STEAM LEARNING ECOLOGIES

LEARNING PATHS AND INTERVENTIONS FOSTERING LEARNERS' SCIENCE-ORIENTED STUDY AND CAREER CHOICES

Deliverable 4.2

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D4.2 Learning paths and interventions fostering learners' science-oriented study and career choices			
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Executive Summary

This report presents the outcomes and key learnings from the mature implementation phase of the STEAM Learning Ecologies (SLE) project, an initiative grounded in the vision articulated in the SLEs Concept White Paper. At its core, the SLE approach promotes inclusive, interdisciplinary, and context-responsive STEAM education through open schooling environments and living lab practices.

Implemented across sixteen countries, the mature phase focused on scaling and refining the SLE framework to address real-world challenges through dynamic collaborations among schools, civil society, enterprises, and non-formal education actors. The report analyses the design and implementation of diverse learning paths and interventions, along with survey data collected from stakeholders.

Key findings indicate that SLEs primarily target learners in secondary education, favoring flexible, small-group formats that promote autonomy and critical thinking. Thematic areas include environmental sustainability, science, technology, health, and social development. Facilitators often act as mentors or coaches rather than instructors, supporting co-creation and learning agency.

Participation in SLEs enhances transversal skills such as creativity, collaboration, and digital literacy, with measurable benefits for both learners and educators. However, challenges such as rigid curricula, limited resources, and time constraints persist.

The report outlines six strategic recommendations to guide future implementation: broaden age and thematic inclusion, prioritize flexible learning formats, promote gender inclusivity, support educator development, advocate for policy and resource alignment, and leverage partnerships for sustainability.

In conclusion, mature SLEs show strong potential for fostering innovation and equity in STEAM education. Scaling their impact will require sustained support at institutional and policy levels, as well as ongoing investment in collaborative, learner-centered practices.

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Table of contents

List of figures

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Introduction

This final report builds on the foundational vision and principles set out in the SLEs Concept White Paper, which introduced the learning ecologies approach as a dynamic fusion of STE(A)M education, open schooling environments, and living lab practices. The overarching aim, as articulated in the White Paper, is to foster "an empowering partnership based on local-level collaboration between formal, non-formal and informal science education providers, enterprises, and civil society." This vision positions STE(A)M not merely as a collection of disciplines but as an integrative and inclusive educational philosophy that emphasizes creativity, critical thinking, and real-world problem-solving. The White Paper further proposes the metaphor of learning ecologies to capture the evolving, interconnected nature of educational pathways, "a rich and robust complex system of relationships, interactions, and opportunities for collaboration and development" that mirrors natural ecosystems in their diversity, adaptability, and scalability. These principles have guided the implementation, analysis, and refinement of mature-phase SLEs documented throughout this report.

The SLE project was conceived to foster innovative, inclusive, and contextually responsive educational experiences that integrate the broad disciplines of Science, Technology, Engineering, Arts and other subjects, and Mathematics. At its core, the project aims to empower educators, learners, and communities by co-creating dynamic learning environments that address real-world challenges through interdisciplinary collaboration. Building on earlier phases of exploration and pilot testing, the mature implementation phase represented a critical milestone marking the expansion, adaptation, and validation of the SLE framework across a wide range of educational systems and socio-cultural contexts.

This final report provides a comprehensive overview of the methodologies, analyses, and key insights derived from the mature implementation phase. Drawing on a diverse set of SLEs implemented in sixteen different countries, the report examines the characteristics, learning pathways, and types of interventions deployed, as well as the survey results and stakeholder feedback that informed our findings. Through this, we aim to not only reflect on the implementation process, but also generate actionable recommendations for future practice, policy alignment, and sustainability. The abundance of figures and tables included throughout the report illustrate the scale and depth of SLE experimentation, ranging from thematic areas, learner formations, educational levels, open schooling experience, role of stakeholders and gender strategies to the duration, structure, and impact of various learning paths and interventions.

As already emphasized, the foundation of the SLE project is rooted in the conceptual vision laid out in the SLEs Concept White Paper, the first deliverable of Work Package 2. That document articulated the SLEs approach as a synthesis of four core elements: STE(A)M as the overarching educational lens, open schooling as the structural pillar, the living labs model as a mode of practice, and local partnerships as the primary context for implementation. Together, these components form the basis for creating what the project defines as "learning ecologies", ecosystems of interconnected learning

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experiences that are inherently diverse, adaptable, and scalable. In this model, STE(A)M education serves as a vehicle for interdisciplinarity, creativity, and inquiry-based learning that provides multiple access points and pathways for all learners, fostering both engagement and equity. As the White Paper states, "this manifold of access points and pathways is in its nature inclusive as it gives space for all to explore, freedom to follow uncharted regions and confidence to think differently."

By embedding this inclusive pedagogical approach within open schooling environments through the practice of living labs, the SLE project unlocks new possibilities for systemic innovation. The goal is to bridge formal, non-formal, and informal education, linking students with enterprises, civil society, and real-world challenges in collaborative and participatory ways. The metaphor of learning ecologies reflects this ambition, suggesting a dynamic and evolving structure of relationships, interactions, and opportunities—much like a natural ecosystem. "Natural ecosystems both provide and require diversity, efficiency, adaptability and scalability," the White Paper notes, and so too must our educational designs. Keeping this perspective in view, the mature phase implementation has prioritized flexibility, contextual sensitivity, and active stakeholder engagement as critical drivers of impact and sustainability.

This document is structured into four main sections, beginning with this Introduction, which outlined the vision, goals, and conceptual foundations of the STE(A)M Learning Ecologies project. It provides essential context for understanding the purpose and scope of the mature implementation phase, as well as the guiding principles drawn from the initial Concept White Paper. The second section, Methodology and Analysis, first presents an in-depth review of the mature-phase SLEs, including their general categorisation and a detailed examination of learning paths and interventions applied. This is followed by the mature implementation phase survey, which discusses the survey methodology, key findings, and concluding remarks based on data collected from participating stakeholders. The third section, Key Insights and Recommendations, offers practical guidance informed by the implementation experience, aimed at supporting future SLE development, policy alignment, and wider adoption. The document concludes with a Summary, a list of References, and two detailed Appendices: one providing profiles of mature-phase SLEs and another containing the full survey questionnaire used in the data collection process. Together, these sections offer a comprehensive account of the project's implementation, outcomes, and lessons learned.

In providing a comprehensive introduction and full historical context, we include below the complete quotation from the executive summary of the SLEs Concept White Paper as published on Month 3 (31/03/23):

"The SLEs White Paper is the first deliverable of Work Package 2. In this document we lay out the main foundational elements on which the SLEs approach and vision are based. We start by describing first the driving needs and aspirations, the policy context, and the relevant initiatives, and then continue with the constituent elements of the SLEs perspective. These include STEAM as the overarching approach, the open schooling as the main pillar and the living labs concept as key practice, altogether synthesized into local partnerships as learning ecologies. We discuss in detail each of these four aspects highlighting their key principles and characteristics.

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In SLEs we envision and embrace STEAM education as an overarching approach across STEM subjects, the arts and all other disciplines that can greatly infuse and increase interdisciplinarity, creativity, problem-solving, critical thinking, integration and inclusiveness in school education and life-long learning. Using STEAM in education is about using subject integration coherently as an instructional approach for experiential and inquiry-based learning that provides multiple access points and diverse learning pathways for all learners to engage in the creative process and meet objectives in all subject areas. We believe that this manifold of access points and pathways is in its nature inclusive as it gives space for all to explore, freedom to follow unchartered regions and confidence to think differently.

We appraise and leverage this approach by embedding it in open schooling environment through living labs practice. This choice is a key opportunity enabler and multiplier by inherently offering a wide spectrum of access points for all involved. Our overall vision in SLEs is to fuse STEAM, open schooling environments and living lab practices within an empowering partnership based on local-level collaboration between formal, non-formal and informal science education providers, enterprises, and civil society. Because such fusion offers a unique opportunity to bridge the gap between formal education and business by developing an appropriate catalysing process in a connected science learning ecosystem where students encounter a wide range of learning experiences and are supported and mentored by experts and peers in ways that could lead to future opportunities in personal, academic, professional, and civic realms enabling new ways of thinking about societal challenges.

Along this line 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. 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 take into account that natural ecosystems both provide and require diversity, efficiency, adaptability and scalability. And so we should ensure that these features are present in our methodological framework and implementation strategy."

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Methodology and analysis

This report presents an in-depth review of the mature implementation phase of the project, focusing on its scope, outcomes, and emergent insights. By examining the variety and structure of learning scenarios implemented across multiple countries, the report seeks to highlight not only the adaptability of the SLE model but also the shared pedagogical values that underpin it, including sustainability, problem-solving, science literacy, creativity, and active engagement with real-world issues. Through systematic analysis and feedback mechanisms, the report contributes to a broader understanding of how STE(A)M education can be meaningfully localized while remaining globally relevant.

The methodology adopted during the mature implementation phase was designed to ensure both consistency and flexibility, enabling local teams to adapt the SLE framework to their specific educational environments. This approach comprised four key stages: initiation, co-creation, implementation, and reflection & evaluation. Data collection was conducted through a mixed-methods approach that combined structured documentation of learning scenarios with evaluative instruments such as surveys, interviews, focus groups, and reflection workshops. Each SLE was documented with a comprehensive learning scenario which consists of a general title, a brief general description, and detailed descriptions of objectives, learning paths, outcomes and contextual metadata, enabling comparative analysis across settings and themes. In total 105 learning scenarios were submitted from 16 different countries.

A central element of the evaluative process was a comprehensive survey, distributed to initiators, educators and key stakeholders toward the end of the implementation period. The survey was structured around ten principal focus areas, encompassing, among others, pedagogical design, student engagement, interdisciplinary integration, and perceived impact. In total, 95 complete responses were collected, providing a robust dataset for analysis. The insights drawn from this data, cross-validated by qualitative feedback and observational methods, form the basis for the findings and recommendations presented in this report.

1.1 Mature implementation phase STEAM Learning Ecologies

The mature implementation phase of the project started in Sep 2024 and lasted until Jun 2025. During that period in total 105 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 the full list of SLEs per country of implementation is tabulated. A general title and a brief

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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.

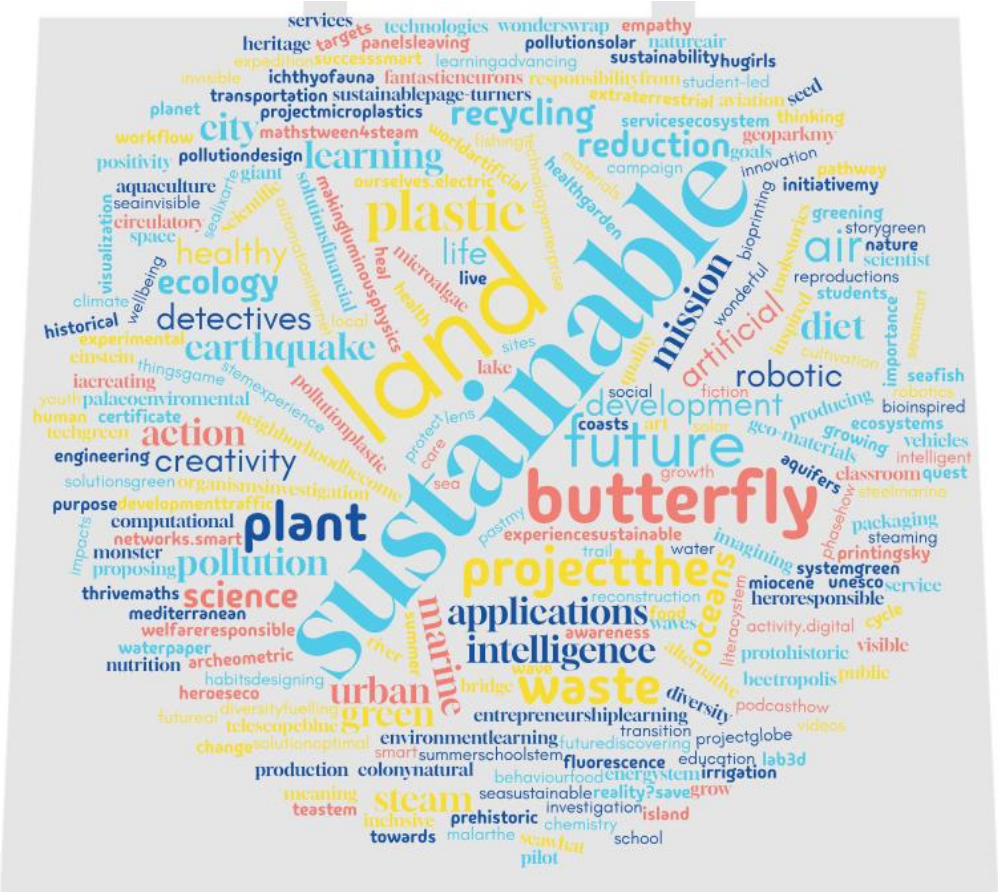

Figure 1 : An illustrative word cloud generated with the titles of SLEs implemented during the mature phase

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, STEAM, and entrepreneurship are included, highlighting a holistic and interdisciplinary approach incorporated across 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 section begins with an overview of the key characteristics of mature phase SLEs, derived from a systematic analysis of the submitted learning scenario documents. This includes aspects such as age range of learners or education level, duration of implementation, degree of open schooling and

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the STE(A)M subjects or fields involved. We then focus on the analysis of learning paths and interventions.

1.1.1 General categorisation

Mature phase SLEs per country

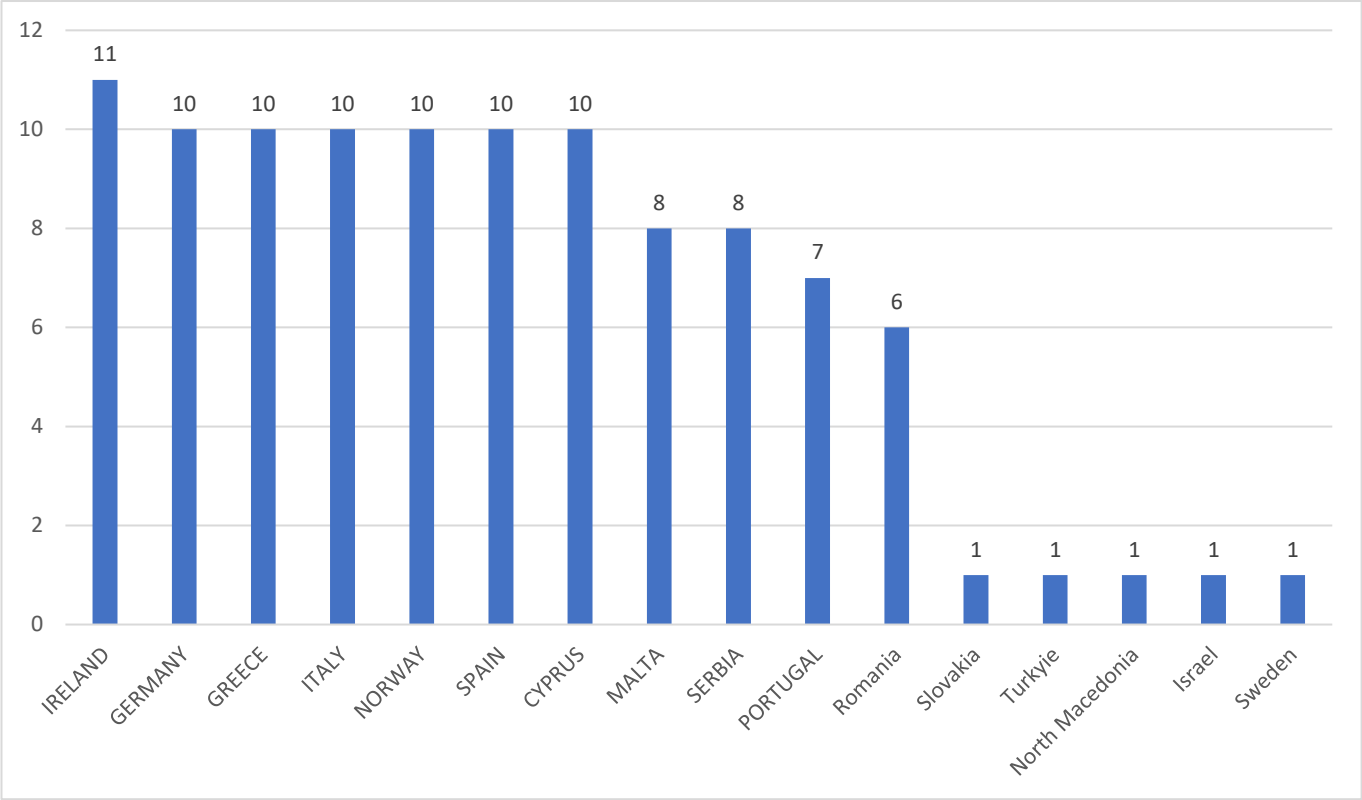

Figure 2 : SLE learning scenarios per country of implementation

The bar chart illustrates the number of SLE learning scenarios submitted by various partner and affiliated countries. The total number is 105 from 16 countries, Ireland leads with the highest number of entries at 11, followed closely by a group of countries, namely Germany, Greece, Italy, Norway, Spain, and Cyprus, each contributing 10 entries. Malta and Serbia follow with 8 entries each, while Portugal submitted 7. SLEs coordinated by EUN correspond to Romania with 6 entries, and to Slovakia, Türkiye, North Macedonia, Israel, and Sweden each contributing 1 entry.

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Number of learners involved

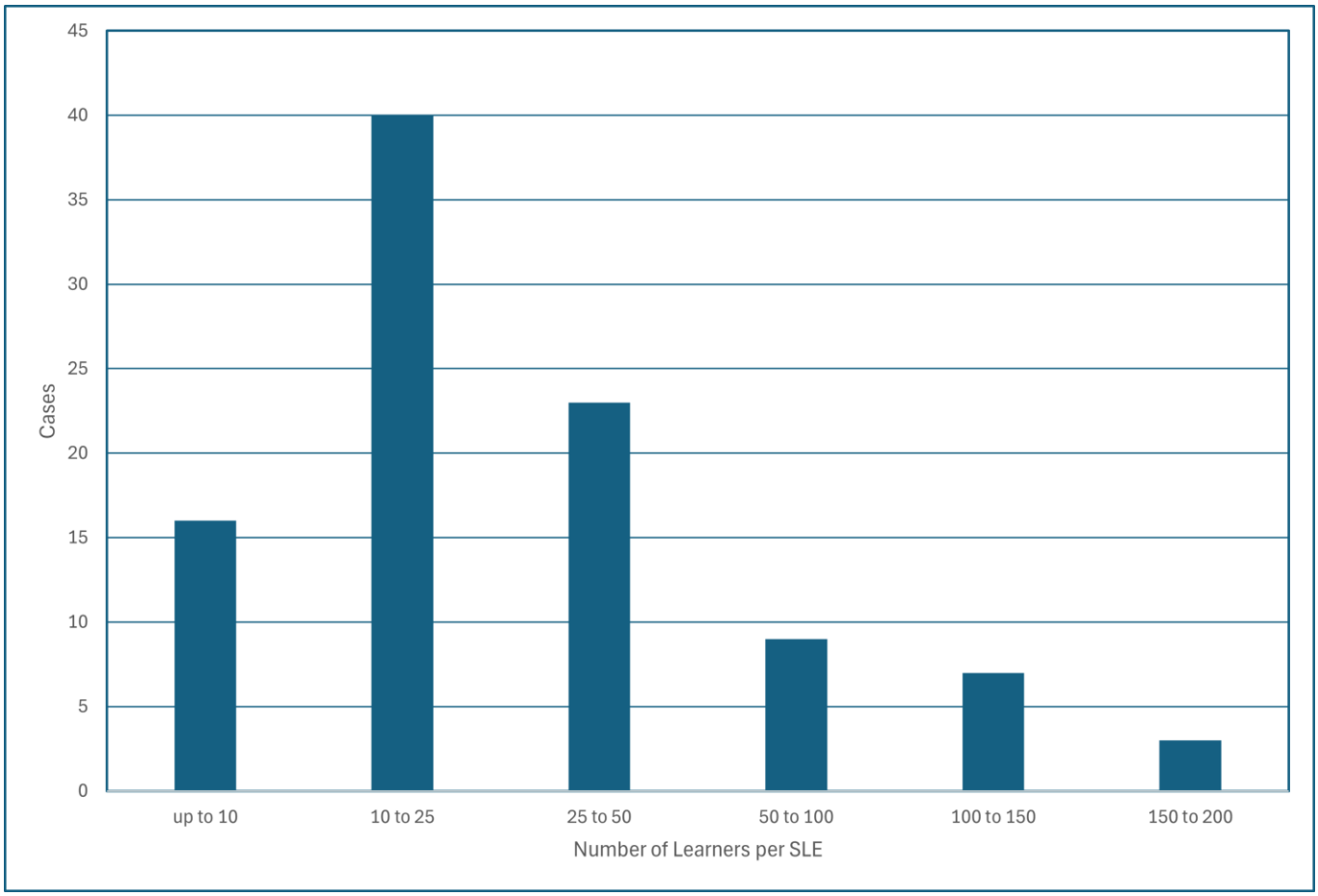

Figure 3 : Distribution of SLEs based on the number of learners involved

The bar chart illustrates the distribution of SLEs based on the number of learners involved in each case. The highest number of entries, 40, occurs in SLEs with 10 to 25 learners, followed by 22 cases in those with 25 to 50 learners. SLEs with up to 10 learners account for 16 cases. As the number of learners increases, the number of implemented SLEs decreases significantly, with 9 cases in the 50 to 100 range, 7 cases in the 100 to 150 range, and just 3 cases in the 150 to 200 range.

Overall, SLEs with up to 50 learners represent 80% of the total cases, highlighting that smaller learning environments are not only more accessible but also more manageable and efficient to support. This reflects the effective alignment between the scale of these environments and the available resources of consortium partners, national coordinators, and initiations, enabling more focused and responsive implementation. The remaining 20% of reported SLEs, which had 50 to 200 learners each, likely reflect the advanced expertise and experience of the partners involved. These cases demonstrate the capacity of experienced teams to design and implement innovative educational initiatives and activities at a larger scale and in more diverse settings, maximising impact and extending the reach of quality learning opportunities.

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Age range of learners / Education level

The age range of learners is also indicated in each submitted learning scenario. The extracted dataset for analysis shows the majority of entries falling within the teenage bracket, particularly ages 12 to 18. There are a few outliers on both ends with some younger participants, ages 4–11 and a smaller group of university students or young adults aged 21 to 24. In more detail, the most frequently represented group is the 15–16 age range, followed closely by ranges such as 12–13, 14–15, and 16–18, suggesting a strong concentration of participation from mid to late teens which correspond to lower and upper secondary education levels. While entries of SLEs implemented with younger learners (ages 4–11) are present, they are relatively sparse. There are also a few older participants in the 21–24 age group, which stands out as a distinct minority. Additionally, some entries span unusually broad age ranges, indicating submissions that were implemented across different education levels, e.g. lower and upper primary, lower and upper secondary, upper primary to lower secondary, or with less strictly defined categories. Overall, the data suggests that SLE mature phase is primarily targeted toward adolescents (corresponding to upper primary, lower and upper secondary education levels), with limited inclusion of younger children (preschool or lower primary education level) and young adults (university or tertiary education level).

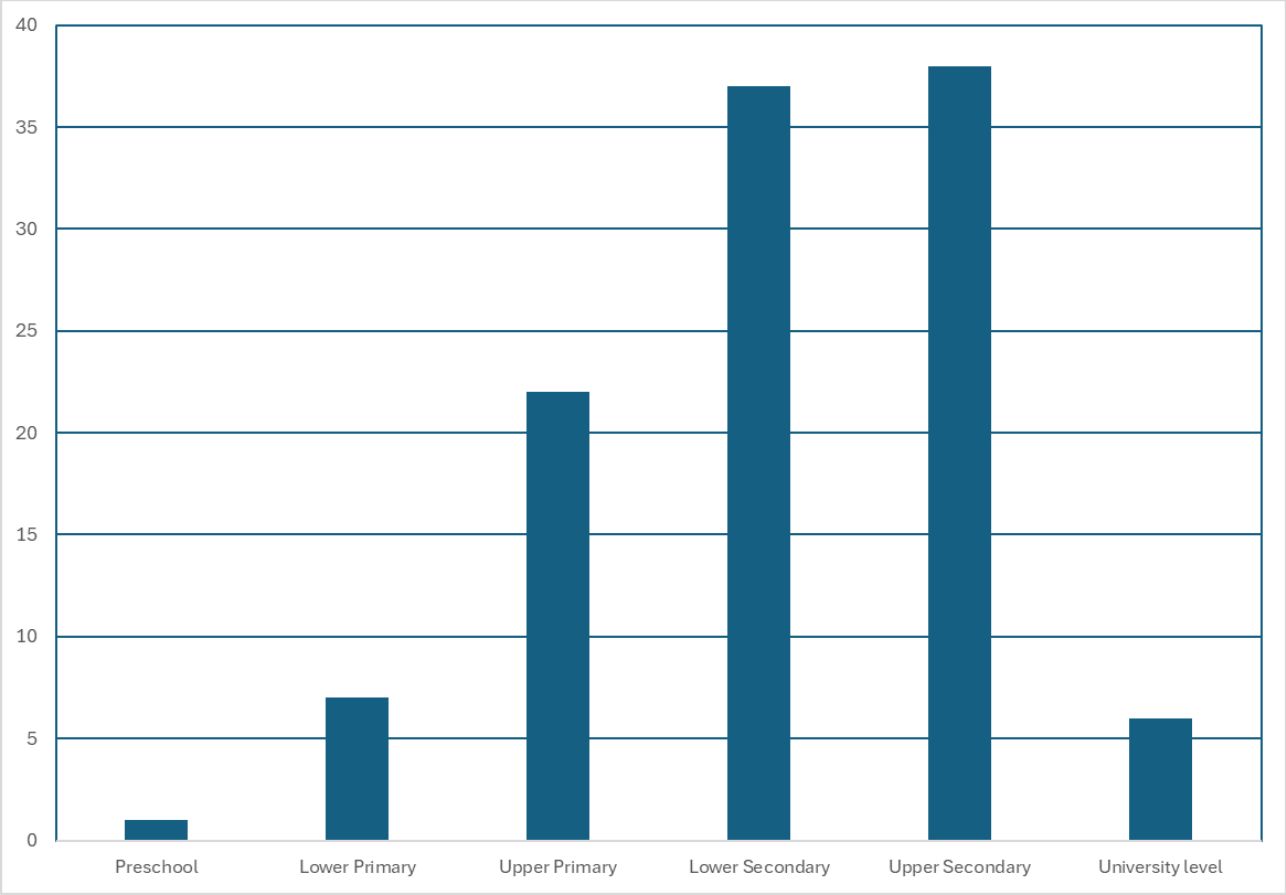

Figure 4 : Distribution of SLE learning scenarios across educational levels

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The bar chart presents the distribution of entries across different educational levels. Upper Secondary has the highest number of entries, with just under 40 submissions; Lower Secondary closely follows, also with around 37 entries; Upper Primary shows moderate participation, contributing approximately 22 entries; Lower Primary and University level have relatively low representation, with around 7 and 6 entries respectively; Preschool has the fewest entries, with only 1 recorded.

The chart clearly indicates that the majority of participants are from Lower Secondary and Upper Secondary levels. This heavily concentrated distribution in the secondary education levels is a reflection of various contributing factors, the most prominent ones being on one hand the expertise of the consortium partners, on the other their established network of contacts or collaborators in the education community, and finally the flexibility of national school curricula and the opportunities that this can provide for implementing the SLE's educational approach.

Duration of implementation

The analysis of SLEs conducted during the mature phase shows that their durations, as outlined in the submitted learning scenarios, generally fall into two main categories. The first includes SLEs that extended over several months, ranging from 1 to 10 months, accounting for 80 out of 105 cases. The second category consists of 23 shorter SLEs, lasting from 1 to several days, which correspond to more intense interventions such as in summercamps or for incorporation in parallel events.

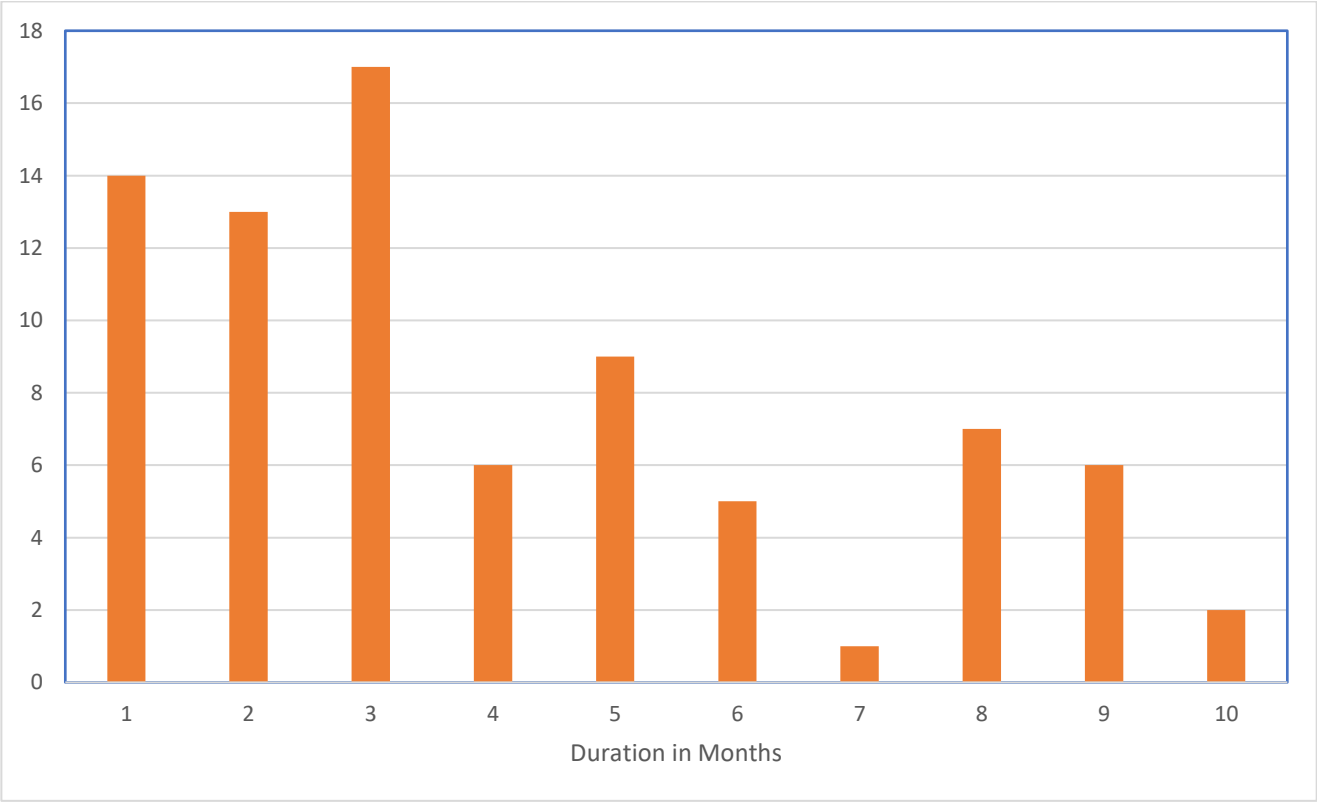

Figure 5 : Distribution of SLE implementation duration from 1 to 10 months
(dataset of 80 entries out of 105 SLEs)

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With respect to the first category of SLEs, the bar chart above illustrates the number of entries based on SLE implementation durations ranging from 1 to 10 months, e.g. spanning a full school year or parts of trimesters or semesters. In total this dataset contains 80 entries out of 105 submitted SLEs. The most common duration is 3 months, with 17 entries, followed by 1 month (14 entries) and 2 months (13 entries). A moderate number of entries fall within the 4 to 6 months range, with decreasing frequency as the duration increases. Notably, longer projects are less common, with only 1 entry for 7 months and 2 entries for 10 months. This trend suggests that short-term projects (1–3 months) are significantly more popular, possibly due to feasibility, ease of execution, shorter available academic cycles or potential windows of implementation opportunities, while extended durations are less favored or practical for most participants.

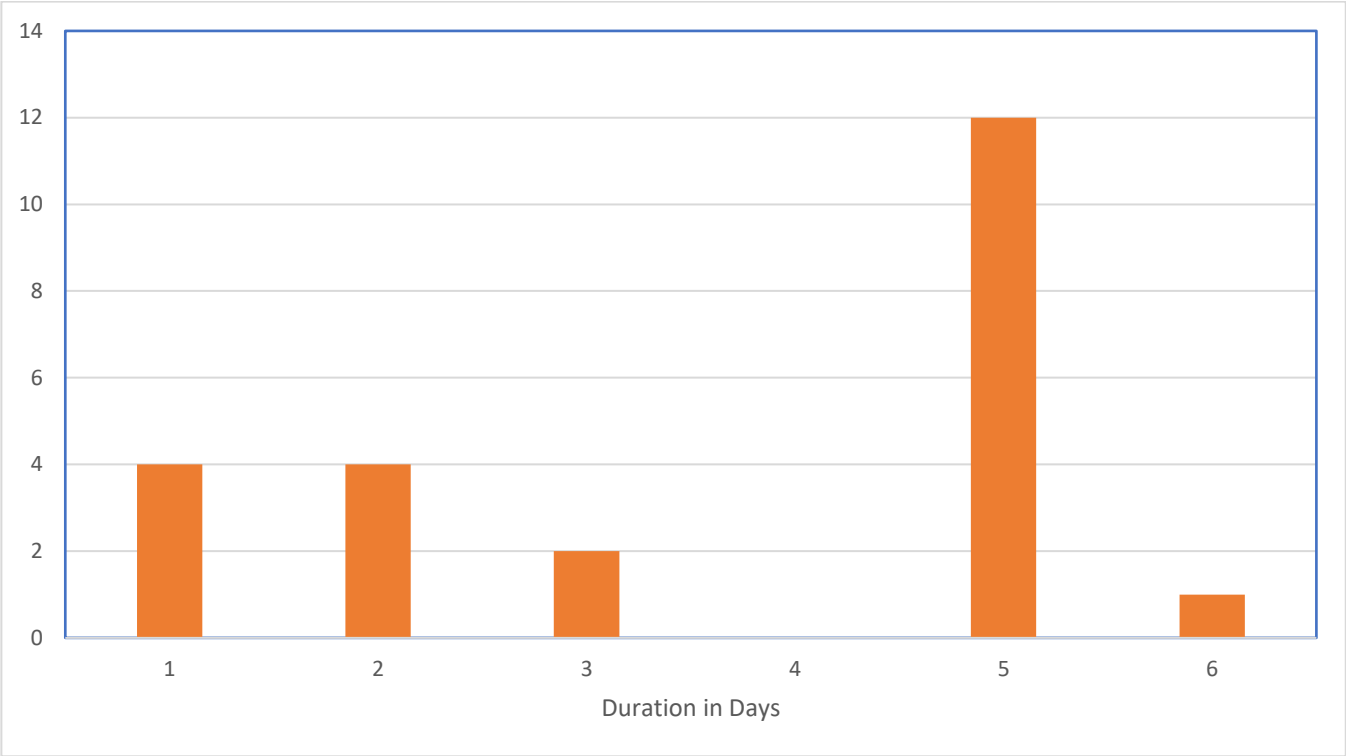

Figure 6 : Distribution of SLE implementation duration from 1 to 6 days
(dataset of 23 entries out of 105 SLEs)

Regarding the second category of 23 SLEs, the bar chart displays the distribution of durations measured in days, ranging from 1 to 6 days. The most frequent duration is 5 days, with 12 entries, showing cases for week-long engagements such as in summerschools. Both 1-day and 2-day implementations are moderately common, with 4 entries each. 3-day ones have a lower count of 2 entries, and 6-day durations are the least frequent with only 1 entry. Overall, the data indicates that short-term, week-long (5-day) projects are the most favored, likely due to their balance between depth and feasibility, while more brief durations with narrow scope are also present but less frequent.

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Open schooling level

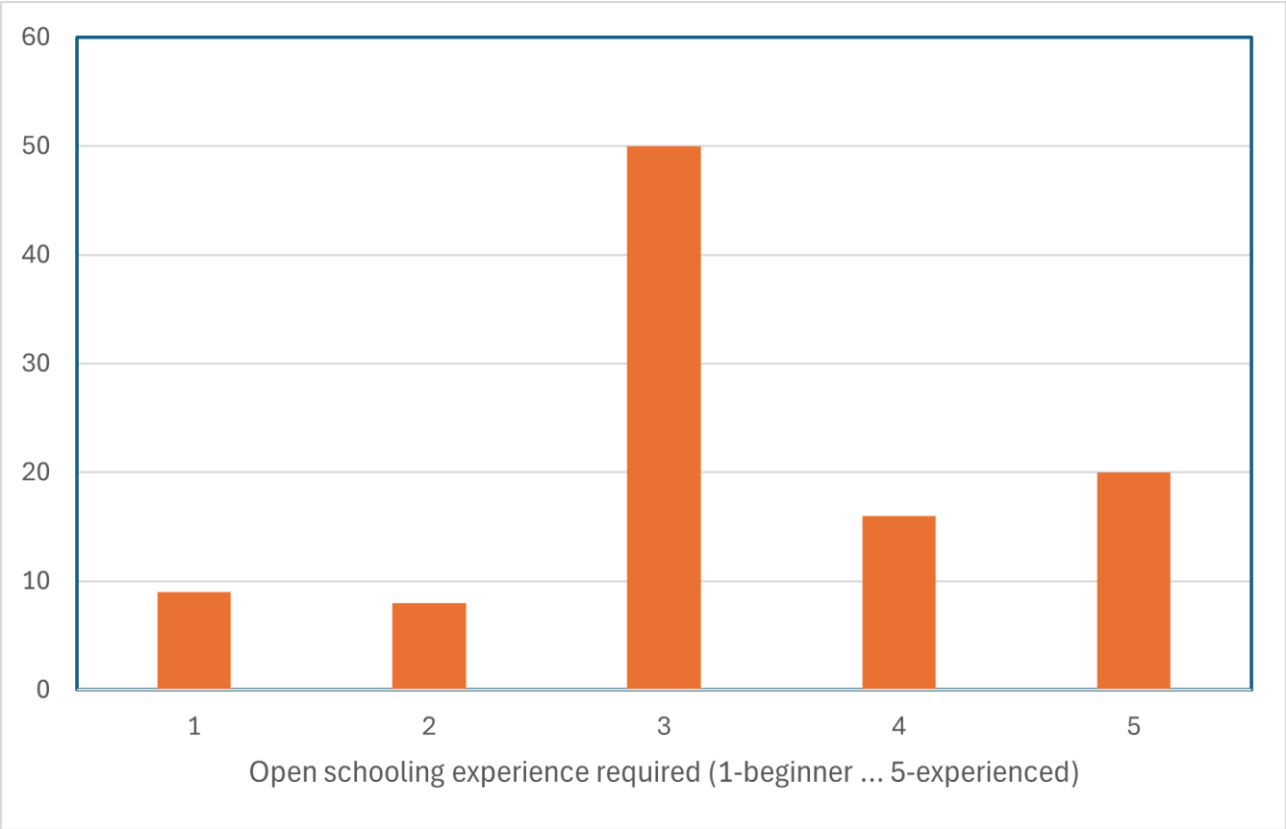

Figure 7 : Distribution of SLEs according to the level of open schooling experience required, range from 1 (beginner) to 5 (experienced)

The bar chart illustrates the levels of open schooling experience required, ranging from 1 (beginner) to 5 (experienced). The sample of entries covers the whole spectrum. The majority of SLEs implemented in mature phase, totaling 50, require or suggest a moderate level of experience (level 3), indicating a preference for individuals or organisations with some foundational knowledge in open schooling. Fewer SLEs demand either minimal or low experience, with approximately 9 and 8 cases requiring levels 1 and 2 respectively. Meanwhile, 15 SLEs call for level 4 experience, and 20 ones require the highest level of experience (level 5). Overall, the chart suggests that SLE's mature implementation phase as seen from the perspective of open schooling experience or level of requirements generally targeted or attracted the interest of participants, individuals or organisations, with some foundational knowledge but not necessarily expert-level experience.

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Thematic areas of interest

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

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

Interest Area	Number of SLEs	Description
Environmental & Sustainability Fields	**24**	**The most represented category, indicating strong emphasis on ecological, climate, and sustainability themes.**
Technology & AI	**22**	**High interest in modern tech, digital tools, AI, and innovation.**
Science & Health	**18**	**Includes natural sciences, life sciences and health related or focused activities.**
Education & Social Development	**15**	**Covers empathy, youth leadership, gender equality, and STEAM education.**
Engineering & Innovation	**10**	**Focused on practical applications in design, transport, energy, and infrastructure.**
Business, Policy & Global Development	**10**	**Involves financial literacy, global citizenship, SDGs, and policy.**

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Art & Communication	**6**	**Emphasizes creativity, science communication, illustration, and storytelling.**
Mathematics & Statistics	**4**	**Least represented; 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, which account for the highest number of interventions. 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. Notably, mathematics and statistics are the least represented, suggesting a potential area for future curriculum enhancement to support data literacy and analytical skills.

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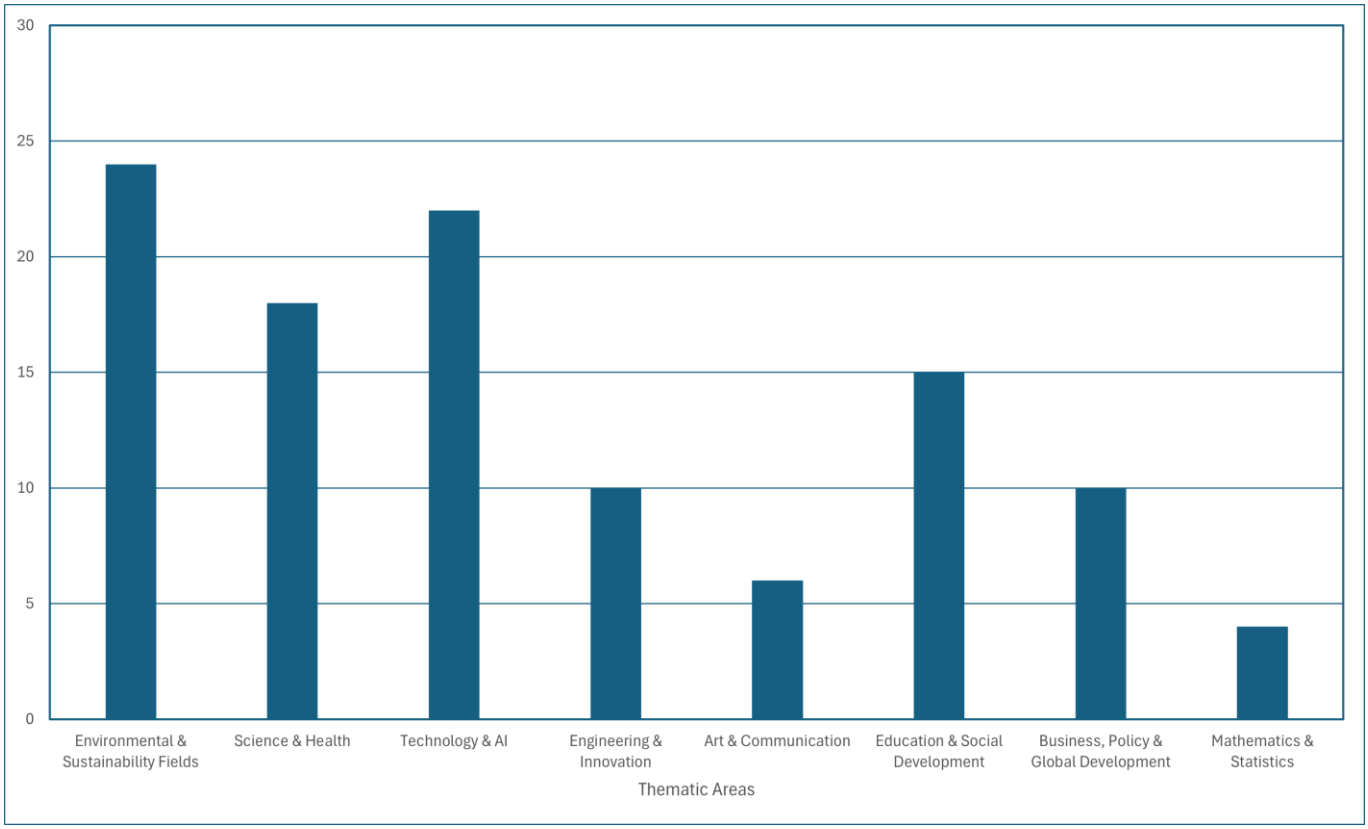

Figure 8 : Distribution of SLEs at the mature implementation phase across key thematic areas of interest

The bar chart above visually represents the number of SLEs categorized into the different thematic areas. As already noted the overall distribution reflects a clear shift toward interdisciplinary, future-oriented learning, with strong integration of environmental sustainability, technology, and social responsibility. The prominence of themes related to climate action, AI, and health indicates an educational focus on addressing real-world challenges and equipping learners with skills relevant to the green and digital transitions. The inclusion of creativity, communication, and global citizenship highlights a holistic approach that values both technical and human-centered competencies. Meanwhile, the relatively lower representation of mathematics and statistics suggests an opportunity to strengthen the integration of quantitative reasoning within broader STEAM frameworks. Collectively, the mature phase SLE activities point to an evolving educational landscape that prioritizes strong multidisciplinary and inclusive approaches where environment, science, health and technology intersect with general education and social themes to promote sustainability and drive future innovation.

1.1.2 Learning paths and interventions

The preparation and development of an SLE entails the pedagogical design and arrangement of learning paths and interventions tailored or adapted to the context of a specific learning scenario. A learning path is a structured and sequential arrangement of educational activities, content, and

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assessments, designed to guide learners toward achieving specific learning objectives or competencies. Learning paths facilitate progressive skill development by organizing instructional materials and learning resources in a logical flow, aligned to learners' prior knowledge, goals, or performance. Learning paths can also be customized in accordance with predefined curriculum frameworks or guidelines, local educational priorities or other circumstancial conditions and factors.

Types of learning paths

Various types of learning paths represent distinct structured approaches used to organize and deliver educational content designed to accommodate learner's needs, objectives, and progression style. Each type of learning path defines how content is sequenced and accessed, thereby facilitating flexible differentiated instruction, enabling adaptive teaching strategies, and supporting personalized learning experiences.

In our analysis of mature implementation phase SLEs we consider the following four types of learning paths: a) linear; b) modular, non-linear or iterative; c) multitargeted or interdisciplinary; d) exploratory inquiry-driven or research oriented.

Linear Learning Path: A linear learning path follows a fixed, sequential instructional model in which learners progress through content in a predetermined order. Each module or unit builds upon the previous one, and progression typically depends on the completion of prior steps and content understanding, ensuring foundational knowledge before advancing to more complex topics.

Modular Non-Linear Learning Path: A modular non-linear learning path consists of independent, self-contained units that learners can access in any order. This model provides maximum flexibility, allowing individuals to navigate content based on personal interest, engagement, prior knowledge, or immediate learning needs. This type of learning path can accomodate several branched subpaths that provide multiple routes through the content, based on the learner's choices, assessment results, or predefined roles. This model supports differentiated instruction by adapting to individual learning preferences or outcomes. Due to its dynamic and flexible nature, it can also accommodate iterative learning approaches, wherein content, skills, or concepts are revisited at multiple stages throughout the learning process, each time with greater depth and complexity. This approach is grounded in the principles of reinforcement and progressive refinement, enabling learners to build upon prior knowledge through repeated exposure, reflective engagement, and ongoing feedback.

Multitargeted or Interdisciplinary Learning Path: A multitargeted or interdisciplinary learning path is designed to address multiple learning objectives, skill sets, or competency areas simultaneously within a single, cohesive learning experience. Unlike traditional linear paths that focus on a singular outcome, multitargeted paths integrate various educational goals allowing learners to progress toward several targets concurrently. A multitargeted learning path is characterized by several distinctive features. It aligns learning activities with multiple objectives, addressing various competency domains such as critical thinking, communication, and subject-matter expertise within a single framework. The content is often integrated, combining interdisciplinary or cross-functional knowledge areas within the same

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learning modules to promote a holistic understanding. This approach also emphasizes learner-centric flexibility, offering adaptive pathways that accommodate individual goals and progression styles.

Exploratory, Inquiry-Driven, or Research-Oriented Learning Path: An exploratory, inquiry-driven, or research-oriented learning path is a learner-centered educational approach that emphasizes active investigation, critical thinking, and knowledge construction through exploration and problem-solving. Rather than following a fixed sequence of content, this type of learning path encourages learners to pose questions, conduct research, and pursue lines of inquiry based on curiosity, relevance, or real-world problems. The path is flexible and non-linear, allowing for discovery and iterative refinement of understanding. Learners take an active role in shaping their learning trajectory by formulating questions and seeking answers. The focus is on the development of skills such as hypothesis generation, data analysis, synthesis, and evidence-based reasoning, often situated in authentic or real-world contexts to enhance relevance and engagement. Moreover, as a learning path or approach, it provides extensive opportunities for mentorship, wherein educators, subject-matter experts, or external stakeholders serve as facilitators or guides, offering ongoing support, access to resources, and constructive feedback throughout the learning process.

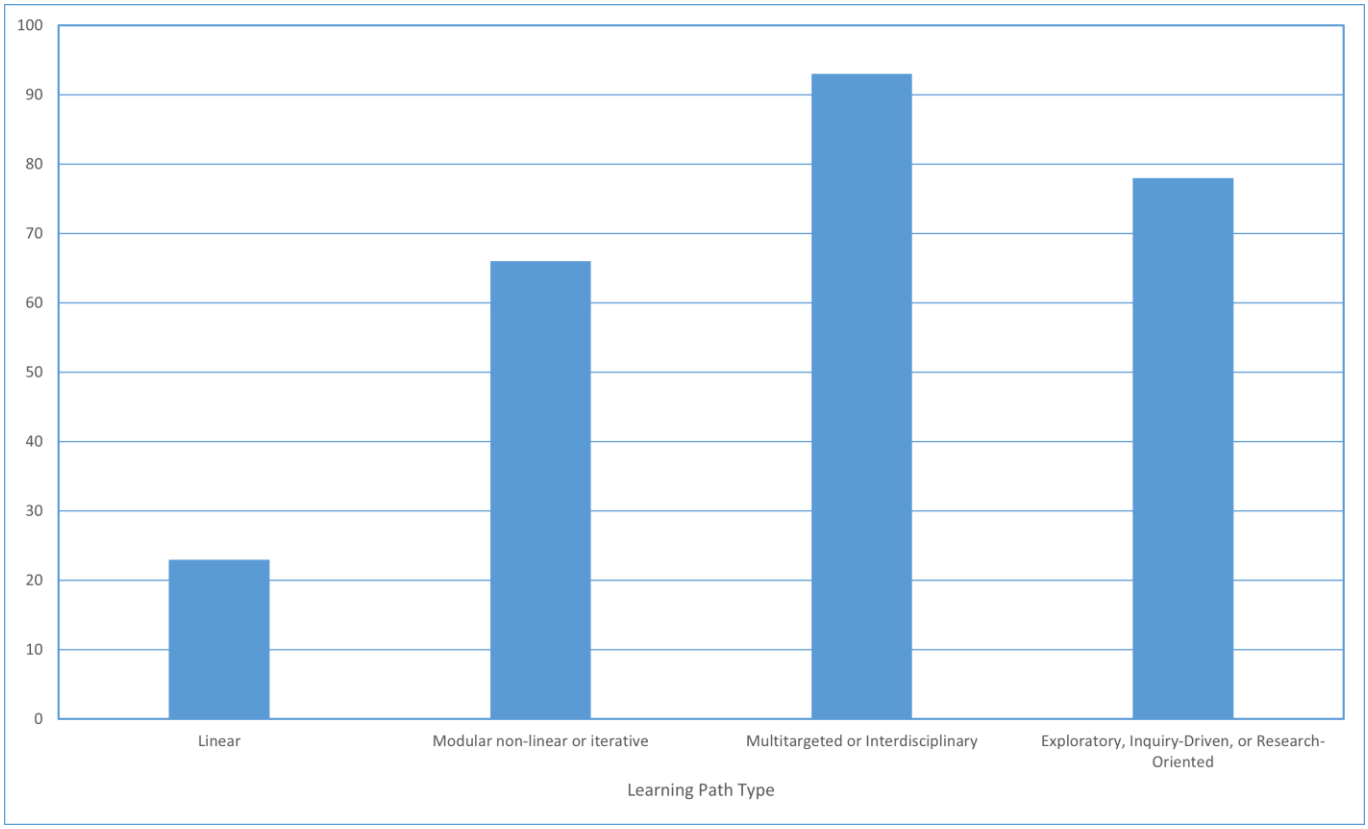

Figure 9 : Categorisation of learning paths in mature implementation phase SLEs

The bar chart presents the distribution of various types of learning paths, derived from the analysis of submitted learning scenarios implemented during the mature phase of the project. The Linear Learning Path type registers the lowest value, approximately 25, indicating comparatively limited adoption or alignment with contemporary educational priorities. In contrast, the

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Modular Non-Linear or Iterative Learning Path demonstrates a substantially higher value of around 65, reflecting increased recognition of its flexibility and capacity for personalized learning progression. The Multitargeted or Interdisciplinary Learning Path emerges as the most prominent, with a value nearing 93, suggesting strong institutional or pedagogical preference for approaches that address multiple competencies and integrate diverse domains of knowledge. Similarly, the Exploratory, Inquiry-Driven, or Research-Oriented Learning Path type scores approximately 80, underscoring its relevance in fostering critical thinking, independent inquiry, and research-based skill development.

Overall, the chart indicates a marked shift from rigid, sequential learning structures toward more flexible, dynamic, learner-centered, and contextually adaptive educational pathways. This trend aligns well with SLEs vision, objectives and pedagogical framework that emphasized interdisciplinary integration, inquiry-based learning, and the cultivation of higher-order cognitive skills.

Learning paths' influence on learners' interest and motivation towards science studies and careers

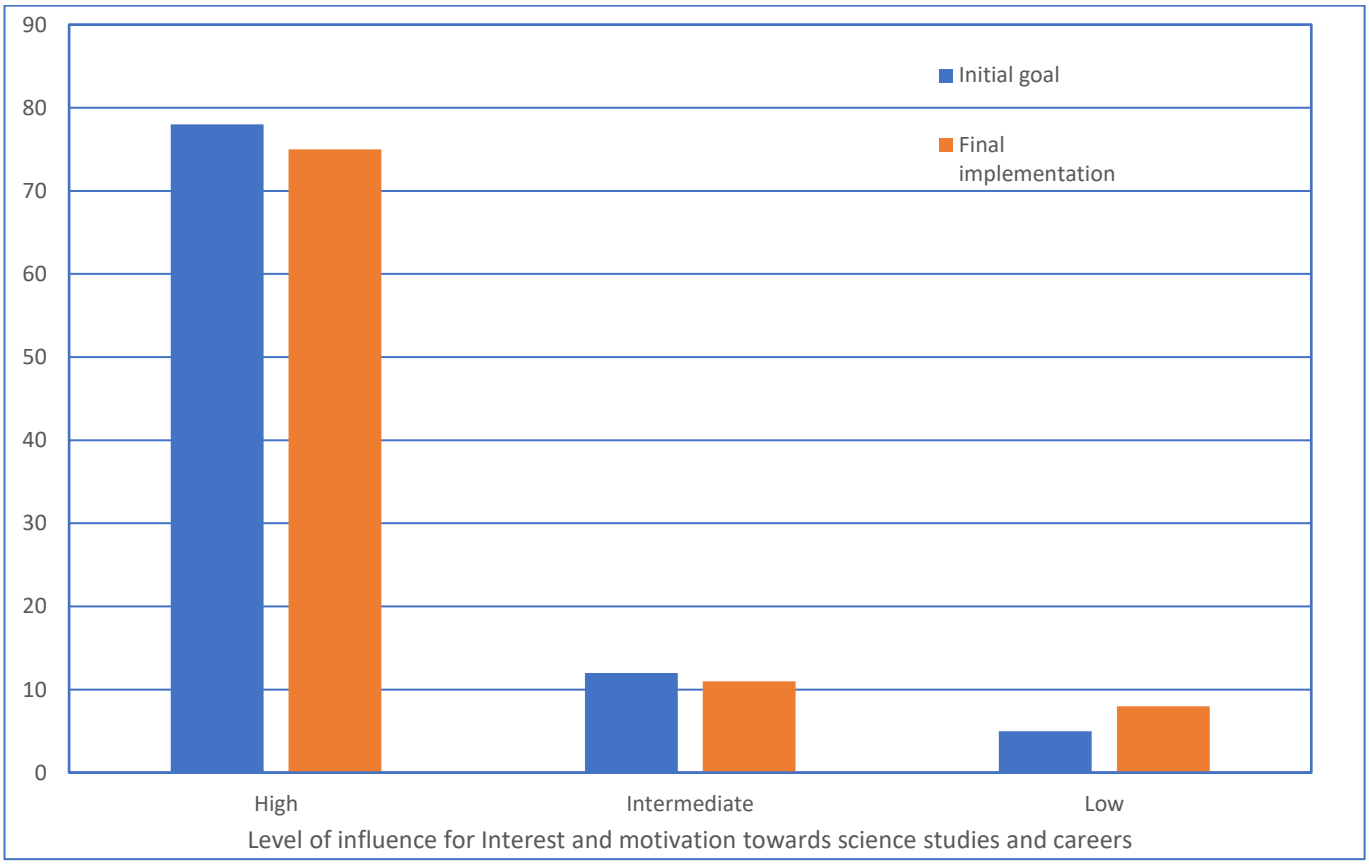

Figure 10 : Initial design goals and final mature phase implementation outcomes regarding the level of learning paths' influence on students' interest and motivation towards science studies and careers

The bar chart compares the initial design goals and final implementation outcomes regarding the level of influence on students' interest and motivation towards science studies and careers. The categories of influence are divided into High, Intermediate, and Low. The chart shows that the majority of influence was expected to be in the High category, with an initial goal of about 78, while the final implementation slightly decreased to approximately 75, still indicating a strong outcome. For the

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Intermediate level, the figures remained close, with the initial goal at around 12 and the final result just below that. In contrast, the Low influence category saw a slight increase, rising from about 6 in the initial goal to 8 in the final implementation. Overall, while there was a minor decline from the original targets, the final results show that the learning paths along the mature implementation phase SLEs was largely successful in achieving high levels of influence.

Gender balance strategy along learning paths of SLEs

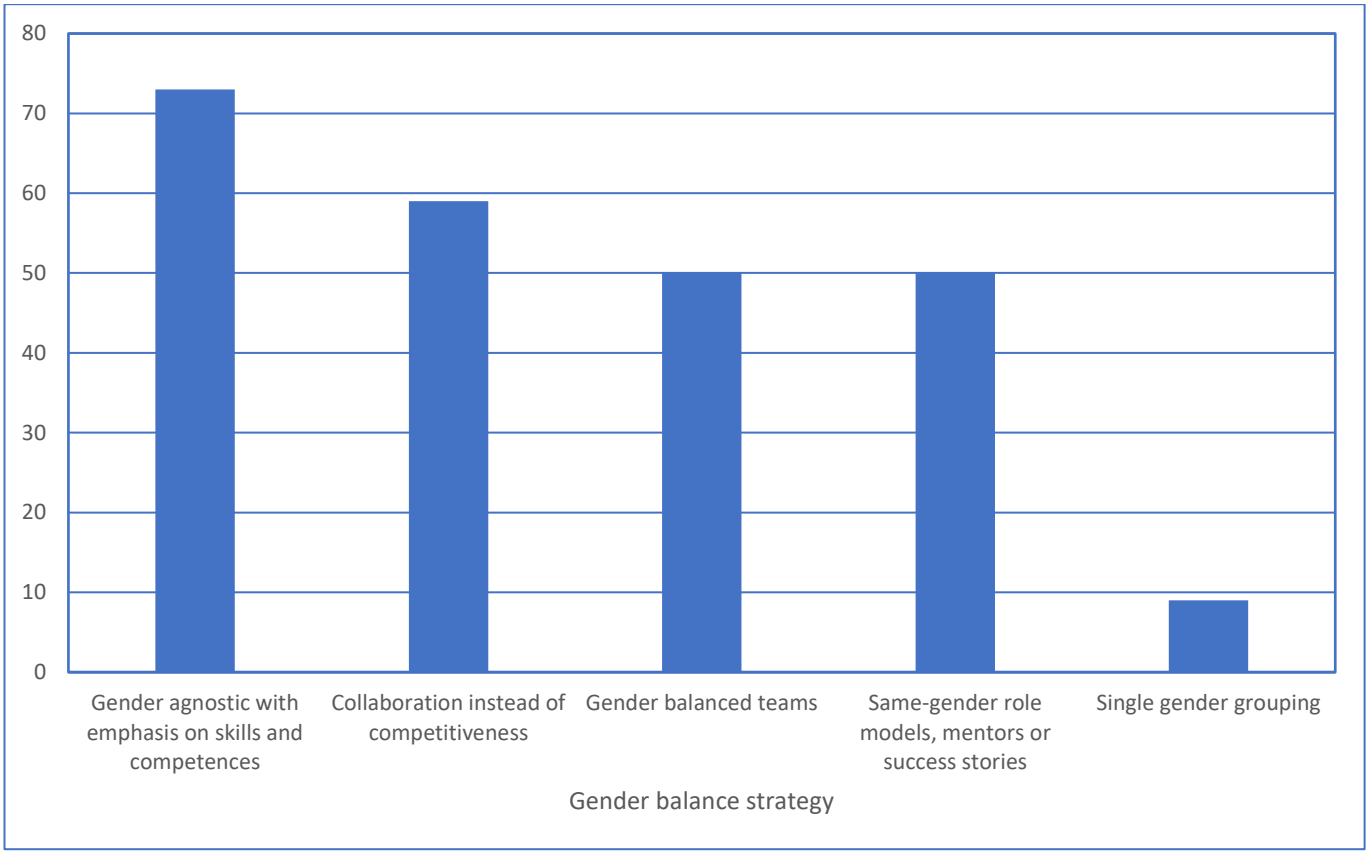

Figure 11 : Gender balance strategy used along learning paths of mature phase SLEs

The bar chart presents various strategies aimed at promoting gender balance, highlighting their relative emphasis or frequency of use in the learning paths of SLEs. The most favored strategy is being gender agnostic with an emphasis on skills and competences, with a value of approximately 73. This is followed by the promotion of collaboration instead of competitiveness at around 59. Three strategies, gender balanced teams, same-gender role models or mentors, and showcasing success stories, each share a similar level of importance at 50. In contrast, single gender grouping is the least preferred strategy, with a significantly lower value of about 9. These results suggest a clear trend toward inclusive and integrative approaches that prioritize ability and cooperation over gender-based separation in learning activities.

Formation of learners along learning paths of SLEs

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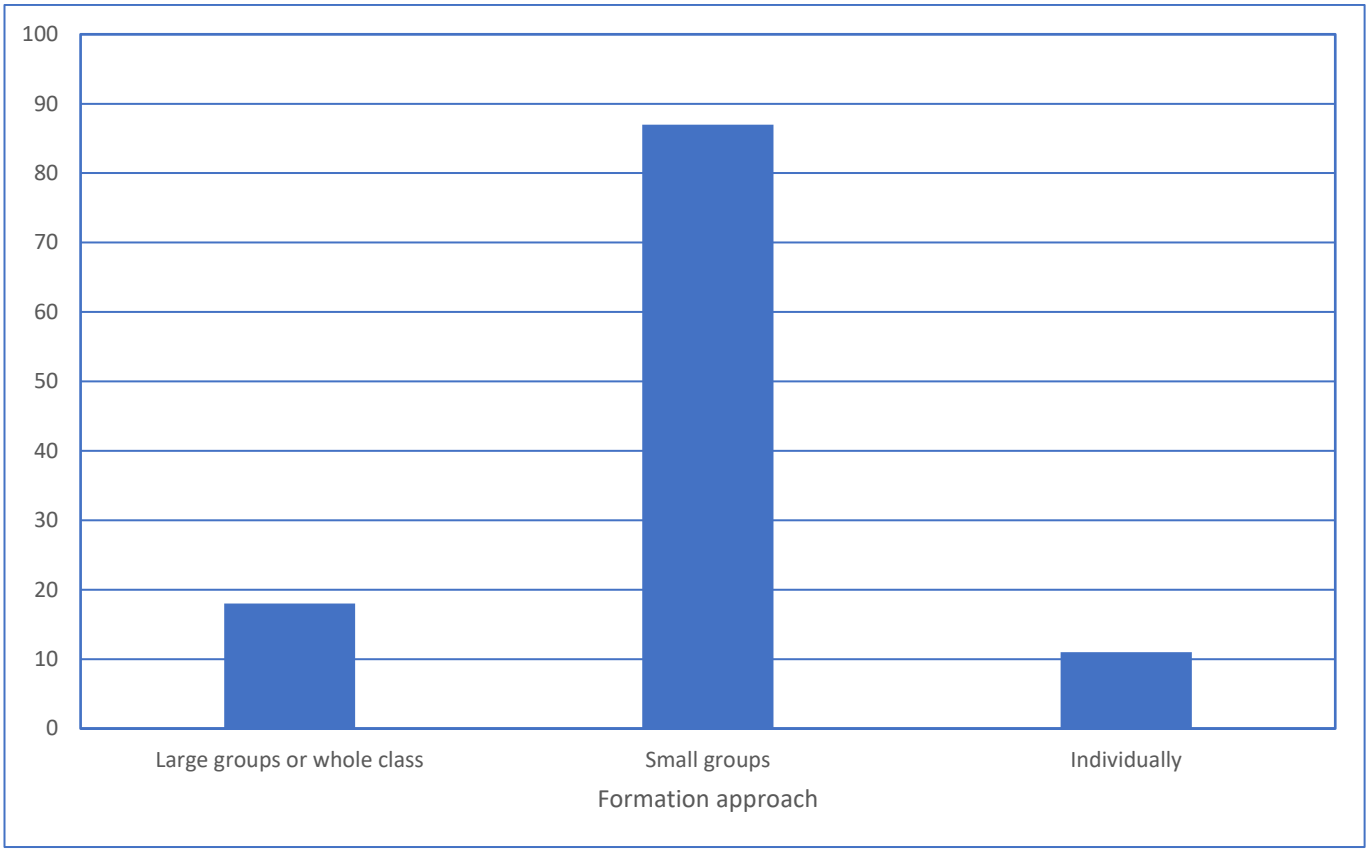

Figure 12 : Formation of learners during the various learning paths of mature phase SLEs

The bar chart illustrates the preferred formation approaches in a given educational or training context along the learning paths of mature phase SLEs, categorized into Large groups or whole class, Small groups, and Individually. The data clearly shows that the most favored approach is working in small groups, with a significantly high value of approximately 88. In contrast, formation in large groups or as a whole class accounts for only about 18, while individual formation is the least common, at around 11. This suggests a strong preference for collaborative learning environments where participants engage in smaller, more interactive settings, promoting greater participation and deeper learning.

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Role of stakeholders along learning paths of SLEs

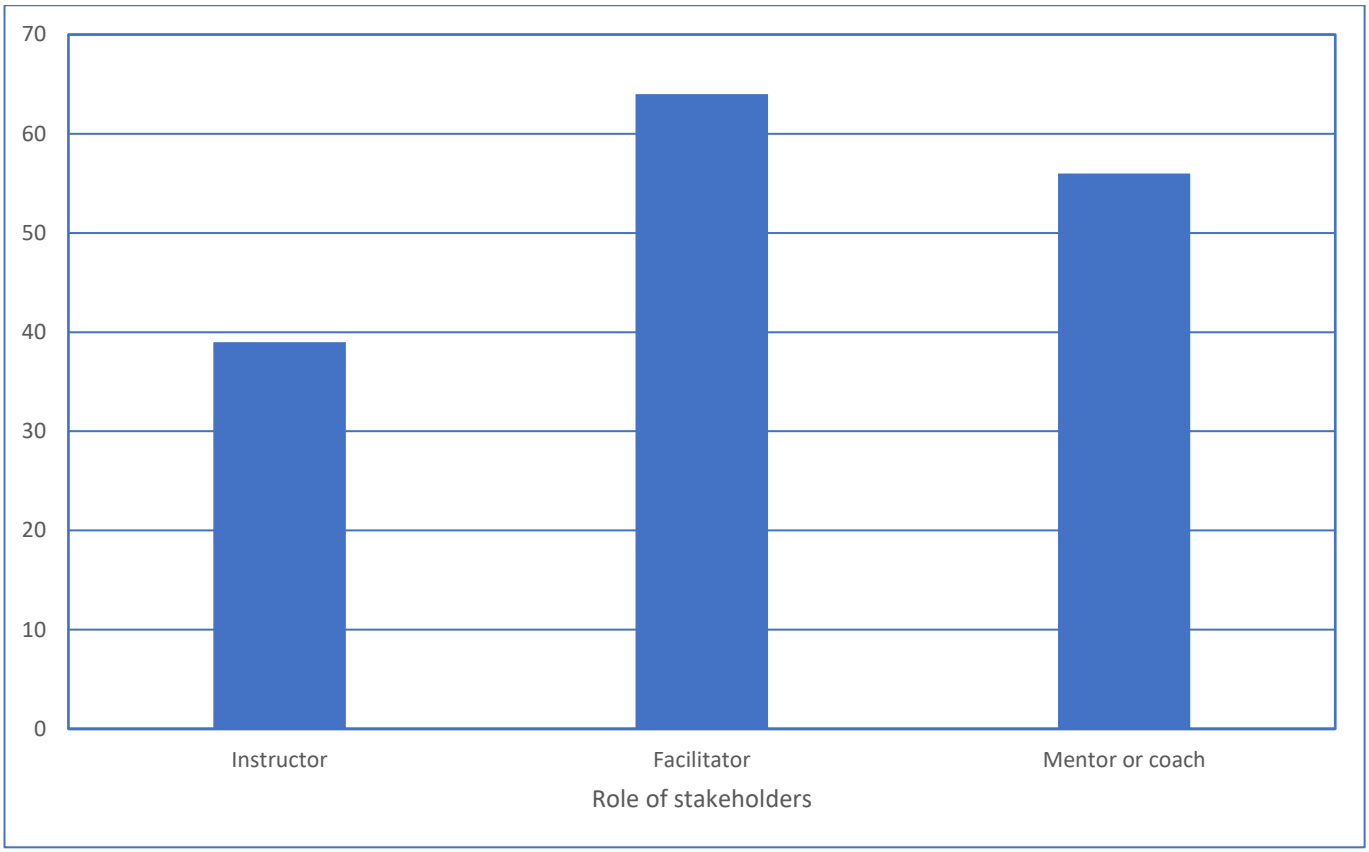

Figure 13 : Prominent role among stakeholders, categorized as Instructor, Facilitator, and Mentor or Coach, along learning paths of mature phase SLEs

The bar chart illustrates the roles of stakeholders in a particular context, categorized as Instructor, Facilitator, and Mentor or Coach. The data indicates that the most prominent role among stakeholders is that of the Facilitator, with a value of approximately 64. This is followed by the role of Mentor or Coach, which stands at around 56. The least represented role is that of the Instructor, with a value of about 39. These findings suggest that stakeholders are more frequently engaged in guiding and supporting roles throughout the various learning paths of SLEs implemented during the mature phase, such as facilitating and mentoring, rather than direct instruction. This trend reflects a shift toward more collaborative and co-creative approaches in stakeholder engagement in line with the initial vision, design and implementation strategy of the SLE project.

Types of interventions

Educational interventions are targeted strategies used to guide and support learners along the learning paths of an SLE. These actions can be driven by systematic observations and assessment data, bound by time or curriculum flexibility, designed to close learning gaps, reinforce skills, ease the transition to more complex topics or improve learners overall concept and content understanding. Effective interventions usually follow a structured process identifying students in need through

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assessments or observation, planning specific support strategies, implementing them consistently, monitoring progress, and adjusting as necessary.

In our analysis of mature implementation phase SLEs we consider the following four tier categorisation scheme of interventions: a) instructional; b) supportive; c) adaptive; d) personalized.

Instructional Interventions: These are targeted actions designed to help learners master specific skills or concepts. They facilitate learning by modifying how content is delivered such as through smaller group instruction, guided practice, or additional time on task. They are often short-term and progress-monitored, aiming to bring students up to the expected level of understanding in various subjects addressed in the learning paths. Typically, in this type of intervention, the existing learning resources remain largely unchanged or are minimally modified or adjusted.

Supportive Interventions: These interventions may focus on or additionally address non-academic factors that affect learning, such as emotional, behavioral, or social challenges. These interventions aim to create a stable and positive environment so students can better engage in learning. This may involve counseling or providing peer support to enhance the inclusion of students from underrepresented groups, supplying additional resources or incentives to improve participation.

Adaptive Interventions: These are flexible, responsive strategies that adjust over time based on learners' progress or changing needs or circumstances. These interventions may be guided by a structured decision-making framework, in which the type, intensity, or duration of support, including learning materials and available resources, is modified and adapted accordingly based on ongoing assessment of learners progress. As expected, they are often more demanding, and time consuming to prepare and implement, making them most effective when used with a small group of learners.

Personalized Interventions: Personalized interventions are tailored to the individual learner's strengths, preferences, pace, and goals. These strategies often use learner profiles or technology to deliver customized learning experiences that align with the student's unique needs and motivations. For example, by using an interactive learning platform that adjusts the difficulty and content of lessons or resources based on an individual's performance and interests.

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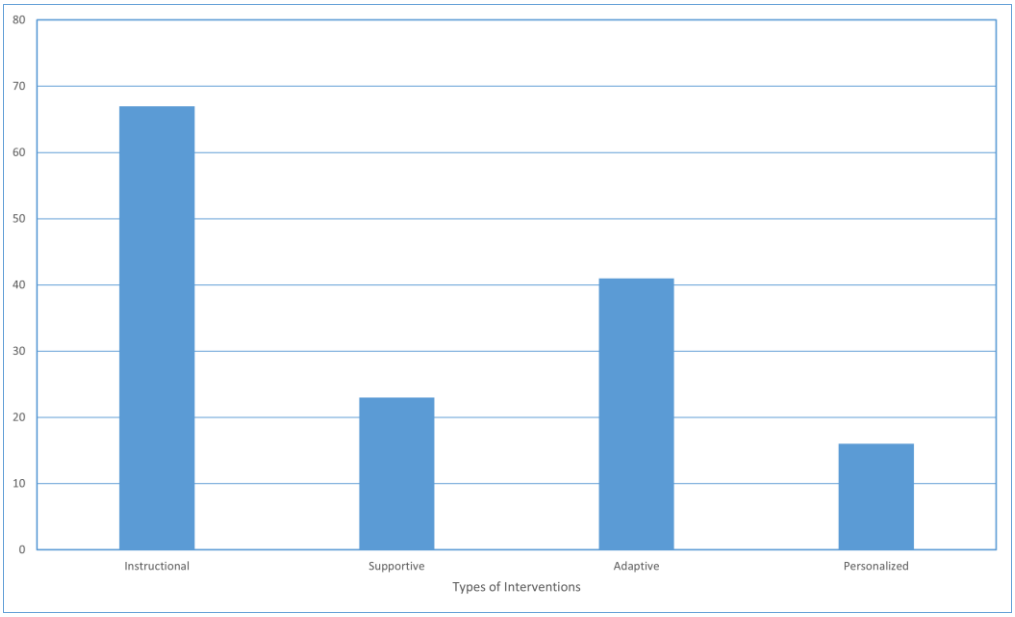

Figure 14 : Types of interventions along learning paths in mature implementation phase SLEs

Based on the analysis of the submitted learning scenarios from the mature implementation phase, the chart above depicts the relative focus or emphasis placed on the four types of educational interventions, instructional, supportive, adaptive, and personalized. Among these, instructional interventions are the most prominent, with a value of cases of approximately 67, indicating their widespread use in addressing academic learning needs. This likely reflects their direct alignment with curriculum goals and the ease of integrating them into standard teaching practices.

Adaptive interventions rank second, with a value around 41. These are moderately utilized and reflect growing recognition of the need for more flexible, data-driven learning environments or assessment-informed approaches that adjust based on learners' progress. Supportive interventions, which focus on emotional, behavioral, and social needs, are used less frequently, represented by a value of about 23, highlighting a smaller but still notable focus on social and inclusive support. This may be due to the additional personnel or specialized resources they require.

Personalized interventions are the least common, with a value close to 16. While highly individualized and potentially impactful, their lower usage may be attributed to the time and resource demands involved in tailoring instruction to each learner's unique profile. Overall, the chart suggests a strong preference for academically focused interventions, with more individualized and holistic support being applied less frequently, possibly due to practical constraints and their more resource-intensive nature.

Relevant professions and careers highlighted in learning paths and interventions

The in-depth analysis of learning scenarios in mature-phase SLEs, along with descriptions of learning paths, stakeholder roles, and their interventions, provides insight into the relevant professions and career pathways emphasized through various educational activities. Table 2 presents a summary of the identified relevant professions and career pathways. The table provides a comprehensive mapping

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of broad thematic and specific educational interest areas to relevant professional pathways, highlighting the broad interdisciplinary potential of STEAM-based learning. Careers range from traditional roles like physicist, biologist, engineer, and educator to emerging fields such as AI ethics specialist, creative technologist, and circular economy consultant. The environmental and sustainability domain offers pathways in renewable energy, marine biology, and green infrastructure, while science and health areas connect to fields like neuroscience, nutrition, and physical and digital well-being. Technology and AI-related activities open routes into software engineering, IoT, and data inetensive fields and careers, illustrating the demand for digital literacy. Engineering domains include not only civic, biomedical, electrical and automotive or aerospace engineering, but also renewables, green and smart systems. Creative storytelling intersects with social education, communication design, and media production. Social development themes foster careers in inclusive and equitable education, policy advising, and youth engagement, while business and global development emphasize innovation, financial education, and international collaboration. Lastly, mathematics and statistics underpin data-driven roles in research, analytics, and predictive modeling. Collectively, these connections showcase how integrated, real-world learning experiences, central to the SLE concept of learning ecologies, can prepare and equip students for a wide range of future-ready careers across scientific, technological, creative, and civic landscapes.

Table 2 : Overview of relevant professions and career pathways aligned with each thematic area of interest, as reflected in the learning paths and interventions of SLEs during the mature implementation phase

Environmental & Sustainability Fields	
Interest Area	**Relevant Careers**
Climate action, pollution, marine life, ecology	Environmental Scientist, Marine Biologist, Ecologist
Sustainable agriculture and food systems	Agronomist, Sustainability Consultant, Food Systems Analyst
Urban sustainability & green cities	Urban Planner, Landscape Architect, Green Infrastructure Specialist
Water and aquifers	Hydrologist, Water Resource Specialist
Waste reduction, recycling, circular economy	Circular Economy Specialist, Environmental Engineer
Environmental storytelling & education	Environmental Educator, Environmental Communicator
Sustainable fishing & aquaculture	Aquaculture Specialist, Fisheries Scientist
Renewable energy (solar, EVs)	Renewable Energy Engineer, Clean Energy Specialist
Science & Health	
Interest Area	**Relevant Careers**

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Natural phenomena	Physicist, Chemist, Biologist, Geologist
Life sciences & biology	Biologist, Microbiologist, Biomedical Scientist
Chemistry and materials	Chemist, Materials Scientist, Lab Technician
Neuroscience & physiology	Neuroscientist, Physiologist, Health Researcher
Health, diet & wellbeing	Nutritionist, Public Health Analyst, Wellness Coach
Air quality and pollution	Environmental Health Analyst, Atmospheric Scientist
Archaeology & paleoenvironments	Geoarchaeologist, Paleontologist, Heritage Scientist
Technology & Artificial Intelligence (AI)	
Interest Area	**Relevant Careers**
AI for SDGs and social good	AI Researcher, Data Scientist, AI Ethics Specialist
Robotics and automation	Robotics Engineer, Automation Specialist, Systems Engineer, Electrical Engineer
Internet of Things (IoT)	IoT Developer, Embedded Systems Engineer, Electrical Engineer
Game development & creative coding	Game Developer, Software Engineer
Computational thinking & simulation	Computational Scientist, Computer Engineer, Software Engineer
Digital creativity & entrepreneurship	Tech Entrepreneur, EdTech Innovator, Creative Technologist, Media Artist, Graphic Designer
Engineering & Innovation	
Interest Area	**Relevant Careers**
Engineering for health	Biomedical Engineer, Health Tech Developer
Aerospace and flight physics	Aerospace Engineer, Mechanical Engineer, Physicist
Green steel and sustainable materials	Materials Engineer, Metallurgist, Chemical Engineer, Operations Engineer
Smart systems & solar panels	Smart Grid Engineer, Solar PV Specialist
Structural design & transportation	Civil Engineer, Transportation Planner
Art, Communication & Creative Storytelling	
Interest Area	**Relevant Careers**

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Nature drawing & science communication	Scientific Illustrator, Science Communicator
AI-generated storytelling	Creative Technologist, Digital Storyteller
Educational filmmaking for social impact	Documentary Filmmaker, Educational Media Producer
Podcasting & STEAM media	Science Podcaster, STEAM Content Creator
Digital creativity	Creative Technologist, Multi-Media Artist, Graphic Designer, Product Designer
Education & Social Development	
Interest Area	**Relevant Careers**
STEM & STEAM education	STEM Educator, Curriculum Developer
Girls in tech and gender inclusion	Diversity & Inclusion Advocate, Gender in STEM Specialist
Youth leadership	SDG Educator, Youth Program Coordinator
Educational summer schools & camps	Program Manager, Informal Educator, Camp Director
Emotional intelligence & empathy	School Counselor, Educator, Community Facilitator, Psychologist, Sociologist
Business, Policy & Global Development	
Interest Area	**Relevant Careers**
Financial education through tech	FinTech Analyst, Financial Educator
Innovation and enterprise	Innovation Strategist, Product Manager, Business Administrator, Economist
Policy for sustainable development	Sustainability Policy Advisor, SDG Consultant, Economist
Inclusive AI and public services	Public Sector Technologist, Digital Inclusion Strategist
Global education and development	International Development Specialist, NGO Program Manager
Mathematics & Statistics	
Interest Area	**Relevant Careers**
Maths education and research	Mathematician, Statistician
Numerical data processing and algorithms	Mathematician, Statistician, Data Scientist, Software Engineer
Predictive analytics and insurance	Actuary, Statistician, Data Scientist, Software Engineer

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1.2 Mature implementation phase survey

1.2.1 Analysis and results

The objective of the survey is to facilitate a comprehensive systematic assessment and detailed review of the mature phase SLEs which were implemented across multiple countries and varied settings. The feedback and insights gathered through the survey analysis serve as valuable cross-validation, allowing data and findings to be verified with other sources and complementary feedback mechanisms, including reflection workshops, focus groups, interviews and consortium meetings. Additionally, this information has been instrumental in shaping key recommendations and future guidance on best practices emerging from the SLE project.

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 was launched in Apr 2025, i.e. near the end of the mature phase, and responses were collected until end of Jun or soon after the completion of each SLE. In total 95 completed questionnaires were collected.

There are ten main 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.

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?

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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?

In the following we present in tabular form the quantitative results of the mature phase survey based on a total of 95 submitted entries out of 105 implemented SLEs. The level of agreement to each statement or observation is quantified by a score indicator in scale from 1 to 5 corresponding to the following 5: strongly agree; 4: agree; 3: neither agree nor disagree; 2: disagree; 1: strongly disagree. For each focus area we then discuss briefly some important consolidated remarks.

Table 1. Results from mature phase project end. N=95

Q1 - General Aims and Objectives: Towards which skills or transversal competencies are students oriented in the SLE?	1	2	3	4	5
Creativity and innovation					4.56
Critical thinking and problem solving					4.57
Communication and collaboration					4.57
Literacy in ICT and new technologies				4.23	
Independence, initiative and self-direction				4.24	
Deconstruction of gender stereotypes				3.87	
Ownership of results/achievements				4.34	
Leadership and responsibility				4.40	
Exposure to real-life situations and problems				4.49	
Interest and motivation towards science studies and science careers				4.38	

Concluding remarks: *there is very high agreement with respect to which skills or transversal competencies learners are oriented to throughout the activities in SLEs. These include not only creativity and innovation, critical thinking and problem solving, communication and collaboration, but also digital literacy, exposure to real-life problems, leadership and responsibility, interest and motivation towards science studies and careers.*

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Q2 - 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				4.45	
Students are able to start a design process to solve a given problem				4.22	
Students have advanced or improved their content and concept knowledge of STEAM curriculum topics				4.22	
Students are able to initiate or follow an inquiry process and actions towards a predetermined goal				4.29	
Students are able to reflect on or self-assess their learning progress, and have gained confidence and independence on acquiring knowledge and skills				4.28	
Students have improved or advanced their ICT and new technologies literacy				4.16	
Students have increased their interest and motivation towards science studies and science careers				4.26	
Students have improved or advanced on interdisciplinary and collaborative learning				4.46	
Students have improved or advanced on deconstruction of gender stereotypes				3.81	

Concluding remarks: *similarly to previous remarks there is also very high agreement with respect to what learners learned or can do after the completion of an SLE. These include improved critical and interdisciplinary thinking along with problem solving and collaborative learning, advancement in content and concept knowledge of STE(A)M topics, improved confidence and independence on acquiring knowledge. Deconstruction of gender stereotypes scored relatively lower which is consistent with the previous results, see Q1.*

Q3 - 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				4.12	
Makes explicit connections between specific content knowledge and educational activities				4.29	

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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				4.45	
Provides students step-by-step guidance during the educational activities				3.95	
Fosters creativity and problem-solving skills by being more like a mentor or coach instead of someone who will give all the answers				4.44	

Concluding remarks: *with respect to the role of stakeholders in SLEs there is strong agreement that this is more like a mentor or coach that fosters creativity and problem-solving skills in learners, and also an active facilitator who encourages learners' initiatives and reflection on outcomes. It is also important that they take into consideration learners' prior knowledge, competences, attitudes and beliefs, but also learning styles and experiences.*

Q4 - 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)				4.08	
When the same educational activity is implemented in whole-class			3.35		
By promoting team working and collaboration in small groups				4.47	
By emphasizing students to work individually and independently			3.16		
By providing interaction and interdisciplinary collaboration opportunities among students of different skills and competences				4.41	
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				4.35	
When educational activities take place in classroom or in school environment				3.62	

Concluding remarks: *learners are better learning in diverse environments that promote team working and interdisciplinary collaboration in small groups, and when they are offered flexibility to choose their learning trajectories according to their preferences and skills.*

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Q5 - 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				3.78	
By encouraging collaboration rather than competitiveness among groups or individuals				4.47	
By promoting tasks or team working with female-only groups			2.55		
By emphasizing students to work in gender balanced teams				4.20	
By providing interaction and collaboration opportunities with female role models/mentors				4.02	
By offering educational activities that put emphasis on skills and competences and not on gender					4.56

Concluding remarks: *increase of female participation and deconstruction of gender stereotypes can be achieved: by offering learning activities that put emphasis on skills and competences and not on gender; by encouraging collaboration rather than competitiveness among individuals or groups; and by emphasizing students to work in gender balanced teams, placing girls in leadership positions, along with providing learners with same-gender mentors, role models and success stories.*

Q6 - What have educators learned or what are they able to do after completing the educational activities of the pilot SLE?	1	2	3	4	5
The experience of designing and implementing the SLE significantly contributes to the professional growth and development of educators, supporting the adoption of innovative STEAM teaching methodologies.					4.59
SLEs helped educators to effectively integrate SLEs principles into their everyday teaching practices also in the future				4.43	
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					4.56
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.					4.63

Concluding remarks: *with respect to schoolteachers, and in general educators, the experience of implementing an SLE significantly contributes to their overall professional development. This is done by supporting the adoption of innovative teaching methodologies and by improving teaching practice*

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and quality with resources, interaction and collaborative engagement with other colleagues and stakeholders.

Q7 - How is the current policy framework in your context 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		2.49			
The public administration (at any level) supports the adoption of initiatives linked to interdisciplinarity and STE(A)M				3.65	
The public administration (at any level) supports the adoption of initiatives linked to multistakeholder partnerships in education				3.59	
The equipment, infrastructures and/or setting available was supporting for the implementation of this activity				4.04	
The administrative or bureaucratic burden on the stakeholders has not been an obstacle for the implementation of this initiative				3.72	

Concluding remarks: *current policy frameworks at national or local level may differ from country to country and may be more supportive or less restrictive regarding the implementation of SLEs or similar initiatives. Overall, the trend is towards supporting the adoption of initiatives linked to interdisciplinarity, STE(A)M and multistakeholder partnerships in education.*

Q8 - Which of the following challenges have you encountered in implementing your pilot SLE?	1	2	3	4	5
Lack of understanding around STE(A)M education		2.07			
Lack of teacher training		2.14			
Lack of time for preparation and collaboration between stakeholders			2.63		
Lack of resources			2.52		
Difficulty to approach and connect to appropriate stakeholders		2.26			
Curriculum constraints			2.51		
Policy and institutional constraints		2.47			

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Concluding remarks: *on the matter of challenges encountered there is difference from country to country, therefore above average numerical results tend to favour a neutral point. However, considering overall the compilation of comments written in the open space for this focus question along with qualitative feedback during co-creation, community and reflection workshops, the reality is that common challenges often stated include curriculum and time constraints, along with lack of resources or institutional constraints. Less of a challenge seems to be understanding around STE(A)M education, teacher training or approach of appropriate stakeholders.*

Q9 - How effective were the collaborative efforts between stakeholders (e.g., educators, administrators, policymakers, community members, industry partners) in planning and implementing the SLE?	**1**	**2**	**3**	**4**	**5**
The collaborative efforts among stakeholders significantly contributed to the success of the SLE					4.51
Stakeholder collaboration enhanced resource-sharing, expertise exchange, and support for innovative educational approaches					4.52
Collaboration fostered a sense of ownership and commitment among stakeholders towards the goals of the SLE				4.33	
Challenges in establishing or maintaining partnerships with other stakeholders impacted on the implementation and effectiveness of the SLE			3.09		
Partnerships with external entities helped ensure long-term sustainability, replication and growth of the SLE beyond the initial implementation phase				4.04	
We are willing to formalize this partnership and keep working together in the SLEs framework, also expanding it with the participation of other stakeholders				4.47	

Concluding remarks: *overall collaborative efforts between stakeholders were quite effective in planning and executing SLEs and contribute significantly to their smooth implementation and success. Well-established collaborations enhanced resource-sharing, exchange of expertise and support. They further promoted sustainability and scalability beyond the initial implementation phase and fostered a sense of ownership and commitment among stakeholders towards the mutual goals.*

Q10 - 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				4.35	

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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.				4.24	
Stakeholder partnerships facilitated access to diverse perspectives, resources, and opportunities for students' engagement STE(A)M learning and improvement of their competences.				4.38	
External partnerships fostered opportunities and provided students with new competences that support their careers in the sector (i.e. "doing like researchers", through role models etc.)				4.25	
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.				3.91	

Concluding remarks: *in accordance with previous remarks, see Q9, partnerships with external organizations or institutions substantially contributed to enriching learners' engagement and opportunities by providing resources, expertise, mentorship, development of key competences and access to specialized facilities and real-world learning experiences.*

1.2.2 Summary of concluding remarks

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.

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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 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.

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Key insights and recommendations

This section synthesizes the findings obtained through the comprehensive analysis of the general characteristics of mature phase SLEs, the in-depth analysis of their learning paths, interventions, including their pedagogical approaches, as well as the results of the quantitative survey instrument. The principal insights and corresponding recommendations for each analytical dimension are presented below.

Key insights and recommendations from SLEs general categorisation analysis

Insights

- **Target Learners:** Majority of activities focus on adolescents (12–18 years), mainly in lower and upper secondary education; younger children and young adults are less represented.
- **Group Size:** Most learning ecologies operate in small to medium groups (up to 50 learners), facilitating focused and manageable learning experiences.
- **Duration:** Projects tend to be short- to medium-term, with most lasting 1–3 months or a few days (e.g., week-long camps), reflecting feasibility within academic calendars.
- **Experience Level:** Implementers usually have moderate to high experience in open schooling, indicating a balance between accessibility for newcomers and advanced expertise.
- **Thematic Focus:** Strong emphasis on environmental sustainability, technology/AI, science and health, and social development themes; less emphasis on mathematics/statistics.
- **Interdisciplinary Approach:** Activities blend analytical and technical skills with creativity, empathy, and global citizenship, addressing real-world challenges like climate action and digital transformation.

Recommendations

- **Expand Age Inclusivity:** Develop more activities for younger children and young adults to broaden STE(A)M learning across age groups.
- **Maintain Manageable Group Sizes:** Continue prioritizing small to medium groups to ensure effective engagement and resource allocation.
- **Optimize Project Duration:** Favor short- to medium-length projects for feasibility while exploring opportunities for longer, deeper learning experiences.
- **Support Skill Development in Open Schooling:** Provide training to increase implementers' expertise, helping novices transition to higher experience levels.
- **Enhance Quantitative Literacy:** Increase integration of mathematics and statistics to strengthen data literacy within STE(A)M frameworks.

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- **Promote Thematic Diversity:** While sustaining focus on sustainability and technology, encourage inclusion of arts, communication, and business themes for well-rounded learning.
- **Foster Interdisciplinary & Real-World Connections:** Design projects that combine technical, social, and creative skills linked to real global issues and sustainable development goals

Key insights and recommendations from the analysis of learning paths and educational interventions

Key Insights

- **Learning Path Types:**
  - Most prominent: Multitargeted/interdisciplinary and exploratory/inquiry-driven paths, reflecting preference for flexible, learner-centred, and integrated approaches.
  - Moderate use: Modular non-linear/iterative paths, valued for adaptability and personalized progression.
  - Least used: Linear paths, indicating a shift away from rigid, sequential instruction.
- **Influence on Motivation:**
  - High impact on learners' interest in science careers, showing learning paths effectively motivate students.
- **Gender Balance Strategies:**
  - Emphasis on gender-neutral approaches focusing on skills and collaboration over competitive settings.
  - Balanced teams, role models, and success stories are moderately used; single-gender grouping is least favoured.
- **Learner Formation:**
  - Strong preference for small group work, promoting collaboration and deeper engagement.
  - Large groups and individual work are less common.
- **Stakeholder Roles:**
  - Predominantly facilitators and mentors/coaches, indicating supportive and guiding roles.
  - Direct instruction is less frequent, highlighting a shift to learner autonomy and co-creation.
- **Types of Educational Interventions:**
  - **Instructional interventions** dominate, reflecting a focus on mastering specific skills aligned to curricula.

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  - **Adaptive interventions** show growing use of flexible, data-informed support.
  - **Supportive interventions** addressing emotional/social needs are less common.
  - **Personalized interventions** are least used, likely due to resource intensity.
- **Career and Profession Linkages:**
  - Learning paths connect broadly to diverse careers across environmental sustainability, science, health, technology, AI, engineering, creative industries, social development, business, and data analytics.
  - This interdisciplinary integration prepares learners for future-ready, real-world professions.

Recommendations

- **Expand Use of Interdisciplinary and Inquiry-Based Paths:** Promote learning designs that integrate multiple competencies and foster curiosity-driven exploration, as these increase engagement and critical thinking.
- **Maintain and Enhance Flexible, Modular Approaches:** Support modular and iterative learning paths to allow personalization and accommodate diverse learner needs and prior knowledge.
- **Strengthen Gender-Inclusive Practices:** Continue emphasizing gender-inclusive strategies and collaboration-focused environments and increase visibility of diverse role models and success stories to inspire all learners.
- **Prioritize Small Group Collaborative Learning:** Design activities favouring small group work to enhance interaction, peer support, and active participation.
- **Promote Facilitator and Mentor Roles:** Encourage educators and stakeholders to adopt facilitation and mentoring roles that empower learner autonomy rather than direct instruction.
- **Increase Support for Adaptive and Personalized Interventions:** Invest in resources and training to enable wider implementation of adaptive and personalized learning supports, balancing academic and socio-emotional needs.
- **Enhance Career Awareness and Integration:** Explicitly connect learning activities to real-world careers across STE(A)M fields, using these links to motivate learners and guide pathways into future professions.
- **Address Practical Constraints for Personalized Support:** Explore scalable technology solutions and collaborative approaches to overcome time/resource challenges in personalizing interventions.

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Key insights and recommendations from the survey questionnaire analysis

Key Insights

- **Transversal Skills Development:** Learners showed strong growth in creativity, critical thinking, collaboration, digital literacy, and leadership through SLE participation, accompanied by heightened motivation for science studies and careers.
- **Learning Outcomes:** SLEs foster interdisciplinary problem-solving, deeper STE(A)M content knowledge, learner confidence, and autonomy.
- **Role of Stakeholders:** Mentors and facilitators support creativity and reflection while adapting to learners' prior knowledge, skills, attitudes, and preferences.
- **Optimal Learning Environments:** Collaborative small-group settings combined with flexible, personalized learning paths best support learner engagement and development.
- **Gender Balance Strategies:** Effective approaches include focusing on competencies rather than gender, promoting collaboration over competition, using gender-balanced teams, and providing same-gender mentors and role models to boost female participation.
- **Educator Development:** Teachers benefit from professional growth via innovative pedagogies, peer collaboration, and shared resources within SLEs.
- **Policy and Challenges:** Although policies increasingly support interdisciplinary STE(A)M education and multi-stakeholder involvement, challenges remain around curriculum rigidity, time, and resources. Issues related to stakeholder engagement and teacher training appear less frequent.
- **Partnership Impact:** Collaboration with external organizations enriches learning by providing mentorship, real-world contexts, and specialized facilities, while enhancing institutional capacity and sustainability.

Recommendations

- **Sustain and Expand Transversal Skills Focus:** Continue prioritizing creativity, critical thinking, collaboration, digital literacy, and leadership development within SLE activities.
- **Strengthen Learner-Centred, Flexible Learning Designs:** Promote small-group collaboration and personalized learning pathways tailored to individual learner profiles.
- **Enhance Gender-Inclusive Practices:** Maintain and broaden strategies emphasizing competence, collaborative activities, balanced teams, and gender-specific mentoring to address participation gaps.
- **Support Educator Professional Development:** Facilitate ongoing training in innovative STE(A)M pedagogies and foster communities of practice among educators.
- **Advocate for Policy Alignment and Resource Allocation:** Engage with policymakers to ease curriculum constraints and secure adequate time and resources for effective SLE implementation.

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- **Leverage Partnerships for Enriched Learning:** Cultivate and sustain collaborations with external stakeholders to provide authentic learning experiences and institutional support

Comprehensive summary of key insights and strategic recommendations

Key Insights

Learner Demographics and Group Dynamics

Most STEAM learning activities target learners aged 12 to 18, predominantly within lower and upper secondary education. Younger children and young adults are comparatively underrepresented, indicating an opportunity to broaden age inclusivity. Learning ecologies generally operate in small to medium groups, typically up to 50 learners, allowing focused, interactive, and manageable learning experiences. Project durations are mostly short to medium term, ranging from several days to three months, aligning with academic calendars and practical feasibility.

Thematic and Pedagogical Focus

Thematic emphases strongly favour environmental sustainability, technology and artificial intelligence, health sciences, and social development. Mathematics and statistics are less emphasized, suggesting a gap in quantitative literacy integration. Pedagogically, SLEs blend technical knowledge with creativity, empathy, and global citizenship, addressing real-world challenges such as climate action and digital transformation. Learning paths largely adopt interdisciplinary and inquiry-driven approaches, with modular and non-linear formats preferred over rigid, linear models. This flexibility supports personalized and exploratory learning that promotes critical thinking and learner autonomy.

Stakeholder Roles and Learning Environment

Facilitators and mentors predominantly guide learners, focusing on supporting autonomy and co-creation rather than direct instruction. This approach enhances learner engagement and reflective thinking. Small group collaboration is favoured, providing peer support and richer interactions, while individual or large group formats are less common. Gender balance strategies focus on gender-agnostic competencies and collaborative learning, with moderate use of balanced teams and role models. Single-gender groupings are rarely used.

Impact on Learners and Educators

Participation in SLEs significantly develops transversal skills such as creativity, critical thinking, collaboration, digital literacy, and leadership. These improvements correlate with increased learner motivation toward STEAM studies and career pathways. Educators also benefit professionally through exposure to innovative pedagogies, peer collaboration, and shared expertise. Despite variations in national and local policies, there is an encouraging trend toward supporting interdisciplinary, multi-stakeholder STEAM initiatives.

Challenges and Policy Environment

Curriculum constraints, limited time, and resource shortages remain key barriers to widespread SLE implementation. However, issues related to stakeholder engagement and teacher training appear less frequent, indicating progress in these areas. Strong partnerships with external organizations—

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providing mentorship, real-world contexts, and specialized facilities—are crucial for enriching learning experiences and sustaining institutional capacity.

Recommendations

Broaden Age Inclusivity and Thematic Diversity

Expand STEAM learning offerings to younger children and young adults, ensuring equitable access across age groups. Incorporate broader themes beyond environmental sustainability and technology, including arts, communication, and business, to cultivate well-rounded STEAM competencies.

Prioritize Small Group, Flexible Learning Designs

Maintain manageable group sizes to optimize engagement and resource allocation. Encourage modular, interdisciplinary, and inquiry-based learning paths that adapt to diverse learner needs, fostering curiosity and critical thinking.

Strengthen Gender-Inclusive Practices

Continue emphasizing competency-based, gender-agnostic approaches with collaborative rather than competitive activities. Increase visibility of diverse role models and success stories to inspire all learners, and foster gender-balanced teams and same-gender mentoring where beneficial.

Enhance Educator Professional Development

Support ongoing training in innovative STEAM pedagogies, open schooling methodologies, and facilitation skills. Foster communities of practice to promote peer collaboration and resource sharing.

Advocate for Policy Alignment and Resource Support

Engage policymakers to address curriculum rigidity and secure dedicated time and funding for STEAM open schooling. Promote frameworks that encourage interdisciplinary, multi-stakeholder educational initiatives.

Expand Adaptive and Personalized Interventions

Invest in scalable technology solutions and collaborative approaches to overcome challenges related to time and resources. Enable broader use of adaptive and personalized learning supports that balance academic and socio-emotional learner needs.

Leverage Partnerships for Sustainable Impact

Cultivate and sustain collaborations with external organizations to provide authentic learning experiences, mentorship, and access to specialized facilities. Partnerships are essential for enhancing learner engagement and institutional capacity for long-term sustainability.

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Summary

The mature phase of the STEAM Learning Ecologies project expanded and validated an inclusive, interdisciplinary approach to education across diverse contexts. Drawing on implementations from sixteen countries, the report details how SLEs bring together formal, non-formal, and informal education through dynamic, locally grounded learning ecosystems making STEAM education more engaging and connected to real-life challenges.

Analysis of the learning paths, interventions, and stakeholder feedback revealed strong engagement with themes such as sustainability, digital innovation, and social development. Most activities involved secondary education levels with learners aged 12–18 and favored small-group, multidisciplinary inquiry-based learning models. Most learning experiences encouraged students to take an active role, supported by teachers and mentors acting more as guides than traditional instructors. Facilitators supported learner autonomy, and the pedagogical focus blended technical, creative, and civic competencies.

The project demonstrated notable impacts on learners' transversal skills and educators' professional growth. However, systemic barriers, particularly curriculum inflexibility and limited resources, remain challenges to broader adoption.

Recommendations highlight the importance of expanding age and thematic diversity, promoting flexible and inclusive learning designs, enhancing teacher training, and strengthening policy support and partnerships.

The findings affirm that SLEs can be powerful tools for reimagining STEAM education, particularly when supported by responsive pedagogies, collaborative networks, and enabling policy environments.

In conclusion, STEAM Learning Ecologies demonstrate significant potential to develop critical transversal skills and motivate learners toward STEAM careers. Success hinges on flexible, learner-centered approaches, supportive facilitation, and inclusive strategies addressing gender and age disparities. Continued investment in educator development, policy advocacy, and strategic partnerships will be vital to overcoming persistent challenges and scaling effective STEAM open schooling initiatives.

References

The SLEs Concept White Paper, Deliverable D2.1 (2023)

The SLEs Methodology – First Version, Deliverable D2.2 (2023)

Partnership monitoring and reflection methodology, Deliverable D3.1 (2023)

Partnership co-creation and facilitation methods and learnings, Deliverable D3.2 (2024)

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Appendix – 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.
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

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			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 analyzed 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.
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 analyzing fossil otoliths from the eastern Mediterranean, particularly around Cyprus, students will investigate past ecosystem conditions, including temperature, salinity, and oceanic circulation. They will 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

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			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 behavior contributes to climate change and biodiversity loss, analyzing 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 time, to realise how special their home town or village really is, because it's different and unique in its own way.

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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 analyzing 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 pediatrician 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.
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

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			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, have the opportunity to 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.
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:

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			Creative thinking, design thinking and problem solving, financial and mathematic eductaion.
30	GERMANY	STEM Experience	In a practical workshops, 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.
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

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			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 general 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 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 neighborhoods 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 neighborhoods or areas in their city with the purpose of influencing or assisting the urban planning efforts of local municipalities.

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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.
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 general 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

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			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 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

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			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.
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.

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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 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.

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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.
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.

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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 Ghollieqa.
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.

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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 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	Physics in Aviation	During this SLE in conjunction with the post-secondary aviation institute, students explore the practical applications of physics in aviation. The visit includes demonstrations of aerodynamics in wind tunnels, insights into aircraft propulsion systems, conductivity in aircraft ,and discussions on flight mechanics. Participants observe how principles such as lift, thrust, drag, and gravity are integrated into aircraft design and operation. The experience provided a valuable connection between theoretical physics concepts and real-world aviation technology.

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71	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.
72	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 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.
73	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

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			accessibility, sustainability, and digital security. Deliverables included MVPs, project report, and stakeholder presentations.
74	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.
75	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.
76	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 awareness about road safety and environmental issues, while students engage in inquiry, empathy, creativity, and peer evaluation throughout the learning process.
77	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.
78	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.

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79	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.
80	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.
81	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 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.
82	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.

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83	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.
84	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.
85	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.
86	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

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			contribute to marine plastic pollution, encouraging greater awareness and responsibility.
87	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.
88	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.
89	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

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			consciousness, and encouraged active citizenship through storytelling and scientific exploration.
90	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.
91	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.
92	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.
93	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

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94	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.
95	SERBIA	Smart Growing: Controlled Plant Cultivation for a Sustainable Future	This SLE centers 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.
96	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.
97	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.
98	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.

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99	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.
100	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.
101	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.
102	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 transversally with other subjects and collaborative work. In addition, it has fostered creativity and critical thinking from a STEAM approach.
103	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
104	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.
105	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.

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Appendix – 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
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					

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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					
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					

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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					
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					

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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					
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

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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.					

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					

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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
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					

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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
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					

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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.)					

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.					

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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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