation for a Sustainable Future	This SLE centres on empowering students to produce vegetables, ornamental, and aromatic herbs in controlled environmental conditions using Grow Box systems. The project integrates STE(A)M disciplines through hands-on, research-based, and collaborative learning paths. Students not only cultivate plants under monitored conditions but also document growth digitally, compare cultivation variables, and share their findings. With support from local agricultural institutions and industry partners, they develop essential 21st-century skills while contributing to sustainable food production. The project culminates in a public presentation at the local science festival, demonstrating how school-based innovation can benefit the broader community.

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100	SPAIN	AI with a Sustainable Lens: Youth Films to Change the World	This Learning Scenario is part of the European project STEAM Learning Ecologies. Through active and participatory methodologies, students in 4th year of ESO (Spanish lower secondary) Biology and Geology worked in heterogeneous teams to design and produce an original short film focused on a Sustainable Development Goal (SDG). After an initial phase of brainstorming and manual storyboard sketching, each group used generative artificial intelligence tools to develop the script, visual frames, soundtrack, and final video editing. The experience allowed students to explore the educational potential of AI, while promoting critical thinking, environmental awareness, creativity and teamwork.
101	SPAIN	Artificial intelligence in the service of the SDGs	This learning situation, aimed at 3rd year ESO students in the subject of Physics and Chemistry, focuses on the unit "Chemistry and society". Through a proposal based on active methodologies such as PBL, the STEAM approach and learning ecologies, students will investigate the impact of different chemical compounds on health and the environment, linking them to the Sustainable Development Goals. With the support of generative artificial intelligence tools, they will design and produce a three-minute informative video in which they will propose sustainable solutions from a scientific, critical and creative point of view.
102	SPAIN	Artificial intelligence in the service of the SDGs	Under the SDGs selected by the students, they must produce 2 audiovisual pieces of maximum 3 minutes with the help of Artificial Intelligence tools.
103	SPAIN	Sustainable Development Goals: an approach with ESO students using AI tools	As part of the subject "Biology and Geology", we analysed the UN Sustainable Development Goals with 12 students in the 4th year of ESO. Two goals have been chosen to elaborate several materials, working on them. We have developed our project on goal 14 "Conservation of underwater life" using AI tools, elaborating several scripts, images, music and finally a video. We contacted researchers in Marine Biology (IEO-CSIC; Xunta); they visited us and gave two conferences in our centre.
104	SPAIN	Stories with meaning: Imagining the monster with AI and SDGs	The 2nd ESO students worked to create 2 short videos using AI-generated images. The activity had the SDGs as a common thread, at least two SDGs should be developed in each video. The process included the choice of narrative format, the development of storyboards and the use of digital applications to edit the videos. In this way, students developed digital, creative and critical skills, reflecting on the social and environmental impact of AI.
105	SPAIN	Innovation and awareness: producing an AI video about an SDG	This learning situation proposes to 4th ESO (16 years) students to explore the potential of generative AI for content creation, focusing on the production of a short video. The focus will be on raising awareness of an SDG chosen by the groups. They will document the process, reflecting on the use of AI, its possibilities and limitations, and present the final result. The aim is to develop digital and technological skills, as well as a critical awareness of the SDGs.
106	SPAIN	From Classroom to Action: SDGs with AI in STEAM Learning	In the framework of the STEAM Learning Ecologie project, students have developed an interdisciplinary learning situation focusing on the Sustainable Development Goals (SDGs). Using Artificial Intelligence tools, they have researched and created an educational video that reflects their understanding and commitment to the different Sustainable Development Goals they have chosen. This experience has strengthened digital competences, worked

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			transversally with other subjects and collaborative work. In addition, it has fostered creativity and critical thinking from a STEAM approach.
107	SPAIN	ADVANCING ODS TARGETS WITH IA	The aim of this project was to raise the visibility of previously chosen SDG goals by creating videos using AI to create story content, images and music
108	SPAIN	Creating videos with Artificial Intelligence inspired by the SDGs	Students in 4th ESO and 1st Baccalaureate were asked to create videos generated entirely with artificial intelligence tools, based on the Sustainable Development Goals (SDGs). The students studied and chose the SDG they liked the most and designed a storyboard beforehand and then created a video of a maximum of 3 minutes in length, including at least six images generated by AI. This activity encourages creativity, digital literacy and critical reflection on global challenges.
109	SPAIN	SDGs and AI: Towards a Sustainable Future	This learning situation was developed within the framework of the European project STE(A)M Learning Ecologies (SLE), in collaboration with Domus. Secondary education students created three audiovisual pieces on various SDGs using artificial intelligence tools. Through this interdisciplinary work, research, and creativity, students developed various skills, critical thinking, and social awareness, adapting the experience to a formal learning situation.

Appendix III – SLE Survey Questionnaire

To facilitate the evaluation of the mature implementation phase SLEs which were implemented in various countries and settings, we devised the following list of statements categorized in a sequence of templated forms/questionnaire that focus on different dimensions of an SLE. The survey is to be addressed to initiators and educators/lead teachers or to the whole group of stakeholders who can utilize it for guidance or as a preliminary list of indicative statements that can help them to characterize their observations from the overall educational activities they tried out during the mature implementation phase. In general, initiators/teachers are also encouraged to suggest their own list of statements or key elements in addition to the proposed ones. The level of agreement to each statement or observation is quantified by a score indicator in scale from 1 to 5 according to the following table. This is to assist project partners in the analysis of the results.

Score scale	Interpretation
5	Strongly agree
4	Agree

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3	Neither agree nor disagree
2	Disagree
1	Strongly disagree

General Aims and Objectives: Towards which skills or transversal competencies are students oriented in the SLE?	1	2	3	4	5
Creativity and innovation					
Critical thinking and problem solving					
Communication and collaboration					
Literacy in ICT and new technologies					
Independence, initiative and self-direction					
Deconstruction of gender stereotypes					
Ownership of results/achievements					
Leadership and responsibility					
• Exposure to real-life situations and problems					
• Interest and motivation towards science studies and science careers					

What have students actually learned or what are they able to do after completing the educational activities of the SLE?	1	2	3	4	5
Students have improved or advanced their critical thinking and problem-solving skills					

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Students are able to start a design process to solve a given problem					
Students have advanced or improved their content and concept knowledge of STEAM curriculum topics					
Students are able to initiate or follow an inquiry process and actions towards a predetermined goal					
Students are able to reflect on or self-assess their learning progress, and have gained confidence and independence on acquiring knowledge and skills					
Students have improved or advanced their ICT and new technologies literacy					
Students have increased their interest and motivation towards science studies and science careers					
Students have improved or advanced on interdisciplinary and collaborative learning					
Students have improved or advanced on deconstruction of gender stereotypes					

How is the group of stakeholders involved in the SLE is facilitating learning?	1	2	3	4	5
Takes into consideration students' prior knowledge, skills, competences, attitudes, beliefs, learning styles and experiences and accordingly organize appropriate learning activities					
Makes explicit connections between specific content knowledge and educational activities					
Is an active facilitator for inquiry- and creativity-based learning, for example by encouraging students' decision-making during inquiry processes, and sharing, evaluating and reflecting on outcomes					
Provides students step-by-step guidance during the educational activities					

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Fosters creativity and problem-solving skills by being more like a mentor or coach instead of someone who will give all the answers					

Where and with whom or how are students learning in the SLE? E.g. are they better learning individually, in small groups, or whole class?	1	2	3	4	5
When students are provided with flexibility to choose from a range of learning trajectories according to their preferences and working styles (individually or in groups)					
When the same educational activity is implemented in whole-class					
By promoting team working and collaboration in small groups					
By emphasizing students to work individually and independently					
By providing interaction and interdisciplinary collaboration opportunities among students of different skills and competences					
With educational activities that take place in a variety of learning environments in- and out-of-school, including e.g. science centers, museums, natural habitats, research institutes, enterprises, fablabs					
When educational activities take place in classroom or in school environment					

How are learning activities in the SLE increasing female participation and deconstructing gender stereotypes?	1	2	3	4	5
By providing students with same-gender role models or success stories					

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By encouraging collaboration rather than competitiveness among groups or individuals					
By promoting tasks or team working with female-only groups					
By emphasizing students to work in gender balanced teams					
By providing interaction and collaboration opportunities with female role models/mentors					
By offering educational activities that put emphasis on skills and competences and not on gender					

What have educators learned or what are they able to do after completing the educational activities of the SLE?	1	2	3	4	5
The experience of implementing the SLE significantly contributes to the professional growth and development of educators, supporting the adoption of innovative STEAM teaching methodologies.					
SLEs helped educators to effectively integrate SLEs principles into their everyday teaching practices also in the future					
Adequate support and educational resources provided to educators by other stakeholders enhance their confidence and capability in implementing the SLEs project, resulting in improved teaching quality					
Collaborative engagement and interaction with other colleagues and stakeholders enrich the implementation experience for educators, fostering a supportive professional community focused on student learning and engagement.					

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Is the current policy framework helping or restricting the implementation of the SLE?	1	2	3	4	5
The administrative or bureaucratic burden on the school has been an obstacle for the implementation of this initiative					
The public administration (at any level) supports the adoption of initiatives linked to interdisciplinarity and STE(A)M					
The public administration (at any level) supports the adoption of initiatives linked to multistakeholder partnerships in education					
The equipment, infrastructures and/or setting available was supporting the implementation of this activity					
The administrative or bureaucratic burden on the stakeholders has not been an obstacle for the implementation of this initiative					

Based on your answers to the questions above, please write which policies, **national frameworks or formal policy tools** in your local or national context facilitate the implementation of open schooling and STEAM in education.

Examples of policy tools can be dedicated moments in the curriculum for interdisciplinary projects, or enhanced autonomy of schools and teachers to implement such projects. If there aren't any, why do you think that is (E.g. not a priority for the policy makers, not in line with existing curricula, etc.)?

Which of the following challenges have you encountered in implementing your SLE?	1	2	3	4	5

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Lack of understanding around STE(A)M education					
Lack of teacher training					
Lack of time for preparation and collaboration between stakeholders					
Lack of resources					
Difficulty to approach and connect to appropriate stakeholders					
Curriculum constraints					
Policy and institutional constraints					
Please elaborate: Are there any **other** obstacles/challenges you encountered during the implementation of your SLE?					

How effective were the collaborative efforts between stakeholders (e.g., educators, administrators, policymakers, community members, industry partners) in planning and implementanting the SLE?	1	2	3	4	5

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The collaborative efforts among stakeholders significantly contributed to the success of the pilot SLE					
Stakeholder collaboration enhanced resource-sharing, expertise exchange, and support for innovative educational approaches					
Collaboration fostered a sense of ownership and commitment among stakeholders towards the goals of the SLE					
Challenges in establishing or maintaining partnerships with other stakeholders impacted the implementation and effectiveness of the SLE					
Partnerships with external entities helped ensure long-term sustainability, replication and growth of the SLE beyond the initial implementation phase					
We are willing to formalize this partnership and keep working together in the SLEs framework, also expanding it with the participation of other stakeholders					

Please elaborate:

Did the collaboration with some stakeholders (eg. Students, parents, the local community, universities and/or industries) create **new opportunities** within your current SLE, or for future iterations of the project?

(For e.g , one stakeholder bringing others onboard, or offering to continue the collaboration in the future, or connecting you with others who could help you realize your SLE.)

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To what extent did partnerships with external organizations or institutions (e.g., universities, businesses, NGOs) contributed to enriching the students' learning opportunities and engagement?	1	2	3	4	5
Partnerships with other stakeholders provided educators with valuable resources, expertise, and real-world connections for students' STE(A)M learning experiences					
Collaboration with external partners facilitated access for educators to specialized facilities, technologies, or mentorship opportunities enhancing the quality and engagement of educational activities in STE(A)M.					
Stakeholder partnerships facilitated access to diverse perspectives, resources, and opportunities for students' engagement STE(A)M learning and improvement of their competences.					
External partnerships have fostered opportunities and provided students with new competences that support their careers in the sector (i.e. doing like researchers, through role models etc.)					
External partnerships have fostered opportunities to involve and attract young females in STEM education and contributed to a reduction of gender gap in the field.					
Would you be able to autonomously **replicate or sustain** the project in the future? What resources or support systems would be necessary to facilitate the replication, sustainability or upscaling of the project in the future/after project ends? Do you have any comments or remarks with regards to some of the chosen answers in this survey? You can add them here.					

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Appendix IV – SLE Methodology Flashcards

SLE Methodology

Flash-cards

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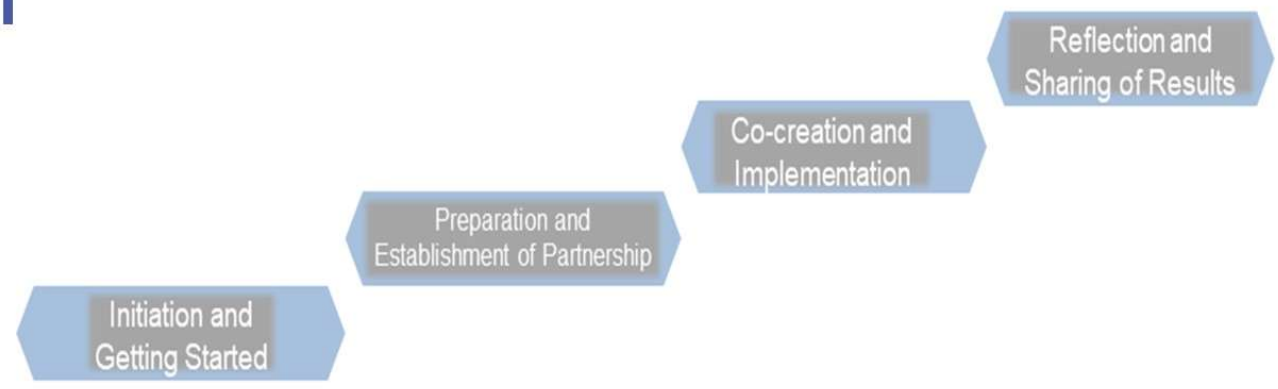
1

SLE step-by-step development process

STEAM LEARNING ECOLOGIES



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Step 1. Initiation and Getting Started

- What do we find bothering or problematic in our everyday life?
- What possible solutions can we think of to improve it?
- What is feasible or what we can do to address the challenge identified?
- Has any idea or solution been tried before?
- Can we think of a new or improved one?
- What are the issues and needs of our community at local/regional level?
- What is community well-being? How is affected? How can we impact it?
- What are the societal challenges we are interested in or we are aware of?
- What do we find interesting to be engaged with?
- From a list of problems or challenges we have identified which one is worth tackling first?

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Step 2. Preparation and Establishment of Partnership

- Who has direct or indirect interest or motivation to participate?
- Who will be impacted, positively or negatively?
- Who will be affected directly or indirectly?
- Who will be benefited?
- Who do we need?
- Who do we know?
- Who is already in our network of contacts that could make a useful contribution, have interest to participate or introduce/recommend potential partners?
- Who has already been part of a similar project about the issue/problem/idea we have chosen?
- What knowledge, experience or authority is needed?
- Who within our local community or contacts could possibly have similar knowledge, experience or authority?
- With whom have we collaborated in the past?
- What is the level of their availability of learning resources?
- What is their willingness and ability to provide support to learners along their learning pathways?
- What role do we envisage for each potential partner?

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Step 3. Co-creation and Implementation

- Creating a project in partnership is done by following or adopting a process such the living lab co-creation practice. Is this process clear to all participants?
- Are all relevant stakeholders included in the process or is their active participation ensured?
- Is a shared vision co-created that is jointly defining the problem statement, goals, and ambitions of all in the partnership?
- Does it clearly embed all stakeholders' interests?
- Co-creation in practice may require participants to commit to a more open, transparent, and flexible attitude and way of working. Are all aware and committed to this?
- Is an overall plan of activities co-created?
- For the plan to succeed, are the committed resources adequate or well-foreseen?
- Is it well divided in tasks or iterative phases of exploration, experimentation, and evaluation?
- Are the expected outcomes or results in each task or phase clearly defined? Are they understood by all?
- Are division and allocation of roles, responsibilities and resources clear to all partners?
- Is allocation based on interest, expertise and capability of each partner?
- Are all aware of and do agree on associated commitments, dependencies, contributions, and implications?

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Step 4. Reflection and Sharing of Results

- Thinking about the whole project, including its objectives, its participants, their roles and actions, its processes, and its outcomes, what did go well and what not?
- Are all relevant stakeholders included in the reflection process or is their active participation ensured?
- What was the main element or elements behind successful outcomes or what was the main cause of any problems?
- Was it process related; people, institution and attitudes related; conditions or resources related?
- What can be done differently, and how?
- What are the main lessons learned?
- How the lessons learned can be best shared and with whom?
- How achieved outcomes or proposed solutions can be sustained or replicated at wider scale?

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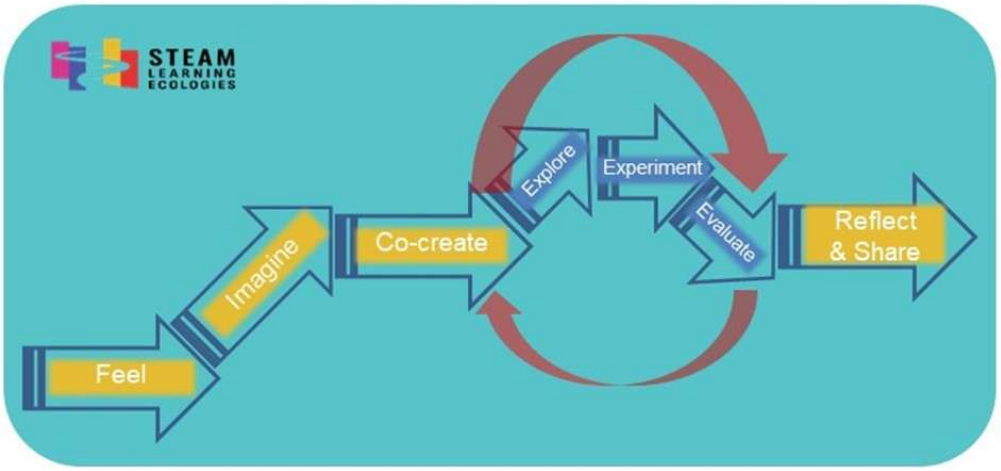
Synthesis of open schooling living lab practice



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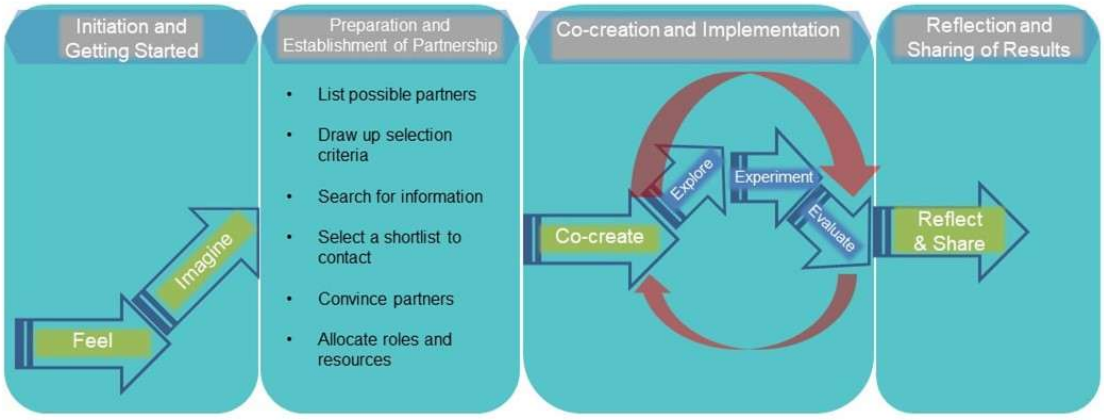
SLE general development process



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