STEAM LEARNING ECOLOGIES

Policy developments and SLEs
Deliverable 5.1

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D5.1. Policy developments and SLEs			
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Executive Summary

This deliverable synthesizes the policy evidence, insights, and lessons learned from three SLEs Policy Briefs developed between 2023 and 2025. Together, these briefs trace the evolution of the STE(A)M Learning Ecologies (SLEs) project, from mapping the policy landscape for Open Schooling and STE(A)M education, through the implementation of pilot activities across 16 countries, to the identification of enabling conditions, barriers, and policy levers for scaling educational innovation in European education systems.

The policy analysis revealed substantial opportunities to embed SLEs principles within existing European and national frameworks. European strategies and frameworks have created a fertile environment for systemic transformation. At local level, the SLEs pilots showcased effective practices for gender inclusion, cross-sectoral collaboration, and student-centred learning. Teachers and external experts evolved from content deliverers to facilitators of inquiry and co-creation, while students assumed agency as problem solvers and active citizens. Successful pilots demonstrated that Open Schooling with a STE(A)M-based approach can complement curricular goals, enrich learning experiences, and strengthen civic participation as well as European citizenship values.

Despite these achievements, the project identified several persistent challenges limiting the institutionalisation of Open Schooling and STE(A)M education across countries: (i) Resource constraints: many pilots depended on temporary project funding, with limited administrative or infrastructural support to sustain activities beyond the funding cycle. (ii) Curriculum rigidity: dense syllabi and time constraints prevented the integration of interdisciplinary, project-based learning within regular class schedules. (iii) Policy fragmentation and limited recognition: a lack of coherent national frameworks and formal acknowledgment of teachers' work limit sustainability and motivation. (iv) Stakeholder coordination: multi-actor collaboration, while essential, often proved administratively complex, dependent on individual leaders, and vulnerable to discontinuity. (v) Digital ethics and governance: the growing integration of AI and digital tools in learning raised new challenges regarding data protection and responsible technology use.

Across the three policy briefs, a coherent vision emerged for advancing Open Schooling and STE(A)M education as drivers of educational innovation and inclusion in Europe. The evidence converges on eight priority areas for policy action and illustrates that Europe's transition toward inclusive, innovative, and resilient education systems depends on bridging the gap between pilot experimentations and systemic policy support.

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Table of contents

Funded by the European Union

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List of figures

List of tables

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1. Introduction and Context

1.1 The STE(A)M Learning Ecologies (SLEs) project

The STE(A)M Learning Ecologies (SLEs) project (2023–2025), funded by the European Union under the Horizon Europe programme (Grant Agreement No. 101094648), aims to transform science and STE(A)M education across Europe through the creation of dynamic learning ecologies: sustainable partnerships connecting schools with their wider local communities. At the heart of the project lies a transformative vision of education that places learners at the center of authentic, community-based challenges requiring integrated STEM problem-solving.

At its core, the project challenges the traditional model of schools as isolated institutions, envisioning them as open and dynamic hubs that actively collaborate with local ecosystems of actors. These ecosystems are sustained by partnerships among diverse stakeholders: formal and informal educators, civil society organisations, enterprises, research institutions, and public authorities. Together they form a « learning ecology » where knowledge, expertise and resources are exchanged continuously between members, enriching every participant and enabling collective problem-solving.

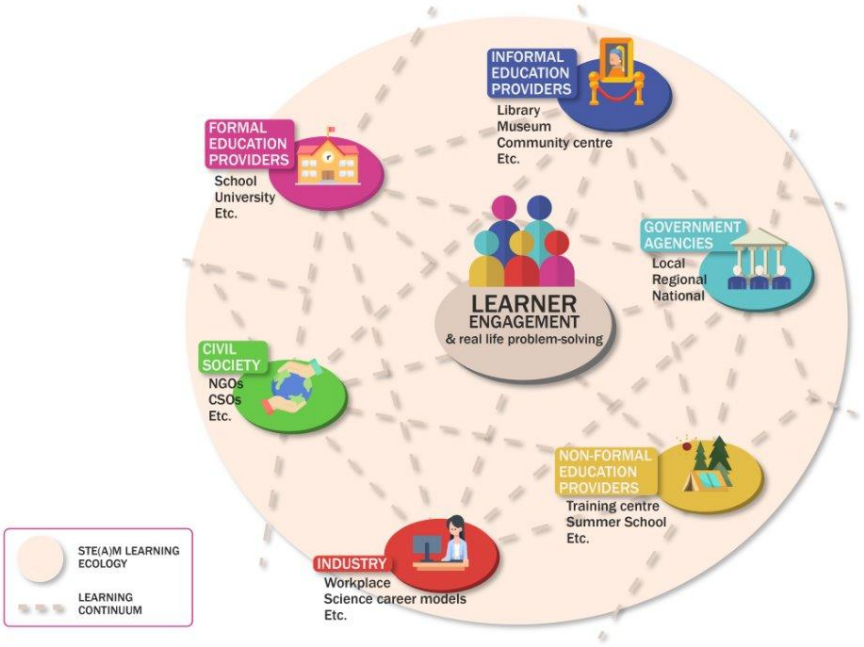

Figure 1 – STE(A)M Learning Ecology Approach

The SLEs methodology (see D2.2) integrates three interrelated dimensions:

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- **Open Schooling as the main pillar** and environment promoting partnerships between different societal actors and the local community, community engagement, access to shared knowledge, and participatory learning processes.
- **Living Labs approach as a key practice** that emphasizes the **central role of the user and the co-creation process,** experimentation and continuous co-design, enabling local adaptation and innovation through real-world feedback.
- **STE(A)M education** as an overarching approach across STEM subjects, the arts and all other non-STEM disciplines that can greatly increase interdisciplinarity, creativity, problem-solving, critical thinking, integration in school education and life-long learning, by engaging learners in real-life problem-solving situations.

Each SLE begins with a real problem grounded in the local community (e.g. an environmental issue, a social challenge, or a sustainability and/or technology concern) that demands the integration of disciplines for its resolution and an ecosystem of actors, beyond the school, working collaboratively. By situating learning within authentic contexts, students are then empowered to become co-creators of new knowledge and solutions.

Over **two implementation cycles** (October 2023 – May 2024 and October 2024 – June 2025), the project has successfully piloted and scaled more than **100** learning ecologies across 16 European and associated countries, directly engaging more than 4.000 learners and over 500 stakeholders of different types (see figure 2 below).

The consortium brings together **13** organisations, namely European Schoolnet (Belgium, coordinator), APRE (Italy), Ellinogermaniki Agogi (Greece), Humboldt University of Berlin (Germany), NTNU (Norway), the University of Cyprus, the Center for the Promotion of Science (Serbia), the Ministry for Education, Sport, Youth, Research and Innovation (Malta), the National University of Ireland Galway, WISTA (Germany), the European Network of Science Centres and Museums (ECSITE, Belgium), Centro Ciência Viva do Algarve (Portugal), and Museos Científicos Coruñeses (Spain).

The pilot activities have been implemented across different (partner and non-partner countries) in Europe, namely Cyprus, Germany, Greece, Ireland, Italy, Malta, North Macedonia, Norway, Portugal, Romania, Serbia, Slovakia, Spain, Sweden, and Turkey, addressing key topics such as environmental awareness, marine environment, arts and heritage, technology and Innovation, health and social awareness or STEM career orientation. The project also contributes to the wider *Open School for Open Societies (OSOS) network*, ensuring alignment with other Horizon Europe initiatives and facilitating the long-term dissemination of methodologies and tools.

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Figure 2: STE(A)M Learning Ecologies in numbers

1.2 Introduction and objectives of the document

This deliverable aims to bring together the collective evidence, reflections, and policy insights included in the **three policy briefs** that have been developed within the SLEs project by APRE, the Italian Agency for the Promotion of European Research and European Schoolnet (EUN) and which can be appreciated in their full version, as annexes at the end of this document.

Each policy brief captures a different phase of the SLEs evolution:

- In the first year, we mapped the European and national policy landscapes for Open Schooling and STE(A)M education, together with the potentials and benefits of open schooling in 12 countries (Policy Brief 1 - *STE(A)M Learning Ecologies (SLEs): Open Schooling For Science Education and a Learning Continuum For All*).
- In the second year, we connected this potential with insights from the 12 pilots, identifying the enabling conditions that support local implementation (Policy Brief 2 - *Strategic Support and Resources In STE(A)M Learning Ecologies*).
- In the third and last policy brief, we analysed the lessons learned, barriers and enablers from scaling 109 learning ecologies across 16 countries (Policy Brief 3 - *Scaling STE(A)M Open Schooling in Europe: Policy Lessons from SLE Pilots*).

Taken together, these outputs trace the trajectory of SLEs from theory to practice, and from pilot projects to systemic results. Building on this progressive learning cycle, the deliverable consolidates

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findings from all three briefs into a coherent synthesis and analysis, focusing specifically on the policy developments, opportunities and blockages in relation to SLEs, to show how open schooling can serve as a powerful, sustainable and cross-sectoral approach for renewing and transforming science and STE(A)M education in Europe.

The aim of this deliverable is fourfold:

a. To summarise the mapping of key policy developments and evolutions at both European and national levels in relation to STE(A)M and open schooling.
b. To highlight exemplary practices and enabling conditions emerging from local pilot implementations.
c. To identify the main obstacles and systemic barriers that emerged to implementing and scaling STE(A)M open schooling.
d. To point to targeted, evidence-based recommendations and ways forward for embedding these approaches into mainstream education systems.

By consolidating the accumulated insights and experiences of the three policy briefs, this deliverable acts as a bridge between the practical experimentation carried out in local schools and communities and the strategic policy environment that supports such experiences. This interplay between policy and practice is at the core of the deliverable, highlighting their mutually reinforcing nature. On the one hand, policy actions serve as structured tools to facilitate the implementation of innovative practices. On the other hand, practical experiences provide tangible evidence of where policies need reinforcement or adjustment, demonstrating gaps and opportunities that can inform future policy development. In this way, the project and its results situate itself within a broader continuum of educational transformation, linking grassroots innovation to evolving European policy agendas on education, skills, sustainability, and inclusion, and underscoring the dynamic and cyclical relationship between policy and practice.

1.3 Links with D5.2 and D5.3

This deliverable offers a strategic overview of policy developments around STE(A)M learning ecologies, emphasising the key policy developments, opportunities and challenges identified through the three policy briefs. However, it is also important to mention that the document is part of an integrated trilogy with two other strategic documents developed by EUN, and based on the results of Task 5.3 (Organisation of Policy Dialogues and Policy Learning Sessions) and Task 5.4 (Policy recommendations), respectively:

- Deliverable **5.2** (due in Nov 2025): examines the organisation, implementation and outcomes of the policy dialogue event, and the two online learning sessions conducted throughout the project. These events brought together different key stakeholders and practitioners from European and national contexts, creating valuable knowledge exchange and evidence validation that directly informs the analysis presented in the policy briefs and in this deliverable here.

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- Deliverable **5.3** (due in Nov 2025): builds systematically on the insights from both D5.1 and D5.2 to develop comprehensive, actionable policy recommendations. While this deliverable (D5.1) synthesizes opportunities and challenges and policy developments, D5.3 transforms these insights into concrete guidance for EU institutions and national and local decision-makers.

Collectively, these three deliverables constitute a coherent outcome which reflects the work carried out in Work Package 5 of the project: from systematic evidence gathering and analysis (D5.1), through structured policy dialogue and stakeholder validation (D5.2), culminating in detailed recommendations for sustainable systemic transformation (D5.3).

2. Methodology and Data collection

The development of the three policy briefs was grounded in a participatory and evidence-based process that combined desk policy research, stakeholder engagement, extensive exchanges and validation activities, carried out throughout the project. This methodological approach ensured that policy insights and recommendations reflected both European and national policy frameworks and the evidence emerging from the implementation of the SLEs pilots in 16 countries.

The process followed a **mixed-method approach** that integrated several data collections and validation activities, developed throughout different project tasks:

- Policy mapping and analysis at EU and national levels, through desk research and surveys distributed to project partners and stakeholders in partner countries (T5.1).
- Insights from surveys (WP4), reflection workshops (WP2) and interviews (WP6) conducted with all stakeholders involved in the pilot activities, providing both quantitative and qualitative insights.
- Analysis of learning scenarios (WP3) and learning products (WP4) produced and filled in by pilot initiators[1] and stakeholders.
- Collaborative reflection workshops conducted with project partners, SLEs pilot initiators, and stakeholders in alignment with WP2 and within the frame of Task 5.2 *Policy-oriented analysis of the evaluation results*.
- Policy dialogue events and learning sessions, such as the *Policy Dialogue at the European Parliament* and the two *online Policy Learning Sessions* organized with key stakeholders, Ministries of Education and European Commission representatives (T5.3).
- Validation sessions with institutional actors, including *Scientix Ministries of Education STEM Representatives*, *DG EAC*, and *DG RTD*, before, during, and after major policy events.

1 In the project, « Pilot initiators » are the actors that initiate and implement SLEs in their respective countries (schools or the various stakeholders within a SLE).

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This multi-layered and comprehensive analytical approach ensured the alignment of the SLEs policy outputs with the main EU priorities on the topic, while capturing the specific policy landscapes, challenges, and opportunities in each participating country.

2.1 Policy mapping and analysis

The first stage consisted of a policy mapping and analysis conducted at both European and national levels. This activity involved the systematic collection and analysis of relevant policy documents, strategic plans, and initiatives (including policy decisions, publications, reforms, STEM plans, curricula reforms) addressing STE(A)M education and open schooling at both EU level and in the pilot countries.

At the European level, reference documents included the *Union of Skills* (2024-2029), *STEM Education Strategic Plan (2024–2029)*, *Draghi report* (2024), the *Action Plan on Basic Skills (2025)*, the *European Education Area*, the *Digital Education Action Plan (2021–2027)*, and other supporting frameworks such as *GreenComp* and the *Council Recommendation on Key Competences for Lifelong Learning (2018)*.

At national level, during the first year of the project, we gathered and analysed policy materials from the 13 participating countries mapping how open schooling and STE(A)M approaches were supported, institutionalized, or emerging within national education systems. This mapping drew on pilot-specific documentation, enabling a comparative understanding of national education strategies, schemes, and professional teacher development opportunities.

This desk research was updated during the second year of the project and enriched through an open-ended questionnaire distributed to project partners and stakeholders, to gather more structured insights on the landscape of existing policies, initiatives, good practices and challenges in open Schooling and STE(A)M in the respective national local contexts. Through this exercise, SLEs partners and stakeholders monitored and analysed policy developments and provided background, context, and perspective for the development of policy recommendations. The purpose of this activity was to gain an understanding of the current state of open schooling and STE(A)M policies and initiatives in these countries as well as the perceptions on good practices and challenges associated with it. A total of 11 questionnaires were analysed, and the questions asked can be appreciated in the table here below:

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Table 1: Questions for policy analysis (2024)

	Question
1	What are the **existing policies** related to STEM/STEAM and open schooling in your country? Refer to the key **elements/dimensions** from the SLEs methodology (i.e., partnerships etc.).
2	What educational challenge do these policies address?
3	Are you aware of any best practices projects in your country related to local **multistakeholder partnerships** in education?
4	Are you aware of any best practice projects or initiatives related to **female participation** in science studies and careers through local stakeholder partnerships?
5	Are you aware of any open schooling initiatives facilitating the transfer of research results to **enterprises** (i.e., industry-research-education partnerships)?
6	Are you aware of any initiatives supporting **industry-funded innovations** in lifelong learning programs in your country?
7	Can you provide **inspirational examples**/good practices of a SLE taking place in your country?
8	What do you think are the **success factors** for the implementation of an SLEs (in your country)?
9	What do you think are the **obstacles/challenges** for the implementation of an SLEs (in your country)?
10	What **concrete measures** (i.e., policy, resources, training etc.) would be needed to overcome the se challenges? Please think about systemic changes and concrete solutions needed at national level

2.2 Co-creation and collective fine-tuning

The second phase focused on co-creation and participatory validation, engaging a wide range of actors involved in the pilots through questionnaires, interviews, collaborative workshops, and reflection sessions.

- In the first year of the project, SLEs partners organised **co-creation workshops (T3.1)** involving numerous stakeholders (teachers, educators, researchers and experts, representatives of science museums, industry, civil society, and public authorities), who joined forces at local level to discuss, develop and start co-creating their learning ecologies in national contexts (specifically in in Greece, Malta, Italy, Germany). The workshop outcomes that included policy-related perspectives on needs, success factors, possible blockages, challenges and opportunities for the implementation of SLEs were monitored and analysed.
- **National and local workshops** were held during the pilot's implementation (between end of 2023 and mid 2025) and served as key spaces for dialogue among practitioners, allowing for the refinement of pilot findings and the identification of shared priorities.
- **95 completed questionnaires** developed under WP4 (see D4.2) were analysed. These were mainly close-ended questions to evaluate the pilot implementation, and most importantly the institutional factors that enabled or hindered implementation.

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- Quantitative data from the questionnaires were cross validated with qualitative insights from the analysis of the learning scenarios: **105 learning scenarios** were analysed (see D.4.2), which reflect the essential elements of the SLE Methodology by explaining what learning paths students took and how they were aligned to the curriculum, how stakeholders contributed to the activities, and what benefits the activities brought in terms of innovation of learning, gender equality, STEM careers.
- Qualitative insights from **semi-structured interviews** as part of the Communication and Dissemination activities with relevant stakeholders (for example, see link) as well as focus groups organised by national coordinators (NCs)[2] (e.g. in Italy, Greece, and Cyprus) during pilot implementation.
- An analysis of the SLEs' **learning products**[3] complemented these insights (see D.4.3).
- Results from the analysis of these sources were consolidated through several **online evaluation and reflection workshops** organised with initiators and stakeholders from participating pilot countries to gather feedback and perspectives on the implementation of open schooling and STE(A)M approaches. A central milestone in this process was the event *"3rd Reflection Workshop: Success and challenges for future policy recommendations and upscaling" (17 June 2024)*, which gathered national coordinators and pilot initiators to exchange experiences and lessons learned from the first implementation cycle. This event was followed by the *2nd Reflection Workshop – Mature Phase* (June 2025), which engaged over 30 representatives from pilot countries in a collective discussion on enablers, barriers, and systemic recommendations for scaling STE(A)M and open schooling in Europe.

These data collection methods fostered a collective reflection among formal, non-formal, and informal education actors on real-life challenges, policy implications, and long-term sustainability pathways emerging from SLEs pilot implementation.

2.3 Validation

Finally, the findings and recommendations from each policy brief were validated through multi-level consultations and dialogue events with practitioners, institutional and policy representatives. This process included structured feedback loops with the *Scientix Ministries of Education STEM Working* Group (in December 2023 and October 2025), representatives from the EU Commission (DG EAC and DG RTD), representatives from National Ministries, key education and non-formal education representatives, and the *Open Schooling Together* (OStogether) network, including sister projects (LEVERS and ICSE Science Factory) or other relevant projects (e.g. STREAM IT, SEER project, School As Living Labs (SALL), RoadSTEAMer).

[2] In SLEs, project partners acted as "National Coordinators" (NCs) and were responsible for the pilot implementation in each country.

[3] In SLEs, "learning products" are the tangible artefacts created by students along their learning paths within the partnership of stakeholders.

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The validation exercises happened during **three dedicated project events**[4], organised collaboratively by APRE and EUN within T.5.3, and held respectively at the end of each project year, in parallel with the finalisation of each of the three policy briefs (see D.5.2 for further details):

- 1st policy dialogue event: *Bring research and innovation to school and beyond* (24 January 2024)
- 2nd policy learning session: *Good Practices and Recommendations for Open Schooling and STE(A)M.*" (24 September 2024)
- 3rd policy learning session: *Celebrating the Achievements of the SLEs Journey and Lessons Learned* (23rd October 2025)

The validation of the policy brief results was conducted both prior to and following the main policy events. Draft versions of the policy briefs, accompanied by targeted feedback questions, were shared with key speakers and stakeholders participating in the roundtables. Their final validation was then also included after the circulation of the revised versions. Following the policy dialogues events, the policy briefs were finalised and made available on the project website (See *Annex 1, 2 and 3*).

This structured, continuous, and participatory feedback process ensured accuracy, policy relevance, and institutional endorsement of the project's policy-related findings. Moreover, this iterative cycle of reflection and validation significantly strengthened the legitimacy of the policy outputs and enhanced their potential impact within European and national education ecosystems.

3. Mapping and Evolution of Open Schooling and STE(A)M Policies across European countries

3.1 The Concepts of STE(A)M and Open Schooling in Europe

The first key finding is related to the definition and conceptualisation of STE(A)M and Open schooling in Europe.

[4] For detailed information on the outcomes and reporting on the events, you can consult D.5.2 (upcoming in November 2025).

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Firstly, for what regards STE(A)M, the SLEs project highlights that the transition from traditional STEM to **STE(A)M**[5] represents more than the simple inclusion of the arts: it signals a deeper shift towards a holistic and human-centred vision of learning. As outlined in the *Joint Research Centre* (*JRC) Guide on STEM and STE(A)M Education and Disciplinary Integration* (European Commission, 2024), the "A" encompasses not only the arts but also the humanities, social sciences, and all disciplines that foster creativity, ethical awareness, cultural literacy, and social responsibility.

Within this framework, STE(A)M-based education is not a fixed or universally defined model. Across Europe, the concept remains heterogeneous and context dependent. National and regional policies interpret and implement STE(A)M in diverse ways, sometimes as project-based or inquiry-based learning, sometimes as interdisciplinary teaching, and sometimes as a curricular enrichment activity. This lack of a **shared understanding** often leads to fragmented reforms and inconsistent policy implementation. While many governments have integrated STE(A)M into curricula, its visibility in assessment systems remains limited. Teachers' collaboration emerges as a crucial enabler of STE(A)M learning, yet it is rarely institutionally supported or formally recognised.

Parallel to the evolution of STE(A)M, Open Schooling emerged as a complementary, though still evolving, concept. It is increasingly recognised in Europe as a strategy to reconnect schools with their surrounding communities and to promote educational innovation through cross-sectoral collaboration. Open schooling brings together formal, non-formal, and informal education providers along with civil society organisations, enterprises, research centres, and cultural institutions to co-design learning opportunities that address real-life challenges. However, despite its growing policy relevance and documented benefits for students and teachers, **open schooling remains a relatively new and underexplored field**. More evidence is needed to understand where it works best, under which conditions and how it can be institutionalised and scaled within education systems.

Finally, **inclusion** remains a defining feature of both STE(A)M and open schooling. By involving diverse social groups and adapting to different learning needs, these approaches promote equitable access to science and empower underrepresented learners, particularly girls and students from disadvantaged backgrounds.

3.2 The Policy Evolution of Open Schooling and STE(A)M in Europe

The integration of open schooling and STE(A)M into European science education has evolved significantly over the past decade, reflecting the European Union's broader ambition to transform learning systems in response to societal, technological, and labour market transitions. A turning point was the publication of the ***Science Education for Responsible Citizenship*** **report (European**

[5] For more details on STE(A)M approach see SLEs White Paper (D.2.1)

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Commission, 2015), which redefined science education as a lifelong, socially grounded process. It called for the inclusion of arts and humanities in STEM disciplines, promoted interdisciplinary and inquiry-based learning, and encouraged partnerships among schools, research organisations, industry, and civil society, laying the conceptual foundations for open schooling.

This direction was strengthened through the ***Council Recommendation on Key Competences for Lifelong Learning*** **(2018)**, which positioned STEM, digital, and citizenship competences as essential for all learners. It explicitly promoted experiential and project-based learning, encouraging cooperation across education sectors and aligning with the open schooling approach. These principles were operationalised through the ***Digital Education Action Plan 2021–2027***, which emphasised teacher readiness, open digital tools, and innovation networks across Europe.

In the current policy cycle, these ideas have gained further momentum within the framework of the ***European Education Area (EEA)*** and the ***Union of Skills*** initiative (2024–2029). Together, these initiatives set out an integrated vision to align education, training, and labour market needs, addressing persistent skill shortages across Europe, particularly in science, mathematics, and engineering. The ***STEM Education Strategic Plan*** **(COM(2025) 89)** translates this vision into measurable objectives, setting clear 2030 targets to increase participation in STEM studies, improve skills, and strengthen cooperation between education and industry. It recognises science and engineering competences as strategic enablers of Europe's technological sovereignty and green and digital transitions, calling for the establishment of ***STEM Education Centres***: living ecosystems connecting schools, universities, museums, and creative industries. The plan also introduces flagship initiatives such **as *Girls Go STEM* and *STEM Futures*** to tackle gender imbalance and declining student performance in scientific subjects. Despite these efforts, data from the JRC and recent European assessments reveal that while the demand for STEM profiles continues to grow, student achievement and interest, particularly among girls, are decreasing, highlighting the urgent need for new pedagogical and systemic approaches.

The ***Action Plan on Basic Skills (2025)*** complements this effort by addressing persistent weaknesses in literacy, numeracy, and digital competences. It promotes hands-on, challenge-based, and interdisciplinary learning to strengthen foundational skills for all learners. Likewise, the ***Draghi Report on EU Competitiveness (2024)*** underscores the strategic importance of investing in talent, digital capacity, and innovation ecosystems, positioning education and training, and especially STE(A)M disciplines, as essential levers for industrial resilience and Europe's global competitiveness. It calls for large-scale investment to close the growing gap between the supply and demand of skilled professionals, particularly in science, engineering, and technology.

By complementing these policy frameworks, the European Commission's *Joint Research Centre (JRC)* has provided crucial scientific evidence and conceptual clarity for both open schooling and STE(A)M education. The ***JRC Brief on STEM and STEAM Education*** **(2024)** emphasises the civic and cultural dimensions of scientific literacy, showing how integrating creativity, ethics, and the arts can make science more inclusive and socially relevant. The JRC ***STEM Competences in the EU*** report (Pokropek, 2024) identifies transversal competences, including systems thinking, critical reflection, and

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collaboration, as central to preparing Europe's youth for the green and digital transitions. The ***GreenComp Framework*** **(2022)** further extends this perspective by defining sustainability competences, especially in projects addressing climate action, biodiversity, and circular economy challenges.

Collectively, these policies and frameworks mark the transition of open schooling and STE(A)M from innovative pedagogical concepts to policy-aligned instruments for system-wide transformation.

3.3 Key policies and initiatives at national level

At the national level, the implementation of open schooling and STE(A)M education reflects a diverse and evolving policy landscape, shaped by institutional frameworks, curricular flexibility and different levels of political commitment. Evidence from the SLEs policy mapping and pilot analysis reveals that while some countries have established formal strategies supporting interdisciplinarity and collaboration, others rely on bottom-up innovation and local partnerships.

Here below is an overview of the **main national frameworks** enabling the implementation of open schooling and STE(A)M approaches, within local education systems and supporting their sustainability and connection with broader national and European policy priorities.

- In **Italy**, the use of *Percorsi per le Competenze Trasversali e per l'Orientamento (**PCTO**)* — "Pathways for Transversal Skills and Orientation", the national framework for work-based learning and career guidance enabled the integration of open schooling activities into formal curricula. Moreover, Italy has capitalised on national funding programmes such as *(PNRR)* "National Recovery and Resilience Plan, which provide substantial financial support for school innovation, teacher training, and infrastructure development. In addition, the **Guidelines for STEM** (*Linee guida per le discipline STEM*) aim to foster interest in STEM subjects across all educational levels by emphasizing hands-on, problem-based learning and integrating technology like programming and robotics. "**Community educational agreements**" (2020-2021), established between schools, local authorities, public and private institutions and third sector are interesting example of how collaborations are formally established between schools and the local community to reduce early school leaving.
- **Malta** has embedded the same vision in its ***National Education Strategy 2024–2030***, which emphasises creativity, inclusion, and innovation, while promoting strong collaboration among schools, universities, museums and local authorities.
- In **Spain**, regional initiatives such as ***STEMbach*** in Galicia, ***STEMcat*** in Catalonia, and ***STEMadrid*** in Madrid showcase how local authorities are fostering student engagement in STEM through both curricular and extracurricular projects in collaboration with universities and industries.
- Countries such as **Norway** and **Romania** benefit from more flexible national curricula that enable schools and teachers to experiment with interdisciplinary, project-based approaches. In **Romania**, the *"Curriculum at the School's Decision"* policy framework allows schools to complement the national curriculum with one additional weekly hour dedicated to competence-

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development projects. Moreover, the *"Green Week"* and *"Alternative Week"* initiatives provide educators with the opportunity to design interdisciplinary and experiential learning projects, focused on sustainability, citizenship, and creativity. These mechanisms have created valuable spaces within the national system to pilot open schooling approaches, supporting schools' autonomy and innovation capacity. This flexibility was also a crucial enabler for the SLEs pilot projects, facilitating the incorporation of STE(A)M and open schooling within regular school timetables.

- In contrast, other contexts, such as **Greece, Serbia and Cyprus**, do not yet have formal open schooling frameworks but have seen significant bottom-up activity through science clubs, networks, science festivals, local partnerships and EU-funded initiatives. These informal or project-based ecosystems have proved essential in promoting experimentation and community engagement, especially where national policies remain fragmented.

Across participating countries, the results show how open schooling, and STE(A)M education, is slowly, unevenly but steadily gaining institutional recognition and reinforced by the growing alignment between national reforms and European frameworks and strategies. These examples encourage national authorities to reconsider their curricula, teacher training systems, and collaboration models, demonstrating how European-level guidance is progressively shaping policy evolution and inspiring science education strategies across member states.

4. Good Practices and Opportunities in SLEs Pilot Countries

The implementation of SLEs pilots across the 16 European and associated countries has generated a rich body of evidence about how open schooling and STE(A)M-based education can be embedded in local contexts, foster collaboration across sectors, and enhance the quality and inclusiveness of science learning. The findings reveal a set of best practices and opportunities, which can be grouped into **five thematic clusters**, presented here below (for further detail of each SLE see D2.3).

4.1 STE(A)M for (gender) inclusion and innovation

Promoting gender equity and inclusion has been a central objective of the SLEs project, reflecting the European Union's commitment to addressing structural imbalances in STEM education. Despite decades of progress, the gender gap remains a persistent challenge, with women significantly underrepresented in disciplines such as computer science, engineering, and physics (European Commission, 2023). This underrepresentation limits individual career opportunities and constrains Europe's collective capacity for innovation and competitiveness. The SLEs approach addresses this gap by embedding learning within community contexts and employing problem-based, co-creative methodologies. These strategies align with research-backed practices for engaging girls in STEM and foster environments where learners, particularly girls, can develop a sense of belonging, motivation,

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and confidence. Indeed, research consistently shows that when learning activities are collaborative, hands-on, and connected to real-life challenges, they increase girls' motivation, confidence, and sense of belonging in STEM disciplines (European Commission, 2021; UNESCO, 2019).

Beyond gender, SLEs have also demonstrated the potential of open schooling to create learning environments inclusive of diverse learners, including those with different abilities, learning styles, or socio-economic backgrounds. This **multidimensional inclusivity** reinforces the concept of SLEs as participatory systems, where every learner can find meaningful ways to contribute to collective knowledge creation. Indeed, pilot projects have considered neurodiversity, rural contexts, digital access, socio-economic barriers, and disengaged learners within their activities. Moreover, gender and broader inclusiveness are cross-cutting considerations in the project, integrated across all stages of SLEs activities: from design, to implementation, and evaluation.

To support this vision, the project also developed the ***SLEs Women in STEM Toolkit*** (2025)[6], which provides educators with strategies and practical resources to promote gender-inclusive STE(A)M education. These include scenario-based learning paths, role model engagement, and activities that highlight the social and ethical dimensions of science and technology.

Pilots' highlights include the following:

- In **Italy**, a notable example is the ***Green Transition & Gender*** pilot, which brought together schools and national actors, including the National Industry Female Committee, universities, training partnerships, and civil society organisations (CSOs) to design gender-inclusive STE(A)M learning paths, which included class discussions about female role models who have made significant contributions to STE(A)M fields or on-site visits where students met with female entrepreneurs, researchers, and medical doctors, gaining first-hand insights into diverse scientific careers.
- **In Serbia**, the *From Plastic Bottle to 3D Printing* pilot similarly provided an inspiring example of how gender-inclusive education can merge technological innovation with social engagement. Within this pilot, students, particularly girl, participated in the entire design and production cycle**,** transforming discarded plastic materials into creative and functional objects through product design, CAD modelling, electronics, and 3D printing**.** Activities were intentionally structured to encourage female participation in domains traditionally perceived as male dominated.
- Other pilots such **Italy** (*Nature & Art* with learners with disabilities), **Cyprus** (Biodiversity for learners with disruptive behaviour), **Norway** (AI adapted for mixed-ability classes), and **Spain** (AI ethics, cultural identity, and representation) have further demonstrated how gender and broader inclusion considerations can be embedded across different educational contexts.

[6] https://www.steamecologies.eu/wp-content/uploads/2025/03/SLEs_Women_STEM_Toolkit_Final.pdf

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Moreover, the pilots adopted a wide range of tools and strategies to address gender and inclusivity, such as:

- **Flexible modular activities**, allowing adaptation of pace and content to meet the needs of diverse learners;
- **Creative documentation** methods (storytelling, mapping, theatre, video) to engage multiple learning styles and intelligences;
- Representation of **role models and diverse materials**, featuring female scientists and culturally varied figures to inspire identification and aspiration;
- **Collaborative, hands-on**, and contextually meaningful learning activities increase engagement and empower all types of learners to contribute actively to scientific inquiry.
- **Recognition and visibility**, through exhibitions, showcases, peer-learning events and public validation of learners' achievements.

Together, these examples illustrate how SLEs pilots have operationalised inclusivity, not as an additional goal, but as an integral part of STE(A)M education. Also, they exemplify how open schooling and partnership with key stakeholders such as industry or research role models, can serve as a framework for inclusive innovation.

However, evidence also shows that such approaches are not yet consistently embedded within **national or regional policy frameworks**. Educational initiatives exist in collaboration with local associations, such as "**Women in science**" (Germany), "**STEM it like a girl**" (Serbia), "**Tween4STEAM**" (Malta), "**Coding Girls**" (Italy) with the aim to raise awareness against gender stereotypes in STEM education, while also supporting career development and orientation for women in STEM subjects through role models, outreach, or mentoring activities. However, from pilots' perspective, structured policy support, guidance on gender-sensitive pedagogies or data monitoring is still often absent. Teachers often lack training, tools, and awareness, and gender- or inclusion-disaggregated monitoring is frequently missing. Addressing this gap requires moving from pilot initiatives to systemic commitment, embedding inclusion and gender equity within national STE(A)M and open schooling strategies, teacher training, and evaluation mechanisms so that gender-inclusive practices become a stable feature of educational systems.

4.2 Partnership and network building

From the initial pilot phase to the mature implementation, strong multi-stakeholder partnerships consistently emerged as a key aspect of successful SLEs. Even in the absence of formal policy frameworks, pilots demonstrated that schools could establish meaningful collaborations with local actors such as **museums, research institutes, NGOs, businesses, and public bodies**. These collaborations enhanced the quality of learning activities while strengthening schools' visibility and legitimacy within their communities.

- The **Galway** STE(A)M Learning Community in Ireland, for example, brought together schools, libraries, artists, and researchers to co-create a mosaic artwork symbolizing community connection and scientific inquiry. In **Cyprus**, the *Butterfly Project* engaged schools, universities,

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and museums in biodiversity monitoring, showcasing how thematic alignment can catalyze cross-sectoral cooperation.

- Partnerships with **research centres and universities** enabled schools to access professional expertise, data, and advanced scientific tools that significantly enriched the learning process and bridged classroom learning with real-world challenges (e.g. university-led initiatives such as **NTNU in Norway**, national research centers in **Italy**, Ciencia Viva in **Portugal**, The Domus Science Museum in **Spain** exemplified how **science centres** can act as catalysts for co-creation, offering laboratories, mentorship and tools to schools and communities).
- The **engagement of local authorities and municipalities** also played a critical role in mobilising stakeholders quickly and bridging formal education with societal challenges. In **Turkey**, for instance, the *Innovation Bridge* SLE secured the support of the **Municipality of İnegöl**, which provided logistical assistance, and the **İnegöl District Education Authority**, which officially endorsed the activities. In Germany, **regional centers** for educational innovation provided infrastructure and guidance for schools to engage with external partners.

Importantly, open schooling partnerships often evolved beyond informal collaborations to form **community networks**. These networks enabled schools to work jointly with municipalities, research organisations, enterprises, and civil society actors on pressing social and environmental challenges. In **Serbia**, for instance, students collaborated with local NGOs and professionals to design solutions for environmental problems, later presenting their work in public forums. In **Cyprus**, the **UNESCO SEMEP Network** connected schools with established science networks, offering guidance, and providing dissemination opportunities for students' outputs. This partnership model illustrates how aligning open schooling initiatives with existing educational and scientific infrastructures can accelerate the uptake and sustainability of pilot projects.

In addition, in several contexts the formalisation of these collaborations through **specific agreements** proved essential for implementation. The signing of *protocols of understanding* between schools and external stakeholders was a **bureaucratic requirement** to initiate activities, ensuring compliance with institutional procedures while clarifying roles and responsibilities. While these agreements introduced bureaucratic complexity, they also legitimized open schooling within institutional frameworks and facilitated long-term collaboration. Importantly, these agreements were adapted to each local context and project needs.

4.3 Active co-creation and innovative teaching methodologies

Another key finding was related to the opportunities generated in innovative teaching methodologies. Throughout the implementation, open schooling and STE(A)M education emerged as powerful tools for pedagogical innovation. The pilots demonstrated that when schools are embedded within their communities and co-create learning experiences with diverse stakeholders, teaching and learning undergo a profound transformation.

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At the heart of this transformation lies the SLEs Methodology, which integrates Living Labs, co-creation, and interdisciplinary learning. At the same time, design thinking and citizen science emerge as powerful teaching and learning methodologies for scientific learning. These approaches foster collaborative inquiry, iterative experimentation, and real-world engagement, enabling students and teachers to become active agents in the learning process. Additionally, such models of co-creation highlight the potential of open schooling to move beyond traditional instruction towards experiential, inquiry-driven, and socially relevant learning.

Living Labs: Co-Creation in Real-World Contexts

The concept of Living Labs, as defined in the SLEs Methodology, refers to participatory environments where educational practice is directly connected to real-world challenges. These labs are not confined to physical spaces but represent dynamic collaborative ecosystems of co-creation, where students, teachers, researchers, and community actors work together to design, test, and refine learning scenarios and learning artifacts.

In the first year of the project, Living Labs were introduced as a theoretical model. By the second year, they had evolved into practical frameworks for implementation. Across countries, Living Labs addressed diverse themes, from health and sustainability to digital citizenship and environmental awareness. Living Labs also facilitated civic engagement, with students designing solutions for local environmental issues and presenting them in public forums.

These environments encouraged iterative learning cycles: students identified problems, developed hypotheses, tested solutions, and reflected on outcomes. Teachers, in turn, adopted new roles as facilitators and co-learners, guiding students through complex, interdisciplinary challenges. The Living Lab model proved especially effective in fostering transversal competences such as critical thinking, collaboration, and ethical reasoning.

Design Thinking: Empathy-Driven Problem Solving

Design thinking emerged as a complementary methodology that supported creativity, empathy, and user-centered innovation. As highlighted in the third policy brief and in external references such as Nabushawo et al. (2022) and Henriksen, Richardson, and Mehta (2017), design thinking enables learners to approach problems from multiple perspectives, prototype solutions, and iterate based on feedback.

Norway provided a compelling example of design thinking in action. Students engaged in community-based projects using a structured design process: they empathized with stakeholders, defined challenges, ideated solutions, built prototypes, and tested them in real-world settings. This approach not only deepened students' understanding of societal issues but also linked academic content to practical application. Teachers reported increased student motivation, improved collaboration, and stronger connections between school and community.

Importantly, design thinking was not limited to technology or engineering projects. It was applied across disciplines, including social sciences, environmental studies, and civic education, demonstrating its versatility and relevance in STE(A)M contexts.

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Citizen Science: Connecting Learners to Research

Citizen science is another approach that played a vital role in bridging formal education with scientific research. By involving students in data collection, analysis, and dissemination, SLEs enabled learners to contribute meaningfully to ongoing research efforts while developing scientific literacy and environmental awareness.

In **Cyprus**, students participated in biodiversity monitoring through platforms like *the European Butterfly Monitoring Scheme* (eBMS). These projects allowed students to collect field data, engage with environmental scientists, and understand the implications of their findings. Other pilots adopted similar models: in Romania, students used sensors and digital tools to monitor air quality; in Malta, remote platforms facilitated collaborative research across schools.

The pilots confirm that open schooling is also a cultural shift in how we understand and enact education. Through innovative teaching and co-creation, schools become laboratories of innovation, students become co-researchers, and teachers become facilitators of change.

4.4 Teacher professional development and recognition

Teacher professional development emerged throughout the project not only as a prerequisite for successful implementation but also as a significant outcome of the pilots. From early implementation, many educators expressed enthusiasm for interdisciplinary and project-based approaches but lacked formal training or institutional support to implement them. The first brief highlighted that traditional professional development is insufficient to prepare teachers for the complexity of co-creation, stakeholder engagement, and real-world problem-solving. Instead, the SLEs model proposes a more integrated approach: teachers learn by doing, develop scenarios, collaborate with external partners, and facilitate student inquiry, becoming not only recipients of training but also as active contributors to educational innovation.

In Italy, Greece, Cyprus, and Malta, for instance, collaboration with universities and research centers provided teachers access to new methodologies and resources, enriching both student learning and teacher instruction.

Portugal offered a particularly strong example of how open schooling can be institutionalised within national professional development frameworks. Participation in the national SLEs pilot was formally recognised as a **credited training course** (25 hours) for educators, enabling them to include their engagement in their Continuing Professional Development (CPD) portfolios. This institutional recognition validated teachers' efforts and ensured that their contribution to innovative teaching practices was officially acknowledged and rewarded within the national education system. The training model adopted was also particularly innovative: teachers implemented SLEs "learning by doing", therefore co-creating and conducting activities directly with students, while receiving continuous guidance and technical support from the Ciência Viva Centre staff.

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Workshops and reflection sessions organized by national coordinators further reinforced teachers' and stakeholders' capacities and helped bridge the gap in the absence of formal professional development structures. The **peer-learning** dimension proved especially valuable, creating communities of practice that enabled teachers to share strategies, exchange resources, and collectively experiment with inclusive pedagogical tools, ensuring mutual learning beyond institutions.

Moreover, **flexible formats** and **inclusive pedagogical tools** such as modular activities, creative documentation, and role model engagement allowed educators to adapt teaching to diverse learner needs, further strengthening the link between professional development, inclusion, and innovation. What we learn is that when supported and recognized, educators can lead the way in implementing inclusive, innovative, and community-connected learning.

4.5 Students' engagement, empowerment and key skills

Learner engagement was one of the key dimensions of the SLEs approach and at the center of the SLEs pilots, as it sustains long-term interest in STEM subjects and contributes to academic success. The pilots revealed several ways through which the model effectively promoted engagement of learners across all educational levels, from early childhood to upper secondary education: young learners explored their environment through play-based inquiry or theatre plays, while older students engaged in complex, research-oriented projects addressing social and environmental issues.

Moreover, from the earliest pilots to the full-scale implementation, students' engagement, creativity, and agency were made visible through tangible **learning products** co-created by students. These artefacts, ranging from scientific prototypes and digital tools to public campaigns and citizen science datasets, served as both the outcome and the evidence of deep learning (also see D.4.3). They reflected the acquisition of knowledge as well as the development of essential transversal competencies such as teamwork, problem-solving, communication, digital literacy, and sustainability awareness.

Across Europe, pilots emphasized the importance of **hands-on, real-world learning experiences** that allowed students to explore societal challenges through interdisciplinary inquiry. Students were involved in designing learning paths, collecting data, and presenting findings.

By the mature phase of implementation, the learning products developed were increasingly sophisticated. In **Spain**, students learned the fundamentals of Artificial Intelligence by exploring and comparing digital tools such as *ChatGPT*, *Gemini*, *Grok*, to create public awareness videos on the UN's Sustainable Development Goals (SDGs). Stakeholders and experts guided learners on AI ethics and data protection, empowering them to use digital tools responsibly and critically.

Also, students became **ambassadors of change**. Their learning products were showcased in events, school exhibitions, and public forums. For example, in **Italy**, students presented their work at the

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European Researchers' Night or at *Science Festivals* in Rome; In **Malta**, each SLE concluded with a public event that celebrated students' achievements and learning trajectories. In **Cyprus**, learners shared their citizen science findings through online platforms and local dissemination events. In **Portugal**, students developed digital campaigns on sustainability, reaching audiences beyond the school walls.

Importantly, these outputs demonstrated that projects grounded in **real-world challenges** generated high levels of engagement. For instance, in projects addressing environmental sustainability, students were not only learning about biodiversity or pollution, but they were also collecting data, analysing trends, and proposing actionable solutions to local authorities. In doing so, they experienced the tangible impact of their contributions, which in turn reinforced their sense of responsibility and self-efficacy. This civic dimension of learning was a defining feature of SLEs pilots, reinforcing the idea that education is not confined to the classroom and content acquisition but is deeply connected to societal transformation and community action. Students gained scientific knowledge, but more importantly, they developed the mindset and skills needed for active citizenship in a rapidly changing world. This sense of ownership also fostered deeper cognitive and emotional engagement. Students demonstrated curiosity, perseverance, and creativity, particularly when working in teams to solve complex, interdisciplinary challenges.

This student-centred model of learning aligns closely with the broader goals of the European Education Area (EEA) and the EU's vision for inclusive, innovative, and participatory education. By cultivating ownership, the SLEs approach nurtured the competences and mindsets essential for lifelong learning, democratic participation, and active citizenship in the context of the green and digital transitions.

5. Challenges and blockages

The cross-country analysis of the SLEs pilots however also reveals a consistent set of structural and operational challenges that limit the long-term integration and institutionalisation of open schooling and STE(A)M education across Europe. While each national context has unique conditions, the evidence collected across the three years of implementation points to four recurring **clusters of barriers**:

- **Resources and Support** – Many pilots operated under tight financial and logistical constraints. Schools often lacked stable funding to purchase materials, cover transport costs, or ensure adequate facilities, depending instead on temporary project-based budgets. Limited infrastructure and administrative support further restricted schools' ability to sustain innovation over time.
- **Curriculum** – Teachers across multiple countries reported that rigid curricula, limited time and dense content requirements prevented them from allocating time to interdisciplinary and project-based learning. In many cases, SLEs activities were conducted outside standard school hours, being perceived as *extra-curricular* rather than integrated learning experiences.

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- **Policy, Sustainability and Recognition** – The absence of structured national frameworks for Open Schooling, coupled with limited institutional recognition of teachers' additional workload, weakened sustainability. Even when pilots succeeded, they risked discontinuation due to lack of formal incentives, policy alignment or financial continuity.
- **Stakeholder and Community Participation** – Multi-actor collaboration was a strength but also a challenge. Bureaucratic processes, coordination complexity, engaging stakeholders from the start without previously established contacts or networks, and reliance on individual leaders often hindered the consistency of partnerships. In some cases, the absence of clear ethical and digital governance guidelines created additional uncertainty for schools and external partners.

Together, these challenges illustrate a system where enthusiasm and innovation coexist with structural limitations. Overcoming these barriers requires dedicated funding, curricular flexibility, policy recognition, and sustainable coordination mechanisms that enable open schooling to evolve from pilots into a stable component of European education ecosystems.

5.1 Resources and support

A primary and cross-cutting challenge identified throughout the pilots was the limited availability of financial, material, and infrastructural resources. From the earliest pilot implementations to the final mature phase, schools and pilot coordinators reported that resource constraints have hindered their ability to implement and sustain STE(A)M open schooling activities. As reported in the first policy brief, schools operated with minimal budgets[7], relying heavily on the voluntary contributions of teachers, researchers or local partners. Without dedicated funding lines, schools and external organisations struggled to cover logistical needs such as transportation for fieldwork, purchase of scientific equipment, or access to external facilities. In some cases, this led to the downsizing or cancellation of planned activities.

By the second year, as pilots expanded and diversified, the resource gap became more apparent. In Italy, for example, the *Blue Mission* pilot project, focusing on marine sustainability and outdoor environmental education, were unable to carry out key components of their learning scenarios (e.g. two fieldtrips planned) due to insufficient funds. Similarly, in Malta, infrastructural limitations such as the lack of air-conditioned venues during the summer months negatively impacted student participation and project continuity, especially in out-of-school settings.

In several contexts (e.g. Cyprus, Romania, and Greece) the lack of dedicated national or local funding for open schooling meant that schools depended on temporary EU projects to initiate STE(A)M-related activities. These examples illustrate that while open schooling thrives on real-world engagement and hands-on learning, such approaches often require resources that go beyond what schools or

[7] Budget for pilot activities was not foreseen in the Grant Agreement (G.A.)

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stakeholders themselves can provide. Also, the reliance on short-term, project-based funding, often tied to EU or national innovation calls makes long-term planning difficult and undermines the sustainability of even the most successful pilots.

The second and third policy briefs further confirmed that the lack of adequate resourcing is not only financial but also **administrative and technical**. Some schools lacked staff specifically assigned to manage partnerships, external communication, or project logistics. Teachers often took on these additional responsibilities on top of their teaching load.

At the policy level, the policy briefs emphasised that structural investment is a precondition for scaling up open schooling. There is also a call to institutionalise support structures for open schooling at national and local levels through innovation offices in schools, or coordination roles for stakeholder engagement. These mechanisms would help reduce the administrative burden on teachers, ensure efficient use of resources, and promote long-term sustainability of open schooling practices within formal education systems.

5.2 Curriculum integration

Curriculum rigidity emerged as one of the most persistent and systemic barriers to the institutionalization of open schooling and STE(A)M education across the SLEs pilot countries. Despite the pedagogical richness and societal relevance of the SLEs approach, many teachers and stakeholders pointed to the challenge of embedding interdisciplinary, project-based, and co-creative methodologies within the constraints of traditional school timetables and subject-based curricula.

From the earliest stages of implementation, stakeholders reported that the structure of national curricula often left little room for experimentation. In **Greece, Norway and Serbia**, educators found it difficult to integrate iterative methodologies into their daily teaching routines. These approaches, which require time for exploration, prototyping, and reflection, were at odds with the rigid scheduling and pressure to cover prescribed content. Similarly, in Ireland, Greece, Spain, Turkey, Serbia, and Germany, teachers cited **curricular overload and time constraints** as critical barriers, noting that the need to complete mandated syllabi limited their capacity to introduce exploratory or interdisciplinary projects.

As a result, many SLEs activities were conducted outside regular class hours, after school, or during the weekend, reinforcing the perception of open schooling as an **"extra-curricular"** activity rather than a core component of formal education. The first policy brief already identified this as a systemic issue: the absence of **allocated time** within the school schedule particularly in schools with heavy subject fragmentation or exam-driven systems.

In the second year of implementation, pilots began to explore how to align SLEs with existing curricular goals. In **Ireland**, for example, a plant growth monitoring project was successfully embedded into the Year 4 science curriculum, allowing students to engage in hands-on inquiry during regular class time.

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In **Spain and Greece**, sustainability-themed SLEs were linked to science and digital skills objectives, demonstrating that with strategic planning, open schooling can complement and enrich formal learning. In **Romania**, curricular flexibility through the "Curriculum at the School's Decision" framework allowed schools to dedicate a weekly hour to competence-development projects, offering a promising institutional pathway for SLE integration.

By the third policy brief, the challenge of curriculum integration had become a focal point for policy dialogue. The pilots showed that when open schooling is formally recognized, through credited training, dedicated hours, or inclusion in national strategies, its impact is amplified. When SLEs were linked to national or regional frameworks they gained legitimacy and visibility within the formal education system. The brief also highlighted that curriculum integration requires a shift in how education systems value interdisciplinary learning, community engagement, and student agency.

Overall, the pilots demonstrated that curriculum integration is both a pedagogical and policy challenge that demands structural support: dedicated hours for project work, flexible assessment criteria, and alignment with transversal competences such as sustainability, citizenship, and digital literacy.

5.3 Policy alignment, sustainability and recognition

At the policy level, the absence of structured national frameworks for open schooling and limited recognition of teachers' additional work also emerged as systemic gaps. While the pilots demonstrated strong local impact and pedagogical innovation, their long-term sustainability risks to be undermined by fragmented policy environments, absence of recognition of teacher and stakeholder contributions, and the lack of structural incentives to embed these practices within national education systems.

The issue of teacher (and stakeholders') **formal recognition** emerged prominent. Educators across countries reported that their engagement in SLEs activities, often involving significant time, coordination, and pedagogical innovation, was not formally acknowledged. In **Spain**, teachers noted that their contributions were invisible within institutional structures, resulting in increased workload without compensation or professional credit. Similar concerns were raised in **Turkey**, where regional disparities in policy implementation and the absence of dedicated funding restricted opportunities for long-term continuation.

In the third policy brief, **sustainability** emerges as a central challenge: although many pilots succeeded in building partnerships, engaging students, and producing impactful learning products, their continuation beyond the project period remains uncertain. Too often, success depended on individual champions, temporary funding, or informal agreements.

Overall the policy briefs collectively highlighted that sustainability depends on three interrelated conditions: a) policy alignment: integrating open schooling into national and regional education strategies, ensuring coherence between innovation projects and system-level frameworks; b) institutional recognition: formally valuing teachers' and stakeholders' contributions through workload allocation, professional credits, or evaluation systems; and c) stable support structures: providing

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ongoing funding, coordination roles, and capacity-building mechanisms to maintain partnerships and continuity beyond project cycles.

5.4 Stakeholder and community participation

While open schooling and SLEs lie on multi-stakeholder collaboration, some pilots revealed that coordination amongst stakeholders was also often complex and time consuming. For all actors, engaging in meaningful partnerships requires significant time, coordination and administrative navigation. In Italy and Cyprus, **bureaucratic requirements**, such as formal cooperation agreements, safety protocols, and procurement procedures, were cited as obstacles and often delayed or complicated collaboration between schools and external actors. The briefs highlighted that some countries experienced **fragmented communication** channels or limited **stakeholder availability**, resulting in siloed interactions and reduced opportunities for co-creation. Logistical challenges, such as coordinating activities across multiple schools or organising off-site learning experiences like field trips, were also widely reported.

A recurring theme was also the reliance on individual champions, motivated teachers, school leaders, or enthusiastic local facilitators, who drove partnerships through personal commitment. While such **distributed leadership** enabled many pilots to initiate, the dependence on personal connections risks fragmentation once those individuals change roles or leave the institution.

A particularly challenging dimension of stakeholder participation also involved the collaboration with **industry/business actors**. While the SLEs model encourages engagement with enterprises to bridge education and the world of work, some pilots revealed that such partnerships were often difficult to initiate and sustain. In several countries, schools found it challenging to engage with industry partners willing to engage in long-term educational collaboration or were themselves reluctant to do so.

Moreover, schools and stakeholders often lacked **centralized platforms** or **institutionalised intermediaries** to facilitate matchmaking with industry or local actors. Without a structured mechanism to connect educational institutions with relevant stakeholders, collaboration risks remaining ad hoc and dependent on personal networks or prior project experience. In this context, the role of national pilot coordinators proved essential: in some contexts, they acted as critical brokers, facilitators, and mediators between schools and external stakeholders, helping to initiate contacts, clarify expectations, and support logistical arrangements. However, this reliance on project-level coordination points to the need to maintain and scale-up formal coordination structures and mechanisms to ensure sustainability and long-term impact.

By the third policy brief, a newer relevant challenge emerged: the **ethical and digital governance** of stakeholder collaboration. In **Spain** and **Norway**, pilots that incorporated artificial intelligence, data analytics, or digital platforms raised concerns about data protection, consent, and responsible use of technology in educational settings. Teachers and school leaders expressed uncertainty, particularly when working with external partners who collected or processed student data. This highlighted the

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need for clear, accessible frameworks that address digital ethics, privacy, and accountability in open schooling contexts.

In conclusion, all the identified challenges point to a perception of open schooling as still peripheral to mainstream education. Despite its alignment with EU strategic priorities STE(A)M open schooling risks being treated as a temporary or extracurricular initiative, rather than a core component of school development, with the risk of weaking impact, and undermining its sustainability. Altogether, the obstacles highlight the need for systemic enablers: sustained financial support, flexible curricula with allocated time, formal teacher recognition, and structured coordination mechanisms for school–community partnerships. Addressing these conditions will be essential to move from project-based innovation to a sustainable, policy-embedded practice within European education systems.

6. Policy recommendations

Based on the identified practices and recurring challenges, the policy briefs and the SLEs project have elaborated eight interconnected policy recommendations that underpin the successful institutionalization and scaling of Open Schooling and STE(A)M learning ecologies across Europe. These themes reflect both systemic enablers and operational levers, and together they form a comprehensive **roadmap for future policy development**. Each theme is supported by targeted recommendations and stakeholder roles, which can be further appreciated in Deliverable 5.3.

Theme 1: Policy development and systemic alignment: Open Schooling requires coherent national and EU-level frameworks that link education, research, and innovation. Recommendations include developing national strategies, fostering cross-ministerial coordination, and adopting shared European guidelines for STE(A)M Learning Ecologies.

Theme 2: Curriculum flexibility and assessment reform: Policies should promote flexible timetables, recognise student projects as valid learning outcomes, and support alternative assessment models aligned with sustainability and civic competences.

Theme 3: Teacher Professional Development (PD), recognition and empowerment Teachers need structured CPD opportunities (credits, certificates), time allocation, and formal recognition to engage in Open Schooling. Recommendations include linking participation to career progression, promoting peer learning, and embedding “learning by doing” models.

Theme 4: Multi-Stakeholder collaboration Partnerships with research, industry, and civil society must be supported through formal coordination mechanisms. Proposals include establishing local Open Schooling hubs, funding facilitator roles, and integrating collaboration into institutional strategies.

Theme 5: Inclusion, gender equality and diversity Open Schooling should actively address equity gaps. Policies should embed gender and inclusion goals in STE(A)M strategies, support mentorship campaigns, and monitor participation data disaggregated by background and ability.

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Theme 6: Digital and green transition integration offer a platform to connect digital and environmental education. Recommendations include embedding GreenComp and DigComp into curricula, promoting real-life sustainability projects, and ensuring ethical use of AI and data.

Theme 7: Funding, infrastructure and institutional support Sustainable implementation requires dedicated funding and structural investment. Proposals include creating national open schooling funding schemes, enabling hybrid financing models, and upgrading school infrastructure linked to SLE networks.

Theme 8: Evaluation, impact and sustainability Scaling Open Schooling depends on robust evidence of impact. Recommendations include developing common indicators, integrating evaluation into national systems, and establishing observatories to document and share practices.

Cross-cutting enabler: leadership and governance Distributed leadership and collaborative governance are essential. School leaders should be empowered to support innovation, and national policymakers should reward educational leadership through recognition and policy support.

7. Conclusions and way forward

The SLEs project has demonstrated the transformative potential of open schooling and STE(A)M learning ecologies to connect education with community life, foster inclusion, and promote innovation. Through partnerships among schools, universities, museums, research centres, civil society, enterprises, and local authorities, SLEs has shown that learning can extend beyond classrooms and become a driver of civic participation, sustainability, and social cohesion.

The evidence gathered across the pilot countries confirms that open schooling and STE(A)M education is both effective and scalable, provided that adequate policy frameworks, funding mechanisms, and institutional support are in place. The lessons emerging from the pilots converge that moving from innovation to systemic impact requires coordinated action across all governance levels, from European to local.

Moreover, the SLEs experience highlights that the open schooling and STE(A)M model can be scaled and sustained within European education systems, but doing so requires structural investment and long-term commitment. Several enabling conditions must be reinforced to ensure its institutionalisation:

- **Dedicated resources.** Stable and long-term funding beyond project cycles is essential. Schools and local actors need financial and infrastructural support to maintain partnerships, create materials, and expand access. Dedicated national and European funding streams—complementing programmes such as *Horizon Europe*, *Erasmus+*, and the *Recovery and Resilience Facility (RRF)* should support the mainstreaming of Open Schooling.
- **Curricular integration.** Embedding Open Schooling in national curricula ensures continuity and legitimacy. Incorporating interdisciplinary, project-based, and community-oriented learning within formal frameworks transforms Open Schooling from enrichment into core education.

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Curricular flexibility, appropriate time allocation, and recognition of learning products are key to its success.

- **Institutional recognition.** Teachers and schools require formal acknowledgment for their engagement in Open Schooling, through continuous professional development (CPD) credits, workload adaptation, or national incentives. Similarly, partnerships with local and regional authorities should be formally recognised within education strategies and long-term planning.
- **Peer-learning and exchange.** Networks such as *Scientix* and *Open Schooling Together (OStogether)* play a vital role in sustaining and scaling innovation. These communities of practice provide mentoring, shared tools, and opportunities for dialogue, ensuring coherence between local actions and European priorities.
- **A shared European vision.** Ultimately, scaling Open Schooling demands a coherent European approach that recognises it as a cornerstone of the *European Education Area*. Open Schooling directly contributes to the objectives of the *STEM Education Strategic Plan* (2025–2030), the *Union of Skills* (2025), and the *Green and Digital Transitions* by making education more inclusive, interdisciplinary, and responsive to societal needs.

By embedding the achievements of SLEs into policy and practice, Europe can ensure that open schooling and STE(A)M education evolves from a successful pilot approach into a sustainable systemic model. This transition will require alignment between innovation, policy reform, and capacity-building efforts, anchoring open schooling as a permanent feature of Europe's learning ecosystem and a catalyst for future-oriented education.

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9. Annexes

The full version of the three policy briefs is published on the SLEs website (the third is upcoming and will be published by December 2025) and is also reported below:

- Policy Brief 1 2023 STE(A)M Learning Ecologies (SLEs): Open Schooling For Science Education and a Learning Continuum For All
- Policy Brief 2 2024 Strategic Support and Resources In STE(A)M Learning Ecologies
- Policy Brief 3 2025 Scaling STE(A)M Open Schooling in Europe: Policy Lessons from SLE Pilots

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EUROPEAN

POLICYBRIEF

Scaling STE(A)M Open Schooling in Europe: Policy Lessons from SLE Pilots

December 2025

Authors:
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INTRODUCTION AND POLICY CONTEXT

Open Schooling, STE(A)M, and the future of learning in Europe

In the context of the green and digital transitions, the European Union is placing renewed emphasis on transforming education systems to meet future societal and economic challenges. Central to this transformation is the promotion of **open, inclusive, and innovation-driven learning environments**, where **STE(A)M education** (Science, Technology, Engineering, Arts and All subjects, and Mathematics) plays a vital role in shaping a resilient, cohesive, and forward-looking Europe.

Strategic Priorities of the European Commission

The **Union of Skills**, one of the flagship EC priorities of the **2024–2029 Political Guidelines**, calls for a stronger alignment between education and labour market needs. This includes fostering interdisciplinary competences, strengthening basic and digital skills along lifelong learning, and promoting gender and social inclusion in technical and scientific fields.

The following EU strategies and initiatives provide a clear mandate for initiatives such as Open Schooling and STE(A)M-based learning:

- **European Education Area (EEA)**: Aims to create a unified, high-quality, and inclusive education space by 2025, prioritising teacher development, equity, and innovation through stronger cooperation across Member States and educational sectors.
- **STEM Education Strategic Plan 2024–2029**: Defines STEM and STE(A)M competences as key to Europe's competitiveness, democratic engagement, and sustainability leadership. It calls for the use of real-life challenges, cross-sector partnerships, and learner-centred pedagogies to increase engagement and diversity in scientific careers.

"Equipping all learners, regardless of gender, background or age, with STEM competences is not only essential for employment, but also for understanding complex global challenges such as climate change, digitalisation and public health."
— European Commission, STEM Education Strategic Plan 2024–2029.

- **Action Plan on Improving Basic Skills (2025)**: Launched under the mandate of EVP Ligia Deca Minzatu, this initiative responds to the persistent challenge of low proficiency in literacy,

numeracy, and digital skills. It reinforces the need for project-based learning and accessible, inclusive approaches for all learners.

- **Digital Education Action Plan (2021–2027)**: Emphasises digital readiness for teachers, the use of open digital tools, and the value of networks, such as open schooling communities, in delivering equity-driven innovation in education.
- **Draghi Report on EU Competitiveness (2024)**: Urges systemic investment in talent, digital capacity, and innovation ecosystems, positioning education and training as strategic enablers of Europe's technological sovereignty and industrial resilience.

EU and International Frameworks

To further ground the open schooling and STE(A)M approach within EU and global policy frameworks, several complementary EU and international references are relevant:

- **Council Recommendation on Key Competences for Lifelong Learning (2018)**: This landmark document sets out eight key competences, including citizenship, cultural awareness, digital and STEM competences. It encourages interdisciplinary, experiential learning, supporting exactly the kind of project-based, inclusive methods used in open schooling.
- **European Sustainability Competence Framework (GreenComp)**: Developed by the JRC, GreenComp promotes a shared understanding of sustainability learning outcomes. It underlines the importance of values, systems thinking, and collaborative problem solving—integral to the scenarios developed through the pilots.
- **Joint Research Centre (JRC) Brief on STEM and STEAM Education (2024)**: Highlights the transformative potential of STE(A)M approaches in developing both scientific literacy and social engagement, especially through the integration of the arts, ethics, and creativity into science education.

"STEAM education can bridge the gap between individual learners' interests and collective societal goals, reinforcing the civic role of science education in Europe."
— JRC Brief on STEM and STEAM Education (2024)

- **STEM Competences in the EU** (JRC138618, 2024): Stresses that transversal competences—such as critical thinking, teamwork, and sustainability awareness—are as important as technical skills in preparing Europe's youth for the green and digital transitions.
- **New European Innovation Agenda (2022)**: Advocates for regional innovation ecosystems that are rooted in strong connections between education, research, and civil society—exactly the role that open schooling seeks to fulfil.

STE(A)M Learning Ecologies (SLEs) Project

The STE(A)M Learning Ecologies (SLEs) project (G.A. 101094648) is a three-year Horizon Europe initiative (2023–2025) that puts science and STE(A)M education as drivers for community engagement and educational innovation. The project supports the development of STE(A)M Learning Ecologies, open schooling partnerships between formal, non-formal and informal education providers, civil society and enterprises who are working together on real-life problem-solving situations within local communities, co-creating real-life, meaningful learning experiences for students.

At the heart of the SLEs approach is the concept of co-creation, the active involvement of diverse stakeholders in every stage of the educational process: from identifying relevant community challenges, to designing and implementing interdisciplinary learning scenarios, and finally co-assessing outcomes. This collaborative approach not only fosters more relevant and inclusive learning but also strengthens the resilience and adaptability of local education ecosystems.

What makes SLEs unique

Unlike conventional one-off initiatives, the SLEs project established living labs for STE(A)M education, grounded in iterative cycles of co-design, testing, reflection, and adaptation. These cycles ensured that educational activities remain responsive to both learners' needs and community priorities. Schools are positioned not as isolated institutions but as collaborative hubs embedded in their local environment and acting as catalysts for civic, digital, and sustainable innovation.

The project brings together three complementary dimensions:

- **Open Schooling**, to embed schools in their communities and facilitate access to knowledge.
- **Living Labs**, to emphasise stakeholder co-creation and real-world experimentation.
- **STE(A)M Education**, to promote interdisciplinary, creativity-driven learning pathways that equip learners with competences needed for innovation and sustainability such as in the green and digital transitions.

Read more about the objectives and development of SLEs in the SLEs Methodology[1].

Strategic alignment

The SLEs project contributes directly to the EU's vision for inclusive, innovative education systems and aligns with several major EU strategies and frameworks:

EU Policy/Strategy	How It Connects to the SLEs Project
STEM Education Strategic Plan	Development of real-life interdisciplinary STE(A)M scenarios
Action Plan on Basic Skills	Reinforcement of literacy, numeracy through real-life applications
GreenComp	Engagement with green sustainability awareness (e.g. biodiversity, food waste and eco-literacy)
Digital Education Action Plan	Student learning artefacts including digital storytelling and student-made campaigns
Key Competences for Lifelong Learning	Focus on citizenship, cultural awareness, creativity, collaboration, ethical and sustainability mindset

OBJECTIVES AND METHODOLOGY

SLEs Implementation 2024-2025

Following Methodology, each of the 109 SLEs identified and addressed local problems through their project, covering a wide range of topics rooted in each country's unique context. SLEs fostered collaboration between a wide variety of open schooling actors, paving the way for the establishment of local networks promoting science at local level. A map with the key topics and the types of stakeholders involved is available at https://www.steamecologies.eu/#Map and in Figure 1.

All pilot stakeholders engaged in co-creation to develop hands-on, science-based learning experiences, and providing resources and expertise for their implementation,(such as delivering class seminars on specific topics such as robotics, supporting student group work in their laboratories, guiding them in the use of new technologies such as AI, 3D printing or robots).Supported by stakeholders, learners shared their work with the community, amplifying the impact of the lessons matured through the project to a wider audience. With this new expertise and learning resources learners explored diverse **STE(A)M careers**, used real-world tools and practices, bridging the gap between schools and the working world.

Teachers also benefited, expanding their pedagogical approaches and growing professionally through collaboration with industry and university.

However, the most notable result of schools' extensive cooperation with stakeholders, is that **it paved the way to future synergies**, cultivating a collaborative culture by establishing local, national and EU-level networks, where emerging problems in the community can be addressed collectively.

Inclusion was another central outcome of this approach: marginalised learners gained opportunities to showcase and develop their skills through practical experiences, and to explore new pathways for developing 21st century skills. Particular attention was given to girls' participation, supported

[1] https://www.steamecologies.eu/wp-content/uploads/2024/09/D2.2_SLEs_Methodology-Updated-Version_v3_streamlined.pdf

by the creation of a dedicated toolkit of initiatives and strategies to promote female engagement in STE(A)M initiatives, the organization of a webinar on gender inclusion, and the emphasis on offering practical STE(A)M experiences through learning paths.

Figure 1 Map of implemented SLEs and stakeholders involved

Evidence and Analysis

Between October 2024 and May 2025, SLEs scaled from 13 pilots in the previous year (see policy brief 2)[2] to 109 across **16 European countries** namely Cyprus, Germany, Greece, Ireland, Spain, Italy, Israel, Malta, Macedonia, Norway, Portugal, Romania, Serbia, Slovakia, Sweden, Turkey.

In response to the scale and complexity of this growth, SLEs partners reinforced their facilitation mechanisms, launched international onboarding, updated support materials, and enabled national coordinators to tailor strategies to local contexts. Further details on the types and outcomes of these support structures are available in Deliverable 3.3 – SLEs Monitoring and Reflection Final Report[3].

Driven by the ambition to capture stakeholder experiences, SLEs collected two key datasets: 105 learning scenarios and 95 completed questionnaires. Quantitative data from the surveys were cross validated with qualitative insights drawn from the analysis of the learning scenarios. and consolidated through an online reflection workshop with initiators from participating countries.

An analysis of the SLEs' learning products complemented these insights. Learning products are central to the SLEs methodology, because they both represent the tangible outcome of learners' and stakeholders' co-creation and involvement, and **evidence learners' engagement and development of their skills, knowledge and competences**. The results of this analysis are provided in Deliverable 4.3 – SLEs Learner Engagement Evaluation Report [4].

These combined efforts provide valuable lessons for scaling Open Schooling, and informing policy recommendations. The main results are presented in the sections that follow.

STE(A)M Open Schooling policy enablers and frameworks in national countries

The implementation of SLEs across various European and associated countries has revealed a complex landscape of national policies, institutional cultures, and educator agency in relation to open

[2] https://www.steamecologies.eu/wp-content/uploads/2025/01/SLEs_2nd-Policy-Brief_final.pdf
[3] https://www.steamecologies.eu/wp-content/uploads/2025/10/D3.3-Ecologies-monitoring-and-reflection-final-report-1.pdf
[4] https://www.steamecologies.eu/wp-content/uploads/2025/10/D4.3-Learner-engagement-evaluation-report.pdf

schooling and STE(A)M education. While many countries possess formal or informal frameworks that support interdisciplinary, community-engaged, and project-based learning, significant challenges persist in mainstreaming these approaches into everyday educational practice.

Key Policy Enablers

Across the pilots, several policy frameworks and conditions emerged as **enablers** of open schooling and STE(A)M initiatives:

- **Curriculum flexibility and teacher autonomy**
  - Countries like **Romania, Sweden, Norway**, and **Germany** benefit from national or regional curricula that explicitly encourage interdisciplinary, project-based learning.
  - Tools like Romania's **"Curriculum at the School's Decision"** and Italy's **PCTO framework** legally enable partnerships with external stakeholders and real-world learning integration.
  - In Cyprus, while there is no formal open schooling policy, the **autonomy** granted to individual educators and schools and the availability of digital citizen science tools served as low-cost enablers of STE(A)M integration and community involvement.
- **National and regional strategies aligned with STE(A)M and open schooling goals**
  - Italy's **STEM Guidelines (2023)** and Malta's **National Education Strategy 2024–2030** prioritize sustainability, inclusion, and innovative teaching, supporting the values behind open schooling.
  - Turkey's **"Century of Türkiye Maarif Model"** promotes holistic, inquiry-based learning with clear interdisciplinary connections.
  - In Spain, regional programs like STEMbach (Galicia), STEMcat (Catalonia) encourage STEM vocation by promoting curricular and extracurricular initiatives for secondary school students with local industries and academic institutions.
- **Government-funds, international and EU programs**
  - Participation in **Erasmus+, eTwinning, Scientix**, and **TÜBİTAK** programs provided structural and financial support for STE(A)M activities in Romania, Turkey, Sweden.
  - In **Italy** and **Romania**, the involvement of schools in national or European networks (e.g. Scientix, and prior H2020 projects) contributed to teacher readiness and institutional openness to innovation.
  - Italy and Germany have capitalized on the national recovery plans or financial school plans such as **PNRR**, **PON**, and the **STEM Action Plan**, providing significant infrastructure, training, and equipment investment.
  - In **Cyprus**, most pilots were enabled by **EU project funding, the UNESCO SEMEP network** and informal science networks, mainly in biodiversity and marine science.
- **University and municipality engagement**
  - In countries such as **Norway**, **Italy**, and **Malta**, universities and local authorities play a critical role in bridging formal education with research outputs and societal and environmental challenges.
  - Projects anchored in **university-led initiatives** (e.g., NTNU in Norway) benefited from curricular and institutional flexibility to embed open schooling.
  - In **Portugal** and **Ireland** SLEs capitalized on prior collaboration frameworks between schools, universities, and local authorities, enabling rapid stakeholder mobilisation.

For what regards gender-inclusive STE(A)M education, while several countries have embraced innovation in STE(A)M through open schooling initiatives, **explicit gender inclusion remains inconsistently addressed at the policy level**. In countries like **Italy, Malta and Romania**, national or regional actors are beginning to embed gender-awareness within STE(A)M learning pathways. However, most national frameworks lack clear guidance on gender-responsive pedagogies, identity

inclusion, or gender-disaggregated monitoring, suggesting that system-level enablers for equity in STE(A)M remain underdeveloped across Europe.

Key insights and findings from SLEs pilots

The SLEs across partner countries offer valuable insights into how Open Schooling and STE(A)M education can be adapted to local contexts, foster multi-stakeholder collaboration, and promote key competences in young learners. These results provide important evidence on the **potential** as well as the **enabling conditions** for implementing open schooling STE(A)M approaches at scale.

1. Curriculum integration and formal teacher recognition enhances relevance

One of the most consistent success factors across pilots was the alignment of SLEs with national curricula or school-level learning goals. This allowed projects to be conducted within regular class hours, avoiding the perception of open schooling as "extra-curricular."

- **Ireland**: Integrated plant growth monitoring into the Year 4 science curriculum, ensuring relevance and easy implementation.
- **Spain & Greece**: Designed sustainability-themed SLEs that aligned with science and digital skills objectives.
- **Norway**: Embedded Design Thinking methodology into the timetable, supporting iterative, inquiry-based learning
- In **Portugal**, SLEs has become a credited training course for educators who implement it. It's also an innovative way of training, because teachers learn 'by doing" an SLE with students, supported by the staff at the Ciencia Viva Centre.

***Policy recommendation*: Enable flexible curriculum frameworks and formal teachers' recognition that allow for interdisciplinary, project-based approaches.**

2. Multi-Stakeholder local collaborations amplify impact

SLEs involving external stakeholders—museums, research institutes, NGOs, businesses, and public bodies—created meaningful, real-world learning environments. These collaborations improved the quality of the activities and strengthened schools' visibility in their communities. They fostered an **ecosystemic approach**, where education was no longer siloed but connected to public science and community well-being. Moreover, in countries with a strong culture of participatory education or active local stakeholder ecosystems, pilots found it easier to initiate and sustain open schooling partnerships.

- **Italy**: Collaborations with research centres such as INAIL (on safety and inclusion), ISPRA (on environmental awareness), and CREA (on nutrition and biodiversity) enabled schools to access expertise, data, and tools that enriched the learning process.
- **Malta**: Partnered with the Malta Maritime Museum and other community actors to enrich the student experience.
- **Serbia**: Local NGOs, professionals, and civic actors co-facilitated sessions and hosted fieldwork.
- **Norway**: Parents, local welfare services, and data partners contributed to real-world relevance.
- In **Cyprus**, some SLEs leveraged local museums, NGOs, and citizen science platforms (eBMS), enabling direct student engagement with biodiversity and environmental data collection.

***Policy recommendation:* Encourage and fund school-community partnerships through national or municipal platforms.**

3. Inclusive STE(A)M design promotes equity and engagement

Projects that offered flexible formats and used inclusive pedagogical tools reported greater student engagement. In addition, several pilots demonstrated that when gender and identity considerations are integrated in the learning design, STE(A)M learning becomes more accessible and relevant to

all students. Supporting teachers in adapting STE(A)M content to classroom diversity proved especially important.

- **Italy**: Used inclusive design via the SPAIC Toolkit and scenario-based learning paths integrating gender and identity to ensure that learners of different backgrounds and abilities could fully participate in the activities.
- Flexible activity scaffolding (**Romania, Greece**) enabled greater participation by girls and other underrepresented groups in STE(A)M
- **Norway**: addressed student diversity in coding experience through scaffolding, peer support, and differentiated tasks.
- **Cyprus**: Several projects involved predominantly female groups. The combination of outdoor learning, digital tools, and community engagement fostered confidence and participation among girls and students with previously low STEM interest.

***Policy recommendation*: Mainstream inclusive design and gender-responsive pedagogies in national STE(A)M frameworks and teacher training programs.**

4. Digital tools increase student engagement

When students engaged with technology,such as sensors, data analysis platforms, or app development, in the context of real-world challenges, they reported increased motivation, deeper understanding, and a stronger sense of competence.

- **Norway**: Piloted AI, IoT, and coding tools in realistic problem-solving, balancing complexity with student experience.
- **Spain**: Addressed AI ethics and data protection while empowering students to use AI responsibly.
- **Malta**: Used Padlet to coordinate multi-school projects, and remote tools to monitor air quality.

***Policy recommendation:* Invest in accessible digital tools and ensure ethical guidance in digital education.**

5. Societal challenges enhance student ownership and systemic learning

When students co-designed solutions to real-world societal issues—like food waste, marine pollution, or local urban planning—they demonstrated greater ownership, critical thinking, and civic responsibility. These projects confirmed what EU-level research has long suggested: that **community-based, challenge-driven learning** increases engagement, retention, and depth of understanding. Moreover, by integrating **STE(A)M content with civic education**, projects enhanced transversal competences such as teamwork, ethical reasoning, communication, and sustainability mindsets.

- **Serbia**: Students engaged in problem-solving for community-relevant environmental issues, later showcasing their solutions in public forums.
- **Italy**: Projects focused on themes like workplace safety, healthy diets, and biodiversity, encouraging students to see themselves as agents of change.
- **Norway**: Students developed solutions for welfare and sustainability problems using a stakeholder-informed design process.
- **Ireland**: Students explored environmental challenges in their immediate surroundings, fostering both place-based awareness and scientific curiosity.
- In **Cyprus**, projects addressing biodiversity loss, marine pollution, and paleoenvironments exemplified the integration of ecological literacy, digital tools, and civic engagement,

***Policy recommendation*: Support civic-oriented STE(A)M projects through funding, teacher training, and curricular flexibility that allows students to tackle community-relevant challenges.**

6. Student outputs have public value and enhance student agency

SLEs produced tangible outputs— such as videos, campaigns, guides, interactive guides, exhibitions— many of which were shared with local authorities or displayed in community events. This

gave students a real audience and contributed to public awareness and civic engagement, showing that school-based projects can generate socially meaningful outputs beyond the classroom.

- **Italy & Serbia**: Student outputs were showcased in municipal events, school exhibitions, or community gatherings.
- **Norway**: Students developed functional prototypes that addressed societal challenges.
- **Malta**: Culmination events and workshops with external stakeholders gave visibility to student voice.
- **Cyprus:** Students sharing their findings with the public and peers through events, presentations, and online platforms. These dissemination activities helped students see their role as environmental stewards.

***Policy recommendation*: Incentivize public-facing educational outputs and promote civic visibility of school projects.**

Blockages and challenges in implementing SLEs

While the pilot implementation of SLEs demonstrated the potential of open schooling and STE(A)M to promote interdisciplinary, real-world learning, a common set of **systemic and practical challenges** emerged across participating countries. These blockages reflect misalignments between educational policy aspirations and the operational realities in schools.

1. Curriculum rigidity and time constraints

Time constraints and curricular overload remain widespread barriers to integrating open schooling into regular school activities. Indeed, across nearly all countries, rigid curricula and dense content requirements were identified as critical barriers:

- In **Ireland**, **Greece**, **Spain**, **Turkey**, **Serbia**, and **Germany**, the pressure to cover the prescribed curriculum limited teachers' ability to introduce interdisciplinary or exploratory projects.
- SLEs were often implemented **outside normal teaching hours** (e.g. **Malta**, **Serbia**, **Spain**), classifying them as “extra-curricular,” thereby reducing their visibility, institutional legitimacy, and accessibility for all students.
- In **Norway**, even with a more flexible curriculum, fitting time-intensive, creative activities into the school schedule was challenging, especially for collaborative or iterative methodologies such as **Design Thinking**.
- In **Cyprus** teachers cited a lack of dedicated hours for Open Schooling within the school calendar as a persistent challenge.

2. Lack of institutional support and policy priority

In several contexts, **open schooling is not yet recognized as a policy priority**, and institutional support is often absent or inconsistent:

- In **Spain**, teachers reported that their work on SLEs was neither institutionally acknowledged nor supported and came at personal cost in terms of time and workload.
- In **Turkey**, while national frameworks are evolving, **implementation gaps** across regions and **limited dedicated funding** make scaling open schooling difficult.
- In **Cyprus** and **Italy**, bureaucratic and administrative hurdles delayed or limited collaborations with external stakeholders, especially when **formal agreements** or **procurement processes** were required.
- In **Cyprus** educators often worked **without formal curriculum time or institutional support**, relying instead on voluntary commitment and project enthusiasm.

3. Limited financial and material resources

The **lack of dedicated funding** was a widespread challenge for many pilot projects:

- In **Italy** and **Cyprus**, project costs (e.g. transportation, materials) were often absorbed through informal contributions from stakeholders, teachers, or external projects.

- In **Malta**, logistical issues such as inadequate facilities (e.g. non-air-conditioned venues in summer) also posed a barrier, especially in out-of-school settings.

4. Teacher capacity and confidence

The successful integration of SLEs depends heavily on **teacher preparedness** and **subject confidence**, particularly for interdisciplinary initiatives:

- In **Greece**, **Turkey**, and **Romania**, some teachers reported a lack of training or confidence in teaching STE(A)M concepts, particularly when it was not their primary subject.
- In **Cyprus**, teachers need clearer methodological frameworks and practical, non-academic guidance—especially to scale up or guide newer schools in Open Schooling.
- Teachers often relied on personal initiative or peer support to bridge knowledge gaps—an unsustainable model without formal professional development structures.

5. Stakeholder coordination and engagement

Open schooling relies on collaboration among diverse stakeholders. Yet:

- **Israel** and **Germany** reported **fragmented stakeholder communication** or limited availability, leading to siloed interactions and reduced co-creation.
- **Serbia** and **Malta** experienced **logistical challenges** in coordinating activities across multiple schools or organizing field trips.
- In **Norway** and **Spain**, working with sensitive data (e.g. AI in public services or student information) highlighted the need for **data protection protocols** and **digital safety awareness**—areas where schools may lack expertise or capacity.

6. Sustainability and recognition

Even where SLEs were successfully implemented, concerns were raised about **sustainability**:

- In **Spain**, **Italy**, and **Malta**, reliance on volunteer time, goodwill, or temporary funding raised questions about how such initiatives could be institutionalized.
- Lack of **recognition for teachers' additional efforts**—whether through workload reduction, incentives, or professional credit—undermines long-term motivation and scalability.
- **sustainability of partnerships** after the pilot phase is a concern, particularly in areas with fewer institutional or financial resources.

POLICY IMPLICATIONS AND RECOMMENDATIONS

Policy recommendations

Policy Recommendation	Linked Challenges / Blockages	Challenge noted by	Implications for Scale-Up & Sustainability
1. Establish dedicated funding streams for Open Schooling	Lack of financial capacity to continue projects; extracurricular status of SLEs; underfunded schools	Italy Greece Spain Malta Cyprus	Financial support is a precondition for continuity and expansion—especially for materials, coordination roles, and teacher incentives.
2. Provide structured but flexible guidance for teachers	Lack of clarity in methodology for some; desire for more tools for co-design	Italy Malta Cyprus	Teachers want autonomy but also need adaptable guidelines and tools to sustain co-creation and integrate SLEs into curricula.
3. Allocate time and formal recognition for teacher participation	Teachers overstretched; SLEs often treated as "add-ons"; lack of institutional recognition	Malta Greece Ireland	Formal time allocation and recognition mechanisms (certificates, CPD credits) are key to making SLEs viable long-term.
4. Build formal coordination structures for school–community partnerships	Partnerships dependent on individuals; lack of sustained engagement mechanisms	Spain Cyprus Italy Turkey	To scale partnerships, schools need templates, role clarity, and support for stakeholder coordination.

Policy Recommendation	Linked Challenges / Blockages	Challenge noted by	Implications for Scale-Up & Sustainability
5. Develop peer mentoring and cross-school exchange networks	Lack of experienced guidance for newcomers; siloed practices	Spain Greece Malta	Networks of experienced SLE implementers can accelerate uptake and reduce entry barriers for new schools.
6. Support inclusive, gender responsive scenario-based design from the start	Inclusivity often addressed reactively; some students left behind	Italy Romania Greece Turkey	Embedding accessibility, gender sensitivity, and identity relevance improves equity and engagement system-wide.
7. Promote dissemination of student outputs in public and civic contexts		Malta Romania Italy	Recognizing and showcasing student work boosts motivation, civic engagement, and public support for Open Schooling.
8. Align SLEs with curriculum goals to ensure institutional fit	SLEs seen as extra-curricular or competing with required content	Ireland Greece Spain	Anchoring Open Schooling in existing curriculum frameworks improves feasibility and sustainability.
9. Provide ethical guidance and open-source digital tools	Unequal access to technology; unclear standards for AI, data use	Spain Norway Italy	Ensures responsible innovation while maintaining equity and low-cost implementation.
10. Leverage existing networks and innovation cultures to support open schooling uptake	Co-creation and partnership readiness varies; successful pilots often built on pre-existing collaboration structures	Germany Italy Romania Ireland Portugal	Capitalising on existing EU networks (e.g. eTwinning, Scientix), science centres, and prior project experience helps new implementers and supports scaling up
11. Foster and support distributed educational leadership for innovation	School or municipal leadership often key to implementation success, even without formal policy	Malta Cyprus Norway Serbia Turkey	Enabling distributed leadership and recognising local innovation champions builds ownership and momentum at local level

Implications for sustainability: a scalable vision with systemic support

The SLE pilot projects revealed significant potential for replication and sustainability but also identified key enabling conditions to scale up open schooling across educational systems. While several countries expressed readiness to continue or replicate their projects autonomously, long-term sustainability will depend on systemic support in key areas such as **funding, institutional frameworks, teacher capacity, and collaborative infrastructure.**

- **Financial support** is a precondition for continuity and expansion of SLEs even for motivated stakeholders
- **Cross sectoral partnerships are transformative but** maintaining them requires formal policy support and structured international/national coordination capacity and mechanisms.
- **Teachers** value autonomy and creative freedom in the methodology, but **need structured, adaptable tools** to co-design open learning paths, as well as **clear guidelines, time allocations, and recognition mechanisms.**
- **Peer-to-peer exchange**, both nationally and across countries is valuable for scaling up.
- SLEs work best when embedded in **school-wide strategies and curriculum**. **Problem-based learning,** where learners engage in real, problem-driven situations helps schools integrate curriculum goals with community relevance.

Overall, the SLE pilots confirmed that a **STE(A)M Open Schooling approach is scalable**, but only if supported by **policy frameworks and conditions** that value innovation, capacity building, inclusion, and community participation. Financial, institutional, and pedagogical investments are needed to move from pilot to policy and to embed these practices sustainably in European education systems.

Year 3 Project Outputs

- Portfolio of SLEs (30) – coming in November
- Learning scenarios (30) – Coming in November
- Read about the latest SLEs activities on the project's website: link here
- SLEs Methodology – Final Coming in December
- SLEs Deliverable 3.3 Learner Engagement Evaluation report
- SLEs Deliverable 4.2 Learning Path Interventions
- SLEs Deliverable 4.3 Monitoring and Reflection Report

Project Identity

Project name

STE(A)M Learning Ecologies (SLEs)

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Consortium

- European Schoolnet (EUN Partnership AISBL), Belgium - Coordinator
- Agenzia per la Promozione della Ricerca Europea (APRE), Italy
- Center for the Promotion of Science (CPN), Serbia - Affiliated Entity
- Centro Ciência Viva do Algarve (CCVALG), Portugal - Affiliated Entity
- Ellinogermaniki Agogi (EA), Greece
- European Network Science Centres & Museums (ECSITE), Belgium
- Humboldt-Universität Zu Berlin (HUB), Germany
- Ministry for Education, Sport, Youth, Research and Innovations (DCM), Malta
- Museos Científicos Coruñeses (CASACIENCIAS), Spain - Affiliated Entity
- National University of Ireland Galway (NUIGALWAY) - Affiliated Entity
- Norwegian University of Science and Technology (NTNU)
- University of Cyprus (UCY), Cyprus
- WISTA, Germany

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Website

- https://www.steamecologies.eu/
- SLES - STE(A)M Learning Ecologies (scientix.eu)

For more information

Contact the SLEs Coordinator at info-sles@eun.org

COLLABORATIONS

The SLEs project is part of the Open Schooling together (OStogether) network of projects and supported by the Scientix community for science education in Europe.

FURTHER READING

- D2.2 SLEs Methodology
- Open Schooling Policy Brief, Make it Open (MiO) and Schools as Living Labs (SALL) Horizon 2020 projects, with the support of the OStogether network.
- SLEs portfolio
-

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EUROPEAN

POLICYBRIEF

STRATEGIC SUPPORT AND RESOURCES IN STE(A)M LEARNING ECOLOGIES

December 2024

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INTRODUCTION AND POLICY CONTEXT

Open schooling and science education context and policies in Europe

Open schooling and science education are key components in developing a well-informed and scientifically literate society in Europe. They both promote the collaboration between schools, communities, CSOs, enterprises and research institutions to create engaging and effective educational experiences, with the aim of empowering the students to have a role in the STEM field. This approach is supported by various European policies and initiatives, including the Open Schools for Open Societies (OSOS)[1] projects, the European Research Area (ERA)[2] policy and the European Education Area (EEA) policy[3].

Building on the work of these European policies/initiatives and on the findings of the first SLEs policy brief, this second SLEs policy brief and its recommendations aim to ensure that science becomes more accessible, relevant, and inclusive, aligning with societal needs and encouraging broader participation in the scientific process. These recommendations will support the institutionalization and sustainability of the SLEs approach, providing a framework for broader adoption and integration into educational systems.

OSOS Projects

The Open Schools for Open Societies (OSOS) network, where the SLEs project is part of, is a key initiative aimed at transforming schools into community hubs that promote scientific literacy and

[1] https://www.schoolofthefuture.eu/en/osos
[2] https://research-and-innovation.ec.europa.eu/strategy/strategy-2020-2024/our-digital-future/european-research-area_en
[3] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0625

innovation. Funded by the European Commission, OSOS focuses on creating open schooling environments where students, teachers, and local communities collaborate on real-world scientific projects.

Key Objectives of OSOS:

- **Promoting inquiry-Based learning:** OSOS encourages inquiry-based learning, where students actively engage in scientific inquiry and problem-solving.
- **Fostering collaboration:** OSOS emphasizes partnerships between schools, businesses, research institutions, and community organizations to enhance learning experiences.
- **Enhancing teacher professional development:** OSOS provides training and resources for teachers to implement open schooling practices effectively.
- **Encouraging student engagement:** By involving students in hands-on projects, OSOS aims to increase student interest and participation in STEM (science, technology, engineering, and mathematics) subjects.

Notable types of OSOS projects:

- **STEM innovation labs:** Schools create innovation labs where students can experiment with new technologies and scientific concepts.
- **Community science projects:** Collaborative projects that address local issues, such as environmental monitoring and sustainable development.
- **Science festivals and fairs:** Schools host events to showcase students' scientific work and engage the broader community in science education.

European Research Area (ERA) and European Education Area (EEA) Policy

The European Research Area (ERA) policy together with the European Education Area (EEA) policy are a strategic framework aimed at creating a unified education, research and innovation landscape across Europe. Together they seek to enhance cooperation, reduce fragmentation, and promote excellence in education, research and innovation by working to make knowledge a foundation for democratic, resilient and inclusive societies.

The **ERA Policy**, in its effort to achieve its fourth objective “Deepening the ERA”, makes clear the need to strengthen the participation of women in STEM fields and foster entrepreneurship as well as the potential of involving young generations in promoting participatory actions concerning the transformation of our economy and society. To this end, the role of science education in formal and non-formal learning contexts is key.

In relation to this, the **ERA Action 14** of the **ERA Policy Agenda 2022-2024** is titled **"Bring Science Closer to Citizens"** and aims to increase public engagement with science through citizen science initiatives, improved science communication, and education and training activities. It focuses on making scientific research more accessible and relevant to everyday life, fostering greater trust in science. This action seeks to strengthen the connection between science and society, ensuring that research is inclusive and aligned with societal needs.

Furthermore, the European Commission in the Communication on the **European Education Area EEA** (2020) recognizes the importance of:

- Promoting gender equality to challenge and dissolve gender stereotypes that constrain the choices of boys and girls for their field of study.
- Starting from the education systems to change behaviours and boost skills for the green economy.
- Pursuing an innovative and multi-disciplinary teaching and learning approaches for basic skills.
- Fostering transversal skills.
- Encouraging non-formal learning which help to gain life and professional skills and competencies.

- Bringing science to schools. To this end, it is worth mentioning the “Researchers at schools” initiative allowing young researchers to engage with teachers and students on different science topics such as climate change, sustainable development, digitalisation, health.

SLEs project is trying to build on these policies and objectives to develop a more open, inclusive and participatory learning environments.

STE(A)M Learning Ecologies (SLEs) Project

The 3 years STE(A)M Learning Ecologies (SLEs) project (G.A. 101094648) aims at promoting science education as part of local community development through the creation of open schooling partnerships between formal, non-formal and informal education providers, civil society and enterprises working together on real-life problem-solving situations within local communities. To this purpose, SLEs introduces the powerful concept of “STE(A)M Learning Ecologies”, intended as partnerships able to provide multiple science learning opportunities for all citizens in a learning continuum of different learning spaces.

The SLEs approach brings together the dimensions of open schooling, living labs, and STE(A)M education. Open schooling promotes collaboration between schools and their communities, transforming educational institutions into community-connected learning hubs. The Living Labs dimension emphasizes co-creation, where stakeholders such as researchers, educators, students, industry professionals, and civil society collaborate closely resulting in designing and testing solutions in real-world settings. STE(A)M education ensures a multidisciplinary approach that fosters creativity and critical thinking.

A key feature of the SLEs project, setting it apart from other initiatives, is its commitment to create sustainable pathways for educational innovation. This is achieved through the co-designed implementation of living labs in iterative cycles, which contrasts with the more common approach of one-shot open schooling initiatives. By involving stakeholders in an ongoing, iterative process, the SLEs project aims to build long-lasting, adaptable educational ecosystems that can evolve with the needs of the community.

Objectives and Methodology

The **first small-scale pilot implementation of SLEs** took place in Year 2 of the SLEs project, between September 2023 to May 2024, in **13 European countries**. In this context, SLEs partners organised several co-creation workshops involving numerous stakeholders (teachers, educators, researchers and experts, representatives of science museums, industry, civil society, and public authorities) who have joined forces at local level to develop and implement learning ecologies. Various webinars have been organised, support material and different guidelines have been created, students’ learning artefacts and feedback have been collected while conclusions have been drawn and initial reflections have been made.

In addition to these efforts, there has been a strong emphasis on **collecting evidence and impressions** on stakeholders’ experiences. This data collection aims to provide insights into the impact of SLEs on communities, thereby informing future improvements and recommendations.

The data collected, which also informs the evidence of this policy brief, includes an open-ended questionnaire delivered to external stakeholders in the different pilot countries, including policymakers and practitioners, to assess the current state of policies in the countries, as well as perceptions on good practices and challenges related to open schooling and STE(A)M implementation in schools. A total of 11 questionnaires have been analysed to this purpose. Moreover, a multiple-choice survey assessing the evaluation of the pilot implementation in the

countries was delivered to project partners, including questions on the learning objectives and competences achieved by students, learning methods adopted, female inclusion, teacher development, stakeholder collaborations and implementation challenges. Qualitative interviews to pilot stakeholders were also used as primary data collection input. Finally, an online co-creation reflection workshop conducted in June 2024 with all project partners to assess the main outputs of the SLEs implementation has been conducted, addressing aspects such as the main benefits of the SLEs and strategies for replication and sustainability. All these data were analysed considering both their quantitative or qualitative aspects, and the main results are reported in the sections here below.

The results of this analysis have been shared and validated during the 2nd SLEs policy learning session that took place in September 2024 online involving key representatives from DG EAC of the European Commission, representatives from national Ministries of education of Italy and Malta, and Open Schooling EU-funded projects ensuring the correctness and relevance of the collected information. This Policy learning session sparked a fruitful discussion that spotlighted some relevant aspects that were accordingly integrated in this policy brief.

EVIDENCE AND ANALYSIS

State of the art of Open Schooling and STE(A)M in national countries

The following points present the current state of policies, resources, and practices supporting STE(A)M education and open schooling approaches throughout Europe:

- A growing focus on the **development of curriculum** suited to include innovative approaches for education can be observed. An example are new courses that are recently introduced integrating Artificial Intelligence (AI) with artistic subjects in high schools in Galicia, Spain. This curriculum development reflects an effort to merge technical and creative skills, preparing students for a multidisciplinary future.

- There is also a strong emphasis in the analysed countries on **professional development**, with several different training courses offered to teachers and educators. The training courses have a specific focus on arts, technology, and artificial intelligence. Both initial and ongoing training programs are designed to ensure that teachers are well-equipped to incorporate STE(A)M elements into their teaching practices. An example is the Italian ministerial initiative *"Scuola Futura",* an open access platform funded by Next Generation EU program providing teachers with online courses and learning paths focused on innovative teaching methods.

- Pilot programs in some countries (e.g. Spain and Norway) are distributing innovative tools like 3D printers and robotics kits to schools, supported by national and local authorities. This **allocation of concrete resources** supports hands-on STE(A)M activities and enhances practical learning experiences for students.

- **Regional centres dedicated to educational innovation** and STE(A)M education are being established in the case of Germany. These centres support the development and dissemination of innovative teaching practices and resources.

- Efforts to **integrate artistic elements** into STEM education are growing in almost all analysed countries. This approach aims to combine creativity with technical knowledge, providing a more holistic educational experience. However, the formal integration in school curricula is not yet mature due to rigid subject-oriented structures and the lack of interdisciplinary frameworks.

- **EU-funded projects and non-formal initiatives**, such as educational apps and interactive campaigns, are promoting STE(A)M education outside traditional classrooms. This is particularly evident in countries such as Cyprus, Serbia, Greece. Such projects help raise awareness and engage students through innovative methods. For instance, in Serbia formally the Ministry of Education recognizes and encourages ambient teaching as a form of open schooling.

- Successful **multistakeholder collaborations and partnerships** between schools, industry, and research organizations are being supported through various EU-funded initiatives implemented in national countries analysed. Examples include the EU4Ocean Coalition and the Youth4Ocean Forum, which bridge gaps between different stakeholders to foster collaborative STE(A)M education.

- In Ireland, policies and tools have clear **educational goals** on creating open and diverse educational experiences, boosting teacher motivation, and optimizing resource use. This is achieved through the active involvement of local communities, offering continuous teacher training, and developing extracurricular activities that align with educational objectives.

Pilot Implementation 2023-2024

SLEs pilot projects were implemented in **13 different countries**, namely Cyprus, Germany, Greece, Ireland, Italy, Malta, Norway, Portugal, Romania, Serbia, Slovakia, Spain. Each pilot SLE initiator, intended as the entity (schools, universities, science centres, museums, research centres, industries) that start to think, develop and implement a pilot learning ecology (they can be either a project's partner or external stakeholders connected with project partners), was invited to identify and address local problems through the implementation of their project, resulting in a great variety of topics that reflected each country's unique local context. These ranged from AI and digital tools to civic education and sustainable behaviours, to the study of earthquake phenomena, or environmental conservation.

Depending on the theme of each pilot, SLEs recruited different types of **stakeholders** (including universities, research centres, NGOs, private organisations, industries, museums etc.) that could provide expertise and resources for the development of project activities and the definition of the learning products (i.e. artefacts constructed by learners along their paths in the SLEs). A total of **28** formal education providers, **20** non-formal education providers, **18** governmental organisations, **7** civil society organisations, **23** industry partners were involved and a total of **1.076** learners took part in the SLEs pilot projects.

In all the pilots, stakeholders and teachers engaged in co-created activities and workshops and supported students in their learning path by providing valuable resources and expertise. These activities include preparation and co-planning, where stakeholders met to agree on the learning paths to be implemented, make important decisions on the tools and resources to be used, divide roles and responsibilities during project implementation, and evaluate progress.

Moreover, stakeholders implemented diverse activities with students, including delivering in class seminars on specific topics, supporting student group work through innovative approaches, guiding them in the use of new technologies such as AI, 3D printing or robots, and organizing field trips. Finally, stakeholders were involved in the organization of dissemination activities whose purpose was to encourage students to share their learning artefacts and experiences with wider audiences. In certain cases, these events were whole-school presentations, in others, stakeholders such as museums and universities hosted exhibitions or presentations for the local community to attend. Other SLEs took advantage of national conferences to share the project results. Finally, some opted for sharing the artefacts with parents through online communication and involve them in their evaluation by organizing contests.

The extensive engagement of stakeholders throughout the design, implementation and dissemination of SLE pilots, allowed students to benefit from richer learning experiences, thanks to the availability of a broader spectrum of expertise and learning resources than the ones their school could offer. Moreover, teachers also had the opportunity to broaden their horizons to new ways of teaching and interacting with learners and grew professionally thanks to the experience gathered.

However, the most notable result of schools' extensive cooperation with stakeholders, is that it paved the way to future synergies, cultivating a collaborative culture at the local level, where emerging problems in the community can be addressed collectively.

During this first pilot implementation, students in the 12 countries co-produced a variety of different **learning products**, by using dedicated learning resources made available by stakeholders in the SLE pilot. These artefacts were an extremely significant element to decentralize formative assessment while allowing a robust integration, enabling an insightful stakeholder dialogue and reflect scientific knowledge, skills and competences acquired during the SLE learning path. Moreover, the direct involvement of students in the production of such artefacts allowed them to develop a sense of ownership and provided the opportunity to experiment directly, gaining hands-on experience to apply what they learned in the SLE. Among the artefacts produced by learners, some illustrative examples are:

- **The Mosaic of the community brain**: the mosaic is the result of a collaboration between CÚRAM – the Science Foundation Ireland Research Centre for Medical Devices based at SLE project partner University of Galway – and three other partners (Ballybane Library, Galway Community College and artist Alison Mac Cormaic). The brain-themed artwork blends 30 mini mosaics from students and library staff, symbolising the unity of cell nuclei in the brain, echoing the project's focus on community connection.
- **A book crossing house realised with recycled materials**: the product was developed by school students in collaboration with Italian stakeholders. The book crossing house serves the purpose of raising awareness among pupils about circular economy and sustainability.
- **A botanical e-book** featuring descriptions illustrations and identification keys for endangered plant species.
- **A DIY seismometer** to collect and analyse data: high-school pupils first designed seismic shake tables to understand, study and demonstrate how earthquakes impact structures and buildings. Then following expert instructions, diagrams and materials they built seismometers to collect data from earthquake activity and to analyse them using software tools just like real scientists and researchers do.

You can explore the full portfolio, which showcases all the artifacts created across the various pilots completed in this phase of the project. **Click here** to access the complete collection.

Good practices and success factors

The analysis of the data collected from the pilot SLEs led us to the following conclusions:

There are good practices and benefits achieved for different stakeholders while implementing a learning ecology, particularly addressing **gender stereotypes**. For example, Malta's GirlsforSTEM project sparked girls' interest in STEM through mentorship and female-led activities. Spain's pilot SLE showed a positive gender balance, with more girls participating. In Italy, younger students were less influenced by gender stereotypes. Serbia's SLE was balanced, with significant participation of girls in ICT activities. All SLEs included female role models to address the gender gap, although teachers sometimes struggled to recognize these efforts. However, while positive outcomes were observed for the ability of SLEs to deconstruct gender stereotypes and develop

ICT literacy these impacts varied greatly across projects, likely because certain pilots focused specifically on these topics, while others did not directly address them.

Key benefits also included **improved interactions between teachers and students**, increased **student engagement**, and **professional development for teachers** achieved through collaboration with researchers and experts. In Italy, Greece, Cyprus, and Malta, researchers and universities provided new methodologies, open resources, expertise and equipment, enhancing both student learning and teacher instruction.

More specifically, SLEs proved highly effective in **developing 21st century skills.** Initiators reported strong gains in their students' creativity and innovation, collaboration and communication, as well as problem solving and critical thinking skills. Furthermore, SLEs exposed students to real-life problems, sparking greater interest and motivation towards STE(A)M studies and careers.

The **Living labs** approach, as part of the SLEs methodology, contributed to the active participation of various stakeholders, including schools, companies, research institutions, and local communities. These partnerships combined expertise and resources, making learning more relevant and engaging. In Malta, collaborations with companies and universities offered students hands-on experiences in STE(A)M fields. Slovakia benefited from partnerships with foreign schools and regional funds, facilitating student mobility and international collaboration.

Inclusiveness for all students was also a key focus. In Italy, foreign girls overcame language barriers through practical project involvement and group conflicts were overcome by working in teams on ethical and practical projects. SLEs ensured equal participation for all students, accommodating individual needs and disabilities.

Partnerships with companies and schools, and the creation **of international networks created by the project**, enriched the SLEs. In Ireland, a successful SLE inspired other stakeholders to participate in future projects. In Italy, stakeholders involved in the pilot phase act as ambassadors and mentors for future replications. Alignment with stakeholders' goals and enthusiasm of initiators ensured broad participation and support. In Serbia, alumni were eager to mentor students in designing a local school gym. Pilots in Germany and Slovakia generated valuable data for further research, fostering a culture of inquiry and scientific contribution.

Obstacles and challenges

When it comes to obstacles and challenges, all countries agree that the difficulties they face are mostly related to **policy, curriculum, time, and resources**. Designing and implementing innovative school practices requires more time for planning, professional development, and infrastructure arrangements, combined with iterative evaluation and refinement processes.

Legal recognition of teachers' and experts' contributions to innovative education is insufficient, and the lack of compensated working hours for additional efforts, hinders their engagement. **Bureaucratic hurdles** create delays and inefficiencies, delaying and undermining progress.

Teachers often lack adequate support from schools and local communities, including limited resources, insufficient professional development, and inadequate community engagement. This **lack of support** makes it difficult to effectively implement and sustain STE(A)M projects. **Traditional subject-oriented approaches** constrain the flexibility needed for hands-on, project-based learning essential to STE(A)M education, reducing opportunities for creative problem-solving and critical thinking.

Schools are not well-prepared to use technological tools, and ongoing professional development opportunities are limited. Existing training programs may not fully equip teachers to integrate STE(A)M elements into their teaching practices. Centralized education policies create **rigid curricula** that hinder the implementation of STE(A)M approaches, leading to generic lesson plans that limit effectiveness and local tailoring of educational practices.

Financial constraints and initial difficulties in collaborating with industry partners limit the potential of STE(A)M initiatives. **Limited funding** and challenges in forming effective industry partnerships slow progress, and the involvement of multiple stakeholders complicates coordination. Engaging various stakeholders in the co-creation of STE(A)M initiatives is challenging, with teachers concerned about their roles and job security. Balancing the demands of formal curricula and assessments with the time needed for innovative projects remains a significant obstacle.

Integrating STE(A)M into curricula and adopting flexible teaching methods are ongoing challenges. **Administrative barriers** and **traditional teaching methods** hinder STE(A)M implementation. There is a need to revive previously active partnership groups and enhance curricula flexibility to support interdisciplinary teaching better.

POLICY IMPLICATIONS AND RECOMMENDATIONS

Policy recommendations and implications

Based on the evidence gathered and analysed, including the validation process that took place within the 2nd Policy Learning Session, we provide a set of recommendations which can contribute to the advancement of open schooling and STE(A)M learning ecologies.

- It is necessary to provide strong **advocacy for increased funding** and securing structural and long-term financial support for schools and teachers to acquire necessary resources for open schooling projects. Insufficient funding or budget constraints hinder the successful implementation of Open Schooling and SLEs, limiting resources for educational activities, materials, and teacher training.

- Encourage the development of policies that support **curriculum flexibility** to integrate open schooling principles, interdisciplinarity, and inclusiveness is also deemed important. This flexibility will encourage the shift from a strictly subject-oriented approach to a more thematic curriculum and learning, facilitating interdisciplinary collaboration and easing engagement with external actors.

- Currently, most of educational innovations are relying on volunteer teachers and extracurricular activities. To achieve sustainable and continuous educational innovation it is imperative to **integrate these initiatives into the formal curriculum**, ensuring that educational innovation is sustained and embedded in everyday school practices.

- **Developing strategies and policies to enhance gender balance and inclusivity in science education is essential**. Existing policies that do not address gender disparities or biases in education pose challenges in promoting female participation and breaking gender stereotypes, thus requiring additional efforts to overcome systemic barriers.

- **Enhancing the collaboration between educational institutions, research bodies, and industry** is another point to be strengthened. This can be achieved, for example by showcasing the long-term benefits for industries or integrating data in citizen science projects by the research centres. By strengthening these connections education experiences will be enriched and students will experience real-world applications of their learning that will enhance their engagement.

- Promoting the adoption of **innovative educational approaches** and methodologies through training including also the use of experiential learning, game-based learning, and design-based learning. Such approach will contribute to making STE(A)M education more

engaging and interactive, ensuring that teachers are provided with training on these innovative approaches and methodologies.

- Creating a robust **support system** for schools and teachers, including professional development and administrative support is of paramount importance. Provide comprehensive training programs to prepare teachers for implementing STE(A)M and open schooling initiatives effectively

- Developing **policies that support community engagement**, strengthening the implementation of open schooling approaches is another key point to be brought to the attention of policymakers. Fostering partnerships between schools, local communities, and external actors is necessary to create a supportive and collaborative educational environment.

- **Supporting the development of policies that prioritize, and support STE(A)M education initiatives** can provide a conducive environment for the implementation of the SLE. Align policies with the goals of promoting interdisciplinary learning and real-world applications, ensuring that STE(A)M education is integrated into national and regional educational strategies.

- **Policies that promote inclusivity and diversity in education** can finally support efforts to increase female participation and deconstruct gender stereotypes within the SLE, aligning with the project's objectives.

- Establish **clear and standardized definitions of interdisciplinary STEM education** to guide curricula development effectively. A unified understanding can facilitate educators' integration of STEM subjects with the arts, promoting well-rounded STE(A)M learning that aligns with modern, interdisciplinary educational goals.

Overall, the alignment of national and European policy framework with the goals and objectives of the SLEs project can greatly influence its successful implementation. Addressing potential barriers and leveraging supportive policies can enhance the impact and sustainability of the project.

Scale-up and sustainability

In relation to scaling up and sustainability of such practices, it is important to **implement policies that facilitate the replication and scaling of successful open schooling practices**. These policies should encourage the integration of STE(A)M education into standard curricula and support effective innovative teaching methods, drawing lessons and ideas from the SLEs implemented in the pilot phase.

- The participation of at least 3-4 **diverse stakeholders**, including educators, industry partners, researchers, and community members is essential. This diversity enriches the educational experience and enhances the quality of open schooling initiatives. Incorporate a mix of schools with different levels of experience in open schooling, providing tailored support based on their experience levels to ensure effective implementation. This approach helps experienced schools build on their successes while guiding new schools through their first steps. Including schools from less central areas ensures diverse representation and equitable opportunities, bridging the gap between urban and rural education.

- Develop **clear guidelines for stakeholder cooperation**, defining roles, responsibilities, and expectations. These guidelines should allow for flexibility and an elastic timeline to accommodate different implementation stages and varying speeds of adoption. This structured but adaptable approach facilitates smoother collaboration and more effective project execution. Establish a network of experienced schools and stakeholders to share good practices and successful strategies. This network acts as a valuable resource for schools embarking on open schooling initiatives, offering practical insights and proven

methods. It also promotes opportunities for peer-to-peer learning among educators, fostering a community of practice where ideas can be exchanged, challenges troubleshot, and support provided.

- Develop comprehensive **strategies for the long-term sustainability of open schooling initiatives**. Integrate successful practices into regular school curricula to ensure continuity and institutional support, embedding STE(A)M education principles into standard teaching frameworks to make them a permanent feature of the educational landscape. Encourage small-scale efforts and low-cost STE(A)M Learning Ecologies (SLEs) to make STE(A)M education more accessible and sustainable. These approaches allow for incremental adoption and experimentation, making it easier for schools with limited resources to participate and benefit while fostering creativity and innovation within financial constraints.

- Establish systems for clear **recognition of teachers' efforts in implementing innovative learning methodologies**. Acknowledging and rewarding educators for their contributions to STE(A)M education motivates them and enhances their commitment to these initiatives. Recognition can come in various forms, such as professional development opportunities, awards, and public acknowledgment of their achievements.

- Enhance **partnerships between formal education and informal education** sectors, such as science centres and museums, which provide **experiential learning opportunities**. These informal education networks bring concepts to life for students, enriching STE(A)M education with **real-world applications**, which increases accessibility and engagement.

- Develop policies to create sustainable partnerships by embedding a **shared ownership model** among schools, communities, and industry partners. Ensuring **young people's active involvement** in such partnerships will make STE(A)M programs more resilient to funding fluctuations, while aligning these initiatives with stakeholders' evolving needs and long-term goals.

From our second year of project implementation, we can conclude that while there has been significant progress in curriculum development, teacher training, and resource allocation in relation to STE(A)M and open schooling policies across Europe, further efforts are required to overcome existing barriers, aligning the national policy frameworks with the goals and objectives of the SLE. Ensuring that STE(A)M education becomes a standard and integral part of the educational experience remains a key goal. By addressing these challenges and building on successful practices, STE(A)M education and open schooling can continue to evolve and thrive.

Year 2 Project Outputs

- Portfolio of pilot SLEs: link here
- Read about the latest SLEs activities on the project's website: link here
- SLEs Methodology – Version 2: available here
- Deliverable 3.2: Ecologies Co-creation and Facilitation. Available here

Project Identity

Project name STE(A)M Learning Ecologies (SLEs)

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CONSORTIUM

- European Schoolnet (EUN Partnership AISBL), Belgium - Coordinator
- Agenzia per la Promozione della Ricerca Europea (APRE), Italy
- Center for the Promotion of Science (CPN), Serbia - Affiliated Entity
- Centro Ciência Viva do Algarve (CCVALG), Portugal - Affiliated Entity
- Ellinogermaniki Agogi (EA), Greece
- European Network Science Centres & Museums (ECSITE), Belgium
- Humboldt-Universität Zu Berlin (HUB), Germany
- Ministry for Education, Sport, Youth, Research and Innovations (DCM), Malta
- Museos Científicos Coruñeses (CASACIENCIAS), Spain - Affiliated Entity
- National University of Ireland Galway (NUIGALWAY) - Affiliated Entity
- Norwegian University of Science and Technology (NTNU)
- University of Cyprus (UCY), Cyprus
- WISTA, Germany

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BUDGET

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WEBSITE

- https://www.steamecologies.eu/
- SLES - STE(A)M Learning Ecologies (scientix.eu)

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COLLABORATIONS

The SLEs project is part of the Open Schooling together (OStogether) network of projects and supported by the Scientix community for science education in Europe.

FURTHER READING

- SLEs Concept White Paper
- SLEs Methodology
- Open Schooling Policy Brief, Make it Open (MiO) and Schools as Living Labs (SALL) Horizon 2020 projects, with the support of the OStogether network.
- SLEs portfolio

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EUROPEAN

POLICYBRIEF

STE(A)M LEARNING ECOLOGIES (SLES): OPEN SCHOOLING FOR SCIENCE EDUCATION AND A LEARNING CONTINUUM FOR ALL

January 2024
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Laura Mentini (APRE), Barbara Quarta (EUN), Evita Tasiopoulou (EUN), Chiara Pocaterra(APRE)

INTRODUCTION AND POLICY CONTEXT

Open schooling is gaining momentum in Europe, enhancing the accessibility and flexibility of education. This transformation aligns with the growing interconnectedness and interdependence of societies worldwide, all while navigating increased competition in the realms of science and technology. To confront the demanding societal issues, it is imperative that every citizen possesses a strong foundation in science and technology. Such knowledge is the bedrock for informed decision-making and fostering innovation, and the policies pertaining to science education wield substantial influence over a society's long-term economic growth and prosperity.

In recent years, Europe has observed a decline in student interest in careers related to science and technology. Furthermore, a substantial gender gap in STEM fields persists, and there has been limited growth in science-based innovation or entrepreneurship. Consequently, Europe faces a shortage of individuals with scientific expertise. To overcome these challenges, the need to boost education and teacher training systems is imperative.

In response to these concerns, the European Union launched its revised **Digital Education Action Plan (2021-2027)**. This initiative seeks to aid EU member states in the sustainable and effective adaptation of their education and training systems to the digital era. It places a strong emphasis on gender equality, particularly by encouraging women's participation in STEM fields. The importance of gender equality in education is underscored in both the Education 2030 Agenda and the UN Sustainable Development Goals (2015). These endeavors advocate for inclusive, equal, and diverse education.

A pivotal moment, emphasizing the priorities and efforts required to reform science education policy at the European level, unfolded in 2015. The expert group on science education of the European Commission released its report titled "**Science Education for Responsible Citizenship**." This report identified the necessity for science education to be a lifelong learning process, commencing from preschool and extending into active citizenship. It also recommended a

shift from STEM to STE(A)M by integrating science with other subjects and disciplines. The report highlighted the significance of collaboration among various educational institutions, enterprises, and civil society to engage individuals with science and stimulate interest in science-related studies and careers. It promoted "open schooling" where schools collaborate with diverse stakeholders on practical projects, thereby fostering partnerships and community involvement. Furthermore, the report acknowledged the critical role of facilitating the sharing and application of scientific research findings among educators, researchers, and professionals from various sectors for mutual learning and progress.

In addition, the **EU key competence framework** for lifelong learning, adopted as a Council recommendation in 2018 has prioritized essential knowledge, skills, and attitudes for lifelong learning, including science and mathematics.
In essence, open schooling within science education policies in Europe are undergoing transformation to address the evolving educational landscape. They aspire to encourage lifelong learning, interdisciplinary approaches, and active community engagement, aligning with the needs of an increasingly interconnected and competitive world. These policy initiatives aim to equip individuals with the knowledge, motivation, and sense of societal responsibility needed to actively participate in the innovation process and confront intricate societal challenges.

In relation to inclusivity and social impact, research recognizes that a STE(A)M learning approach, by focusing on creating creative and innovative environments, is also beneficial for the inclusion of all student learning styles and disabilities (e.g. gifted children, those with special education needs etc.) and recognizes the potentiality of an open schooling approach involving the community to enhance education as well as social stimuli in more deprived school areas.

Additionally, the fourth objective of 'A new ERA for Research and Innovation' policy (COM (2020) 628 final) consists of deepening the **European Research Area** (ERA) to promote the free circulation of knowledge connecting all actors across Europe, including in education, training and the labour market. Through science education and other RRI (Responsible Research and Innovation) principles, the outcomes of Research and Innovation (R&I) are understood, trusted and increasingly used, by scientists, researchers, entrepreneurs and informed citizens to the benefit of society.

In this context, the STE(A)M Learning Ecologies (SLEs) project aims to create new open schooling partnerships in local communities to foster improved science education for all citizens and to contribute to a learning continuum for all. This policy brief outlines initial findings and recommendations about the challenges and opportunities associated with the use and mainstreaming of open schooling in science education and through the creation and development of STE(A)M Learning Ecologies across Europe.

OBJECTIVES AND METHODOLOGY

The SLEs project aims at promoting science education as part of local community development through the creation of open schooling partnerships between formal, non-formal and informal education providers, civil society and enterprises working together on real-life problem-solving situations within local communities. To this purpose, SLEs introduces the powerful concept of STE(A)M Learning Ecologies as partnerships able to provide multiple science learning opportunities for all citizens in a learning continuum of different learning spaces.

In the first six months of implementation, from January to June 2023, SLEs developed an initial methodological framework for the creation of STE(A)M Learning Ecologies (including the SLEs White Paper and the SLEs Methodology First version), which will be validated and improved based on the experience of two SLEs implementation cycles across Europe.

The first small-scale pilot implementation of SLEs in 13 countries has started in autumn 2023. In this context, SLEs partners organised several co-creation workshops involving numerous stakeholders (teachers, educators, researchers and experts, representatives of science museums,

industry, civil society, and public authorities) who are joining forces at local level to develop and implement learning ecologies.

During the first year of the project, evidence was also collected through surveys from SLEs project partners, who monitored and analysed policy developments at national level to provide background, context, and perspective for the development of the SLEs policy recommendations. This analysis was carried out in twelve project countries, namely: Cyprus, Germany, Greece, Ireland, Italy, Malta, Norway, Romania, Serbia, Slovakia, Spain, Sweden. The purpose of this activity was to gain an understanding of the current state of open schooling in these countries with a view on the challenges and opportunities associated to it in science education. The analysis focused on national policies and initiatives that are associated with, benefit from, or have the potential to incorporate the STE(A)M Learning Ecologies approach for fostering open schooling and inclusive STE(A)M Education accessible to everyone.

The results of this analysis have been shared with and validated by the Scientix Ministries of Education STEM representatives Working Group[1], ensuring the correctness and relevance of the collected information, as well as with the SLEs project partners coming from 13 EU countries. The SLEs policy dialogue event that took place in the European Parliament (Brussels) in January 2024 involving key representatives from DG EAC and DG RTD of the European Commission and Open Schooling EU-funded projects[2] served as a further validation step.

Evidence and Analysis

According to the collected evidence, open schooling linked to multistakeholder partnership and STE(A)M education addresses crosscutting challenges in the project countries. These are related to economic growth and the alignment with labour market needs, lifelong learning, active participation and citizenship, environmental education and sustainability, teacher competences, educational quality and innovation, and ensuring inclusion of all children in education.

Open schooling and STE(A)M learning initiatives at EU level:

Several different initiatives launched by the European Commission have been launched to support a next generation of equipped talents such as **"Girls Go Circular"**, that aims to equip the teenagers with skills needed for the circular economy; the Digital Education Action Plan, focusing on the Entrepreneurial skills of students; **"Science is wonderful"** initiative, which connects research and schooling in an Annual science fair hosted in April in Brussels for more than 3000 pupils, through interactive and co-created games and materials. "**Researchers' at school**" call, which enables researchers to enter classrooms all year-round bringing games, discussion and a playful approach. Finally, to support interconnections amongst subjects through a STE(A)M approach supporting teachers happens through initiatives such as **"European School Education Platform" or the "STEAM Academy".**

Open schooling and STE(A)M learning in EU countries: policies and initiatives

Open schooling is present in official policies in different European countries, such as Malta, Italy, and Germany, through the establishment of partnerships with external stakeholders, networking for out of school learning opportunities, and supporting extracurricular STEM projects. The "**Community educational agreements**" (2020-2021) in Italy, between schools, local authorities, public and private institutions and third sector represents and interesting example of how collaborations are formally established between schools and the local community to reduce early school leaving. In Malta, open education and open educational resources are embraced in national

[1] Including Ministries of education representatives from: Belgium, Croatia, Cyprus, Czech Republic, Denmark, Finland, France, Greece, Hungary, Italy, Lithuania, Luxembourg, Malta, Poland, Portugal, Romania, Serbia, Slovakia, Spain, Switzerland, Turkey

[2] School As Living Labs (SALL) project, RoadSTEAMER project; Open Schooling together cluster).

learning strategies. The Government in Germany supports out of school learning and extracurricular projects through STEM plans and partnership guidance.

In some other instances, open schooling and the establishment of educational partnerships does not appear in official documents, however, stakeholder collaborations are developed within educational initiatives and programmes such as School Science clubs and Science festivals (as in the case of Spain), or when working on specific topics such as climate change education, outdoor learning or digital education, as in the case of Sweden, Slovakia and Romania.

Another group of countries, such as Greece, Cyprus, Ireland and Serbia do not present official policies related to open schooling yet, but rather focus more clearly on ensuring lifelong learning and STE(A)M education through interdisciplinarity and the enhancement of 21st century skills.

Enhancing female participation in science education and careers through local stakeholder partnerships is a common practice in almost all analysed EU countries. Educational initiatives, often in collaboration with local foundations and associations, such as "**Women in science**" (Germany), "**STEM it like a girl**" (Serbia), "Girls4STEM" (Malta), "Coding Girls" (Italy) are intended to raise awareness against gender stereotypes in STEM education, while also supporting career development and orientation for women in STEM subjects through role models, outreach, or mentoring activities.

Collaborations between education, research and industry, promoting transferring of research results and lifelong learning is often an occasional and informal practice in the project countries. Lack of funding and connection between research & development and companies is one of the possible challenges. Activities promoted by the private sector are intended to enhance learner engagement in schools, by bringing innovations, hands-on learning, or supporting career orientation and entrepreneurship through counselling, fellowships, and mentoring programmes. These are especially driven by the biotech or green sector (e.g. Italy, Malta, Germany). Only in the case of Ireland, Malta and Romania, partnerships are formalized between research and universities with the aim to expand STE(A)M education and transferable skills.

SLEs good practices and inspirational initiatives are already present in different EU countries and include summer camps (e.g. Girls4STEM in Malta), afterschool activities, school labs, out of school visits, science festivals and exhibitions (e.g. European Researchers' Night in Italy), learning communities (e.g. Galway STE(A)M Learning Community, Ireland) or edutainment science museums. Such experiences are, however, usually ad-hoc initiatives, or informally promoted. Sustainable and long-term SLEs models are either linked to EU funding and programmes (e.g. Schools as living Labs, SEER, OSOS) or are present on some occasions in national initiatives (e.g. the "Butterfly project", in Cyprus, engaging multiple stakeholders such as schools, universities, museums, policy makers).

Challenges identified in SLEs implementation

Major obstacles in the implementation of STE(A)M open schooling can be summarized as follows:

- **Interdisciplinarity:** There is a lack of opportunities for teachers to collaborate with colleagues across STEM subjects and non-STEM disciplines and there is still a low level of multidisciplinary in the curriculum and taught approaches. A need for more cross-disciplinary and interdisciplinary approaches is addressed, since interdisciplinarity is often still regarded as a secondary approach to the traditional disciplinary one.

- **Multi-stakeholder partnerships in education:** Partnerships are seldom supported by local authorities. As long as collaborations are voluntary or informally established, schools will perceive them as extra work and will encounter difficulties in connecting with other stakeholders. Adequate support is necessary for stakeholders to organize effective learning paths.

- **Policies, resources, funding and capacities:** Higher attention is still needed from national and European policies to have educated and informed citizens on science-related

topics. Lack of facilities and resources constraints represent another major obstacle in the implementation of STE(A)M learning Ecologies. Schools lack adequate funding to adopt innovative approaches and teachers lack adequate training opportunities to foster open, inclusive and innovative STE(A)M education.

- **Flexibility:** Time constraints, lengthy bureaucratic procedures, lack of flexibility in curriculum and assessment are sever challenges for the implementation of a SLEs from the school perspective.

POLICY IMPLICATIONS AND RECOMMENDATIONS

Based on the collected evidence, open schooling policies and initiatives linked to STE(A)M education and multistakeholder collaborations are in place in some European countries, but still need to be mainstreamed and implemented in a structured way to advance towards sustainable and long-term learning models. There is also a strong need to **investigate more on the impact** of existing EU-funded projects and better **support, promote and scale-up effective STE(A)M learning paths across Europe.**

We provide a set of initial recommendations targeted to different stakeholders to contribute to the advancement of open schooling and STE(A)M learning ecologies, fostering a more inclusive and dynamic educational system that prepares learners for the challenges of the future. Overall, it is important to ensure that **learning is relevant and applicable** to students' lives and that Its goals are aligned with the needs, values and aspirations of the community and the broader society.

European policy level

- Overcome the fragmented sectorial approach between Directorate-Generals in the European Commission would enable to adopt a **more coordinated approach**, aligning EU funded projects with broader, holistic strategies.
- Provide national ministries with policy **support and guidance** in developing new policies for open schooling and science education.
- Create conditions for open dialogues to **co-create policy recommendations** between science education practitioners and relevant DGs and Parliamentary representatives at EU-level.
- Increase **funding** in research and innovation to deepen the ERA policy agenda and make the outcomes of R&I understood and increasingly used by educated informed citizens for the benefit of society.
- Include **science education** as requirement in R&I calls and/or proposal templates, to mainstream and support the adoption of science education practices for raising awareness and co-design research findings.
- **Support financing the upscaling and mainstreaming** of results of SLEs and other similar STEAM open schooling projects to guarantee the promotion, impact and sustainability of the project results.
- Increase support for transnational projects to foster cross-border collaboration and exchange of best practices in formal and non-formal education.
- Position the STE(A)M Learning Ecology as a holistic approach within science education in the European initiatives and policy approaches, emphasizing its role in preparing citizens for future challenges across various subjects and learning environments.

National policy level

- Formulate a **clear national-level policy** dedicated to STEM and STE(A)M education to guide the effective implementation of the STE(A)M Learning Ecology.
- Promote **integration** between knowledge and skills in arts and humanities and natural sciences, mathematics as well as technological and technical disciplines (STE(A)M) **in education policies and national curricula.**
- Introduce **open schooling as a formal component** of the national curriculum and evaluation system, making it easier for schools and teachers to adopt these practices.

- Recognize the **benefits** of an open schooling STE(A)M approach to support **inclusive learning environments** for all types of learners (e.g. with different learning styles, students with special educational needs and disabilities, living in disadvantaged socio-economic school contexts etc.)
- Provide comprehensive **training programs for teachers** to facilitate their engagement with multiple stakeholders, fostering effective implementation of the STE(A)M Learning Ecology.
- Enhance funding opportunities to strengthen **collaborative projects in schools** (collaboration between different partners / research + industry / girls in STEM etc.).
- Increase funding opportunities for research and innovation on open schooling and science education across countries.

Education authority level (National Agencies and all relevant stakeholders)

- Develop a **shared vision** for STE(A)M education and discuss and develop a common understanding of the role of STE(A)M education in preparing students for the future and in addressing societal challenges.
- Establish **clear goals and expectations** about STE(A)M achievements, and make sure that the goals and expectations allow for **continuous evaluation and improvement.**
- Promote women **role models in STEM careers**, with a particular emphasis on showcasing **young women** in these fields. This can be achieved through targeted campaigns, mentorship programs, and initiatives that highlight success stories.
- Comprehensively **integrate innovative approaches** with the curriculum, which requires intensive collaboration among educators, curriculum developers, scientists and innovators, industry experts and the integration of science, technology, engineering, mathematics (STEM) and the arts (STEAM).
- Create **spaces and conditions for collaboration and coordination** amongst all relevant stakeholders (educators, curriculum developers, scientists and innovators, industry experts, policy makers).
- **Co-create policy developments,** and advocate for comprehensive policies that will promote ambitious goals and include funding for curriculum development, professional development, school facilities, mobility, as well as for raising public awareness.

Educational practice and teachers' level

- Adopt innovative **STE(A)M learning approaches** promoted and developed at European and national level, such as hands on activities, project-based, experiential learning, whereby students apply their knowledge and skills to real-world problems.
- Use the materials and tools available in different platforms at European and national level for science education.
- Develop and implement **continuous professional training** to equip educators with the skills and knowledge needed to effectively implement open schooling and STE(A)M approaches, stay up to date and evolve, through content knowledge, innovative pedagogy and use of technology.
- Provide teachers with **space, time, opportunities, motivation,** and structured curricular plans that encourage the implementation of effective STEAM learning and the collaboration within their schools and with external partners.
- Create **supportive and inspiring learning environments**, fostering a culture of exploration, creativity, innovation, collaboration, love of learning and resilience.
- Recognize the role of **school leaders** in a distributed perspective to support within school collaborations and provide teachers with the adequate support needed.
- Develop truly **collaborative, mutually beneficial partnerships** with community organizations (e.g. museums, universities, businesses, local authorities, NGOs etc.). Higher attention is still needed for the establishment of **research-education-industry partnerships** to foster student entrepreneurship and career opportunities.
- Encourage continuous interaction with the **community** to ensure that open schooling remains responsive to local needs and challenges, therefore opening the school to the community and the community to the school.

Year 1 Project Outputs

In March and June 2023, the SLEs consortium published two important documents that form the basis of the STE(A)M Learning Ecology framework that the project aims to create, implement, and evaluate: the SLEs Concept White Paper and the SLEs Methodology first version.

The SLEs Concept White Paper describes the main foundational elements on which the SLEs approach and vision are based: STEAM Education (overarching approach), Open Schooling environment (main pillar), and Living Lab approach (key practice). The White Paper also puts forward the concept of learning ecologies, offering a powerful new way to envision local open schooling partnerships, and describes the driving needs, policy context and relevant initiatives about open schooling in science education.

The SLEs Methodology is a comprehensive document presenting a methodological framework for the development of the STE(A)M Learning Ecologies. Consisting of guidelines to facilitate a co-creation process and establish partnerships, stakeholder engagement, step-by-step SLEs development process, examples of successful SLEs, this deliverable offers a wide range of theoretical and practical concepts and ideas to National coordinators, educators, and other relevant stakeholders of the SLEs project. The SLEs Methodology also forms the basis for the SLEs Pilot cycle, and it will be revised based on the feedback received from the piloting phase.

Project Identity

Project name

STE(A)M Learning Ecologies (SLEs)

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Consortium

- European Schoolnet (EUN Partnership AISBL), Belgium - Coordinator
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- Center for the Promotion of Science (CPN), Serbia - Affiliated Entity
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WEBSITE

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FURTHER READING

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