

SALTO DIGITAL RESOURCE CENTRE

STEM EDUCATION

BUILDING FUTURE-ORIENTED SKILLS
THROUGH STEAM PROJECTS

Science - Technology - Engineering - Mathematics

$$X = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$



STEM Education

Building future-oriented skills through STEAM projects

A strong focus on STEM education and training is essential for sustaining Europe's competitiveness, preparedness, and technological leadership. STEM skills are crucial not only for mastering emerging technologies but also for driving their development and ensuring responsible use.

High-quality STEM education can be a powerful driver of equality, equipping individuals with critical technical and problem-solving abilities, boosting their resilience in a rapidly changing job market, and creating pathways to high-quality employment. By promoting innovative and engaging teaching methods in STEM, education systems can better inspire learners, reduce inequalities, and cultivate the talent needed for Europe's future prosperity.

STEM Education Strategic Plan:

<https://education.ec.europa.eu/document/stem-education-strategic-plan-legal-document>



This material supports Erasmus+ projects and educational institutions in addressing STEM education. Although it does not constitute an official guideline, it offers thoughtfully curated steps and key considerations to support effective planning and implementation of STEM education and training.

European SALTO Digital
Resource Centre

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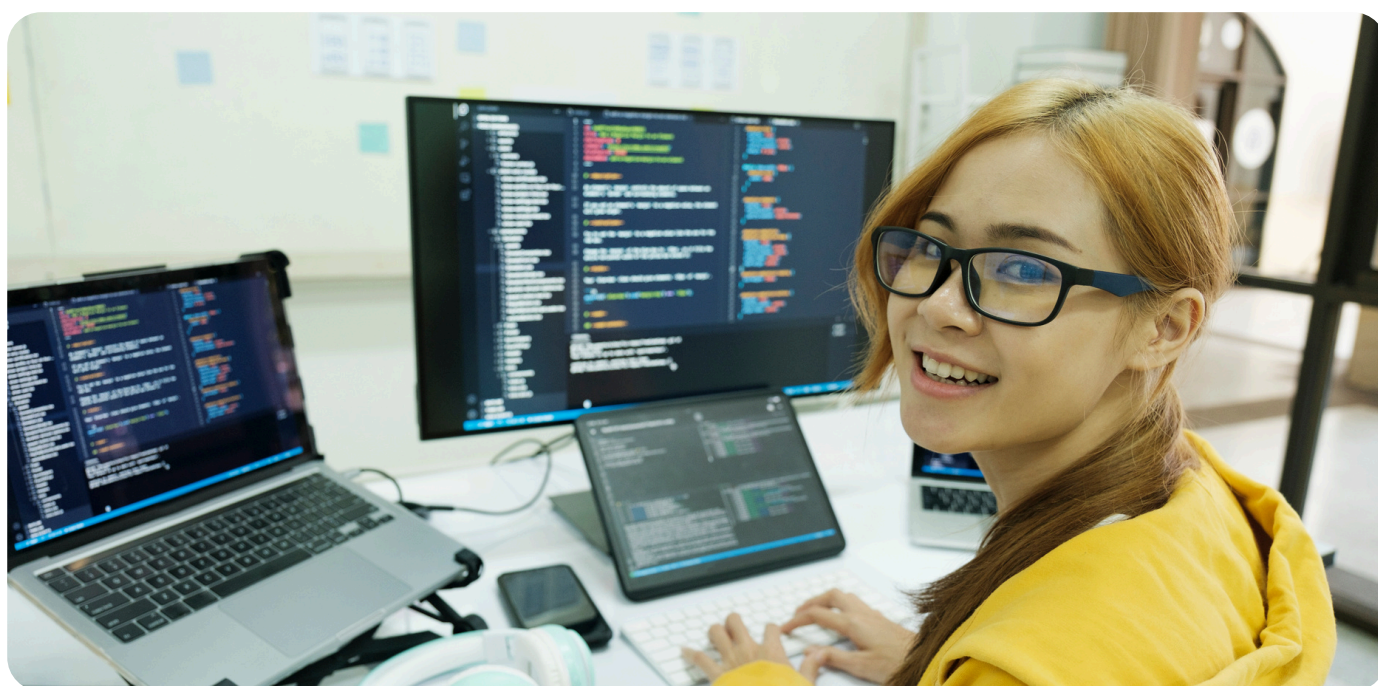
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STEM Education



As societies become increasingly data-driven and technologically complex, learners require competences to understand and navigate this environment. Science, technology, engineering, and mathematics, collectively known as STEM, provide a strong foundation for this understanding. STEM education equips learners to investigate phenomena, use evidence to make decisions, apply technological tools, and design practical solutions to real problems.

The Erasmus+ Programme plays a pivotal role in strengthening STEM competences, supporting learners' ability to think critically, interpret information, and participate meaningfully in modern life. The programme offers schools, vocational institutions, youth organizations, adult learning providers, and higher education institutions opportunities to collaborate across borders, develop innovative learning methods, and integrate interdisciplinary approaches into their curricula. Through these activities, learners experience how STEM knowledge and STEAM practices can be applied in authentic and meaningful contexts.



2 What is STEM?

STEM stands for Science, Technology, Engineering, and Mathematics. Each of these areas contributes to a broader skill set that supports learners in understanding how the world works and in addressing challenges in logical, systematic, and creative ways.

- **Science** focuses on curiosity, observation, experimentation, and the construction of evidence-based explanations.
- **Technology** emphasizes the use of digital technology, devices, and systems to access information, create content, and solve practical tasks.
- **Engineering** centers on designing and building new solutions and improving existing ones, often through iterative problem-solving and prototyping.
- **Mathematics** provides tools for reasoning, modeling, representing relationships, and analyzing patterns and quantities.

STEM skills include scientific inquiry, problem-solving, logical reasoning, computational thinking, data literacy, and the ability to use digital technology effectively. They also include the capacity to design prototypes, test ideas, improve solutions, and interpret numerical and graphical information. These skills are not purely technical; they also support creativity, communication, collaboration, and the ability to handle complex tasks.



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Why Integrate STEM and the Arts – The Value of STEAM

While STEM equips learners with essential analytical and technological competences, innovation also demands imagination, design, cultural understanding, and the ability to consider broader human and societal contexts. For this reason, many modern educational practices extend STEM to STEAM, where the “A” stands for the arts, including visual arts, design, humanities, social sciences, and creative disciplines.

STEAM breaks down barriers between traditional school subjects by integrating creative and scientific thinking. Learners may explore real-world problems by combining empirical investigation with creative expression, ethical reflection, and collaborative design. This interdisciplinary approach enhances learners’ ability to apply scientific and technological knowledge in meaningful, relevant contexts. STEAM projects often create environments that resemble creative laboratories, where learners design experiments, build models, use digital technology, create artistic representations, and develop solutions that combine logic, form, function, and purpose.



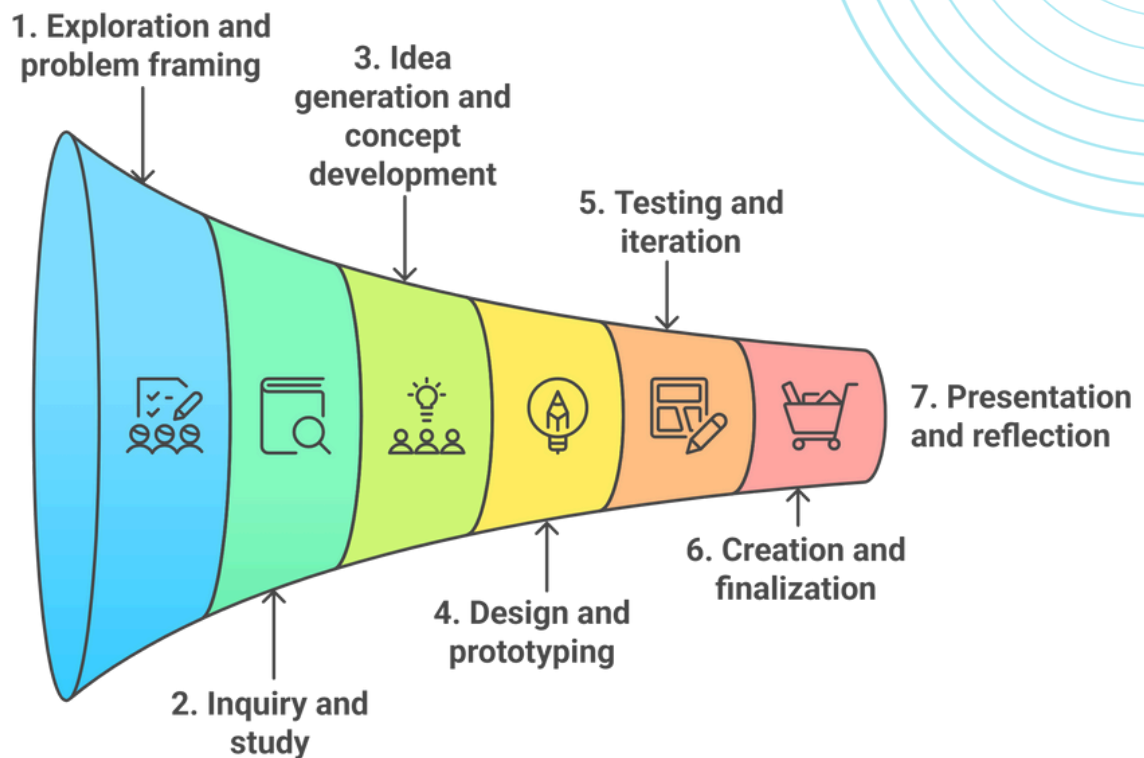
4 How Are STEM Skills Developed in STEAM Projects?



STEAM projects provide ideal conditions for learning holistic STEM skills by encouraging learners to actively engage with real-world challenges using real materials and tools. For example, when learners design a sustainable city model, they apply scientific knowledge about energy and ecology, use engineering principles to build prototypes, analyze data from their designs, and create artistic representations to communicate their ideas. In this process, they learn to observe, test, calculate, design, interpret, visualize, and reflect upon their findings.

Similarly, when young people develop a digital storytelling project that incorporates coding and multimedia creation, they acquire technological skills, practice mathematical logic, solve engineering challenges in structuring digital content, and express their ideas through artistic choices. STEAM thus supports the development of STEM competences by integrating them into engaging, purposeful activities.

Through these kinds of projects, learners also develop design skills, systems thinking, teamwork, and the ability to use evidence in decision-making. They learn to design solutions that are not only technically functional but also meaningful and socially responsible.



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Typical Pedagogical Phases in STEAM Projects

- 1. Exploration and Problem Framing:** Learners explore a real-world phenomenon, situation, or challenge, ask questions, identify problems, and define what they want to investigate or design.
- 2. Inquiry and Study:** Learners gather information, conduct experiments, observe, analyze, and build understanding through the use of scientific and mathematical reasoning. In this phase, learners search for relevant resources and additional information they need to advance the process.
- 3. Idea Generation and Concept Development:** Learners brainstorm possible solutions, sketch ideas, make plans, and evaluate different approaches using both creative and analytical thinking.
- 4. Design and Prototyping:** Learners design and build prototypes, models, or digital artifacts using engineering, artistic, and technological tools and techniques.
- 5. Testing and Iteration:** Learners test their prototypes or solutions, collect data, reflect on the results, and improve their designs through iterative cycles.
- 6. Creation and Finalization:** Learners develop a refined solution, artifact, or outcome that integrates scientific, technological, engineering, artistic, and mathematical elements.
- 7. Presentation and Reflection:** Learners communicate their results, explain their reasoning, demonstrate their prototypes, and reflect on what they learned and how their ideas evolved.

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How Can STEM Skills and STEAM Learning Be Supported in Erasmus+ Projects?

Erasmus+ provides opportunities for organizations to **collaborate internationally** and introduce innovative approaches to STEM and STEAM learning. **Mobility** periods enable learners to participate in activities that may not be available in their home context. At the same time, **cooperation partnerships** allow educators and institutions to jointly develop, for example, new curricula, tools, and pedagogical strategies.

Projects supported by Erasmus+ often combine hands-on experimentation with cross-cultural collaboration. Learners work with peers from other countries; they may compare data, discuss solutions, and learn how scientific and technological issues are approached in different educational and cultural settings. These experiences help learners understand the broader relevance of STEM and STEAM competences and strengthen motivation through real-world engagement.

Teacher training in Erasmus+ projects plays an equally important role by supporting educators in adopting inquiry-based methods, using digital tools effectively, integrating the arts and creativity into science subjects, and designing learning activities that promote gender inclusion and encourage STEM participation.

In addition, **Digital Opportunity Traineeships (DOTs)** in higher education and vocational education and training allow participants to gain hands-on experience in digital and technological environments, thereby strengthening their practical STEM competences. During these traineeships, participants work with real digital tools, software, data, or technological processes, thereby deepening their understanding of how science, technology, engineering, and mathematics are applied in professional contexts. DOTs can support participants in developing future-oriented STEM competences by immersing them in authentic technological settings that promote innovation, creativity, and practical skill development.



In school education, the Erasmus+ project may focus on learners' collaborative design and co-creation of solutions to authentic challenges. These projects frequently involve hands-on activities, such as building prototypes, programming simple robots, constructing gadgets, or experimenting with digital tools that support engineering thinking.

Many projects may also address green topics and sustainability, encouraging learners to explore real environmental issues in their local communities. For example, learners might collect air quality or biodiversity data, analyze the results using mathematical and digital tools, and compare their findings with partner schools across Europe. Through this process, they develop skills in scientific observation, data analysis, digital measurement techniques, and the interpretation of environmental indicators.

At the same time, they strengthen their communication competences by presenting their discoveries in creative formats such as videos, exhibitions, podcasts, or digital posters, thereby learning to share scientific results with diverse audiences.

In another project, learners may collaborate on robotics and coding challenges. Working in international teams, they design simple robots, program them to complete tasks, and reflect on the effectiveness of their solutions. These activities naturally develop engineering thinking and computational thinking skills, teamwork, and iterative problem-solving.





In vocational education and training, learners may explore applied technologies such as renewable energy systems, CNC machining, 3D printing, or smart mobility solutions. For example, a VET partnership might organize work-based learning in a solar technology company abroad, where learners observe real installations, analyze energy production data, and practice technical measurements. Such activities reinforce mathematical modeling, engineering competences, and digital skills.

In higher education, STEAM-based projects often bring together learners from engineering, design, and social sciences programs. They might work in joint innovation studios, developing prototypes for assistive technologies or environmentally friendly materials. These collaborations demonstrate how STEM knowledge becomes more powerful when combined with design thinking, ethics, and social research.

Youth organizations can also provide STEM learning opportunities by organizing international hackathons, maker workshops, digital storytelling projects, and sustainability-focused design challenges. Young people can work with sensors, coding platforms, digital fabrication tools, or creative media while developing teamwork, communication, and socio-emotional skills.

Adult education providers can use STEM projects to promote digital upskilling, offering opportunities for adults to learn, for example, coding basics, to develop data literacy, or explore how everyday technologies operate. These approaches broaden STEM competences beyond school and university settings.

6

Encouraging More Girls and Women to Participate in STEM



Despite positive developments, girls and women remain underrepresented in STEM learning pathways and careers. This underrepresentation may be influenced by factors such as social expectations, limited exposure to role models, confidence gaps, and stereotypes about scientific and technical fields. Creating equal opportunities requires supportive learning environments where all learners feel welcome and capable of succeeding in STEM.

Erasmus+ projects can address this by, for example, highlighting female role models, offering mentoring systems, using inclusive teaching approaches, and connecting STEM learning to topics that many learners find meaningful, such as sustainability, creativity, and community well-being. Projects that combine science and technology with the arts, storytelling, or social innovation often appeal strongly to diverse groups of learners and demonstrate that STEM is relevant to everyone in their everyday lives. By linking STEM to real-world issues, emphasizing creativity, and using collaborative learning approaches, Erasmus+ projects can help girls and women build confidence, interest, and a sense of identity in STEM fields.

7 Moving Forward: Questions for Reflection

The development of STEM and STEAM education raises several important questions for educators and institutions. They may reflect on how interdisciplinary approaches can be integrated more systematically into curricula and how inquiry-based and project-based learning, as well as projects, can be supported in everyday teaching practices. Strengthening teachers' confidence and competence in guiding open-ended investigations, integrating digital tools, and facilitating collaborative problem-solving is essential for high-quality STEM learning.

It is equally important to consider how inclusive practices can be improved so that all learners, including girls and women, learners with fewer opportunities, and other underrepresented groups, have equal access to STEM pathways and learning experiences. Questions also arise about the evolving role of digital technologies and artificial intelligence (AI) in STEM education, and how learners can be guided to use these technologies responsibly, ethically, and creatively. As AI, data science, and digital tools become increasingly embedded in STEM subjects, educational institutions need strategies to help learners understand both the potential and limitations of these technologies.

Finally, many institutions may explore how Erasmus+ collaboration and projects can further support the creation of cross-border communities of practice, enabling educators to exchange ideas, co-design learning materials, and develop shared approaches to STEM and STEAM teaching. One particularly valuable platform for such collaboration is the European Digital Education Hub, an online community where educators, digital education developers, and researchers collaborate. The Digital Education Hub offers peer learning groups, expert discussions, professional development activities, thematic events, and opportunities to share innovative resources. By engaging with the Digital Education Hub, educators can access the latest developments in digital pedagogy, connect with colleagues across Europe, and contribute to shaping future-oriented digital learning environments.

Questions to Consider:

1. How can STEM and STEAM be integrated more effectively into everyday teaching and learning?
2. What support do teachers need to use inquiry-based and project-based methods in STEM education?
3. How can learning environments better promote creativity and hands-on STEM exploration?
4. What actions can encourage more girls, women, and underrepresented groups to participate in STEM?
5. How can digital tools and AI be used meaningfully in STEM learning?
6. How can Erasmus+ projects strengthen learners' STEM skills?

Resources and more information:

- STEM Education and Training, European Education Area, <https://education.ec.europa.eu/focus-topics/stem>
- STEM and ICT initiatives and resources, European Education Area, <https://education.ec.europa.eu/focus-topics/digital-education/stem/resources>
- Women's participation in STEM studies and careers, Digital Education Action Plan, <https://education.ec.europa.eu/focus-topics/digital-education/action-plan/Women-participation-in-STEM>
- Learning Computational Thinking in Phenomena-based Co-creation Projects / Computational Thinking Education in K12: <https://doi.org/10.7551/mitpress/13375.001.0001>
- STEAM as an Approach, Theme Card by SALTO Digital: <https://urly.fi/3K4j>
- Computational Thinking, Theme Card by SALTO Digital: <https://urly.fi/3TFL>



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