WP3 Analysis of STEAM policy gaps and needs

Deliverable 3.3 Policy Recommendations for STEAM

ROADSTEAMER

Deliverable 3.3

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Revision History

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Abbreviation	Description
AI	Artificial intelligence
CPD	Continuous professional development
D	Deliverable
DDP	Distributed Design Platform
DOIT	Digital fabrication and making for social innovators
EASE	**E**motionally intelligent **A**pproach to teaching **S**peaking in a for**E**ign language
EU	European Union
JRC	Joint Research Centre
LC	The Lisbon Council for Economic Competitiveness and Social Renewal Asbl
mAkE	African European Maker Innovation Ecosystem
PO	Politecnico di Milano
SEND	Special educational needs and disabilities
SI	Social Innovation
SME	Small and medium-sized enterprise
STEAM	Science, Technology, Engineering, Arts and Mathematics
STEM	Science, technology, engineering, and mathematics
SV	Science View
T.A.P. / TAP	Teacher-Artist Partnership
TIMSS	National Center for Education Statistics
UoE	The University of Exeter
WP	Work Package
ZSI	Zentrum für Soziale Innovation

Abstract

Deliverable 3.3, "Policy Recommendations for STEAM," represents the culmination of the Road-STEAMer project's work in identifying policy gaps and needs in the field of STEAM education within Europe. The report builds upon previous analyses (D3.1 and D3.2) to develop actionable recommendations for enhancing STEAM education at local, national, and EU levels, with a specific focus on Horizon Europe. These recommendations are designed to align with the EU's broader educational and societal goals, emphasising interdisciplinary learning, inclusivity, and alignment with labour market demands.

The deliverable outlines a co-creative methodology involving extensive stakeholder engagement across multiple workshops and interactive events. This participatory approach ensured that the recommendations were grounded in real-world insights from educators, policymakers, industry representatives, and the broader community. Key outcomes include eight targeted policy recommendations, organised under four themes: strengthening the STEAM curriculum, enhancing the learning environment and teacher training, aligning STEAM education with societal and industrial needs, and promoting equity, diversity, and inclusion.

Recognising the challenges of integrating STEAM into traditional education systems, the report highlights the importance of teacher training, interdisciplinary learning materials, and collaborative learning environments. It underscores the need for policy alignment with societal challenges, such as the Green Deal, and the promotion of equitable opportunities for underrepresented groups in STEAM education.

The recommendations are supported by a preliminary risk analysis that identifies barriers to implementation and proposes strategies for overcoming these challenges. By fostering a more inclusive and innovative educational landscape, this deliverable aims to contribute to the Road-STEAMer policy roadmap.

1. Introduction

1.1 About Road-STEAMer

The overall aim of the project is to develop a STEAM roadmap for science education in Horizon Europe, i.e. a plan of action that will provide guidance to EU's key funding programme for research and innovation on how to encourage more interest in STEM through the use of artistic approaches, involving creative thinking and applied arts (the "A" in 'STEAM').

The consortium aims to provide Europe with this roadmap, through:

- Collaboration and co-creation with the stakeholder communities of science and arts education, research, innovation and creativity, through intensive exchange, dialogue and mutual learning among them which will produce better knowledge and shared understandings of the relevant opportunities, challenges and needs.
- A bottom-up approach emphasising educational practice and practitioners' agency rather than high-level conceptualisations of STEAM and generic top-down plans (in reality often just vague statements of intention) for its adoption in science and arts education.
- A specific focus on ways to leverage the power of STEAM approaches, as manifested through exemplary cases and best practices, so as to enable a bridging of open science and open schooling which can catalyse an increased impact for science education as a crucial tool for addressing Europe's current scientific and societal challenges.

1.2 About this Deliverable

D3.3 Policy Recommendations for STEAM is the final deliverable in WP3, titled 'Analysis of STEAM Policy Gaps and Needs' and feeds into further work in WP5, specifically D5.1 'STEAM roadmap for science education in Horizon Europe v1'.

It follows a logical progression, building on prior analysis of existing policies, identifying critical gaps, and culminating in actionable recommendations to address these deficiencies. More specifically, the first report, 'D3.1 Policy Context for STEAM' was dedicated to policy analysis and the current landscape of STE(A)M (Science, Technology, Engineering, Arts, and Mathematics) policies in Europe. It specifically examined policy initiatives and targeted strategies implemented by various European countries to promote innovation and interdisciplinary education. The succinct deliverable 'D3.2 Policy gap analysis' aimed at identifying potential gaps in the policy landscape and risks in existing policy contexts. STEAM

criteria and needs for STEAM, earlier identified in the project (c.f. D2.1, D2.2, D2.3, D4.1, D4.2, D4.3), were ranked by consortium partners and stakeholders and applied to the previously gathered policies in D3.1 to identify weaknesses and gaps. For instance, the policy recommendations were to be embedded in the wider STEAM context and needs for STEAM analysis (D2.1), which reports on research indicating that current STEM educational practices are generally not very inclusive, leading many students to feel that 'science is not for them' (Archer, 2010). Intersectional factors, such as gender, migration background, socio-economic conditions, the science and educational, and cultural capital of parents, contribute to the underrepresentation of diverse groups in STEM (e.g. Seebacher et al., 2021; Votruba-Drzal et al., 2016). This highlights the need for broader socio-cultural participation and the dismantling of traditional STEM stereotypes and the need for STEAM approaches to overcome identified weaknesses of traditional STEM education.

D3.3 gathers policy recommendations (national, local, EU) to fill these gaps on different levels: national, local and the EU level. In particular, at the European level we are specifically focussing on recommendations relating to the introduction of STEAM in Horizon Europe, consistently with the main objectives of the project.

D3.3 is organised into the following sections:

1. **Introduction**: This section provides an overview of the wider scope of the project and the relation to other deliverables.
2. **Methodology**: The next section outlines the methodology employed, as well as the processes of data collection and generation of policy recommendations for STEAM (Science, Technology, Engineering, Arts, and Mathematics).
3. **Results from Co-creation workshops and policy dialogue:** This section describes policy recommendations resulting from interactive formats with consortium partners and stakeholders during various events, from the gathering to the validation phase.
4. **STEAM policy recommendations**: The fourth section comprises the final list of validated policy recommendations. They are structured according to four policy themes and different implementation levels, i.e. local, country and the EU.
5. **Preliminary risk analysis of proposed policy recommendations:** This section presents the likelihood of implementation of all eight policy recommendations as well as potential barriers and opportunities on the way.
6. **Discussion and Conclusion**: In the concluding section, there is a discussion of the findings and a description of the anticipated next steps towards a Road-STEAMer roadmap.

2. Methodology

The development of the final policy recommendations was a collaborative and iterative process, incorporating insights from diverse activities and workshops at key stages. Each phase brought valuable contributions, ensuring the recommendations were thoroughly reviewed, validated, and refined to address the needs and priorities of all stakeholders. Below is an overview of the critical activities that shaped the policy recommendations, from drafting to validation in addition to the two WP3 deliverables **D3.1 – Policy Context for STEAM** and **D3.2 – Analysis of Policy Gaps for STEAM**.

The process of developing STEAM policy recommendations is structured into three phases (see Figures 1- 3):

1) The gathering phase: in this initial phase, the outputs from the previous WP3 deliverables served as the foundation for discussions during various interactive events involving a diverse range of stakeholders. These discussions resulted in the creation of draft policy recommendations.

2) The fine-tuning phase: the draft policy recommendations from phase 1 were revisited and refined through discussions held at three additional events, once again involving a diverse mix of stakeholders. The objective was to further enhance and fine-tune the recommendations.

3) The validation phase: in this final phase, the policy recommendations were assessed for feasibility and potential implementation risks, with the goal of producing a finalised list of STEAM policy recommendations.

2.1 The Gathering Phase

The following workshops and activities played a key role in shaping the first draft of the recommendations:

Dates of workshops & activities:
- Policy Dialogue Event at Exeter, UK: 22nd of May 2024
- Maker Workshop in Barcelona, Spain: 15th March 2024
- Workshop at the 16th International Social Innovation Research Conference (ISIRC) in Bern, Switzerland: 2nd September 2024

Figure 1: Gathering Phase

2.2 The Fine-Tuning Phase

The second draft of the policy recommendations incorporates input from the following activities:

Dates of workshops & activities:
- Road-STEAMer Online Consortium Meeting: 18th September 2024
- Feedback on the Road-STEAMer Miro-Board: 18th September – 18th November 2024
- Review of fine-tuned Policy Recommendations: 2nd – 20th December 2024

Figure 2: Fine-Tuning Phase

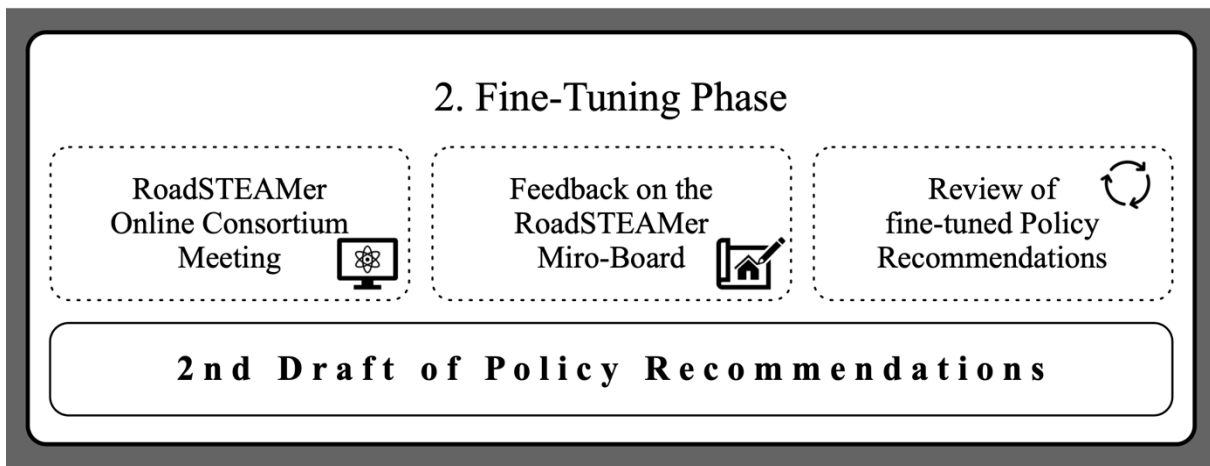## 2.3 The Validation Phase

During the validation phase, the following events played a key role in shaping the final policy recommendations:

Dates of workshops & activities:

- Validation Workshop in Athens, Greece: 14th January 2025
- Risk Assessment in Athens, Greece: 14th January 2025
- Review of final Policy Recommendations between 20th – 24th January 2025
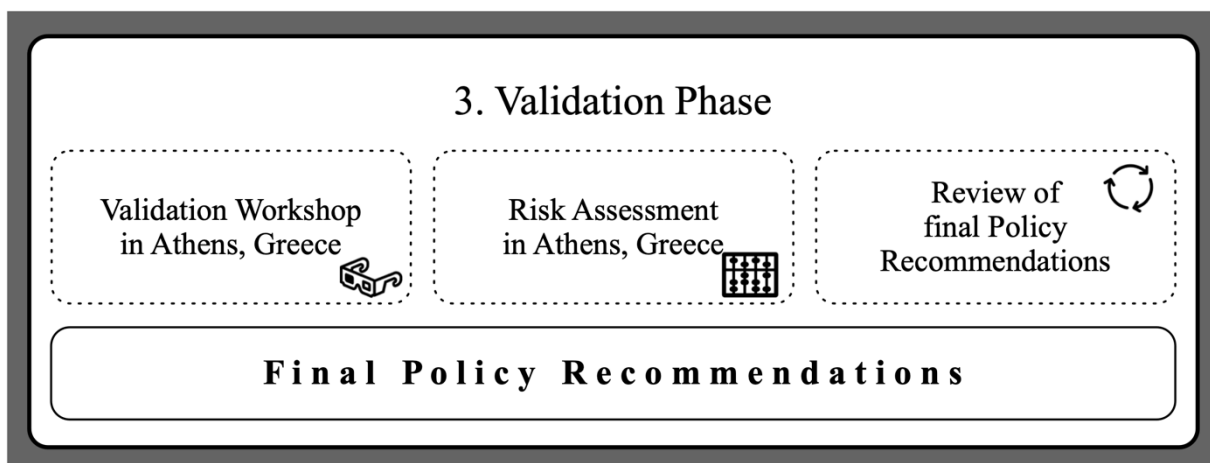

Figure 3: Validation Phase

3. Results from Co-creation Workshops and Policy Dialogue

The development of policy recommendations within the Road-STEAMer project has been enriched through a series of dynamic workshops and collaborative activities. These events provided opportunities to engage with diverse stakeholders, gather valuable insights, and refine recommendations through dialogue and co-creation. Each activity contributed uniquely to the iterative process, addressing key challenges in STEAM education and advancing actionable strategies.

This section highlights the structure, outcomes, and key takeaways from these workshops and discussions. From interactive dialogue events and hands-on maker workshops to validation exercises and innovative methodologies like the *Brainwalk* (see chapter 3.5 Co-creation Workshop with Road-STEAMer Consortium and Stakeholders), these activities collectively shaped the direction and depth of the final policy recommendations.

3.1 Policy Dialogue at Exeter

The first interactive exchange on the subject took place on 22nd May 2024 during the consortium meeting at Exeter in the form of a policy dialogue with four panellists and invited stakeholders from different fields as well as consortium partners. The University of Exeter organised the event with the participation of consortium members.

This dialogue took place after 'D3.1 Policy Context for STEAM' was already finalised and 'D3.2 Policy gap analysis' was underway, before policy gaps had been identified, thus representing a first attempt to discuss potential policy fields supporting STEAM education.

The four panellists were:
- Prof. Kerry Chappell: Associate Professor in Education, University of Exeter, UK
- Prof. Pam Burnard: Professor of Arts, Creativities and Educations, University of Cambridge, UK
- Annalisa Addis: Project manager and Research Associate at the Lisbon Council, Coordinator of the Road-STEAMer project
- Anita Wood: lecturer in primary teacher education, University of Exeter, UK

The panel discussion was facilitated by Prof. Lindsay Hetherington, Associate Professor in Science Education / Deputy Head of School, University of Exeter, UK.

The dialogue started with a keynote talk by Prof. Burnard followed by the panel discussion.

Figure 4: Dialogue Event on Policy Recommendations with Panellists

The following bullet points summarise the most salient points of discussion regarding policy recommendations.

- Real world cases are needed for better connection between school and outside world: schools often operate in silos resulting in a neglect of subject relevance for real life in the eyes of pupils. Open school approaches and learning around real world cases would recognise this effect and support the transfer of trained skills at school.
- Teacher education on STEAM is needed: STEAM education can only be implemented if teachers have the possibility for further training on STEAM education and have access to STEAM materials and practices.

- STEAM should focus on bringing the best out of the learners, not just attending to industry needs: to make pupils job ready not only do industry needs have to be reflected, but skills for personal development need acknowledging.
- It is necessary to make an economic case for policy makers to justify the return-on-investment for STEAM, acknowledging the potential of working with industries at the same time.
- There is a need for policy makers to experience how education in the 21st century could look, since their imagination is prompted by their own education, which usually has been completed some decades ago.
- Therefore, it is important to listen to and integrate the voices of the students themselves since they are the ones to experience education currently and understand what might be needed for their futures, they see ahead for themselves.
- Education should not be decided by a small group of people but be opened up for consultation with stakeholders and young people to make sensible changes.
- There is inequitable remuneration for teacher training in some countries like the UK, where STEM training is resourced better than arts training including through the provision of bursaries for trainees. This should be recognised and resource allocated for complementary arts and STEAM teacher training which should similarly be mapped in classroom provision.
- We should not only look holistically at disciplines but also at the educational trajectory with its various stages from kindergarten to university and disconnection between the different stages.
- Comment by an event attendee: the World Economic Forum placed creativity as the 2nd most important skill required in the labour market, which is not reflected in the current curricula.

In conclusion, the policy dialogue at the University of Exeter marked a critical first step in identifying and addressing the gaps in STEAM education policies. The insights gathered from the panellists and stakeholders emphasised the need for a holistic, inclusive approach to policy-making that bridges real-world relevance, teacher training, and student voices while addressing systemic inequities and preparing education systems for the demands of the 21st century.

3.2 Maker Discussion Group

The Road-STEAMer team participated in a two-hour workshop organised by the two EU-funded maker projects, mAkE – African European Maker Innovation Ecosystems[1] and Distributed Design Platform[2] (DDP) to discuss the connection between STEAM education and maker projects in schools in Barcelona on 15th March 2024.

One of the five parallel workshops was dedicated to Road-STEAMer and elaborated policy recommendations for improving the current educational system. The workshop aimed to explore innovative ways to support emerging talents, facilitate skill acquisition, foster networking, and create new opportunities. Maker education is a hands-on, project-based learning approach that encourages students to design, experiment, build and invent using a combination of traditional crafts, emerging technologies and digital fabrication tools, exemplifying STEAM education by naturally integrating Science, Technology, Engineering, Arts and creative methods, and Mathematics through creative problem-solving activities like 3D printing, robotics, or electronic crafts.

In one session, the Road-STEAMer team worked together with eight participants to develop policy recommendations for promoting STEAM practices in schools by incorporating makerspaces into existing educational settings. Each group session followed the 'policy framing prompts' (see below, questions 1. to 8.), designed by the DDP project, which provided a structured guide for the discussion as follows:

1. What is the policy you would like to change or influence?
2. Who are the policymakers you would like to convince?
3. What is the entry point to grab the attention of these policymakers?
4. What are the winning points to convince this policymaker of your position?
5. What is the long-term change you would see if policy shifted in your favour?
6. What would the direct benefit be?
7. What would the wider benefit be?
8. What should this policymaker do?

The results of each step in the template discussion were recorded on sticky notes and shared with all participants at the end of the workshop. A representative from each group took on the role of 'speaker' and presented their group's refined ideas to the others. The table below highlights the main discussion themes and key points.

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[1] https://makeafricaeu.org/
[2] https://distributeddesign.eu/about/

Table 1: Results of Road-STEAMer Group Session

Discussion stream 1: Policy Recommendations and Target Groups	Policy recommendation advocating for the integration of maker education into school curricula. Target groups identified for this policy include the Ministry of Education, Teacher associations, and Members of Parliament.
Discussion stream 2: Benefits of Integration	Emphasising benefits such as decreased unemployment, reduced school dropouts, and increased innovation and creativity. Highlighting that integrating makerspaces can make students more employable and improve teaching methods through hands-on, project-based learning.
Discussion stream 3: Learning Enhancement	Discussing the improvement in understanding interdisciplinary connections and their real-world applications. Contributions to students' skill development and self-awareness through hands-on experiences and project-based learning.
Discussion stream 4: Involvement of Companies and SMEs	Suggesting the involvement of companies and SMEs to enhance learning transfer and employability. Proposal to have students work with companies during holidays or school time on real-life projects. Encouraging companies to fund makerspaces in schools and teacher training for better-educated school leavers.
Discussion stream 5: Funding and Quality Assurance	Main funding sources proposed to be from government and public bodies like local municipalities. Emphasising the importance of openness and quality in education materials and approaches.
Discussion stream 6: Making Learning More 'Real'	Involving companies and SMEs in education, creating makerspaces, and training teachers will make learning more exciting and realistic.

Participants in the Road-STEAMer group session agreed that a lack of scientific understanding is often rooted in students' school experiences and the way science and related subjects are presented.

Integrating 'making' and 'maker education' into school curricula could transform traditional STEM approaches into more dynamic and suitable STEAM education. This would make learning more engaging and inclusive, while also enhancing scientific understanding by allowing students to tackle real-life problems alongside teachers and classmates. Establishing makerspaces in schools could not only help students develop essential skills for navigating a complex world, but also foster a positive attitude toward science, and also the arts. The integration of science, arts, and hands-on approaches like maker activities can, at the same time, facilitate the transfer of school knowledge and enhance a deeper understanding of interdisciplinary relationships between subjects by applying them to real-world problems.

Since makerspaces are costly and schools often face budget limitations, it was proposed during the group session to collaborate with small and medium enterprises (SMEs) and companies. One suggestion was to have students work with these companies during holidays or participate in real-life projects throughout the school year. Another idea discussed was for SMEs or companies to co-fund makerspaces in schools alongside public bodies like local municipalities. This collaboration would allow students to gain valuable hands-on experience, while companies would benefit from a more skilled and prepared pool of graduates. It was also emphasised that the openness and quality of educational materials must be maintained. By partnering with companies and SMEs through internships and co-funded makerspaces, teachers can make learning more 'real' and engaging for students.

3.3 Discussion at Social Innovation in Education Conference (Bern)

At the International Social Innovation Research Conference in Bern, the Road-STEAMer project was presented as an example of supporting transformative social innovation in the education field, where STEAM replaced STEM education practices to meet some already identified gaps.

The presentation was followed by an interactive discussion supported by the Mentimeter tool, where questions could be answered via mobile phones, which were then displayed on the big screen.

The presentation defined social innovation (SI) as practices that effectively tackle societal issues and are successfully adopted by relevant groups. The focus was on applying transformative SI principles, including system analysis, design, co-design, and impact evaluation.

The presentation highlighted the challenges in traditional STEM education and the potential of STEAM to address these through interdisciplinary, inclusive practices. The Road-STEAMer project was discussed as an initiative aimed at developing a roadmap for integrating STEAM in education, emphasising collaboration and co-creation. The DOIT[3] project served as an example, illustrating a hands-on, step-by-step approach for young social innovators. Policy recommendations underscored the need for educational institutions to adopt and practice these innovations, advocating for resources, teacher training, and partnerships with SMEs to make learning more practical and engaging.

In the following interactive part, the first question (c.f. Figure 5) aimed to discuss which policies should be changed for the implementation of STEAM (or another transformative Social Innovation practice in education).

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[3] https://cordis.europa.eu/article/id/415749-doit-practical-experiences-for-future-innovators

The collective input centred around four key themes:

1. **Empowering the Relevance of Arts and Creative Approaches**: One of the primary discussion points emphasised the importance of elevating the role of arts and creative approaches within the STEAM framework. Participants highlighted that creative approaches often receive less recognition compared to traditional STEM subjects. Policies should aim to integrate arts and creative approaches more fully and equitably, showcasing its role in fostering creativity and holistic problem-solving. This integration can enrich learning experiences and drive students to develop innovative, interdisciplinary thinking.

2. **Flexibility in Curricula**: Another crucial point raised was the need for flexibility in educational curricula. Current rigid curricula can limit the adoption of new teaching methodologies and hinder the adaptability required for incorporating STEAM approaches. The group suggested policies that promote adaptable and modular curricula, allowing educators to tailor teaching methods that align with students' diverse learning needs and interests. This would create space for more dynamic and engaging learning environments.

3. **Equivalence of Disciplines**: The discussion also pointed to the necessity of establishing equivalence among disciplines in the educational system. This idea stressed that creative arts, technology, and engineering should hold equal value and support within school programmes, rather than being supplementary to the core STEM areas. Policy changes in this direction would help remove hierarchical biases and encourage students to view all subjects as integral to their education and potential career paths.

4. **From the Bottom-Up Approach**: The final point was the advocacy for a bottom-up approach in implementing STEAM education policies. This method suggests starting at the school level with proof-of-concept projects and gradually scaling up to district, regional, and eventually national levels. This grassroots strategy allows for evidence-based adjustments and ensures that policies are practical and contextually relevant. It also supports the idea of piloting initiatives locally to gather data and refine methods before broader application, fostering greater buy-in from educators and stakeholders.

These points reflect a comprehensive approach to reimagining and transforming educational policies to support a well-rounded, inclusive, and flexible STEAM curriculum.
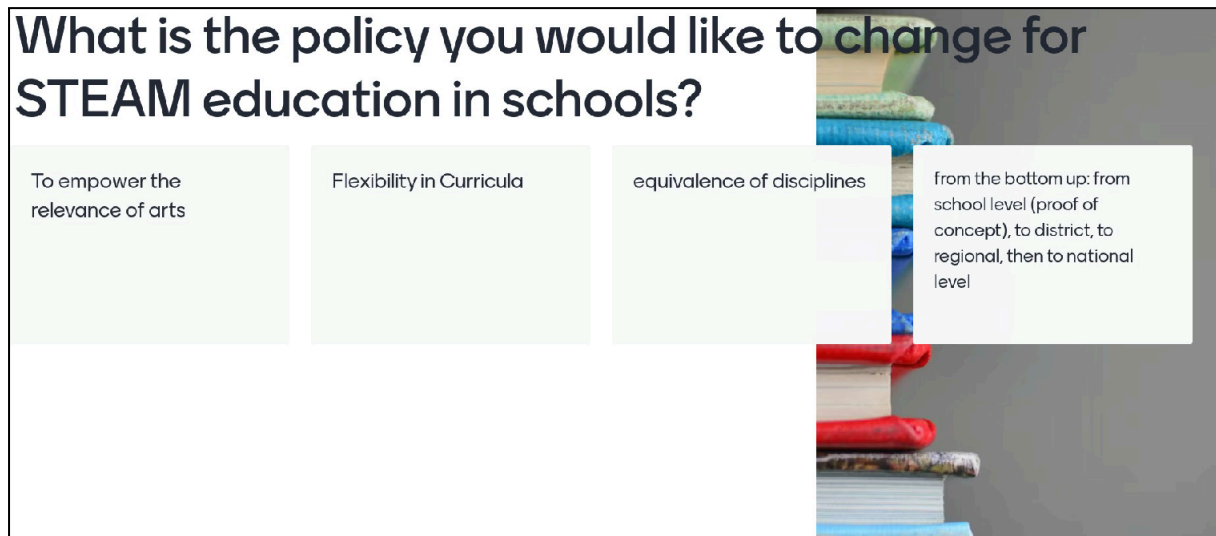

Figure 5: Mentimeter - Question 1

When discussing the key policymakers (c.f. Figure 6) that need to be convinced for the successful implementation of STEAM education policies, participants highlighted a range of influential actors. The responses indicate the necessity of engaging with stakeholders at various levels of governance and education management:

1. **Education Ministry**: This was identified as the primary target for policy change efforts. Convincing national education ministries is crucial as they have the authority to enact policies that standardise curricula, allocate funding, and set educational priorities. Their endorsement and active support can drive systemic change and facilitate the nationwide adoption of STEAM practices.

2. **National Government**: The involvement of broader government entities is essential for securing long-term policy commitments and integrating STEAM initiatives into wider educational reform agendas. National governments can influence legislation, budget allocation, and national standards, ensuring that STEAM education receives the necessary resources and legislative backing.

3. **Department of Education**: Engaging with departments of education at both national and regional levels is pivotal for developing and adapting STEAM curricula. These departments play a key role in aligning educational content with policy goals and ensuring that schools have the guidance and frameworks needed for implementation.

4. **Local Government**: Local governmental bodies are vital for grassroots support and the practical application of STEAM initiatives. Policies that start at the local level can often serve as pilot programmes, proving the efficacy of new educational methods before scaling up to broader contexts. Local governments can also offer more immediate support through community engagement and localised funding.

5. **School Directors**: School leaders are essential advocates within the educational ecosystem. Their role in managing school operations and influencing teaching practices positions them as critical players in fostering a STEAM-friendly environment. Convincing school directors can help initiate school-level changes, setting examples for best practices and building momentum for broader adoption.

6. **Educational and Community Leaders**: The responses also mentioned the importance of leveraging local success stories and involving influential educational leaders who can champion the cause. Such stories can serve as powerful examples to demonstrate the real-world impact and benefits of STEAM education, making the case for its expansion more compelling.

Overall, these responses emphasise a multi-level approach to influencing policy, combining top-down and bottom-up strategies to secure comprehensive support for STEAM education. By targeting a broad range of policymakers, the path to impactful and sustainable educational transformation becomes clearer and more achievable.

Figure 6: Mentimeter - Question 2

For the question on effective strategies to capture policymakers' attention for STEAM education advocacy (c.f. Figure 7), participants shared a variety of insightful tactics. These suggestions emphasised the importance of compelling approaches that can resonate with different stakeholders and drive the necessary policy change:

1. **Presenting Local Success Stories**: One of the most powerful ways to engage policymakers is through tangible examples of success. Showcasing local case studies where STEAM education has led to measurable positive outcomes can make the argument more relatable and persuasive. Demonstrating the real-world benefits for students, schools, and communities helps illustrate the potential of STEAM and builds a compelling narrative for scaling these practices.

2. **Increased Wellbeing:** One of the most compelling arguments for policymakers is the focus on increased wellbeing. STEAM education, with its integration of arts and creativity alongside traditional STEM subjects, has shown to foster a more engaging and balanced learning environment. These elements contribute to reducing student stress and enhancing their sense of accomplishment and belonging in school.

3. **Data-Driven Evidence and Impact Assessments**: Policymakers are often influenced by solid data that supports proposed initiatives. Providing detailed impact assessments, metrics on student performance, and evidence from pilot programmes or existing models can bolster the case for STEAM education. This approach highlights the value and effectiveness of STEAM in enhancing educational outcomes and addresses concerns about the return on investment.

4. **Engagement with Stakeholders and Partnerships**: Building alliances with influential educational leaders, community organisations, and industry partners can strengthen advocacy efforts. By involving stakeholders who are well-respected within the policy sphere, the message gains credibility and reach. Joint presentations and testimonials from educators, industry leaders, and even students can create a multi-voice narrative that underscores the demand and support for STEAM education.

5. **Workshops and Interactive Demonstrations**: Organising workshops or interactive sessions that invite policymakers to experience aspects of STEAM education firsthand can be an effective strategy. Such events can provide a dynamic environment for policymakers to see the engagement and creativity STEAM fosters among students, making the concept more tangible and impactful.

6. **Aligning STEAM Goals with Broader Policy Objectives**: Positioning STEAM education as a means to fulfil broader educational and economic policy goals is crucial. Policymakers are more likely to support initiatives that align with existing priorities, such as workforce development, innovation, and inclusivity. Framing STEAM education as an essential component of preparing a future-ready, skilled workforce and promoting social equity can make it a more attractive proposition.

7. **Media Campaigns and Public Awareness**: Utilising media to create a buzz and draw attention to the importance of STEAM education can be effective. Media coverage through articles, news segments, and social media campaigns can build public support and place pressure on policymakers to prioritise the issue. Public endorsement from notable figures in education and industry can also amplify the impact.

By employing a combination of these strategies, advocates can build a robust and persuasive approach to engaging policymakers and influencing positive changes for STEAM education implementation.
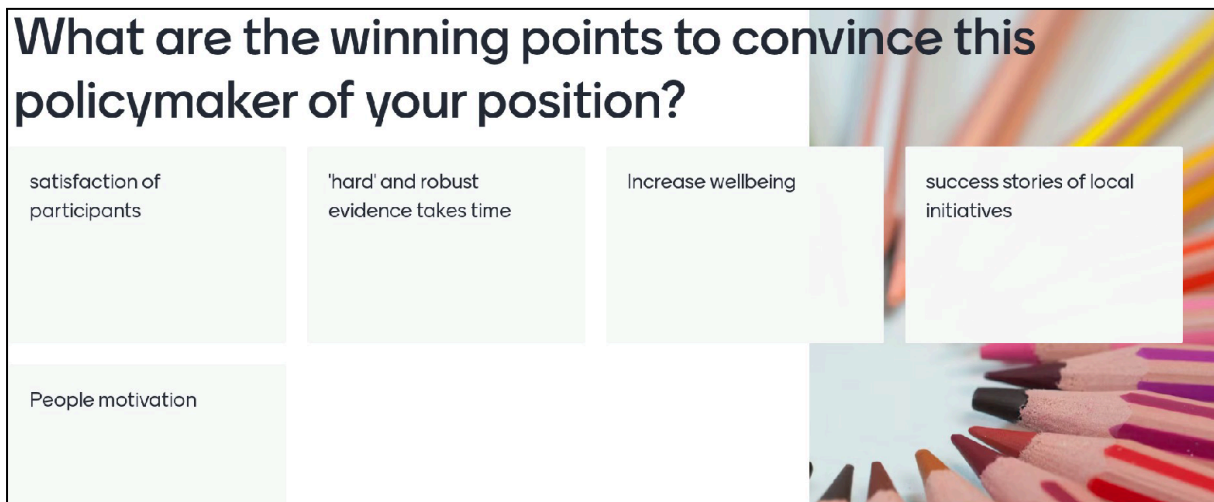
Figure 7: Mentimeter - Question 3

3.4 Interactive Exercise during Online Consortium Meeting

On September 18th, as part of the Road-STEAMer project online consortium meeting, the ZSI team organised an interactive exercise aimed at gathering initial feedback on a set of preliminary recommendations which were formulated on the basis of the three previous events. This exercise utilised a collaborative Miro board (see figure Figure 8: Interactive exercise on Miro Board) and was structured into three distinct phases to facilitate input from consortium partners.

In the first phase, consortium partners were invited to evaluate the importance of the recommendations by responding to the prompt: "***What are the most important recommendations from your perspective?***". Participants were asked to allocate three stars (represented as blue stars on Miro board) they deemed most significant. This enabled consortium partners to prioritise the recommendations effectively, guided by participants' perspectives on their relative importance.

In the second phase, the consortium partners were asked to assess the risks associated with the recommendations, focusing on the likelihood of each recommendation not being implemented. This step was guided by the question: *"**Which recommendations have the highest risk of not being deployed?"*** Participants used red triangles to indicate their perceived level of risk (see Figure 8).

In the final phase, participants were encouraged to **provide additional feedback** in the form of written comments on the specific recommendations, contributing further to the refinement process. Following the conclusion of the exercise, the consortium partners were invited to elaborate further on their comments left on the Miro board for further discussion with the consortium (see comments in orange speech bubbles).

This interactive and structured approach allowed for a comprehensive and participatory assessment of the recommendations, ensuring that both the importance and feasibility of each recommendation were critically reviewed and further discussed.
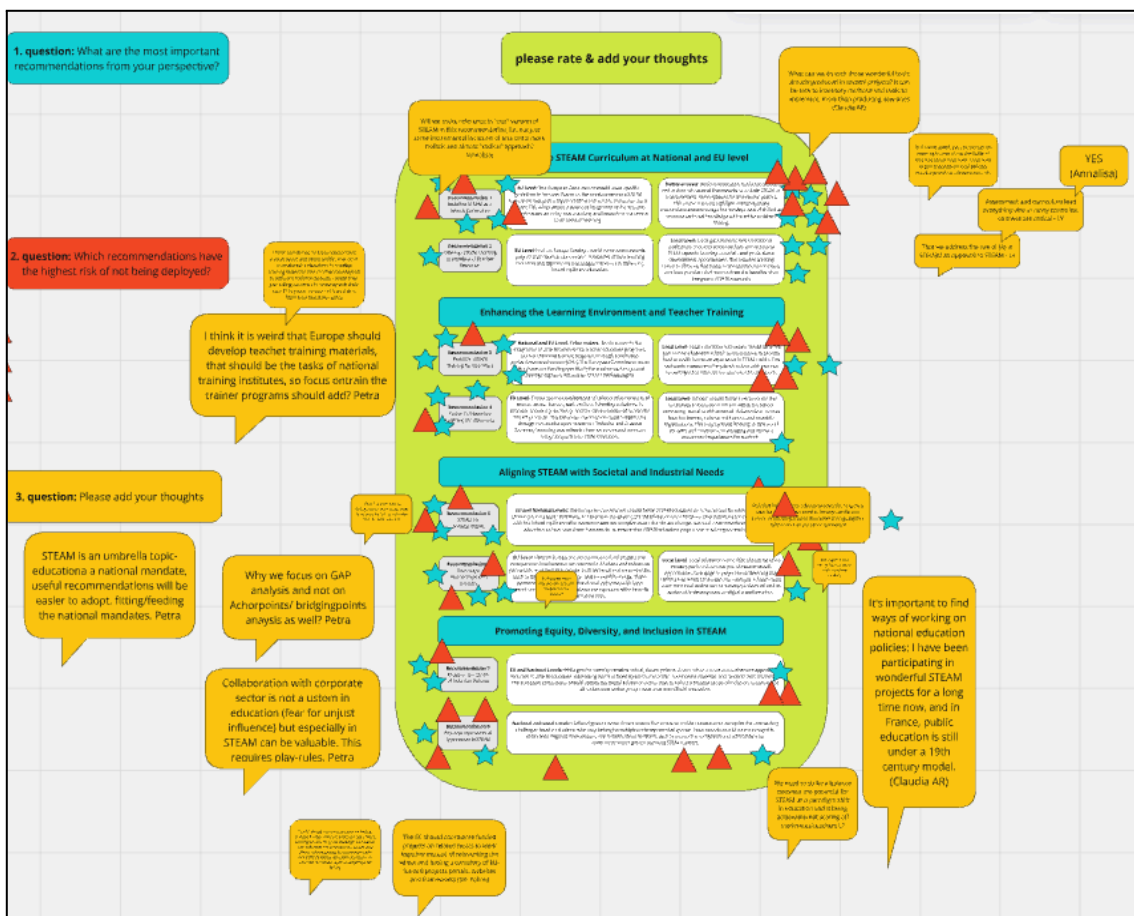

Figure 8: Interactive Exercise on Miro Board

As the text in Figure 8 is difficult to read, each recommendation is outlined below, along with its two ratings: significance level (represented by stars) and risk of not being implemented (represented by triangles).

Strengthening the STEAM Curriculum at National and EU level

Recommendation 1: Redefine STEAM as a Holistic Curriculum

- EU Level: The European Commission should issue specific guidelines to Member States on the development of a STEAM curriculum that places equal emphasis on science literacy and arts into STEM education, ensuring that creativity and innovation are central to all areas of learning.
    - Level of importance: 4
    - Risk of not being implemented: 3

- National Level: National education ministries should revise their educational frameworks to include STEAM as a core element, moving beyond STEM-centric policies. This revision should highlight interdisciplinary connections and encourage the development of skills that combine technical knowledge with creative problem solving.
    - Level of importance: 4
    - Risk of not being implemented: 6

Recommendation 2: Develop STEAM Learning Materials and Teacher Resources

- EU Level: Horizon Europe funding should be directed towards projects that develop open-access, innovative STEAM teaching materials and digital tools that support teachers in delivering interdisciplinary education.
    - Level of importance: 1

- Local Level: Local governments and educational institutions should provide teachers with access to STEAM-specific learning materials and professional development opportunities. This includes creating resource libraries that feature case studies, lesson plans, and best practice that demonstrate the benefits of an integrated STEAM approach.
    - Level of importance: 3
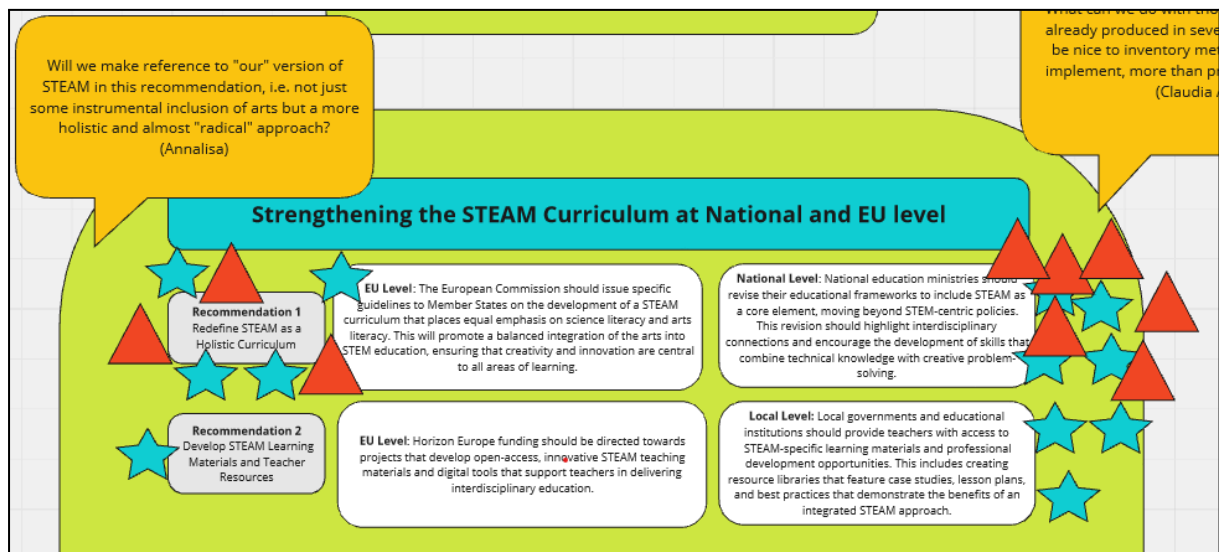
Figure 9: Miro Board Rating for "Strengthening the STEAM Curriculum at National and EU level"

Comments from the Group Discussion:

Education is primarily a national responsibility, and while many valuable STEAM-related tools are developed at the EU level, they are often underutilised. It was suggested to focus on "train-the-trainer" programs that allow national training institutes to adapt EU resources for their own context. Teachers are often constrained by time and resources, so working through national systems is more effective.

There is optimism about the EU level's potential to advance STEAM education, but at the national/local level, implementation is challenged by existing policies, societal factors, and infrastructure. Teachers, as the main link between policy and classroom implementation, need more support in training and access to materials.

Despite the positive outcomes from many STEAM projects, public education systems are resistant to change, especially compared to private institutions. It was argued that instead of creating new tools, existing successful tools should be inventoried and implemented within national policies, especially in countries like France, where outdated models still dominate.

The concern about EU-funded projects leading to unnecessary duplication was echoed. Instead of constantly "reinventing the wheel," the European Commission should coordinate efforts between projects to make better use of existing resources and tools, enhancing collaboration rather than proliferation of underutilised portals.

Enhancing the Learning Environment and Teacher Training

Workshop participants rated the recommendations in this topic by assigning stars to those they considered the most important and triangles to those they believed had the highest risk of not being implemented.

Recommendation 3: Prioritise STEAM Training for Educators

- National and EU Level: Policy makers should mandate the integration of STEAM training into teacher education programs, both at the initial training stage and through continuous professional development (CPD). The European Commission could offer Erasmus+ funding specifically for teacher exchanges and training programs focused on STEAM methodologies.
    - Level of importance: 4
    - Risk of not being implemented: 1

- Local Level: Local education authorities should facilitate partnerships between schools and industries to provide teachers with hands-on experience in STEAM fields. This real-world exposure will equip educators with practical knowledge that they can transfer into the classroom.
    - Level of importance: 2
    - Risk of not being implemented: 4

Recommendation 4: Foster Collaborative Learning Environments

- EU Level: Encourage the development of collaborative networks of schools across Europe, such as Open Schooling initiatives, to promote knowledge exchange and the dissemination of successful STEAM practices. The European Commission could support this through Horizon Europe's cluster on "Inclusive and Creative Societies", ensuring that schools are resources and ideas on integrating arts into STEM education.
    - o Level of importance: 3
    - o Risk of not being implemented: 1

- Local Level: Schools should foster environments that encourage collaboration not just within the school community, but also with external stakeholders, such as local business, cultural institutions, and scientific organisations. This helps ground learning in real-world contexts and creates more engaging and relevant educational experiences for students.
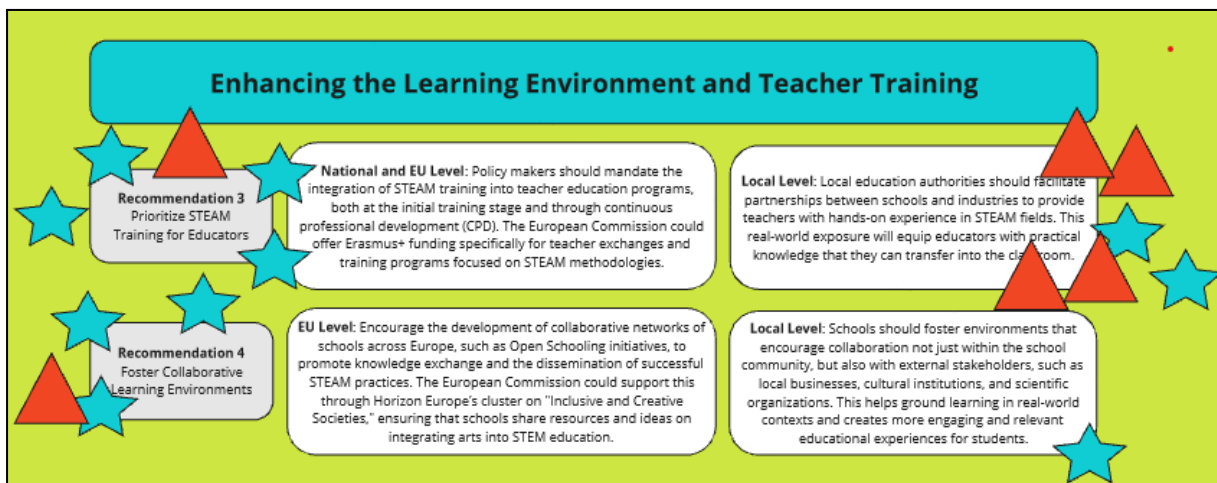   - o Level of importance: 1

Figure 10: Miro Board Rating for "Enhancing the Learning Environment and Teacher Training"

Comments from the Group Discussion:

Teachers are typically trained within their national context, and it's crucial to empower teacher training institutes by providing adaptable EU-developed materials. This would enable better incorporation of STEAM education into existing systems, avoiding the challenge of directly targeting individual teachers who may lack time or resources for additional training.

EU-funded projects can create opportunities to develop training materials that national contexts may not be able to produce on their own. Collaborating across countries can bring these resources to a wider audience, making STEAM education more effective by building on existing practices rather than creating new ones from scratch.

The importance of providing teachers with the necessary training and materials to implement STEAM effectively was stressed. Teachers are the key players in bridging policy and classroom practice, and their training should focus on providing accessible, ready-to-use resources.

Aligning STEAM with Societal and Industrial Needs

Workshop participants rated the recommendations in this topic by assigning stars to those they considered the most important and triangles to those they believed had the highest risk of not being implemented.

Recommendation 5: STEAM for Societal Impact

- EU and National Levels: the European Commission should frame STEAM education as a critical tool for addressing societal challenges in its policy initiatives. For example, integrating STEAM education for secondary and tertiary education into Green Deal initiatives can provide students with the interdisciplinary skills needed to address complex issues like climate change. National governments should align their education policies with these frameworks to ensure that STEAM education plays a role in solving societal challenges.
    - o Level of importance: 6
    - o Risk of not being implemented: 5

Recommendation 6: Encourage Partnerships with Industry

- EU Level: Horizon Europe should continue to fund projects that build partnerships between educational institutions and industries, particularly in sectors that require both technical and creative skills, such as digital innovation, design, and renewable energy. These partnerships can help align educational outcomes with labour market needs, ensuring that students are equipped with the skills required for future jobs.
  - o Level of importance: 3
  - o Risk of not being implemented: 2

- Local Level: local education authorities should facilitate industry partnerships that provide students with opportunities to engage in project-based learning that reflects real-world challenges. For example, schools could work with local businesses to develop projects related to sustainable development or digital transformation.
  - o Level of importance: 1
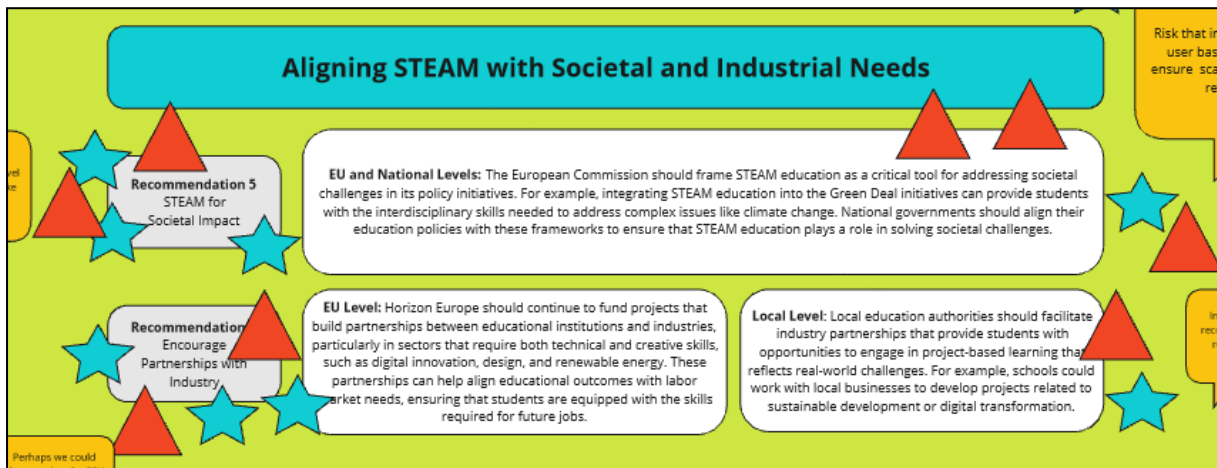 - o Risk of not being implemented: 1

Figure 11: Miro Board Rating for "Aligning STEAM with Societal and Industrial Needs"

Comments from the Group Discussion:

Collaboration between education and industry can be beneficial but requires clear legislative frameworks to avoid undue corporate influence. Many industries are willing to invest in education, but rules must be set to ensure mutual benefit without compromising educational values. Collaborative efforts, particularly in digital education, need to be shaped by input from the educational side to avoid industry dominance.

Continuous education in collaboration with industries is essential, especially for making STEAM education accessible to diverse groups. The current educational model is outdated and not adapted to new technologies. The European Commission should fund projects that focus on flexible, continuous education co-created with industries, with special attention to underrepresented groups.

Instead of creating new teaching materials, the focus should be on highlighting and utilizing existing practices that align with STEAM criteria. This approach ensures that valuable tools are not overlooked, and good practices can be brought into the spotlight in innovative ways. The importance of not duplicating efforts but rather refining what is already available was emphasised.

Promoting Equity, Diversity, and Inclusion in STEAM

Workshop participants rated the recommendations in this topic by assigning stars to those they considered the most important and triangles to those they believed had the highest risk of not being implemented.

Recommendation 7: Broaden the Scope of Inclusion Policies

- EU and National Levels: While gender diversity remains critical, future policies should adopt a more comprehensive approach to inclusion in STEAM education, addressing barriers faced by ethnic minorities, low-income students, and students with disabilities. The European Commission should update the Digital Education Plan to reflect a broader scope of inclusion, ensuring that all underrepresented groups have access to STEAM education.
    - Level of importance: 3
    - Risk of not being implemented: 3

Recommendation 8: Promote Intersectional Approaches in STEAM

- National and Local Levels: National governments should ensure that inclusion in education recognise the intersecting challenges faced by students, who may belong to multiple underrepresented groups. Local schools should be encouraged to implement targeted interventions that support these students, such as mentorship programs and scholarships for underrepresented groups pursuing STEAM careers.
    - o Level of importance: 3
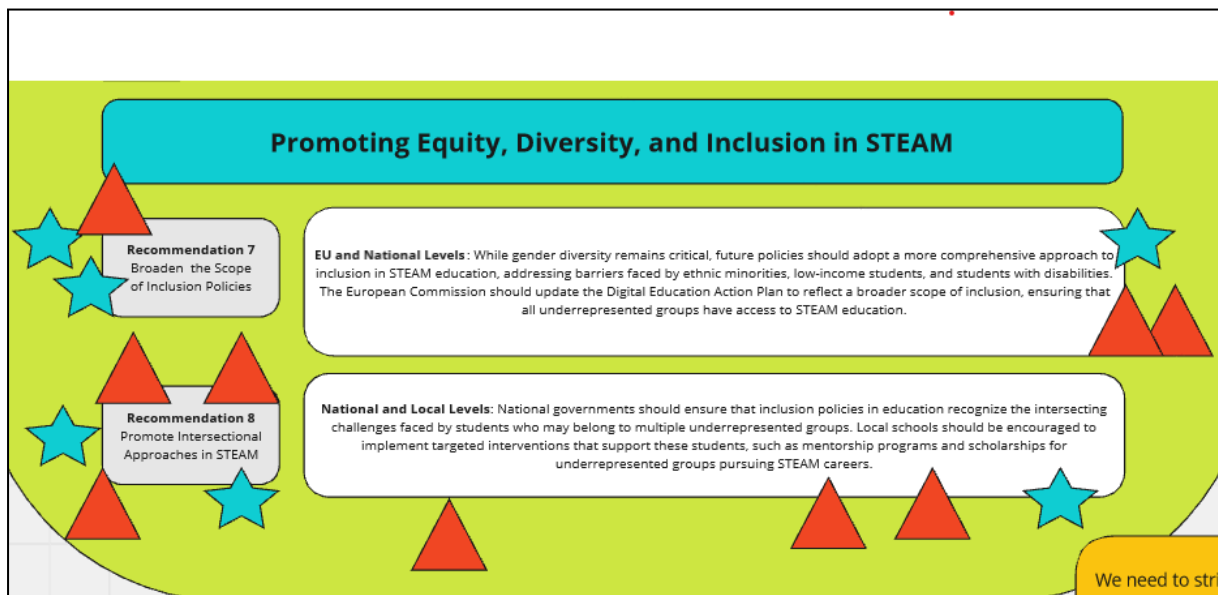   - o Risk of not being implemented: 6

Figure 12: Miro Board Rating for "Promoting Equity, Diversity, and Inclusion in STEAM"

Comments from the Group Discussion:

Equity and inclusivity in STEAM education are critical but challenging. Current outreach efforts often fail to reach marginalised students who could benefit most. The challenge lies in making STEAM education accessible to underrepresented groups who do not typically engage with existing resources.

STEAM has the potential to be transformative in promoting equity, diversity, and inclusion because it inherently incorporates these values. However, when advocating for significant changes in education, it is important to balance ambition with practical implementation to avoid alienating more moderate educators and policymakers. Incremental change may be more effective in achieving broad acceptance while pushing for equity.

The importance of designing flexible educational approaches that reach diverse and vulnerable groups, which are often excluded from traditional educational models, was emphasised. Lifelong learning initiatives should address equity and inclusion, offering accessible pathways to STEAM education for all learners.

Conclusions from the Workshop

Strengthening the STEAM Curriculum at National and EU Levels

Aligning the STEAM curriculum across national and EU levels presents challenges due to the national context of education systems. Teachers typically rely on national curricula, and although there are many tools developed at the EU level, they are underused. The solution lies in focusing on teacher training institutes to adapt EU-developed materials for national contexts. There is also a need for better coordination between EU-funded projects to avoid duplication and improve the use of existing resources. Practical implementation at the national level requires addressing local policies, infrastructures, and societal priorities.

Enhancing the Learning Environment and Teacher Training

Teacher training plays a pivotal role in implementing STEAM education. The emphasis should be on supporting teachers through training programs that provide relevant, accessible materials. Involving teacher training institutes can streamline the process by adapting existing tools for national use. Additionally, EU-funded projects should focus on highlighting and refining existing good practices instead of constantly creating new ones. Teachers need practical, ready-to-use materials to bridge the gap between policy and classroom practice.

Aligning STEAM with Societal and Industrial Needs

Collaboration between the education sector and industries, especially in technology, is essential for ensuring that STEAM education keeps pace with societal and industrial advancements. Legislative frameworks should be established to prevent undue influence from the private sector while fostering meaningful partnerships. Lifelong learning and continuous education should be made flexible and accessible, particularly for underrepresented groups, to address societal challenges and ensure inclusion in STEAM education. The European Commission should prioritise projects that bridge the gap between education and industry in meaningful, coordinated ways.

Promoting Equity, Diversity, and Inclusion in STEAM

Equity and inclusivity remain key challenges in STEAM education. Current outreach efforts often fail to reach marginalised and underrepresented groups. STEAM has the potential to drive a paradigm shift toward a more inclusive educational model, but the approach must be gradual to avoid overwhelming teachers and policymakers. Incremental steps are needed to make STEAM education more accessible, and outreach should specifically target vulnerable groups. Collaborative efforts and flexible learning models can help promote diversity and inclusion, ensuring that STEAM education reaches all learners.

In the analysis of the ratings, it appears that although Recommendation 1 – "Redefine STEAM as a Holistic Curriculum" - received a total of 8 stars, highlighting its importance as the top priority from the list, it also garnered the most triangles, indicating that it carries the highest risk of not being successfully implemented. The following table gives an overview of the ratings per policy recommendation in respect to perceived importance and risk of not being implemented.

	Importance of recommendation	Implementation Risks	Total Sum: Importance	Total Sum: Impl. Risks
Recommendation 1				
EU-level	4	3	8	9
National level	4	6		
Recommendation 2				
EU-level	1	0	4	0
National level	3	0		
Recommendation 3				
EU-level	4	1	6	5
National level	2	4		
Recommendation 4				
EU-level	3	1	4	1
National level	1	0		
Recommendation 5				
EU + national	6	5	6	5
Recommendation 6				
EU-level	3	2	4	1
National level	1	1		
Recommendation 7				
EU + national	3	3	3	3
Recommendation 8				
EU + national	3	6	3	6

Figure 13: Overview of Rating of the Online Workshop

As the overview above shows, overall policies on EU level were rated more important than policies on national level, while with the risk of failed implementation was rated higher on national than on EU level. The least important policies according to ratings were policies 7 and 8 on inclusion and diversity.

3.5 Co-Creation Workshop with Road-STEAMer Consortium and Stakeholders

A co-creation workshop on policy recommendations for STEAM education was held in Athens on January 14th alongside the consortium meeting. The event brought together consortium partners and invited stakeholders to discuss the second version of the policy recommendations. The aim was to validate the recommendations and assess their likelihood of implementation through a collaborative, participatory approach.

The 2.5 hours workshop was structured as follows:

(1) **Welcome Note** by the Greek partners.

(2) **Project Introduction** by the project coordinator.

(3) **Interactive Discussion** and collection of external stakeholders' statements, facilitated by the dissemination partner.

(4) **Introduction to Policy Recommendations** and explanation of the *Brainwalk* exercise.

(5) **Brainwalk Exercise** (detailed below).

(6) **Presentation of Key Results** from the group discussions.

(7) **Recommendation Ratings**: Stakeholders assessed the likelihood of implementation for each recommendation using Mentimeter (results below).

(8) **Outlook and Closing Remarks** to conclude the session.

The *Brainwalk* is a facilitation technique designed to foster focused, discussion-light collaboration by displaying group work results as "exhibits" in a gallery-style format. Participants move between stations, engaging with each group's output, asking questions, and leaving feedback via notes like Post-its. This method utilises the collective intelligence of the group, promoting diverse perspectives and shared solutions.

Implementation:

1. **Display of Policy Recommendations**: Each recommendation is prominently written on a flipchart and positioned around the room (in our case on tables). During the first round, participants move silently from one flipchart to another, leaving their written comments and reflections on each recommendation.

2. **Rotation and Feedback**: Participants engage in a structured rotation between stations at timed intervals. They discuss the recommendations, and the feedback already provided on the flipcharts, sharing insights and leaving additional comments or suggestions to enhance the discussion.

3. **Wrap-Up and Summary**: The activity concludes with a brief presentation summarising the notes and feedback collected on the flipcharts. This is followed by a group discussion, allowing for further reflection, prioritisation, and collective decision-making on the outcomes.

Figure 14: Co-creation Workshop with Stakeholders regarding STEAM

Interest in participation from external stakeholders was remarkably high, with over 60 individuals registered, representing the diverse groups of the quadruple helix model. Unfortunately, adverse weather conditions, including heavy rain and significant traffic disruptions, limited attendance on the day of the event, resulting in the presence of only seven external stakeholders. Despite these challenges, the workshop proved highly productive, yielding valuable feedback and a wealth of complementary insights.

During the introduction session, we presented the four policy themes, each accompanied by two recommendations. These were displayed on flipcharts, allowing participants to engage interactively by sharing their thoughts on sticky notes.

Given that many registered participants were unable to attend the event, the consortium has uploaded the refined policy recommendations to the Road-STEAMer platform (https://community.road-steamer.eu/assemblies/policy-recommendations/f/96/). This ensures that all stakeholders have the opportunity to review the recommendations, provide additional feedback, and contribute to the ongoing refinement process.

Below, we outline the four themes, and their corresponding recommendations as presented on the flipcharts. This is followed by a summary of the insights gathered from the sticky notes and key points noted during the final presentation at the conclusion of the workshop.

Strengthening the STEAM Curriculum at National and EU Levels

Recommendation 1: Redefine STEAM as a Holistic Curriculum

EU Level: The European Commission should issue specific guidelines to Member States on the development of a STEAM curriculum that places equal emphasis on science literacy and arts into STEM education, ensuring that creativity and innovation are central to all areas of learning.

National Level: National education ministries should revise their educational frameworks to include STEAM as a core element, moving beyond STEM-centric policies. This revision should highlight interdisciplinary connections and encourage the development of skills that combine technical knowledge with creative problem solving.

Reflection on & Validation of Policy Recommendation 1:

The discussion on STEAM policy recommendations emphasised the importance of integrating arts with traditional STEM subjects, such as linking physics with music. Participants underscored the need to treat arts as an equal partner within STEAM, rather than merely a tool to support STEM disciplines. This balance was seen as vital for fostering meaningful interdisciplinary collaboration and innovation.

A key point of the discussion was the need to adopt a combined approach, incorporating both bottom-up initiatives driven by practitioners and top-down strategies from policymakers. Expanding STEAM education requires breaking out of the existing community of practitioners and reaching a broader audience, ensuring inclusivity and wider engagement.

The issue of curriculum design was another central theme, with participants advocating for greater freedom of choice in school curricula. This flexibility is essential to effectively integrate sciences, humanities, and arts, and to support the development of a wide range of skills. European educational discourse increasingly recognises the importance of skills development, not only in technical and scientific areas but also in creative fields. Participants stressed the importance of an interdisciplinary approach to skill-building as a cornerstone of modern education.

The distinction between "arts education" and "arts in education" sparked considerable debate. It was agreed that arts should not be reduced to a mere instrument for STEM but should be valued equally within the STEAM framework. This topic was recognised as part of an ongoing dialogue that extends beyond this discussion and remains critical to shaping future approaches to STEAM.

Participants also highlighted the significant role of informal learning spaces, such as museums and science centres, in complementing formal education. These spaces were seen as vital for fostering interdisciplinary learning and providing unique opportunities to engage with STEAM in innovative and creative ways.

In summary, the discussion largely validated the recommendation to redefine STEAM as a holistic curriculum, with strong support for the integration of arts and creative approaches and sciences, interdisciplinary connections, and skill development. However, it also suggested a need for minor refinements to address flexibility in curricula. Additionally, the inclusion of informal learning spaces could strengthen the recommendation's impact, ensuring a broader and more inclusive approach to STEAM education.

Recommendation 2: Develop STEAM Learning Materials and Teacher Resources

EU Level: Horizon Europe funding should be directed towards projects that develop open-access, innovative STEAM teaching materials and digital tools that support teachers in delivering interdisciplinary education.

Local Level: Local governments and educational institutions should provide teachers with access to STEAM-specific learning materials and professional development opportunities. This includes creating resource libraries that feature case studies, lesson plans, and best practice that demonstrate the benefits of an integrated STEAM approach.

Reflection on & Validation of Policy Recommendation 2:

The discussion and feedback on STEAM Recommendation 2 highlighted several key points regarding the development of learning materials and teacher resources. One significant issue raised was the need for better teacher preparation and support. Current teacher education, particularly at the secondary level, often lacks a focus on interdisciplinary learning. Participants stressed the importance of providing continuous professional development (CPD) for teachers to address both STEAM and digital innovation, both separately and in an integrated manner. A suggestion was also made to promote teacher-artist partnerships (T.A.P.) to foster creativity and interdisciplinary collaboration. Additionally, it was noted that many useful materials, including those produced through EU-funded projects, are currently underutilised, and efforts should be made to gather and provide access to these resources.

Participants further emphasised the importance of ensuring STEAM materials are well-organised, searchable, and easily accessible to educators. There was a call to prioritise pedagogical relevance over flashy or superficial projects, focusing on meaningful content that genuinely supports interdisciplinary education. A broader concern was the general lack of clarity and understanding surrounding STEAM, which remains a barrier to its widespread adoption. Participants noted that many discussions and resources are still confined to a "bubble" of those already invested in STEAM, and there is a clear need to reach a wider audience, including educators who may be unfamiliar with or sceptical about the approach.

In summary, while the discussion largely validated Recommendation 2, it also suggested refinements to enhance its impact. These refinements include explicitly supporting teacher CPD that addresses both STEAM and digital innovation, improving the accessibility and searchability of learning materials, and making better use of underutilised resources from previous projects. Efforts must also be made to expand the reach of STEAM to engage a broader audience beyond the existing community of practitioners.

Feedback from the **Road-STEAMer platform**[4] also highlights the importance of creating open-access STEAM resources while emphasizing the need for adaptability. Educators require time, training, and support to modify these materials to meet different formats, student needs, and curricula.

The suggestion focuses on the use of modular and reusable learning objects, paired with targeted upskilling opportunities for teachers. This approach would help educators effectively adapt, remix, and implement existing resources. Additionally, establishing a repository of adaptable STEAM learning objects, combined with training on customization, would help prevent underutilization and ensure these resources have a tangible impact in classrooms.

Enhancing the Learning Environment and Teacher Training

Recommendation 3: Prioritise STEAM Training for Educators
National and EU Level: Policy makers should mandate the integration of STEAM training into teacher education programs, both at the initial training stage and through continuous professional development (CPD). The European Commission could offer Erasmus+ funding specifically for teacher exchanges and training programs focused on STEAM methodologies. In addition, there should be more focus on "**train-the-trainer**" **programs**, which enable national training institutions to adapt EU resources to specific contexts using tailored content and tools.

Local Level: Local education authorities should facilitate partnerships between schools and industries to provide teachers with hands-on experience in STEAM fields. This real-world exposure will equip educators with practical knowledge that they can transfer into the classroom.

Reflection on & Validation of Policy Recommendation 3:
The discussion on STEAM Recommendation 3 focused on the prioritisation of STEAM training for educators, with significant attention given to motivating teachers to engage in such training. Participants noted that motivation is influenced by factors such as salaries, teaching hours, and the availability of opportunities such as sabbaticals or other forms of leave to facilitate participation in continuous professional development (CPD). A recurring theme was the importance of integrating STEAM training into pre-service teacher education.

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[4] https://community.road-steamer.eu/assemblies/policy-recommendations/f/96/proposals/68

In many cases, such as in Greece, educators are primarily trained as subject specialists (e.g., physicists, chemists, or biologists) without adequate exposure to pedagogy or interdisciplinary methods, including the integration of arts into their teaching. This siloed approach to teacher education was identified as a significant barrier to STEAM implementation, which requires a more holistic and integrated approach to training.

Participants also highlighted the need for dedicated university departments or programmes that focus on training educators specifically for interdisciplinary STEAM education. This could address gaps in existing programmes that often prioritise individual disciplines over the integration of subjects. The importance of training teachers not only to integrate arts into their curriculum but also to engage with and include local communities, manage projects, and communicate effectively was emphasised. These skills are critical for implementing STEAM effectively but are often overlooked in traditional teacher training.

Additionally, ensuring recognition, certification, and even monetary incentives for participation in STEAM training was proposed as a way to legitimise and encourage broader engagement among educators.

In summary, while the discussion broadly supports Recommendation 3, some refinements are suggested to enhance its effectiveness. These include integrating STEAM training into pre-service teacher education as a mandatory component, addressing siloed approaches to subject-specific training, and expanding the focus of training to include project management, community engagement, and communication skills.

Feedback from the **Road-STEAMer platform**[5] also underscores the importance of integrating STEAM training into teacher education, emphasizing that real impact requires time, collaboration, and continuous learning. Educators often juggle multiple roles as facilitators, coordinators, and lifelong learners, which can make it difficult to find the time and support needed for interdisciplinary collaboration and co-design of learning experiences.

A structured approach, such as the use of competence frameworks like STEAMComp Edu[6], can play a crucial role in addressing these challenges. These frameworks support educators in developing the necessary competences and can be integrated into train-the-trainer models and Erasmus+ initiatives, ensuring scalable and adaptable professional development opportunities.

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[5] https://community.road-steamer.eu/assemblies/policy-recommendations/f/96/proposals/69
[6] https://www.mdpi.com/2227-7102/14/1/25

Recommendation 4: Foster Collaborative Learning Environments

EU Level: Encourage the development of collaborative networks of schools across Europe, such as Open Schooling initiatives, to promote knowledge exchange and the dissemination of successful STEAM practices. The European Commission could support this through Horizon Europe's cluster on "Inclusive and Creative Societies", ensuring that schools are resources and ideas on integrating arts into STEM education.

Local Level: Schools should foster environments that encourage collaboration not just within the school community, but also with external stakeholders, such as local business, cultural institutions, and scientific organisations. This helps ground learning in real-world contexts and creates more engaging and relevant educational experiences for students.

Reflection on & Validation of Policy Recommendation 4:

The discussion on Recommendation 4, which focuses on fostering collaborative learning environments, highlighted several key points. At the European level, there was broad support for encouraging the development of collaborative networks of schools, such as through Open Schooling initiatives. These networks could benefit from established platforms like Scientix[7] and EASE[8] to adopt and fund STEAM activities. Participants also suggested incorporating digital collaborative environments alongside physical ones to further foster communities and facilitate knowledge exchange.

At the local level, schools were encouraged to promote collaboration not only within their communities but also with external stakeholders such as local businesses, cultural institutions, and scientific organisations. This approach could ground learning in real-world contexts and enhance the relevance of STEAM education. However, the issue of motivation for teachers emerged as a critical factor. Participants emphasised the importance of involving teachers in co-creation processes to make them active contributors to interventions in their educational systems. Mechanisms to reward and incentivise teachers for their involvement were strongly recommended, as motivation and recognition are essential for sustained engagement.

Another major challenge identified was the issue of time constraints and heavy workloads faced by teachers. These factors often hinder the implementation of larger collaborative

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[7] Scientix: https://www.scientix.eu/
[8] EASE: https://ease-educators.com/

actions. Additionally, it was noted that the way learning is assessed in schools may not align with the goals of such collaborative initiatives, which could discourage participation.

In summary, while the discussion largely validated Recommendation 4, it also pointed to several refinements that could enhance its effectiveness. These include explicitly addressing the need for digital collaborative spaces alongside physical networks, incorporating mechanisms to reward and motivate teachers, and considering how time constraints and existing assessment frameworks impact the feasibility of collaborative projects.

Aligning STEAM with Societal and Industrial Needs

Recommendation 5: STEAM for Societal Impact

EU and National Levels: The European Commission should frame STEAM education as a critical tool for addressing societal challenges in its policy initiatives. For example, integrating STEAM education into the Green Deal initiatives can provide students with the interdisciplinary skills needed to address complex issues like climate change. National governments should align their education policies with these frameworks to ensure that STEAM education plays a role in solving societal challenges.

Reflection on & Validation of Policy Recommendation 5:

The discussion on Recommendation 5, focusing on STEAM for societal impact, highlighted several key themes. Participants emphasised the importance of explicitly linking STEAM education to broader EU missions, even in cases where education is not explicitly mentioned. It was noted that STEAM can play a critical role in addressing societal challenges, such as those outlined in the Green Deal, by equipping students with interdisciplinary skills to propose and implement solutions to complex issues like climate change.

Another significant point raised was the need for curricula to address the inherent non-neutrality of technology and design. Participants stressed the importance of teaching students to critically reflect on how technological and scientific developments are shaped by and influence political values and societal norms. This aligns with the goal of fostering critical citizenship and responsible engagement with technology and science among future generations.

Challenges related to collaboration with industry were also briefly touched upon, particularly in balancing profit-driven motives with ethical considerations. While this discussion intersected with another recommendation, it underscored the complexities of ensuring that STEAM education aligns with societal values while working with external stakeholders.

A further strand of the conversation revolved around the difficulty of measuring the economic impact of STEAM education. Participants highlighted the need to focus on promoting critical thinking and adaptability rather than solely tying STEAM education to current job market trends, as many existing roles may not persist in the future. Instead of making narrow claims about employability, it was suggested that STEAM should emphasise skills that prepare students for unforeseen changes in the job market and society at large.

The scalability of small-scale projects was also discussed, with suggestions to leverage existing EU funding schemes like Erasmus+ to create larger, more impactful initiatives. It was noted that better coordination of these projects, alongside innovative methodologies for measuring impact, could help demonstrate the broader societal value of STEAM education.

In summary, while the discussion broadly validates Recommendation 5, several refinements are recommended. These include explicitly linking STEAM education to EU missions and societal challenges, integrating critical reflections on the political and ethical dimensions of technology into curricula, and focusing on developing adaptable and transferable skills rather than narrowly defined employability outcomes. Additionally, mechanisms to scale and measure the societal impact of STEAM projects should be incorporated, leveraging existing EU funding and methodologies.

Recommendation 6: Encourage Partnerships with Industry

EU Level: Horizon Europe should continue to fund projects that build partnerships between educational institutions and industries, particularly in sectors that require both technical and creative skills, such as digital innovation, design, and renewable energy. These partnerships can help align educational outcomes with labour market needs, ensuring that students are equipped with the skills required for future jobs.

Local Level: Local education authorities should facilitate industry partnerships that provide students with opportunities to engage in project-based learning that reflects real-world challenges. For example, schools could collaborate with local businesses to develop projects

focused on sustainable development or digital transformation. To prevent undue corporate influence, clear legislative frameworks should be put in place.

Reflection on & Validation of Policy Recommendation 6:

The discussion on Recommendation 6, which focuses on encouraging partnerships with industry, highlighted both opportunities and challenges associated with connecting education and the private sector. Participants agreed that such partnerships can provide valuable opportunities for students to engage in real-world, project-based learning, particularly in areas like sustainable development and digital transformation. Mentorship was identified as a key mechanism for fostering interaction between professionals, scientists, and students, helping to bridge the gap between education and industry. This approach was particularly praised for its potential to benefit schools in remote or rural areas, where access to industry expertise is often limited.

However, the discussion also raised significant concerns about the risks of undue corporate influence on public education. It was strongly emphasised that while partnerships with industry are beneficial, they must not compromise the public nature of education or be reduced to opportunities for marketing by private companies. Clear legislative frameworks were deemed essential to safeguard the integrity of public education and ensure that industry engagement serves educational rather than commercial objectives.

At the EU level, participants supported the continuation of Horizon Europe funding for projects that build partnerships between educational institutions and industries, particularly in sectors requiring both technical and creative skills. At the local level, it was suggested that education authorities should provide incentives for industries to collaborate with schools and clearly articulate the benefits of such partnerships. These efforts should align with labour market needs while protecting the core values of public education.

In summary, the discussion largely validated Recommendation 6 but highlighted the need for refinements. Specifically, it is recommended that the role of mentorship in industry-education partnerships be explicitly mentioned as a means of fostering meaningful interaction. Furthermore, stronger emphasis should be placed on developing and enforcing clear legislative frameworks to prevent undue corporate influence and protect the public nature of education.

Promoting Equity, Diversity, and Inclusion in STEAM

Recommendation 7: Broaden the Scope of Inclusion Policies

EU and National Levels: While gender diversity remains critical, future policies should adopt a more comprehensive approach to inclusion in STEAM education, addressing barriers faced by ethnic minorities, low-income students, and students with disabilities. The European Commission should update the Digital Education Plan to reflect a broader scope of inclusion, ensuring that all underrepresented groups have access to STEAM education.

Reflection on & Validation of Policy Recommendation 7:

The discussion on Recommendation 7, which focuses on broadening the scope of inclusion policies in STEAM education, highlighted the need for a more comprehensive and targeted approach to addressing barriers faced by underrepresented groups. Participants emphasised that many individuals, including students from ethnic minorities, low-income backgrounds, and those with disabilities, may not access STEAM education because they do not see its relevance to their lives or needs. STEAM practitioners were encouraged to better align educational activities with the specific interests and aspirations of these groups, potentially through role models and tailored outreach initiatives. A key suggestion was to use technology, including artificial intelligence, to create accessible online courses and activities that can reach vulnerable and geographically isolated populations. Participants also noted the importance of ensuring that students with disabilities are given equitable opportunities to engage with STEAM subjects, such as physics, by adapting learning methods and materials to their needs. The discussion further touched upon societal perceptions of STEAM careers. In some non-EU countries, careers in engineering are seen as prestigious and attractive for women, which could serve as a model for promoting gender diversity and broader inclusivity in Europe. Participants also suggested making an economic case for inclusivity, highlighting the national costs of unemployment and the benefits of integrating underrepresented groups into STEAM fields.

Finally, the need to prepare for and address potential anti-inclusion rhetoric was mentioned, underlining the importance of strong advocacy and clear communication about the value of inclusion in STEAM education.

In summary, the discussion validated Recommendation 7 while identifying areas for refinement. These include emphasising the use of AI and technology to create accessible learning opportunities, promoting role models to make STEAM more appealing, and ensuring that the specific needs of underrepresented groups are addressed in policies and practices.

Recommendation 8: Promote Intersectional Approaches in STEAM

National and Local Levels: National government should ensure that inclusion in education acknowledges the intersecting challenges faced by students who belong to multiple underrepresented groups. Local schools should be encouraged to implement targeted interventions to support these students, such as mentorship programs and scholarships for underrepresented groups pursuing STEAM careers. Flexible educational approaches that address the needs of diverse and vulnerable groups should receive greater support.

Reflection on & Validation of Policy Recommendation 8:

The discussion on Recommendation 8, which focuses on promoting intersectional approaches in STEAM education, emphasised the importance of addressing the compounded challenges faced by students belonging to multiple underrepresented groups. Participants stressed the need to devise methods that transcend language and cultural barriers, making STEAM education more accessible to diverse populations. This was noted as a broader issue relevant to all forms of education, though particularly important within STEAM due to its interdisciplinary nature and potential for inclusive practices.

The role of local communities in these programmes was discussed, with participants highlighting the importance of designing interventions that are locally relevant and capable of addressing community-specific challenges. The concept of a "STEAM career" itself was questioned, with suggestions to better define and communicate the types of opportunities STEAM education can provide. A significant challenge identified was the current global political climate, characterised in some regions by a shift towards right-wing ideologies and reduced political focus on marginalised groups. This context was acknowledged as a potential barrier to implementing intersectional approaches, requiring sustained advocacy and innovative strategies to ensure inclusion remains a priority. Participants also noted the potential of STEAM, particularly the Arts, to foster inclusive practices and encourage engagement from underrepresented groups. Interactive tools, such as educational games, were suggested as a way to involve vulnerable populations and support their learning experiences.

In summary, the discussion validated Recommendation 8 but suggested several refinements to strengthen its impact. These include explicitly addressing language and cultural barriers, ensuring that programmes are designed to support local communities, and clarifying the concept of STEAM careers to make them more tangible and appealing.

4. STEAM Policy Recommendations

This section will offer specific recommendations aimed at addressing these gaps and creating a more inclusive and robust policy framework for STEAM education across Europe. Drawing from the detailed analysis in D3.2, the recommendations should be framed around STEAM curriculum, context, and agenda, ensuring alignment with both societal needs and educational reforms at local, national, and EU levels.

They represent the final version of policy recommendations after several rounds of iteration, from the gathering phase to the fine-tuning and finally the validation phase, with consortium partners along with representatives of the quadruple helix who provided input and feedback in (co-creation) events.

In the following we present four policy themes with two recommendations each, resulting in a final list of eight policy recommendations.

Policy Theme 1: Strengthening the STEAM Curriculum at National and EU Level

Recommendation 1: Redefine STEAM as a Holistic Curriculum

EU Level: The European Commission should issue specific guidelines to Member States on the development of a holistic STEAM curriculum that places emphasis on both science and arts literacy, ensuring that creativity and innovation are central and connected to all areas of learning, while also promoting flexibility to integrate interdisciplinary elements and allowing for freedom of choice in curriculum design. The role of informal learning spaces, such as museums and science centres, should be acknowledged as complementary to formal education. Projects such as Road-STEAMer now offer theory-practice derived frameworks via which this kind of holistic curriculum can be designed addressing the key criteria of: creativity; collaboration; disciplinary inter-relationships; real-world connection; thinking-making-doing; inclusion, personalisation, empowerment; and equity (Chappell & Hetherington, 2023; Chappell et al., in press).

National Level: National education ministries should revise their educational frameworks to include STEAM as a core element, moving beyond STEM-centric policies, and to allow for some flexibility in school. This revision should enhance interdisciplinary connections and encourage the development of skills that combine technical knowledge with creative problem solving.

Recommendation 2: Develop STEAM Learning Materials and Teacher Resources

EU Level: Horizon Europe funding should be directed towards projects that develop open-access, innovative STEAM teaching materials and digital tools to support teachers in delivering interdisciplinary education and assessing learning outcomes, as also highlighted by the Road-STEAMer criteria of valuing disciplinary inter-relationships (Chappell & Hetherington, 2023). These materials should prioritise pedagogical relevance, ensuring they are meaningful rather than solely engaging or performative. Additionally, efforts should be made to gather already existing and make accessible (in different languages and accessibility formats) under-utilised resources from previous projects, including EU-funded initiatives, to maximise their impact.

Local Level: Local governments and educational institutions should provide teachers with access to STEAM-specific learning materials in all relevant languages, access formats, and professional development opportunities. This includes creating resource libraries featuring case studies, lesson plans, and best practices that demonstrate the benefits of an integrated STEAM approach.

Theme 2: Enhancing the Learning Environment and Teacher Training

Recommendation 3: Prioritise STEAM Training for Educators

National and EU Level: Policy makers should mandate the integration of STEAM training into teacher education programmes, both at the initial training stage and through continuous professional development (CPD). The European Commission could offer Erasmus+ funding specifically for teacher exchanges, training programmes, and peer-led initiatives focused on STEAM methodologies. This should include a "train-the-trainer" approach, enabling national training institutions to adapt EU resources to specific contexts using tailored content and tools.

Local Level: Local education authorities should facilitate partnerships between schools and industries to provide teachers with hands-on experience in STEAM fields. This real-world exposure will equip educators with practical knowledge that they can transfer into the classroom.

Recommendation 4: Foster Collaborative Learning Environments

EU Level: Encourage the development of collaborative networks of schools across Europe, such as Open Schooling initiatives, to promote knowledge exchange and the dissemination

of successful STEAM practices. The European Commission could support these efforts through Horizon Europe's cluster on "Inclusive and Creative Societies," ensuring that schools have access to both physical and digital collaborative environments.

Local Level: Schools should foster environments that encourage collaboration, not just within the school community but also with external stakeholders such as local businesses, cultural and arts institutions, and scientific organisations. This would help ground learning in real-world contexts and create engaging and relevant educational experiences for students. Additionally, mechanisms should be implemented to recognise, connect and reward teachers who actively participate in collaborative projects, providing them with motivation and acknowledgment for their efforts. Teacher involvement should be supported through co-creation processes that integrate their input into interventions within local and national educational systems.

Theme 3: Aligning STEAM with Societal and Industrial Needs

Recommendation 5: STEAM for Societal Impact

EU and National Levels: The European Commission should frame STEAM education as a critical tool for addressing societal challenges in its policy initiatives. For example, integrating STEAM education into the Green Deal initiatives can provide students (especially in secondary and tertiary education) with the interdisciplinary skills needed to address complex issues like the climate emergency. Additionally, STEAM education should explicitly promote critical thinking and the ability to reflect on the ethical, political, and societal dimensions of technology and design, recognising that these are not neutral. National governments should align their education policies with these frameworks to ensure that STEAM education plays a role in solving societal challenges.

Recommendation 6: Encourage Partnerships with Industry

EU Level: Horizon Europe should continue to fund projects that build partnerships between educational institutions and industries, particularly in sectors requiring both technical and creative skills, such as digital innovation, design, and renewable energy. Grounded in the Road-STEAMer criteria of real-world connections and thinking-making-doing (Chappell & Hetherington, 2023), alongside the outcomes of WP3, these partnerships should include mentorship programmes to foster meaningful interaction between professionals, scientists, artists and students, ensuring that students gain insights into real-world applications of their learning. These partnerships can help align educational outcomes with labour market needs, ensuring that students are equipped with the skills required for future jobs.

Local Level: Local education authorities should facilitate industry partnerships that provide students with opportunities to engage in project-based learning that reflects real-world challenges. Schools could collaborate with local businesses to develop projects focused on areas like sustainable development or digital transformation. To encourage industry participation, local authorities should articulate the benefits of collaboration and provide incentives where necessary. To prevent undue corporate influence, clear legislative frameworks should be put in place.

Theme 4: Promoting Equity, Diversity, and Inclusion in STEAM

Recommendation 7: Broaden the Scope of Inclusion Policies

EU and National Levels: While gender diversity remains critical, future policies should adopt a more comprehensive approach to inclusion in STEAM education. Grounded in WP3 outcomes as well as the Road-STEAMer criteria of inclusion, personalisation and empowerment (Chappell & Hetherington, 2023), and Unterfrauner et al. (2023) articulation of the value of inclusion in STEAM practices, they should address barriers faced by ethnic minorities, low-income students, and students with disabilities to provide access to a range of educational options and approaches that can cater for the variety of their needs, and provide funding to monitor the effectiveness of those measures. The European Commission should update the Digital Education Plan to reflect a broader scope of inclusion, ensuring that all underrepresented groups have access to STEAM education. Furthermore, strategies should be developed to counter anti-inclusion rhetoric and promote the economic and societal benefits of inclusivity in STEAM education.

Recommendation 8: Promote Intersectional Approaches in STEAM

National and Local Levels: National government should ensure that inclusion in education acknowledges the intersecting challenges faced by students who belong to multiple underrepresented groups (as also recognised by work in WP2 and 4 within Road-STEAMer; Unterfrauner et al., 2023; 2024; Chappell & Hetherington, 2023). This includes addressing language and cultural barriers to make STEAM education more accessible and relevant to diverse populations. Local schools should be encouraged to implement targeted interventions to support these students, such as mentorship programs and scholarships for underrepresented groups pursuing STEAM careers. Flexible educational approaches that address the needs of diverse and vulnerable groups should receive greater support.

5. Preliminary Risk Analysis of Proposed Policy Recommendations

After the workshop, participants were asked to rate the *likelihood of implementation* for each recommendation on a scale ranging from "very unlikely" (0) to "very likely" (5) using a Mentimeter survey (see Figure 15). Following the rating exercise, participants were also invited to elaborate on their ratings, providing valuable insights into the perceived opportunities and challenges tied to each recommendation.
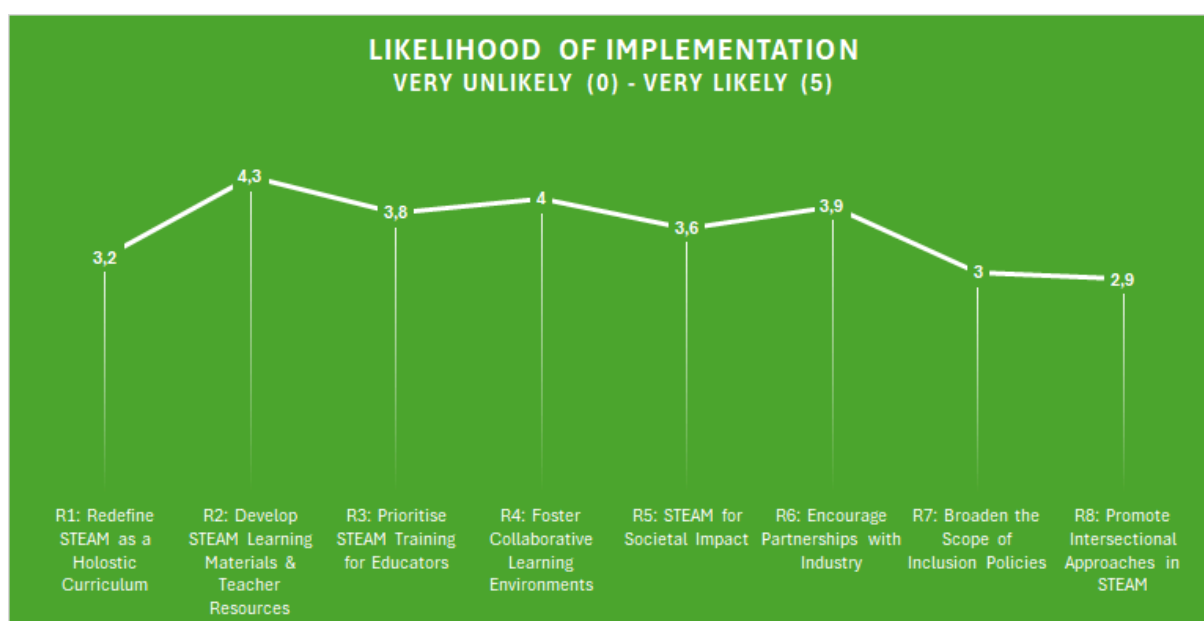

Figure 15: Overview of Rating (Mentimeter Exercise) in Athens, Greece

As the above figure with the average scores on a scale from 0 (=very unlikely) to 5 (=very likely) shows, these ranged between 2.9 to 4.3. So overall it was perceived that all policy recommendations were more likely than unlikely to be implemented. The most probable implementation was given to **Recommendation 2** on developing STEAM learning materials and the lowest likelihood to **Recommendation 8** on promoting intersectional approaches in STEAM.

The following analysis integrates this feedback, highlighting both the opportunities and systemic barriers identified by participants, as well as the likelihood of implementation based on their ratings.

Policy theme 1: Strengthening the STEAM Curriculum at National and EU Level

Rating for Recommendation 1: Redefine STEAM as a Holistic Curriculum (3.2)

Implementing STEAM as a holistic curriculum is challenging across different countries due to systemic resistance and the conservative nature of education systems, which make structural and systemic changes politically and practically difficult. While the breadth of STEAM is recognised as valuable, its label remains contentious, with concerns that framing it as "holistic" might dilute the emphasis on the arts, sciences, and their interdisciplinarity. Despite its evident importance and potential for low-cost implementation, STEAM is not seen as a priority for policymakers, and old-school attitudes further hinder progress. There is a strong call for a clear and proper definition to address ambiguity and opposition. The integration of new structures would require significant effort from practitioners, and the EU's *ability to* influence national curricula centrally defined by each Member State remains uncertain. Critics worry about the balance between arts and sciences, questioning whether core arts learning objectives and STEM goals would be fully supported or compromised. Nevertheless, STEAM's interdisciplinary nature offers schools meaningful opportunities for real-world collaboration across curricula. The focus should be on ensuring its goals are supported, regardless of how it is labelled.

Rating for Recommendation 2: Develop STEAM Learning Materials and Teacher Resources (4.3)

There is strong support for the development of STEAM learning materials and teacher resources, with many recognising the significant need for this effort. A large volume of resources already exists, but the challenge lies in mapping, organising, and centralising these materials, as well as translating them into multiple languages and formats for accessibility. Leveraging existing resources, particularly those from previous EU-funded initiatives, is seen as feasible and valuable, especially when supported by organisations dedicated to this task.

Participants emphasise the importance of transitioning STEAM material development from informal to formal education settings. While the creation of new materials is achievable, the focus should also be on ensuring their accessibility and practical use by educators. Centralising resources into a cohesive library featuring best practices, lesson plans, and case studies is seen as a promising approach.

However, key challenges remain in terms of widespread implementation and defining what constitutes STEAM beyond its own sector. Questions were raised about whether the materials will be effectively utilised, as professional teachers are often able to develop and adapt resources themselves in collaboration with colleagues, tailoring them to local contexts. Ultimately, while this recommendation is seen as highly important and feasible, its success depends on proper organisation, dissemination, and support for educators to integrate these resources effectively into their teaching practices.

Theme 2: Enhancing the Learning Environment and Teacher Training

Rating for Recommendation 3: Prioritise STEAM Training for Educators (3.8)

There is widespread agreement that prioritising STEAM training for educators is essential for advancing STEAM education and empowering teachers to act as change agents. However, significant challenges must be addressed for successful implementation. While many acknowledge the importance of integrating STEAM training into teacher education and professional development, resistance to change, particularly among university professors and entrenched education systems, remains a barrier.

One major concern is the limited time and capacity of teachers, who are often overwhelmed by existing workloads, making it difficult to engage in additional training. Governments may support the idea in principle, but without adequate funding and time allocation, scaling these initiatives to reach all educators will be highly challenging. The need for political will, substantial funding, and changes to teacher training curricula are emphasised, with some suggesting mirroring these changes after successful informal education initiatives.

Real-world exposure through partnerships with industries is seen as a valuable component, equipping educators with practical knowledge to enrich classroom teaching. However, this requires strong local support and collaboration, as well as careful adaptation to national and local contexts.

Key suggestions include starting STEAM training at the university level to address the gap for those entering teaching from non-education faculties, implementing a "train-the-trainer" approach to scale efforts, and fostering professional learning environments where teachers can share knowledge, collaborate, and learn from peers. While this recommendation is viewed as a priority and necessary for the field's development, its success hinges on

addressing systemic challenges, securing funding, and providing educators with the time and support to engage meaningfully in STEAM training.

Rating for recommendation 4: Foster Collaborative Learning Environments (4)

The recommendation to foster collaborative learning environments is seen as a crucial and promising step for advancing STEAM education, but its implementation faces notable challenges. Many agree that collaboration among schools, educators, and external stakeholders — such as businesses, cultural institutions, and scientific organisations — can create engaging, real-world learning experiences and cultivate trusted spaces where innovation thrives. Collaborative networks, like Open Schooling initiatives, and programmes like Erasmus+ are viewed as strong tools for promoting knowledge exchange and co-creation processes.

However, the effectiveness of collaboration depends heavily on adequate infrastructure, funding, and institutional support. Limited budgets across Europe and the need for curriculum changes to accommodate collaboration are identified as significant barriers. Additionally, generational and cultural clashes among educators can hinder the adoption of innovative, collaborative practices, despite many teachers being eager to bring new solutions into schools.

Social media and digital tools are recognised as enablers of collaboration, particularly as teachers become more comfortable using them. Rewarding and recognising teacher involvement in collaborative projects is considered essential for motivation and sustained engagement. Aligning efforts across leadership, teachers, and students is emphasised as critical to creating environments that support collaboration effectively.

Overall, while fostering collaborative learning environments aligns with current trends in education and has considerable potential, its success depends on securing financial resources, building necessary infrastructure, overcoming resistance to change, and providing institutional and cultural support at all levels.

Theme 3: Aligning STEAM with Societal and Industrial Needs

Rating for Recommendation 5: STEAM for Societal Impact (3.6)

The feedback highlights strong support for framing STEAM education as a critical tool for addressing societal challenges, such as those outlined in the Green Deal initiatives, and for promoting interdisciplinary skills and critical thinking. There is recognition that this approach aligns with contemporary educational trends and emphasises the importance of engaging students in societal issues like the climate emergency, equity, and the science-society dialogue. STEAM is seen as inherently linked to societal challenges, making it highly relevant for fostering engagement, responsibility, and ethical reflection.

However, concerns were raised that without proper framing and political will, this initiative risks being diluted into superficial efforts that fail to tackle societal responsibilities meaningfully. The success of this recommendation depends on securing buy-in from stakeholders outside of education who may not prioritise these goals, as well as navigating the sensitive and shifting political climate, which might place less emphasis on addressing societal challenges.

Participants stress the importance of demonstrating tangible societal impacts from STEAM activities to attract broader participation and support. They also emphasise that aligning national policies with EU frameworks will be critical to scaling this approach effectively. STEAM education's integration with the Green Agenda is seen as particularly promising for helping students understand and engage with sustainability, societal changes, and ethical dilemmas. While this is a key priority in contemporary education, its implementation requires strategic alignment with political and societal priorities to maximise its impact.

Rating for Recommendation 6: Encourage Partnerships with Industry (3.9)

The feedback acknowledges the importance and potential of partnerships between educational institutions and industry to bridge the gap between educational outcomes and labour market needs, equipping students with the skills required for future jobs. Industry partnerships are seen as valuable for fostering project-based learning, mentorship opportunities, and exposing students to real-world applications of their studies, particularly in areas like digital innovation, design, and renewable energy. There is optimism that industries have a vested interest in supporting such initiatives to develop qualified future employees.

However, achieving a balanced and mutually beneficial partnership is seen as challenging. Concerns were raised about the potential for undue corporate influence in education, with some expressing fears that certain political climates, particularly those favouring privatisation, could lead to the exploitation of educational systems by industry. Ensuring transparency, autonomy, and equality in these partnerships is critical to maintaining trust and preventing practices like "greenwashing" by industries with questionable motives.

Funding is a recurring concern, as initiating and sustaining these partnerships may require financial support. Local authorities and schools will need to articulate the benefits of collaboration to industries and provide incentives where necessary to encourage participation. Additionally, partnerships should extend beyond for-profit industries to include non-profit organizations and creative sectors, which can bring diverse perspectives and opportunities.

The feedback also highlights the importance of aligning partnerships with trusted environments, clear legislative frameworks, and transparent procedures to mitigate risks. While partnerships with industry are seen as a rich opportunity to enhance leadership, professional development, and access to modern technology for teachers and students, careful implementation is essential to ensure these initiatives are equitable, ethical, and effective.

Theme 4: Promoting Equity, Diversity, and Inclusion in STEAM

Rating for Recommendation 7: Broaden the Scope of Inclusion Policies (3)

The feedback strongly emphasises the importance of broadening inclusion policies in STEAM education to address barriers faced by underrepresented groups such as ethnic minorities, low-income students, and students with disabilities. Inclusion is viewed as essential to fostering equitable opportunities and integrating all parts of society. However, significant challenges are noted in aligning this goal with current political climates, particularly in regions experiencing a conservative or populist shift, which may hinder efforts to advance inclusive policies.

Participants highlight that achieving meaningful inclusion requires tailored approaches rather than one-size-fits-all solutions, suggesting that educational institutions must offer a variety of options to meet the diverse needs of learners. Additionally, while inclusion should be a priority for schools and society at large, some question whether STEAM is the most effective

or unique avenue for driving inclusivity. Debates continue as to its positioning, viewing it as one among the many opportunities for broader educational reform and how these might be networked and catalysed to make real change happen.

Key obstacles include political resistance, and strained resources in education systems, such as the UK's underfunded SEND (Special Educational Needs and Disabilities) system. The difficulty of measuring and implementing inclusion policies adds further complexity. To address these challenges, strategies must focus on countering anti-inclusion rhetoric and emphasising the economic and societal benefits of inclusivity.

Overall, while the need for expanded inclusion policies is widely recognised, success depends on overcoming political and systemic barriers, ensuring flexibility in implementation, and integrating inclusion into the broader vision of educational institutions.

Rating for Recommendation 8: Promote Intersectional Approaches in STEAM (2.9)

There is strong agreement that intersectionality is integral to STEAM education, as it aligns with its transdisciplinary and inclusive nature. Addressing the intersecting challenges faced by students from multiple underrepresented groups, such as language, cultural, and socio-economic barriers, is seen as necessary for making STEAM education more accessible and relevant.

However, several challenges are highlighted. Similar to Recommendation 7, the current political climate, particularly the rise of right-wing and populist attitudes, poses a significant obstacle to prioritising intersectionality in education. While intersectional approaches are viewed as essential, feedback suggests that even achieving basic inclusion remains an ongoing struggle, and intersectionality may represent the next step rather than an immediate priority.

To advance this recommendation, there is a call for greater integration of intersectional thinking into teacher education, as well as broader support for interdisciplinary collaborations and the application of new technologies. Despite challenges, promoting intersectionality in STEAM is viewed as a key goal that underscores the need for flexible and tailored approaches to meet the diverse needs of vulnerable groups. While it may not currently be a priority for Europe, its long-term societal and economic benefits remain clear.

Summary of Risk Analysis

The recommendations collectively outline a comprehensive strategy for advancing STEAM education in Europe, emphasising the integration of interdisciplinary approaches, inclusion, and real-world relevance, as articulated in the Road-STEAMer criteria (Chappell & Hetherington, 2023). They address critical areas such as curriculum reform, educator training, resource development, partnerships with industry, and broader inclusion policies. While the potential impact of these recommendations is widely recognised, their likelihood of implementation varies, reflecting both systemic challenges and political contexts.

The highest-rated recommendations for implementation are **Recommendation 2: Develop STEAM Learning Materials and Teacher Resources** (4.3 likelihood) and **Recommendation 4: Foster Collaborative Learning Environments** (4 likelihood). These recommendations are seen as feasible due to the existing momentum in resource development and collaboration within the education sector. Leveraging existing tools, technologies, and informal networks provides a strong foundation for scaling these initiatives.

Recommendation 6: Encourage Partnerships with Industry (3.9 likelihood) and **Recommendation 3: Prioritise STEAM Training for Educators** (3.8 likelihood) also rank high, as industry interest and the critical need for teacher training are acknowledged. However, challenges such as funding, infrastructure, and ensuring equitable and ethical partnerships will need to be addressed to ensure successful implementation.

Recommendation 5: STEAM for Societal Impact (3.6 likelihood) highlights the importance of linking STEAM education to pressing societal challenges like climate change. While its alignment with EU priorities such as the Green Deal is promising, political will and tangible demonstration of societal benefits will be key to driving adoption.

Lower-rated recommendations, such as **Recommendation 1: Redefine STEAM as a Holistic Curriculum** (3.2 likelihood), **Recommendation 7: Broaden the Scope of Inclusion Policies** (3 likelihood), and **Recommendation 8: Promote Intersectional Approaches in STEAM** (2.9 likelihood), face greater resistance. These reflect systemic barriers such as political climates resistant to change, the conservative nature of educational systems, and resource constraints. While inclusion and intersectionality are seen as essential goals, their implementation is perceived as more complex and long-term, requiring foundational progress in other areas first.

Overall, the recommendations are well-aligned with contemporary educational needs, but their success depends on overcoming funding, political, and systemic hurdles. Prioritising the more feasible recommendations, such as resource development and collaboration, could create momentum for addressing more challenging areas like inclusion and intersectionality. A phased approach, coupled with strong advocacy, alignment with societal priorities, and adequate support for educators, will be essential for driving meaningful and sustainable progress in STEAM education across Europe.

6. Discussion and Conclusion

The policy recommendations presented in this report reflect a critical response to the identified gaps in STEM and STEAM education across the EU, emphasising the need for inclusive, interdisciplinary, and future-proof educational practices. The Road-STEAMer project has aimed to create actionable pathways for addressing these challenges, utilising a co-creative methodology that ensures the policy recommendations are both pragmatic and reflective of stakeholder input.

Very recently, the Joint Research Centre (JRC) published a report 'STEM competencies, challenges, and measurements' (Pokropek et al., 2024) and interestingly, many of our findings and recommendations resonate with the report.

The transition from STEM to STEAM, as highlighted in both the Road-STEAMer analysis and the JRC's report, underscores the value of integrating arts and creativity into technical disciplines to foster holistic learning outcomes. This integration not only addresses the traditional siloed approach to STEM but also cultivates transversal skills such as critical thinking, creativity, collaboration, and adaptability—skills increasingly vital for navigating the complexities of the 21st century. However, implementing these approaches remains fraught with challenges, as highlighted in the JRC's findings.

These challenges include a lack of consensus on what constitutes effective STEAM education, insufficient empirical research in the European context, and disparities in resource allocation and teacher training. It should be noted though, that the Road-STEAMer project has worked some way to addressing the question of what constitutes effective STEAM education through the articulation of core STEAM criteria (Chappell & Hetherington, 2023) and a flexible theoretical framework connected to practice which can support this (Yeomans et al., 2023; Yeomans et al., 2025).

A central theme emerging from the Road-STEAMer workshops is the critical role of teacher training and resource development. Teachers are pivotal in translating policy into classroom practice, yet they often lack access to the interdisciplinary tools and methodologies necessary for implementing STEAM curricula. This aligns with the JRC's findings, which underscore the need for targeted professional development programmes and the creation of open-access, high-quality teaching materials. Such initiatives must be coupled with systemic

support at the national and EU levels, ensuring alignment between policy objectives and classroom realities.

Another key issue is the equitable distribution of educational opportunities. As the JRC report highlights, socio-economic and cultural disparities continue to impede access to STEM education, particularly among underrepresented groups. The Road-STEAMer project has addressed this by promoting policies that prioritise equity, diversity, and inclusion, advocating for the dismantling of traditional stereotypes and the development of inclusive educational practices (Unterfrauner et al., 2023). These efforts are essential for not only expanding participation but also fostering a sense of belonging and engagement among students, which has been shown to enhance learning outcomes.

The alignment of education with societal and industrial needs is another focal point. The Road-STEAMer policy recommendations stress the importance of real-world applications and collaborations with industry, a sentiment echoed in the JRC's call for educational models that prepare students for the dynamic demands of the labour market. Integrating makerspaces, project-based learning, and partnerships with SMEs can bridge the gap between theoretical knowledge and practical skills, making education more relevant and impactful.

However, achieving these goals requires overcoming significant barriers. The resistance to change within traditional educational systems, the fragmentation of policy initiatives across member states, and the varying levels of readiness among educational institutions pose considerable challenges. As highlighted in the JRC report, a coordinated, evidence-based approach is essential for addressing these obstacles. This includes leveraging large-scale assessments like PISA and TIMSS to evaluate the effectiveness of STEAM education and guide policy adjustments.

In conclusion, the Road-STEAMer project provides a comprehensive framework for advancing STEAM education in Europe, grounded in co-creation, inclusivity, and alignment with societal needs. The deliverable depicts a set of recommendations for the introduction of STEAM in Horizon Europe, as well as barriers on the way. The policy recommendations presented here are not only actionable but also adaptable, feeding into the Road-STEAMer policy roadmap for fostering a more inclusive, innovative, and future-ready education system. Moving forward, it is imperative to prioritise the development of robust empirical research, the alignment of policies with classroom practices, and the equitable distribution of resources to ensure that STEAM education fulfils its transformative potential for all learners.

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