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STEAME TEACHER ACADEMY

Guidelines for facilitating the learning of STEAME
Reference Number: 101102619

Module and Workshop Learning Plan

Module Number and Area/Topic: 14. GREEN ISSUES IN STEAME EDUCATION

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1. Introduction and broad description of the context and goal of the area/topic addressed with reference to the STEAME Teacher Facilitators Competence Framework for student and serving teachers

Integrating green issues into STEAME education is essential for preparing students to tackle the environmental challenges of the 21st century.

Green issues in STEAME education focuses on establishing sustainability and environmental awareness into STEAME curricula and practices. These initiatives aim to equip students with the knowledge and skills needed to address global environmental challenges by examining innovative and sustainable solutions. Given the breadth of the content available the workshop will introduce green issues in general and then develop an area further.

1. Sustainable Curriculum Development

- **Incorporating Environmental Science**: Integrating environmental science topics such as climate change, biodiversity, and renewable energy into STEAME courses. This provides a fundamental understanding of ecological principles and environmental issues.
- **Project-Based Learning**: The focus is on hands-on, project-based learning approaches that involve solving real-world environmental problems. Examples include creating sustainable urban plans, expanding renewable energy, developing conservation strategies and using data for democratic engagement.

2. Green Technologies

- **Renewable Energy Systems**: Teaching students about the design, implementation, and benefits of renewable energy technologies such as solar, wind, and hydroelectric power. Projects might include building small-scale renewable energy models or analysing energy efficiency.
- **Sustainable Practices**: Promoting the use of sustainable materials and processes in production projects. This includes studying the lifecycle of products, reducing waste, and recycling materials.

3. Environmental Data Science

- **Data Collection and Analysis**: Training students to collect and analyse environmental data using modern technology. This might involve remote sensing, Geographic Information Systems (GIS), and other data tools to monitor environmental changes and impacts.
- **Citizen Science Projects**: Engaging in citizen science projects where data on local environmental issues can be collected, such as air and water quality, biodiversity, and climate patterns.

4. Green Chemistry

- **Sustainable Chemistry**: Teaching the principles of green chemistry, which focuses on designing chemical products and processes that reduce or eliminate the use and generation of hazardous substances. This includes topics like bio-based materials, environmentally benign solvents, and minimising waste.

5. Sustainable Computing and IT

- **Energy-Efficient Computing**: Exploring ways to reduce the energy consumption of computing systems, including the development of energy-efficient algorithms, hardware, and data centres.
- **E-Waste Management**: Educating students about the environmental impact of electronic waste and promoting practices for recycling and disposing of electronics responsibly.

6. Environmental Management and Urban Planning

- **Sustainable Urban Development**: Studying the principles of sustainable urban planning, including green building design, sustainable transportation, and the creation of green spaces.
- **Water Resource Management**: Teaching techniques for sustainable water management, including the design of efficient irrigation, wastewater treatment, and conservation practices.

7. Climate Science and Environmental Modelling

- **Climate Change Education**: Providing education on the science of climate change, its impacts, and mitigation strategies.
- **Modelling and Simulation**: Using mathematical and computer models to simulate environmental processes and predict the outcomes of different scenarios, such as the impact of deforestation or the effectiveness of carbon sequestration techniques.

8. Interdisciplinary Approaches

- **Environmental Policy**: Incorporating studies of environmental policy and economics into STEAME education to provide a broad context. This includes understanding regulations, sustainability certifications, and economic incentives for green technologies.
- **Collaborative Projects**: Encouraging interdisciplinary collaboration on projects that require knowledge from multiple STEAME fields to solve complex environmental problems.

2. Learning objectives and learning outcomes with reference to the defined list of learning outcomes in the Competence framework

Incorporating green issues into STEAME (Science, Technology, Engineering, and Mathematics) education involves setting clear learning objectives and outcomes that aim to equip students with the knowledge and skills needed to address environmental challenges.

Learning Objectives

1. **Understanding Environmental Principles**
    - The foundations of key environmental science concepts, such as ecosystems, biodiversity, and sustainability.
    - The causes and effects of environmental issues like climate change, pollution, and resource depletion.
2. **Developing Problem-Solving Skills**
    - Apply scientific methods to develop innovative solutions to environmental problems.
    - Use critical thinking to analyse and evaluate the effectiveness of different sustainability practices and technologies.
3. **Promoting Sustainable Practices**
    - Recognise the principles of sustainable development, renewable energy and eco-friendly design.
    - Understand the lifecycle of products and materials to promote recycling, waste reduction, and sustainable consumption.
4. **Engaging in Interdisciplinary Learning**
    - Integrate knowledge from different STEAME fields to understand the complexity of environmental issues.
    - Interdisciplinary project collaboration to address real-world sustainability challenges.
5. **Utilizing Data and Technology**
    - Use modern tools and technologies, such as Geographic Information Systems (GIS), remote sensing, and data analytics, to monitor and assess environmental conditions.
    - Utilise simulations and models to predict environmental outcomes and test sustainability strategies.
6. **Fostering Environmental Stewardship**
    - Cultivate a sense of ethics and civic responsibility regarding environmental conservation and sustainability.
    - Encourage active participation in community-based environmental projects and citizen science initiatives.

Learning Outcomes

1. **Knowledge and Comprehension**
    - Demonstrate an understanding of environmental science principles and sustainability concepts.
    - Explain scientific, technological, and societal aspects of major environmental challenges.
2. **Application and Analysis**
    - Design and conduct experiments or projects that address environmental problems using sustainable methods.
    - Analyse environmental data to draw conclusions and make informed decisions about sustainability practices.
3. **Innovation and Creativity**
    - Identify and review innovative solutions and prototypes that reduce environmental impact, such as energy-efficient devices, waste reduction systems, or conservation techniques.
    - Use models or simulations to predict the environmental impact of various actions and policies.
4. **Communication and Collaboration**

- Effectively communicate scientific findings and sustainability concepts to different audiences, including the local community.
- Collaborate with others in interdisciplinary teams to address complex environmental problems.

5. **Ethical and Responsible Actions**
    - Exhibit a commitment to ethical practices in scientific activities, particularly concerning environment, conservation and sustainability.
    - Participate in (local and global) sustainability initiatives, demonstrating advocacy for environmental stewardship.
6. **Lifelong Learning and Adaptability**
    - Show an interest in learning about new developments in environmental science and sustainable technologies.
    - Adapt to new information and evolving scientific understanding to stay current with best practices.

3. Competences that are developed

Incorporating green issues into education requires developing a set of competences that equip students with the necessary skills, knowledge, attitudes, and values to address environmental challenges and promote sustainability.

- **Understand Complex Systems**: Ability to analyse and understand the complexity and interconnectedness of ecological, social, and economic systems.
- **Critical Thinking**: Evaluate interdependencies and feedback loops within and between systems
- **Future-oriented Thinking**: Capacity to identify future trends and scenarios related to environmental change and sustainability challenges.
- **Strategic Planning**: Develop strategies and plans to address potential environmental impacts.
- **Values-based Understanding**: Integrate sustainability values and principles.
- **Ethics**: Make ethical judgments regarding environmental issues and sustainability practices.
- **Teamwork and Networking**: Ability to work effectively with others in collaborative efforts towards sustainability.
- **Community Engagement**: Participate with local communities to promote and implement sustainable practices.
- **Problem-solving Skills**: Identify, analyse, and address environmental problems through practical solutions.
- **Implementation and Management**: Ability to plan, implement, and manage sustainable initiatives.
- **Analytical Skills**: Critically analyse environmental data and information to make informed decisions.
- **Reflection and Evaluation**: Reflect on and evaluate the effectiveness of sustainability practices and educational approaches.
- **Personal Reflection**: Understand one's own values, attitudes, and behaviour towards the environment.
- **Motivation for Change**: Cultivate a personal commitment to sustainability and environmental stewardship.
- **Interdisciplinarity**: Integrate knowledge and methods from different disciplines to solve complex challenges.
- **Holistic Perspective**: View problems from multiple perspectives to develop comprehensive and inclusive solutions.

The key competences are derived from international frameworks including the European Commission GreenComp Competence Model. GreenComp is the European sustainability competence framework, outlines the key competences needed to foster sustainable development and environmental responsibility. It aims to equip individuals with the knowledge, skills, and attitudes necessary to make informed and responsible decisions that benefit the environment, society, and the economy.

4. Content and Resources (providing information on the various constituents/ dimensions of the topic under consideration), including presenter's notes for guidelines of the workshops organisation

For a workshop focused on green issues in STEAME, it is important to provide engaging content that addresses environmental challenges and sustainable solutions. This is a plan and possible resource list for such a workshop:

Workshop Plan

The workshop includes an introduction and then a choice of sessions based on the interest and relevance to the organisers / participants. Followed by a dealing with data and collaborative project approaches. Finally the workshop will conclude with reflective and evaluative activities.

Introduction to the workshop Green Issues in STEAME

- Overview of environmental challenges
- Importance of sustainability in STEAME
- Key concepts: carbon footprint, renewable energy, sustainable practices

Workshop content – select from Section A-E as relevant and feasible

Section A: Renewable Energy

- Types of renewable energy: solar, wind, hydro, geothermal, and biomass
- Case studies of successful renewable energy projects
- Hands-on activity: Creating a simple solar-powered device

Section B: Sustainable Design

- Principles of sustainable design
- Eco-friendly materials and green techniques
- Workshop activity: Designing a sustainable building

Section C: Environmental Impact of Technology

- Analysis of the lifecycle of electronic devices
- E-waste management and recycling
- Discussion: Reducing environmental impact through technological innovation

Section D: Green Chemistry

- Basics of green chemistry and its principles
- Examples of green chemical processes and products
- Experiment: Creating biodegradable plastic

Section E: Data Science - Climate Change

- Using geoinformation to understand climate change
- Tools and software for climate data analysis
- Hands-on activity: Analysing climate data

Collaborative Projects

- Implementing PBL
- Group work
- Group presentations

Conclusions

- Reflective session - recap of key learning
- Workshop evaluation and peer feedback
- Open discussion and Q&A

Possible Resources

1. **Books and Articles**
   - "Sustainable Energy – Without the Hot Air" by David JC MacKay
   - UNEP: Green Chemistry and Sustainability Manual
   - "Cradle to Cradle: Remaking the Way We Make Things", William McDonough & Michael Braungart
   - Research articles from journals like “International Research in Geographical and Environmental Education”, “European Journal of Geography”, "Renewable Energy", "Sustainable Materials and Technologies" etc.
2. **Online Courses and Webinars**
   - UNESCO: “Developing Understanding of Education for Sustainable Development”
   - Teaching the Future: “Data Tools and Resources”
   - FEE Academy: “Learning & Teaching about the SDGs”
   - Coursera: "Sustainability and Green Business Strategy"
   - OECD Webinars: “Green Talks Live”
   - Webinar series by the Environmental and Energy Study Institute (EESI)
3. **Software and Tools**
   - ArcGIS Online and Storymaps
   - EcoLife: Reducing your carbon footprint
   - RETScreen: Clean energy management software
   - OpenLCA: Life cycle assessment software
4. **DIY Kits and Experiment Supplies**
   - Solar car kits for renewable energy activities
   - Green chemistry kits for safe in-class experiments
   - Recyclable materials for design projects
5. **Websites and Organizations**
   - European Environment Agency (EEA): Resources on sustainability and environment
   - GREEEN: Environment Education European Network
   - Green Chemistry Institute: Educational materials and case studies
   - National Renewable Energy Laboratory (NREL): Information on renewable energy technologies
6. **Interactive Activities and Games**
   - Simulations like "Climate Change: The Board Game" to understand the impact of decisions on the environment
   - Online platforms like Kahoot! for quizzes and interactive learning sessions
7. **Field Trips and Virtual Tours**
   - Visits to local renewable energy plants, green buildings or conservation projects and national parks
   - Virtual tours of facilities like the Tesla Gigafactory or the Eden Project

By integrating some of these components into your workshop, participants will gain a comprehensive understanding of green issues in STEAME and be equipped with practical skills and knowledge to contribute to sustainability efforts in their fields.

Presenter's Notes for Workshop Organisation:

Guidelines for organizing the workshop include:

- Clearly defining the objectives of each thematic session.
- Providing hands-on demonstrations.
- Encouraging interactive discussions and collaborative problem-solving activities.
- Allocating time for participants to explore and experiment with the green issues introduced.
- Offering supplementary resources and reference materials for further exploration.
- Incorporating group activities that promote networking and knowledge exchange.

5. Methodology and approaches for the module training presentation and guidelines for workshops organisation

Developing a workshop focused on green issues in STEAME education involves creating an engaging, hands-on, and interdisciplinary experience that will help participants understand and address environmental challenges. Here are some methods and approaches which can be used to design and conduct such a workshop:

Workshop Design

Introduction and Overview

- **Objective**: Provide an overview of the workshop, its goals, and the importance of integrating green issues into STEAME education.
- **Activities**: Brief presentations highlighting key environmental challenges and the role of STEAME in addressing them.

Interactive Discussions

- **Objective**: Introduce key concepts in environmental science, sustainability, and green technologies.
- **Methods**: Use interactive lectures combined with Q&A sessions to encourage participant engagement. Incorporate real-world examples and case studies.
- **Approach**: Facilitate discussions on topics such as climate change, renewable energy, waste management, and sustainable agriculture.

Hands-On Activities and Experiments

- **Objective**: Provide practical experience in applying STEAME principles to solve environmental problems.
- **Methods**: Organize lab experiments, fieldwork, and design projects.
- **Examples**:
    - **Renewable Energy Projects**: Build small solar panels or wind turbines.
    - **Water Quality Testing**: Conduct experiments to test local water sources for pollutants.
    - **Sustainable Engineering Challenges**: Design eco-friendly products or systems using recycled materials.

Problem-Based Learning (PBL)

- **Objective**: Engage participants in solving real-world environmental problems through collaboration and critical thinking.
- **Methods**: Present a problem scenario related to an environmental issue and have participants work in groups to develop solutions.
- **Approach**: Use PBL to tackle issues such as designing sustainable cities, reducing carbon footprints, or improving recycling systems.

Technology and Data Analysis

- **Objective**: Teach participants how to use technology and data to monitor and analyze environmental conditions.
- **Methods**: Utilize tools such as Geographic Information Systems (GIS), remote sensing, and data visualization software.
- **Activities**: Conduct workshops on using software to map deforestation, analyse climate data, or track wildlife populations.

Field Visits and Experiential Learning

- **Objective**: Provide real-world experience and connect theoretical knowledge to practical applications.
- **Methods**: Organise field vists for example to local nature reserves, recycling centres, renewable energy plants, or sustainable farms.
- **Activities**: Engage in activities such as tree planting, wildlife monitoring, or observing sustainable practices in action.

Collaborative Projects and Presentations

- **Objective**: Foster teamwork and communication skills while working on sustainability projects.
- **Methods**: Have participants form groups to work on long-term projects that they will present at the end of the workshop.
- **Approach**: Projects can range from creating educational campaigns on sustainability to designing prototypes of green technologies.

Reflection and Evaluation

- **Objective**: Encourage participants to reflect on their learning experiences and provide feedback for future improvement.
- **Methods**: Use reflective journals, group discussions, and evaluation forms.
- **Activities**: Facilitate a final session where participants share their reflections, discuss challenges faced, and suggest improvements for future workshops.

By using these methods and approaches, educators can create a dynamic and impactful workshop that not only imparts essential knowledge and skills but also inspires participants to take action for a sustainable future.

6. Instruments/Tools/Supporting Materials/Resources to be used

Integrating green issues in STEAME education requires a wide variety of tools, materials, and resources to effectively introduce concepts of sustainability and engage participants in hands-on, experiential learning. A possible list of useful resources includes:

Tools and Technologies

Data Collection and Analysis

- **GIS Software**: Tools like ArcGIS and QGIS for mapping and analyzing spatial data related to environmental conditions.
- **Remote Sensing Tools**: Satellite imagery and remote sensing applications like Google Earth Engine for monitoring environmental changes.

Energy Monitoring and Simulation

- **Energy Audit Kits**: Devices to measure energy consumption in schools or homes, such as the Kill A Watt meter.
- **Simulation Software**: Tools like HOMER Energy for modeling and simulating renewable energy systems.

Environmental Sensors

- **Air Quality Monitors**: Devices that measure pollutants in the air, such as particulate matter and CO2 levels.
- **Water Testing Kits**: Kits for testing water quality parameters like pH, nitrates, and turbidity.

Hands-On Experiment Kits

- **Renewable Energy Kits**: Kits that allow students to build and experiment with solar panels, wind turbines, and other renewable energy technologies (e.g., Snap Circuits Green Energy Kit).
- **Recycling and Waste Management Kits**: Materials to create compost bins, recycling projects, and waste audits.

DIY Projects

- **Recycled Materials**: Use of recycled plastics, cardboard, and other materials for creating eco-friendly products and prototypes.
- **Green Chemistry Supplies :** chemicals and laboratory equipment
- **Gardening Supplies**: Seeds, soil, and tools for garden projects to teach about sustainable agriculture and ecosystems.

Sources Of Educational Resources

1. **Curriculum and Lesson Plans**
   - **Project Learning Tree**: Offers a variety of environmental education resources and lesson plans tailored for different age groups.
   - **Eco-Schools**: comprehensive sustainability curriculum and project ideas for school education.
2. **Online Networks**
   - **Green Education networks:** Education for Climate initiative. Learning for the Green Trainsition
   - **Teaching Green**: training courses

- **Earthwatch Education**: a community with sources and resources
- **United Nations Environment Programme**: series of environmental training MOOCs
- **Teaching the Future**: training on climate change and data
- **Khan Academy**: Free educational resources climate change, ecology, and green technologies.

3. **References**
   - "**A Collated List of Online Climate Change Learning Resources**". Sustainability and Environmental Education
   - **"Green Education: back to nature"**, free online with case studies
   - **"The Green Classroom"**: A book offering practical activities and lesson plans for integrating environmental education into the classroom.
   - **"Sustainable Engineering: Concepts, Design and Case Studies"**: Provides insights and examples on sustainable engineering practices.

4. Citizen Science Projects

Explore and engage in citizen science projects, for instance

- those on the European Citizen Science Platform https://eu-citizen.science/projects?keywords=climate%20change
- or global projects like **Globe Observer**: a NASA citizen science project that allows participants to collect environmental data to support climate research.

5. Collaborative Platforms

- **GikiZero**: a task-based platform to calculate your carbon footprint and find steps to reduce it.
- **EcoChallenge**: An online platform for teams to take on sustainability challenges and track their impact.
- **STEM Learning Ecosystems**: A community of practice that supports collaboration among educators, students, and community organizations to promote STEM learning and sustainability.

6. Digital and Interactive Resources, including games

- **YouTube Channels**: Channels like https://videos.feedspot.com/global_warming_youtube_channels/ offer educational content on environmental science, climate and sustainability. Resources from organisations like the European Environment Agency, such as https://www.youtube.com/watch?v=jS0ZIUtsQHg and https://www.youtube.com/watch?v=n9Ej5E47TNI
- **Documentaries**: Films like the "Climate Change on Trial", "EU Climate deal", "Before the Flood" and "An Inconvenient Truth" provide compelling narratives on climate change and sustainability.
- **Games**: use game-based learning that allows participants to explore sustainability and climate change, for instance at https://teachingthefuture.eu/climate-games-and-simulations-for-education/.

PART 1	Workshop introduction: green issues in STEAME
Learning Objectives	**Understand Environmental Principles** The foundations of key environmental science concepts, such as ecosystems, biodiversity, and sustainability. The causes and effects of environmental issues like climate change, pollution, and resource depletion. Embedding green issues into STEAME curriculum
Learning Outcomes	**Knowledge and Comprehension** Demonstrate an understanding of environmental science principles and sustainability concepts. Explain scientific, technological, and societal aspects of major environmental challenges.
Competences	**Understand Complex Systems**: Ability to analyse and understand the complexity and interconnectedness of ecological, social, and economic systems in sustainable development
Content, Resources and Tools	The materials will present examples from Renewable Energy, Sustainable design, Environmental impact of technology, Green Chemistry and Data science and climate change
Activities	**Presentation** with examples of the breadth, extent and complexity of green issues **Participants will address Curriculum Design**: Embedding sustainability themes across various subjects and grade levels
Estimated Time	**60 minutes**

PART 2/3	Practical Activities: Data Science, Climate Change and Gamification
Learning Objectives	**Developing Problem-Solving Skills** Apply scientific methods to an environmental problem Use critical thinking to analyse and evaluate sustainability practices **Promoting Sustainable Practices** Recognise the principles of sustainable development Understand adaptation and mitigation **Engaging in Interdisciplinary Learning** Integrate different STEAME fields to understand the complexity of an environmental issue. Addressing a real-world sustainability challenges. **Utilizing Data and Technology** Use modern tools and technologies, such as Geographic Information Systems (GIS), remote sensing, and data analytics, to monitor and assess environmental conditions. Predict environmental outcomes of sustainability strategies.
Learning Outcomes	**Application and Analysis** Explore an environmental problem Analyse environmental data to draw conclusions. **Innovation and Creativity** Review solutions of adaptation and mitigation to reduce environmental impact Explore climate futures.

	Communication and Collaboration Communicate findings and sustainability concepts Collaborate with others to address a complex environmental problem.
Competences	**Critical Thinking**: Evaluate interdependencies and feedback loops within and between systems **Future-oriented Thinking**: Capacity to identify future trends and scenarios related to environmental change and sustainability challenges with respect to climate change. **Values-based Understanding**: Integrate sustainability values and principles. **Ethics**: Make ethical judgments regarding climate issues and sustainability. **Teamwork and Networking**: Ability to work effectively with others in collaborative efforts towards sustainability. **Analytical Skills**: Critically analyse environmental data and information to make informed decisions. **Reflection and Evaluation**: Reflect on and evaluate the effectiveness of sustainability practices and educational approaches. **Personal Reflection**: Understand one's own values, attitudes, and behaviour towards the environment. **Interdisciplinarity**: Integrate knowledge and methods from different disciplines to solve complex challenges. **Holistic Perspective**: View problems from multiple perspectives to develop comprehensive and inclusive solutions.
Content, Resources and Tools	**Online Course: Climate Geoinquiry** Teaching the Future Using data dashboards https://teachingthefuture.eu/module-4/ **Software and Tools** Teaching the Future data dashboards https://teachingthefuture.eu/climate-dashboards/ **Interactive Activities and Games** Simulations on "Climate Change: The Board Game" to understand the impact of decisions on the environment **Websites and Organizations** Climate education resources https://www.eurogeography.eu/projects/geodem/gallery-of-resources-2/
Activities	Explore global, regional and local climate past, present and future using data dashboards Play a climate game (in groups) to explore possible policy solutions influencing future climate https://en-roads.climateinteractive.org/scenario.html?v=24.5.0 Explore the gallery of tools and resources for climate education and plan for teaching https://www.eurogeography.eu/projects/geodem/gallery-of-resources-2/
Estimated Time	**180 minutes**

PART 3	**Evaluation of Learning Outcomes**
Learning Objectives	Summarize key insights from the workshop. Reflect briefly on personal development.

	Assess and self-assess green (climate change) issues tools and resources in STEAME
Learning Outcomes	By the end of this session, participants will have: - evaluated the challenges of developing green issues in STEAME and - reflectively assessed the range of resources, tools and technologies supporting the use of green issues in STEAME related to climate change.
Competences	Reflection on performance as a STEAME project facilitator.
Content, Resources and Tools	Post-its and markers Survey tool (online or paper-base)
Activities	Group activity to discuss, develop and share key ideas and issues (20 minutes) Individual survey completion (5 minutes) General discussion and conclusion (5 minutes)
Estimated Time	**30 minutes**