# EUROPEAN POLICYBRIEF

## PICKING UP STEAM

This is the first of three policy briefs to be developed as part of the Road-STEAMer project. "*Picking up STEAM*" aims to convey the results of the first year of the project to policy makers, with special attention to the European context, in a way that is easily understandable and approachable, in order to boost the agenda of STEAM in Europe.

**February 2024**

## INTRODUCTION

Recent years, especially since the COVID-19 pandemic, have shown more than ever how the world (and Europe) increasingly need a science literate population and require more scientists in order to generate present and future societies that are sustainable, healthy, just and prosperous.

Europe is currently facing a lack of skilled employees, particularly in sectors such as Science, Technology, Engineering and Mathematics (STEM), and the situation is not much different elsewhere in the world. Beyond the overall scarcity of STEM professionals, another issue is the persistent underrepresentation of women and marginalised groups in these fields of employment. This is not just a problem for those who are excluded. Increased diversity could provide different understandings of scientific and technological problems, leading to pursuing alternative solutions and more inclusive products – ultimately, society as a whole could benefit. Furthermore, a solid background in science education could be beneficial for all citizens (regardless of occupation), in order to better support them in an increasingly complex and digitised world.

This poses huge demands on educational systems, unlikely to be met with instruction-as-usual. Education pioneers and experts advocate for up-to-date approaches that go beyond STEM, to incorporate artistic and creative approaches - what is generally referred to as STEAM - as these have the potential to increase student engagement, be more inclusive of marginalised groups, and foster the development of soft skills and interdisciplinary practices.

It is against this backdrop that the European Commission launched a call to develop and deliver a STEAM roadmap for Science Education in Horizon Europe, in synergy with Erasmus. And this is where the Road-STEAMer project comes into play. Building on expertise in approaches involving

"out-of-school science activities", open schooling, and the use of arts and creative thinking, the project is aiming to develop a roadmap that will support decision makers in mainstreaming STEAM and ultimately stand better chances to address the pressing societal needs mentioned above. With this policy brief, we take stock of the work carried out during the first year of the Road-STEAMer project, focusing in particular on building a common understanding, and laying the foundations of the work that will inform the development of the roadmap.

## Evidence and Analysis

The need for improving the provision of STE(A)M education in Europe is clearly reflected in a number of policy initiatives such as Action 7 of the European Skills Agenda[1] which focuses on bolstering the number of STEM graduates, or the European Pillar of Social Rights Action Plan[2] aiming to ensure that at least 80 percent of individuals aged 16-74 possess basic digital skills. Apart from ensuring a sufficient number of graduates in the relevant fields, another challenge is to anticipate further technological developments and ensure that future generations will be able to manage them. With regards to artificial intelligence (AI), UNESCO Assistant Director-General for Education Giannini recently wrote: "we need education systems that help our societies construct ideas about what AI is and should be, what we want to do with it, and where we want to construct guardrails and draw red lines"[3]. This means going beyond purely technical skills, to embrace a more holistic approach to science and technology - something that is at the core of STEAM education.

A key aspect that emerged as part of the work on developing the Road-STEAMer research framework, is that the concept of STEAM is not universally and unequivocally defined. The field is complex and multi-faceted, but there is some consensus that STEAM education is not merely about the inclusion of the Arts as a discrete discipline to the "STEM" list comprising Science, Technology, Engineering, and Mathematics. In fact, the focus is often on interdisciplinarity and creative thinking, and on the benefits of a more holistic approach to education. Road-STEAMer has produced a set of criteria in its research framework[4] that are applicable to STEAM practices of relevance for the project: Collaboration, Disciplinary inter-relationships, Thinking-making-doing, Creativity, Real-world connection and Inclusion/ Personalisation/ Empowerment. These principles are all underpinned by the core principle/value of Equity. The latter refers, on the one hand, to the rejection of hierarchies among disciplines, and also within the classroom, with students taking a more proactive role in learning, guided by teachers-facilitators[5], and on the other hand, to equity being a possible outcome of STEAM practices[6], though this second claim would need further corroboration. By and large, STEAM education could then be understood as an interdisciplinary and transdisciplinary approach equipping people with a more holistic view of the world, building on convergent and divergent thinking skills[7].

It is important to note that the definition of the Road-STEAMer criteria, as well as subsequent work to analyse and systematise various educational approaches to develop a conceptual framework for

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[1] European Commission (2020). European Skills Agenda for Sustainable Competitiveness, Social Fairness and Resilience, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM/2020/274 final, 1 July 2020. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0274

[2]European Commission (2021). TOPIC ID: HORIZON-WIDERA-2021-ERA-01-70, Last accessed on 30 August 2023 https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/horizon-widera-2021-era-01-70

[3]Giannini, S. (2023), Reflections on generative AI and the future of education. © UNESCO 2023, https://unesdoc.unesco.org/ark:/48223/pf0000385877

[4]Chappell, K., and Hetherington, L. (2023) Research Framework, Deliverable 4.1 Road-STEAMer - Developing a STEAM Roadmap for Science Education in Horizon Europe

[5]Allina, B. (2018). The development of STEAM educational policy to promote student creativity and social empowerment, Arts Education Policy Review, 119:2, 77-87, DOI:10.1080/10632913.2017.1296392

[6] Carter CE, Barnett H, Burns K, et al. (2021). Defining STEAM Approaches for Higher Education. European Journal of STEM Education. 2021;6(1), 13. https://doi.org/10.20897/ejsteme/11354

[7]Land, M. H. (2013). Full STEAM ahead: The benefits of integrating the arts into STEM. Procedia Computer Science, 20, 547-552. https://doi.org/10.1016/j.procs.2013.09.317

STEAM[8], are grounded in, and specifically relevant to, the main focus areas of the project: the transition from secondary to tertiary education, the role of the Arts, and the worlds of open science and open schooling, the latter being an approach focused on learning via real-world applications of science in cooperation with societal actors other than schools.

In parallel, another strand of the Road-STEAMer work in the first year has been dedicated to better understanding the socio-economic context and the needs related to STE(A)M education. What emerged from this line of research - which is presented more in detail in Deliverable 2.1 - Socio-Economic Context and Relevant Needs - is that family, social and economic background in addition to science and educational capital deeply influence the capacity of individuals to achieve full participation in STE(A)M disciplines. The literature review has also shown the fundamental relevance of intersectional inequalities (gender, race, class, migration background and others) that hinder the creation of inclusive educational and work environments[9]. In other words, the vast majority of those who work in these fields tend to be male and white. Gender divides and inequalities within the education system also tend to disproportionately affect marginalised girls[10], and more broadly, students from less privileged backgrounds continue to face underrepresentation in STEM. Although decisions related to pursuing STEM careers may seem individual and voluntary, various structural factors come into play such as ethnicity, family structures, language spoken at home, all closely correlated with socio-economic background. Unfortunately, in the EU, the lack of intersectional lenses in STEM studies, research, and industry is evident due to the scarcity of disaggregated data and research incorporation[11]. The phenomenon called the "hostile obstacle course" is helpful to explains the existence of (symbolic or overt) systematic barriers that members of marginalised communities encounter at different levels, such as biases that permeate disciplines and institutions, gender and racial pay gaps, harassment, lack of role models, as well as the internalisation of reduced value and self-worth[12]. This clearly points to the need for social and epistemic justice, rather than simply working towards improving participation[13].

The hostile obstacle course has a wider impact on society considering that, as highlighted in the introduction, there is a pressing need for more professionals in STEM fields, in Europe and beyond. In this respect, there are indications that a STEAM approach could foster confidence and motivation, challenging widespread perceptions of scientific subjects and careers being "difficult", particularly at the critical stage between secondary (high school) and tertiary education (university). But there is more than just a need for "more scientists": it is essential to ensure more diversity in the field. STEAM approaches informed by equity and inclusion/personalisation/empowerment could help increase the number of women and other underrepresented groups. Besides being a desirable outcome per se, increased representation could reduce bias in science and provide more diverse role models for future generations of students. More appealing and inclusive STEAM approaches, coupled with critical thinking skills, could also help increase science literacy across the board. This is about giving everyone the tools to understand and competently navigate an increasingly complex world, to make informed decisions on issues such as health, and to competently use digital technologies, regardless of their field of occupation. Finally, STEAM could help improve alignment between educational outcomes and industry needs, with a focus on what will remain relevant in the decades to come. From this perspective, encouraging the development of soft skills, critical thinking and creativity, interwoven with mastery of the method of scientific inquiry, and the ability to cross disciplinary silos appear to be of crucial importance. Also, tackling real-world problems appears to be a promising path to making education more relevant. The next

[8]Yeomans, L., Chappell, K., Hetherington, L., Bresciani, S., Unterfrauner, E., Fabian, C., Koulouris, P. (2023) Road-STEAMer Conceptual Framework, Deliverable 2.2, Road-STEAMer - Developing a STEAM Roadmap for Science Education in Horizon Europe.

[9]Unterfrauner, E., Fabian, C. M., Yeomans,L., Voulgari, I., Sotiriou, M., Sotiropoulos, D.,Cherouvis, S., Koulouris, P., Bresciani, S. (2023) Socio-Economic Context and Relevant Needs, Deliverable 2.1, Road-STEAMer - Developing a STEAM Roadmap for Science Education in Horizon Europe

[10]Sánchez-Tapia, I., & Alam, A. (2020). Towards an Equal Future: Reimagining Girls' Education through STEM. UNICEF

[11]Directorate-General for Research and Innovation (2021, November 24). She figures 2021 :Gender in research and innovation: statistics and indicators. Publications Office of the EU. https://data.europa.eu/doi/10.2777/06090

[12] Berhe, A. A., Barnes, R. T., Hastings, M. G., Mattheis, A., Schneider, B., Williams, B. M., & Marín-Spiotta, E. (2021). Scientists from historically excluded groups face a hostile obstacle course. Nature Geoscience, 15(1), 2-4. https://doi.org/10.1038/s41561-021-00868-0

[13]Intemann, K. (2009). Why diversity matters: Understanding and applying the diversity component of the national science Foundation's broader impacts criterion. Social Epistemology, 23(3-4), 249-266. https://doi.org/10.1080/02691720903364134

section begins to address areas for potential policy implication, which will be explored in detail over the course of the remainder of the project and through the two subsequent policy briefs due at the end of the second and of the third year of the project.

## Policy Implications and Recommendations

At this stage of the Road-STEAMer project, it is possible to outline how supporting a shift to mainstreaming to STEAM education could help tackle the societal needs that were previously identified. The work of Road-STEAMer will continue to explore the practices, challenges and enabling factors that can lead to:

- **Improving science literacy for all**, to ensure that younger generations have the necessary skills to make informed decisions, critically evaluate claims, and understand scientific knowledge;
- **Increasing uptake of STEAM careers**, to have the necessary workforce to fill gaps in employment which are projected to increase in account of the "twin transitions" in the years to come;
- **Increasing diversity in STEAM** to move towards greater social justice, offering more opportunities to currently underrepresented groups, and benefitting from their perspective;
- **Improving alignment between educational outcomes and industry needs**, to reduce current mismatches in the labour market.

Exploring specific policy recommendations for each of these critical policy areas for STEAM education will be the focus of the Road-STEAMer project in the years to come. Using co-creation approaches, the project team aims to point to the specific STEAM approaches that will emerge as the beacons of good practice, worthy of being mainstreamed into educational curricula and, critically, into teachers' training. The work will then culminate with the development of a policy roadmap for STEAM in Europe to move forward in the four areas above.

## Sustainability and Legacy

The main legacy of the Road-STEAMer project will be its roadmap, which will aim to shape the promotion of STEAM in Horizon Europe and other national and EU-level educational programmes. In addition, the project will also release the "Road-STEAMer Toolbox", a user-friendly, of graphically designed summaries of all results, gained experiences, evaluation findings and policy recommendations of the project. This modular set of professionally produced publicity materials allows different members of the stakeholder community to find the summary of information as well as inspirational best practices and success stories they need to embark on new or sustain their existing science education activities.

## Research Parameters

The overall aim of the Road-STEAMer 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 core approaches adopted by the consortium are:

- collaboration and co-creation with the stakeholder communities  science education, research, innovation and creativity;
- a bottom-up approach emphasising educational practice and practitioners' agency;
- a specific focus on ways to leverage the power of STEAM approaches, as manifested through exemplary cases and best practices.

During the first year of the project, the consortium has focused on laying the foundations for the work of the following years, which will culminate with the development of the Roadmap. In particular, consortium members have carried out literature reviews, complemented by co-creation workshops to validate the findings of the desk research, and integrate additional perspectives. This has led to the development of a report on the socio-economic context and relevant needs (deliverable 2.1) and of a research framework for STEAM education (deliverable 4.1) outlining the key criteria to be used in Road-STEAMer. Further to the identification of the criteria, the Road-STEAMer consortium proceeded to work on an overarching conceptual framework (deliverable 2.2) that will guide the development of the roadmap, through a rigorous literature review followed by another co-creation workshop.

This policy brief, which constitutes deliverable 7.4, reviews and takes stock of the results of the first year of the project, aiming to  convey them to policy makers, with special attention to the European context, in a way that is easily understandable and approachable, in order to boost the agenda of STEAM in Europe. As an additional validation step, the four main policy areas presented above have been discussed with stakeholders during two workshops, one in July 2023 (while the policy brief was under development), and one in October 2023 (after publication of the first version of the deliverable).

## Project Identity

**Project name**

Developing a STEAM Roadmap for Science Education in Horizon Europe (Road-STEAMer)

**Coordinator**

The Lisbon Council for Economic Competitiveness asbl,
Brussels, Belgium, info@lisboncouncil.net

**Consortium**

- Association Européenne des Expositions Scientifiques, Techniques et Industrielles (ECSITE), Brussels, Belgium
- Association TRACES Théories et Réflexions sur l'Apprendre, la Communication et l'Éducation Scientifiques, Paris, France
- Centrum Nauki Kopernik, Warsaw, Poland
- Ellinikh Enosh Dhmosiografon Episthmhs, Syggrafeon Episthmhs Kai Eikoinoniologon Episthmhs Astiki Etaireia (Science View), Nea Ionia, Greece
- Ellinogermaniki Agogi Scholi Panagea Savva AE, Pallini, Greece
- Engineering - Ingegneria Informatica S.P.A., Rome, Italy
- European School Heads Association (ESHA), Utrecht, Netherlands
- National Center Junior Academy of Sciences of Ukraine, NC JASU, Kiev, Ukraine
- Panteio Panepistimio Koinonikon Kaipolitikon Epistimon, Kallithea, Greece
- Politecnico di Milano, Milan, Italy
- Università ta' Malta, Msida, Malta
- Zentrum für Soziale Innovation (ZSI), Vienna, Austria
- University of Exeter, Exeter, UK

**Funding scheme**

HORIZON.4.2 - Reforming and enhancing the European R&I System (main) and HORIZON.4.2.4 - Open science; call HORIZON-WIDERA-2021-ERA-01, Topic 70 Developing a STE(A)M roadmap for Science Education in Horizon Europe.

**Duration**

September 2022 – August 2025 (36 months).

**Budget**

EU contribution: 1 660 625 €.

**Website**

www.road-steamer.eu

**For more information**

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**Further reading**

Chappell, K., and Hetherington, L. (2023) Research Framework, Deliverable 4.1 Road-STEAMer - Developing a STEAM Roadmap for Science Education in Horizon Europe, https://www.road-steamer.eu/wp-content/uploads/2024/01/D4.1_Research-Framework.pdf

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