



European Education Area Strategic Framework Working Group on Schools: Learning for Sustainability

Plenary Meeting: STEM education, sustainability and
green careers



**Working Group Learning for sustainability: STEM
education, sustainability and green careers.**

Input Paper

Table of Contents

Introduction	4
Background and context	4
What is STEM?	4
The scale of the STEM challenge.....	5
What STEM and learning for sustainability have in common	6
What are green jobs and careers?.....	7
Preparing learners for green careers	7
Examples of green career resources.....	9
Conclusion and reflection questions	9
References.....	11

This paper was prepared by Conor GALVIN, PhD for the plenary session of the EU Working Group on Schools: *Learning for Sustainability*, 12-13 Feb 2025, at Brussels, Belgium.

For more information about the European Commission's work on learning for sustainability see: <https://education.ec.europa.eu/focus-topics/green-education/learning-for-environmental-sustainability> .

For information and publications relating to the working group see: <https://wikis.ec.europa.eu/display/EAC/Learning+for+Sustainability> .

Introduction

The green transition is set to reshape the labour market, with new green jobs emerging and existing ones disappearing or changing. Indeed, Europe is already facing significant labour shortages and skills gaps in this area. While schools play a broader role in fostering active citizenship, critical thinking and global education, they also have a vital role in preparing young people for future careers, including those in the green economy.

The purpose of this paper is to examine how learning for sustainability (i) intersects with STEM education and (ii) can contribute to preparing learners for green careers. The paper serves as input for the upcoming Working Group plenary meeting on STEM education, sustainability and green careers, 12-13 March 2025.

Background and context

The Draghi Report on the future of European competitiveness (2024) warns that without decisive action on productivity, investment and skills development, Europe risks losing its global competitiveness, particularly in strategic sectors such as clean tech, AI and advanced manufacturing.

Similarly, in the 2024-2029 Political Guidelines, European Commission President von der Leyen highlighted the growing global competition the EU faces and cautioned that Europe must not “fall behind and lose its competitive edge in this race.” She stressed the importance of enhancing skills levels across the EU through lifelong learning and announced a Union of Skills initiative to boost European competitiveness and align workforce capabilities with the needs of the green and digital economy. Central to this initiative is a STEM Education Strategic Plan, which will be part of the broader Union of Skills package.

The European Commission’s recently published foresight report considers climate change and environmental degradation as “an existential threat to the European Union and to the world”. It further describes the necessary transition towards greener and more sustainable economies as “a game changer in the EU labour market alongside digitalisation and automation” and notes that “skill needs will change with impacts far beyond the key occupations driving them, affecting all economic sectors”.¹

The European Commission’s renewed focus on competitiveness, STEM talent and innovation skills can be expected to shape education policy work and requires a reappraisal of how school education policy can contribute to and promote STEM learning as well as interest and uptake in green skills and jobs.

What is STEM?

STEM education (science, technology, engineering and mathematics) originated as a term in the US in the 1990s as a response to a rapidly changing workforce. Over time, the concept of STEM has evolved beyond the labour market to focus on integrated learning approaches, problem-solving and real-world applications. More recently, the focus has shifted towards integrated STEM (also referred to as ‘iSTEM’). Rather than teaching STEM subjects separately, iSTEM promotes a more cohesive, interdisciplinary curriculum and teaching methods that reflect the complexity of real-world challenges.

¹ European Commission: Directorate-General for Research and Innovation, Knudsen, M., Caniëls, M., Dickinson, P., Hery, M. et al.,(2024) Futures of green skills and jobs in Europe in 2050 – Scenarios and policy implications, Publications Office of the European Union, 2024, <https://data.europa.eu/doi/10.2777/36430>.

This approach also emphasises the development of key transversal skills, such as creativity, critical thinking and problem-solving. Another related concept is STEAM education, which incorporates the arts—such as visual arts, humanities and social sciences—into STEM subjects. Like integrated STEM, STEAM promotes a more holistic approach to learning – both educational approaches seek to build the scientific literacy of learners, and, with the inclusion of the arts, student creativity is positioned as a key skill that must receive special attention.

The scale of the STEM challenge

The transition to a competitive, net-zero economy requires scientific, technological and problem-solving skills, particularly in sectors such as renewable energy, sustainable materials and circular economy solutions. The growing EU emphasis on skills for competitiveness will seek to address demand for STEM professionals with sustainability expertise by ensuring learners gain the skills needed for high-growth sectors, including green hydrogen, carbon capture, smart grids and bio-based industries.

Education and training play a crucial role in igniting interest in STEM from an early age and developing STEM competences. However, evidence shows considerable systemic challenges in STEM education that need to be overcome. These include growing numbers of 15-year-olds underachieving in mathematics and science¹², low levels of digital competences¹³, shortages of qualified STEM teachers in most EU countries,¹⁴ as well as a talent, diversity and gender gaps in STEM studies and careers. Nonetheless, by fostering problem-solving, innovation and systems thinking, STEM education holds great promise in preparing young people for emerging career opportunities in sectors such as sustainable engineering, renewable energy and circular economies.

While progress is being made, ensuring equitable access to high-quality STEM and sustainability education also remains a challenge and will require both continued investment and collaboration across sectors. The number of STEM tertiary graduates is rising,¹⁵ but the pace is insufficient to keep up with the growth in demand for STEM jobs. Moreover, although women make up the majority of university graduates in all European countries, they continue to be underrepresented in STEM disciplines and hold only a quarter of STEM-related jobs¹⁶ and even less in the ICT sector¹⁷.

¹² According to 2022 Programme for International Student Assessment (PISA), at EU level, the underachievement rate now reaches 29.5% in mathematics, and 24.2% in science (The twin challenge of equity and excellence in basic skills in the EU. An EU comparative analysis of the PISA 2022 results).

¹³ European Commission (2024). *International Computer and Information Literacy Study (ICILS) in Europe – 2023. Main findings and Educational Policy implications*.

¹⁴ Most EU education systems report shortages of permanent or temporary STEM teachers, with only a few exceptions (Greece, Italy, Cyprus, Hungary, Portugal, and Romania). See the 2022 Eurydice report on mathematics and science learning in schools (referring to the 2020-21 school year) and the 2023 Education and Training Monitor.

¹⁵ In 2022, there were 23.0 tertiary (ISCED 5-8) graduates in STEM per thousand young people. At EU level, this ratio has increased by 3.4 since 2017, and a positive trend is observable in all EU Member States but for Malta, Slovakia, Czechia, Poland, and Lithuania.

¹⁶ Even though women continue to earn university degrees at a higher rate than men in certain STEM fields (e.g. biology), they hold just one-quarter of jobs in STEM-related professions (Fondazione Deloitte, 2022).

¹⁷ Digital Decade Progress Report (2024).

What STEM and learning for sustainability have in common

Both STEM and sustainability education have a particular focus on **science education**. Indeed, the Sciences and science education have traditionally played an important role in advancing environmental education and learning for sustainability. Students' environmental awareness is associated with their science competences. PISA 2018 showed that those 15-year-olds that scored highest on questions on environmental science were the most familiar with complex environmental issues. In contrast, students with lower achievement in science, 'often reported an almost naïve optimism that the environmental challenges will go away in the future' (Schleicher, 2021).

While not all solutions will be and should be scientific and technological, many of the European Green Deal policy areas are STEM intensive. Active and engaging learning for sustainability can potentially increase interest and motivation to study STEM in school, VET and higher education and pursue careers in STEM and sustainable development.

To encourage learners to recognise and make links between the social, economic and environmental dimensions of sustainability (IDoS, 2019)¹⁸, STEM learning can be enhanced through a **STEAM approach** where learning and teaching are contextualised in political, environmental, socio-economic, and cultural challenges, thereby connecting to real-world problem solving, collaboration, inquiry and critical thinking. This approach can also strengthen links and interaction between formal, non-formal and informal learning and build links to the world of work. Despite the positive educational outcomes associated with the STEAM approach, it is not yet widely implemented across Europe (Eurydice, 2011). **Enquiry-based learning and citizen science** are key pedagogies that can further support learning for sustainability and STEM education through focusing on science literacy, including observation and experimentation.

Both STEM and learning for sustainability place value on **active and innovative approaches to learning**: For example, project-based learning focussed on real world challenges features centrally to both. Students engage in hands-on projects addressing key environmental and economic challenges, such as AI-driven climate modelling to predict energy demand, optimising clean energy solutions such as solar panels and wind turbines and exploring circular economy innovations through biodegradable materials and waste-to-energy conversion. Similarly, both these fields **encourage partnerships between schools, universities, NGOs and industry** to provide real-world applications of STEM.

Interdisciplinary approaches are key in both STEM and learning for sustainability, reflecting the interconnected nature of economic, environmental, and technological challenges. For instance, in mathematics, students can apply data analysis and statistical modelling to measure carbon footprints, fostering an understanding of environmental impact. Physics and chemistry offer avenues to explore innovations such as battery storage advancements, hydrogen fuel cells and green chemistry alternatives. In computer science, AI models can be developed to predict climate risks and create smart city solutions. Additionally, engineering and design play a crucial role in innovating biodegradable packaging, low-energy building materials, and nature-based solutions for urban planning. By integrating these interdisciplinary perspectives, educators can equip students with the knowledge and skills needed

¹⁸ The *International Dialogue on STEM Education*, was held at Robert Bosch Stiftung in Berlin, Germany on December 5 and 6, 2019. The main topic of the conference was STEM Education for Sustainable Development.

STEM EDUCATION, SUSTAINABILITY AND GREEN CAREERS

to address global sustainability challenges through a holistic and interconnected approach – while simultaneously developing key STEM skills.

In conclusion, both STEM education and learning for sustainability can arguably play a key role in equipping students with the skills needed to tackle climate change and resource management, which are central to Europe's green and digital transitions. Moreover, the European Centre for the Development of Vocational Training (Cedefop) has long highlighted that green skills and innovation are crucial for inclusive growth, aligning strongly with the objectives of the European Green Deal (Cedefop/OECD, 2015).

What are green jobs and careers?

Green jobs are roles that help protect, restore and improve the environment and support sustainability. As industries work to address the challenges of climate change, many are shifting towards renewable energy, energy efficiency and sustainable practices. This transition is creating new job opportunities in areas such as electric vehicles, clean energy production and resource conservation. Examples of green jobs include environmental technicians, agricultural specialists, wind turbine and solar panel technicians and green construction managers. In addition to specific green job profiles, *all* jobs need to be 'greened' by looking at how resource and process management can become more climate friendly. The entire working population needs to build and strengthen green skills and competences.

Preparing learners for green careers

As noted earlier, the green transition is expected to significantly alter the labour market, with new green jobs emerging (e.g. related to hydrogen production, engineering wind technologies...) and existing ones disappearing or changing (e.g. coal mining). According to the European Commission's (2023) Employment and Social Developments in Europe report, companies are experiencing labour shortages despite available opportunities and markets– and find themselves needing to adapt to evolving skill requirements driven by the green and digital transitions. A decreasing population of working-age individuals further demands greater diversity and inclusivity in the green job market.

Schools play a key role in preparing young people for green jobs and careers. A recent OECD working paper highlights that while many young people are interested in pursuing green careers, they often lack awareness of the opportunities available (OECD 2024). Certain types of training interventions could have a sizable impact on this skills gap while also – if properly communicated – contribute to wider understanding of the opportunities for green careers (Chang & Mann, 2024).

These include:

1. **Re-skilling:** Transition-oriented re-skilling needed for people whose skills will become obsolete as they are in declining sectors (e.g. coal mining).
2. **Up-skilling:** Sectors where up-skilling will suffice (e.g. as the automotive sector transitions to producing electric vehicles).
3. **Existing green jobs:** Training to meet increasing demand for established 'green' occupations (e.g. wind turbine technician).
4. **Emerging green jobs:** Training for new and emerging occupations linked to new 'green' products (e.g. skills required for hydrogen-based energy production).

Schools and education systems can actively support green career preparation by integrating environmental literacy into the education system, thereby ensuring that sustainability values are deeply

STEM EDUCATION, SUSTAINABILITY AND GREEN CAREERS

ingrained and applicable not only to explicitly green jobs but also to a broader range of careers (Chang & Mann, 2024).

Career guidance should incorporate structured self-reflection, using frameworks such as the OECD model for green guidance, to help students identify how their skills align with environmental goals and how specific pathways to careers in these areas can be taken. Career advisers and teachers require access to up-to-date information about labour market trends, green job opportunities and the skills required for high-impact careers in these fields. By providing educators with timely and relevant labour market insights, schools can empower students to make informed decisions about their career trajectories and guide them towards green-related careers that align with their strengths and interests. Moreover, careers advisers and schools are uniquely positioned to promote gender and diversity inclusion, thereby maximising Europe's STEM talent pipeline and ensuring that underrepresented groups have equal access to opportunities in these fields (Nuttall, 2024).

Partnerships with businesses and the environmental sector can provide invaluable real-world exposure through volunteering, internships and direct industry experiences. These provide early exposure to green STEM careers through such industry partnerships, mentorship programmes, and hands-on experiences in emerging sectors (e.g., battery technologies, bioengineering, sustainable urban design). In this context, mentorship programmes can help students navigate common challenges, such as understanding and defining green jobs, recognising that many essential green skills are transferable across industries and addressing gender imbalances in traditionally male-dominated fields such as engineering. By implementing such strategies, schools can better equip students with the knowledge, experience, and confidence needed to pursue meaningful careers in the green economy.

There may also be a significant role for environmental sector interests to play in incentivising uptake of green STEM fields. This could include initiatives such as scholarships, apprenticeships, and other incentives for students pursuing STEM and sustainability-related careers. Models for such interventions already exist in the technology industries and could perhaps be readily reconfigured for green careers.²¹

A strong vocational education and training (VET) skills base is essential for driving the green transition, supporting a greener Europe, delivering the European Green Deal, and ensuring a just global transition. Green skills must be developed across low-, medium-, and high-technology professions, with VET systems and schools playing a crucial role in enabling green advancements. To respond swiftly to the impacts of climate change, short-term skills programmes should be improved, emphasising transferable skills that allow workers to adapt quickly to new job roles.

The talent base for green skills must be expanded to meet the growing demand for green jobs, particularly in light of Europe's declining labour-market-age population, which poses significant demographic and mobility challenges. Greater diversity and inclusivity are essential in this regard. Addressing gender imbalances and fostering inclusiveness should therefore be key priorities in skills policy planning. This includes implementing initiatives that promote a more balanced gender distribution and enhancing inclusivity within schools, as well as universities and research organisations focused on green technologies.

²¹ The types of GenZ recruitment and support programmes advocated by Templeton & Partners (2023) would be a good example of this. See <https://www.templeton-recruitment.com/tech-news/the-future-of-tech-investing-in-a-diverse-and-young-workforce>

Examples of green career resources

- **WindEurope** (EU-wide): Card game to raise awareness about wind energy careers and book featuring 21 individuals in clean energy to inspire children about renewable energy career opportunities.
- **FoodEducators** (EIT Food, EU-wide): Lesson plans and interactive activities to help students explore agrifood careers, highlighting the diversity of skills and professions in sustainable food systems.
- **Bildungsberatung NÖ** (Austria): A personalised career development programme offering digital and in-person guidance that links green careers to school curricula.
- **Career Portals** (Ireland): A comprehensive career exploration platform, featuring 33 employment sectors, including three dedicated to the green economy with interactive materials, videos, career interviews, and skills assessments.
- **Excelsiorienta** (Italy): An online career portal supporting secondary school students in exploring green career pathways.
- **Jobba Grönt** (Sweden): A career initiative focused on agriculture, forestry, and environmental careers, showcasing a wide range of green career and educational pathways.
- **JobDD: Métiers Engagé** (France): Features quizzes and games that match students' skills and interests with green career pathways while linking results to the UN Sustainable Development Goals.
- **Gesucht-Gefunden: Ich!** (Germany): An interactive tool for 12-18-year-olds to self-assess their skills and explore career options, focusing on sustainable industries.

Conclusion and reflection questions

The transition to a net-zero economy will require a highly skilled workforce, in fields such as renewable energy, circular economy and green technologies. However, systemic challenges in STEM education—such as teacher shortages, gender disparities and an insufficient number of graduates—threaten to slow progress.

Both STEM and learning for sustainability offer a powerful way to equip learners with problem-solving, systems thinking and ethical decision-making skills, though care must be taken to avoid a narrow technical focus. A STEAM approach, which incorporates the arts, further enhances interdisciplinary learning and creativity, fostering holistic solutions to complex challenges. Innovative educational strategies such as project-based learning, workplace partnerships, and citizen science initiatives provide students with real-world applications of STEM and sustainability.

Research shows that while students are concerned about the climate crisis and sustainability, many lack awareness of job opportunities in fields such as renewable energy, the circular economy and green technology. Schools can bridge this gap by integrating green career education into STEM and sustainability learning, offering hands-on projects, workplace visits and industry connections. By highlighting real-world applications, education can empower and inspire young people to pursue careers in the green economy.

STEM EDUCATION, SUSTAINABILITY AND GREEN CAREERS

Questions for reflection:

Regarding STEM: How can the integration of sustainability in STEM education enhance students' ability to apply their knowledge to real-world challenges and solutions? And how can this make learning more relevant? Are there synergies in approaches between STEM and learning for sustainability?

Regarding green careers: At what educational stage should career guidance related to green jobs begin, and what should it encompass? What strategies can schools employ to increase awareness among students about the range of green career opportunities available? How can schools collaborate with industry and other players to inspire interest in green jobs?

Regarding policy action: How can national policy frameworks be designed to effectively support labour market transitions from brown to green energy? What strategies can policymakers implement to foster strong partnerships between public, private, and not-for-profit organisations to drive innovation in green skills and employment? Additionally, how can national employment and skills strategies be adapted to meet the needs of both workers and businesses in the transition to a greener economy?

References

- Bianchi, G., Pisiotis, U. and Cabrera Giraldez, M. (2022). *GreenComp -The European Sustainability Competence Framework*, Edited by M. Bacigalupo and Y. Punie, Vol. EUR 30955 EN. Publications Office of the European Union, Luxembourg.
- Cedefop; OECD (2015). *Green skills and innovation for inclusive growth*. Luxembourg: Publications Office of the European Union. Cedefop reference series.
- Chang, Y. and A. Mann (2024). “Enhancing green career guidance systems for sustainable futures”, OECD Education Working Papers, No. 318, OECD Publishing, Paris, <https://doi.org/10.1787/e6ad2d9c-en>.
- Eurofound (2023). *Fit for 55 climate package: Impact on EU employment by 2030*, Publications Office of the European Union, Luxembourg.
- European Commission: Directorate-General for Research and Innovation (2024), Knudsen, M., Caniëls, M., Dickinson, P., Hery, M. et al., *Futures of green skills and jobs in Europe in 2050 – Scenarios and policy implications*, Publications Office of the European Union, 2024, <https://data.europa.eu/doi/10.2777/36430>
- European Commission: Directorate-General for Employment, Social Affairs and Inclusion (2023), *Employment and social developments in Europe 2023*, Publications Office of the European Union, 2023, <https://data.europa.eu/doi/10.2767/089698>
- European Commission: Directorate-General for Education, Youth, Sport and Culture (2021). Tasiopoulou, E., Billon, N., Finlayson, A., Siarova, H. et al., *Education for environmental sustainability – Policies and approaches in European Union Member States – Final report*, Tasiopoulou, E.(editor), Billon, N.(editor), Finlayson, A.(editor), Siarova, H.(editor), Pribuišis, K.(editor), Gras-Velazquez, A.(editor), Mulvik, I.(editor), Bajorinaitė, M.(editor), Sabaliauskas, E.(editor), Fronza, V.(editor), Vežikauskaitė, J.(editor) and Disterheft, A.(editor), Publications Office of the European Union, 2021, <https://data.europa.eu/doi/10.2766/391>
- European Commission: Directorate-General for Research and Innovation, Knudsen, M., Caniëls, M., Dickinson, P., Hery, M., Könnölä, T., & Lotz-Sisitka, H. (2024). *Futures of green skills and jobs in Europe in 2050 : scenarios and policy implications*, Publications Office of the European Union. <https://data.europa.eu/doi/10.2777/36430>
- Nuttall, B. (2024). Green career education and guidance through the perceptions and experiences of career practitioners in English secondary schools. *Journal of the National Institute for Career Education and Counselling*, 53(1), 105-121.
- O'Donnell, C., Blanchard, K. P., Strom, K. J., D'Amico, A., Mogck, A., Alcazar, R., Brennan, V., Ayman Elsayed, A., Fitzgerald, A., , Eliana Greenbaum, E., Osman, E., & Sepiurka, M. (2024). The Network for Emergent Socio-Scientific Thinking (NESST): collaboration for a shared transformative future through STEM Education. *Sustainable Earth Reviews*, 7(1), 24. <https://doi.org/10.1186/s42055-024-00092-9>
- OECD Career Readiness Team (2024). *Cultivating Green Futures: Helping students understand and progress towards green jobs*. OECD Education Policy Perspectives; No.104.
- Schleicher, A. (2021), *Learning from the Past, Looking to the Future: Excellence and Equity for all* , International Summit on the Teaching Profession, OECD Publishing, Paris, <https://doi.org/10.1787/f43c1728-en>.