ENVIRONMENTAL EDUCATION AND CLIMATE CHANGE E-CURRICULUM

(Modules for High School 9, 10 or 11th Classes)

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ABSTRACT

Not even one country has not observed the impacts of climate change — each and every country has been observing the negative effects of climate change in many sectors. The EU clearly suggests that effective environmental education is essential in fighting climate change and solving environmental problems. Unless effective environmental education is provided to all segments of society, environmental issues will continue to be the most crucial problems of the 21st century.

This study under the LeMoon project aims to develop an e-curriculum of environmental education for secondary school students to help them understand the ecological balance and their roles in this balance. It also aims to help individuals gain sustainable perspectives on proper environmental management and the necessary skills to be active participants who report higher levels of concern for environmental issues.

Document analysis, as one of the qualitative research methods, was used while creating this e-curriculum. This research method was mainly utilised to collect the data, and it found the ground of the study. The curriculums from different countries and the articles and theses written on the curriculums were accessed, and the content of those documents was carefully and systematically examined and evaluated. Besides, some desk research to review available insights into climate change and environmental issues of secondary education, and students were engaged. There were some interviews and focus groups organized. The research participants were young people, teachers, youth workers, policymakers, and members of the wider school community. They aimed at collecting practices on what activities schools have put in place to address climate change issues and how they are addressed. They also sought to

explore the needs and experiences of the community to connect the literature review with community needs.

Based on the data from the LeMoon project study, a curriculum for environmental education and climate change was designed for Secondary Education (High School, 9, 10, or 11th grades). The relevant literature also supports the need for the curriculum and reflects its benefits for secondary school education.

Key Words: climate change, environmental education, e-curriculum development

Introduction

Climate change especially refers to global warming. In its summary for policymakers of the fifth assessment report, the International Panel on Climate Change (further IPCC, 2014, p.5) stated that it is "extremely likely that more than half of the observed increase in global average surface temperature from 1951 to 2010" was caused by human activity. It also stated that human actions have all sorts of triggering effects on environmental consequences, from flooding to disappearing lakes (IPCC, 2014).

Following the information supplied by the IPCC (2014; 2023), this study aims to provide guidance for the design of e-curriculum for high school students, who are scientifically explained as the optimal group for environmental education thanks to their motivation to take environmental actions, with the necessary knowledge, skills, and values to inspire positive environmental behaviour change.

A qualitative research method was used while designing that curriculum. In qualitative research, the research topic is tried to be revealed by questions such as "how and why" in detail and in an understanding way instead of measurable features such as the quantity, average and number of people or phenomena (Denzin & Lincoln, 1998). The qualitative research method provides the researcher flexibility in the research design and realisation. Developing new methods and approaches according to the situation at each research stage and making changes in the research structure constitute the essence of qualitative research. Another feature of qualitative research is that they are exploratory. Exploratory research is very useful in illuminating poorly studied topics (Neuman, 2014). For these reasons, the qualitative research method was preferred for the curriculum design.

In the study, document analysis, which is one of the qualitative research methods, was mostly used. Document analysis is a qualitative research method used to rigorously and systematically analyze the content of written documents (Wach, 2013). To collect the data that set the ground for the study, the curricula of different countries, research papers and theses written on these curricula were reached and analyzed. These curricula, papers, and theses were translated into English, and English Language teachers and language experts in the project team controlled translations and verified reliability. The translations of the studies were examined in detail. While conducting content evaluations, a curriculum expert discussed the consistency and usefulness of

the opinions. Two separate web-based search engines – Galileo, an online library search system, and Google Scholar search engines – were used to reach studies and research in the field.

In addition to the document analysis, focus group discussions with different stakeholders and expert interviews were conducted. The data gathered from focus groups were analysed using thematic analysis; thematic maps for e-curriculum development were created. Expert interviews were conducted to consult the proposed topics for the e-curriculum.

ENVIRONMENTAL EDUCATION AND CLIMATE CHANGE E-CURRICULUM
(further e-Curriculum)

1. METHODOLOGY FOR THE E-CURRICULUM:

The e-curriculum is based on a modular approach. The learning units – the modules – are organised into meaningful chunks. Although the content and objectives are determined separately for each module and do not follow a linear sequence, the knowledge and skills gained before are complementary. These modules are accessible through a user-friendly online platform.

The four basic elements of the e-Curriculum are suggested to be included in each module: (1) Objectives, (2) Teaching/learning content, (3) Suggested teaching process, and (4) Evaluation.

As today's learning is not imagined without the use of technology, it is recommended that e-curriculum includes:

1. Core content: environmental concepts, climate change science terminology, core environmental problems and sustainable development good practices.

2. Multimedia Resources: videos, animations, and infographics to enhance engagement and understanding of complex environmental issues.

3. Descriptions of in-class or virtual activities:

- **Virtual Labs:** Including virtual experiments and simulations provide hands-on experiences, allowing learners to explore environmental phenomena in a controlled digital environment.
- **(Virtual) Field Trips:** Exploring (virtual) field trips to environmental sites, ecosystems, and climate-related projects, providing a sense of exploration and connection to real-world applications.
- **Case Studies:** Presenting real-world case studies that highlight successful environmental initiatives and challenges encourages critical thinking and problem-solving.

- **Guest Lectures:** Recorded or live guest lectures from experts in environmental science and climate change offer diverse perspectives and insights.
- **Project-Based Learning:** Integrating projects that require learners to apply knowledge to address local environmental issues, promoting practical application and community engagement.
- **Personalised Learning:** Tailoring the e-curriculum to accommodate different learning styles and paces, allowing students to progress through content at their own speed.

4. Interaction questions for deeper knowledge:

- **Discussion Forums or topics for online/in-class discussions:** Implementing discussions with students contributes to a better understanding of key topics, sharing insights, and collaboration on projects, fostering a sense of community and knowledge exchange.

5. Self-Assessment Quizzes or Templates for Knowledge Evaluation: Embedding quizzes and assessments within modules to gauge understanding, reinforce learning, and provide immediate feedback to learners.

2. E-CURRICULUM OBJECTIVES

It is recommended that each module has its aim. Each part of the module has its specific objectives. It is recommended to address the development of the following key competencies while designing each module:

1. **Communication in foreign languages competency**. It is based on the ability to understand, express and interpret feelings, thoughts, concepts, facts and opinions orally and in writing in various appropriate social and cultural contexts. Content and Language Integrated Learning *(further CLIL)* refers to teaching subjects such as science, history and geography to students through a foreign language. In that approach, the foreign language is used to learn a non-language subject, and both language and the subject have a joint role. As the content of the e-curriculum makes strong references to the other subjects and all modules result from international cooperation, it is natural to adopt CLIL as one of the approaches underlined and create CLIL activities.

2. **Mathematical competency** and **basic competencies in science/technology**: Mathematical competency means developing a mathematical way of thinking to solve a series of problems encountered in everyday life. It includes the skills and desires to use mathematical modes of thinking (logical and spatial thinking) and presentation (formulas, models, fiction, graphs, and tables) to varying degrees. STEAM is an approach that uses Science, Technology, Engineering, the Arts and Mathematics as access points for guiding students' inquiry, dialogue, and critical thinking. Many researchers support STEAM as a

promising approach that positively impacts students' achievement and teacher efficacy, making it another approach adopted in the e-curriculum.

3. **Digital competency** covers the safe and critical use of information and communication technologies for work, daily life and communication. This competency includes access to information and evaluation of knowledge, using technologies for information storage, production, presentation and exchange in public networks and communication via the Internet. Digital competency plays a crucial role as the educational curriculum is delivered typically through digital devices and on an online platform. Digital competency enables students to effectively navigate and utilise various digital tools and the project e-learning platform, where the e-Curriculum resides. It also equips them with the skills to critically evaluate digital information sources' credibility, accuracy, and relevance and promote collaboration and communication with peers and instructors through various digital channels, such as email, discussion forums, video conferencing, and social media platforms.

4. **Learning to learn competency** covers pursuing learning and the ability to insist on it for learners to organize their own learning actions individually or as a group, including effective time and knowledge management. Thus, in the e-Curriculum, students encounter diverse learning experiences, practice technologies, and experience diverse teaching methods. Access to online resources promotes self-regulated learning and learning to learn competency.

5. **Social and citizenship-related competencies** include personal, interpersonal and intercultural competencies that allow individuals to participate effectively and constructively in society and working life and equip individuals with features that will resolve conflicts when necessary. Thus e-Curriculum empowers students to become active and engaged citizens by providing discussion questions, resources and activities that require deeper thinking and promote civic learning and community service.

6. **Initiative and entrepreneurship competencies** refer to the individual's ability to transform his thoughts into action. They include creativity, innovation, risk-taking, and the ability to plan and manage projects to achieve goals. They also include being aware of ethical values and supporting good governance. Thus, e-Curriculum encourages students to think outside the box, explore new ideas, and develop creative solutions to real-world problems. They learn to generate innovative projects, products, or services that leverage digital technologies and address emerging challenges in society.

7. **Cultural awareness and expression competencies.** Various media resources are used in the e-Curriculum, including music, performing arts, literature, and visual arts. It is an appreciation of the importance of creatively expressing opinions, experiences and feelings. Thus, students encounter various cultural perspectives, traditions, and worldviews. By engaging with diverse cultural content and interacting with peers from different cultures,

students develop empathy, tolerance, and respect for cultural differences, contributing to a more inclusive and culturally responsive learning community

In addition to the above mentioned, the e-Curriculum aims to promote students' systems–thinking, anticipatory (future thinking), normative, strategic, interpersonal, collaboration, critical thinking, self-awareness, and integrated problem-solving competencies.

Each module in the e-Curiculum has its specific objectives. After implementation of the activities in the modules, students will be able to:

- develop a positive attitude towards the events occurring in nature;
- comprehend that each person leaves a positive or negative mark around them;
- establish a relationship between the use of natural resources and production and consumption activities;
- use scientific process skills and life skills in the process of discovering nature and understanding the relationship between human and the environment;
- gain awareness of sustainable development and to believe in the necessity of leaving a livable environment to future generations;
- comprehend the importance of efficient use of resources and sustainability with a local, national and global perspective on environmental problems and climate change;
- have knowledge about environmental issues and the effects of global climate change on the environment, society and economy;
- receive responsibility to prevent and mitigate the problems posed by climate change;
- gain awareness about the institutions and organisations, national /international agreements studying climate change;
- have knowledge about environmentally friendly technologies;
- to create career awareness and to get to know the relevant professional fields related to the environment.

This e-Curriculum design is based on the Competency-Based Approach; the objectives are structured gradually and sequentially according to the principle of graduality and sequentiality, from simple to complex, from easy to difficult, and from concrete to abstract. Teaching principles such as relevance, openness, and vitality were applied while aiming at module objectives.

Bloom's taxonomy was referred to when formulating module objectives. The objectives were written to require different cognitive level activities, from the most superficial level (remembering information) to the highest one (creation).

Accordingly, the e-Curriculum aims at four different levels. Level I is a knowledge level, providing receivers with knowledge of ecological concepts that can help them make ecologically sound environmental decisions. Level II is also at a knowledge level, focusing on understanding and awareness concerning many aspects of human

environmental behaviour. Level III is at a cognitive process or skills level, focusing on those skills needed for issue investigation, evaluation, and value clarification. Level IV is also a process or skills level, focusing on those processes important to citizenship action (participation).

The objectives indicate the fundamental learning in the module. As recommended by the field experts of the LeMOON project research, the e-curriculum has six modules, each containing 4-8 objectives. Module topics are also the result of qualitative research (document analysis, focus groups, and expert interviews). They are presented in the following chapter.

3. E-CURRICULUM: MODULES, AIMS AND EXPECTED LEARNING OUTCOMES

Module 1 – Human and Nature

This module aims to help students observe nature, discover its delicate balance, and develop a positive attitude towards preserving natural balance by recognising the interaction between humans and nature and the roles of living and inanimate beings in this interaction.

Recommended Duration: 12 hours

Topic/Concepts: nature, living and inanimate beings, natural equilibrium/ balance

Part 1. The interaction between humans and nature, positive and negative impacts

At the end of this learning part, students will be able to:

- Realise that they are part of the environment they live in based on their observations.
- Give examples of the interaction between humans and nature.
- Discuss the positive and negative aspects of the interaction between humans and nature.

Part 2. The effects of unplanned settlement, industrialisation, transportation and other actions (such as overpopulation)

At the end of this learning part, students will be able to:

- Comprehend the positive and negative effects of unplanned settlement industrialisation, transportation and other activities on nature.
- Identify and discuss the problems arising from unplanned urbanisation
- Suggest a proposal for a solution to address the issue of unplanned urbanisation.

Part 3. The positive and negative effects of nature on human beings (including natural and artificial environment; nature-human interactions)

At the end of this learning part, students will be able to:

- Recognise and give local and global examples of the positive and negative effects of nature on human beings on the basis of living-inanimate beings' interactions and living-living beings' interactions;
- Distinguish natural environments from artificial environments;
- Make reasonings for the need of artificial environments.

Part 4. The roles of producers and consumers on the natural balance (consumerism; statistics)

At the end of this learning part, students will be able to:

- Draw the conclusion that nature has a delicate balance.
- Discuss the roles of producers and consumers in natural balance.
- Analyse and evaluate the statistics regarding production and consumption.

Part 5. Maintaining the natural balance (social awareness projects; responsible behaviours)

At the end of this learning part, students will be able to:

- Recognise that they are responsible for developing attitudes and behaviours to maintain the natural balance.
- Design a project that creates social awareness for the protection of the natural balance.
- Present the social awareness-raising project (action plan, calendar, milestones, etc.)

Part 6. The environmental ethics and dilemmas (literature review, case study)

At the end of this learning part, students will be able to:

- Discuss the environmental ethics and dilemmas, reviewing the relevant literature.
- Comment on behaviours that adversely affect the natural balance in the context of environmental ethics and dilemmas.
- Create a summary document indicating discussed environmental ethics and dilemmas through case studies.

Module 2 – Cyclical Nature

This module aims to help students classify natural resources, notice the flow of matter and energy in nature through the cycles of matter and energy, and comprehend the effect of this flow on natural life and living things.

Recommended Duration: 12 lessons.

Topic/Concepts: natural resources, material cycles, energy flow.

Part 1. Naming various natural resources within their qualifications (natural resources; geographical features of natural resources)

At the end of this learning part, students will be able to:

- Define and give examples of the natural resources by use of their observations.
- Explain the qualifications of the natural resources in their immediate vicinity.
- Compare different natural resources in partner countries

Part 2. Grouping the natural resources on Earth (air; soil; sun; wind; oil; natural gas; coal)

At the end of this learning part, students will be able to:

- Identify various natural resources (such as air, water, soil, sun, wind, oil, natural gas, coal, etc.).
- Group various natural resources.
- Explain the pros and cons of the use of each resource**.**

Part 3. Sustainability of the natural resources (sustainability; responsible use)

At the end of this learning part, students will be able to:

- Review literature regarding how natural resources are sustained.
- Write research reports about the sustainability of the natural resources.
- Present the research reports.

Part 4. The difference between the matter cycle and the energy flow in an ecosystem (matter cycle; energy flow)

At the end of this learning part, students will be able to:

- Comprehend why matter (such as water or carbon) cycles but energy does not in an ecosystem.
- Give examples about the matter cycle and flow of energy.
- Make inferences about the effect of disruption in the matter cycle and energy flow on natural life.

Part 5. Ultimate source of energy and the form of energy while leaving the ecosystem (source/s of energy; energy forms)

At the end of this learning part, students will be able to:

- Identify the ultimate source of energy.
- Illustrate how (in what form) energy leaves an ecosystem.
- Generate a presentation using digital tools to evaluate diverse uses of energy sources.

6. The effects of exploitation of natural resources (exploitation; social, economic, political results)

At the end of this learning part, students will be able to:

-   Synthesise the causes and effects of exploitation of the natural resources.
-   Interpret the causes and effects socially, economically and politically.
-   Anticipate the future effects of exploitation of the natural resources.

Module 3 – Nature And Climate Change

This module aims to introduce students to climate change, including the greenhouse effect and global warming as causes of climate change. While studying the greenhouse effect and global warming, it is also suggested that meaningful combinations with consumption and other reasons be made, and pollution and some other environmental problems should be studied as well.

Recommended Duration: 12 lessons

Topic/Concepts: Greenhouse Gases & Emission Sources; Radiative Forcing; Earth's Atmosphere; Radiation Balance; The (Runaway) Greenhouse Effect; Difference between Weather and Climate, ecological footprint

Part 1. Ecological footprint (ecological footprint; production-consumption balance)

At the end of this learning part, students will be able to:

-   Explain the ecological footprint.
-   Give examples of ecological footprints referring to production-consumption.
-   Calculate and compare their ecological footprint (using digital tools)

Part 2. Greenhouse gases (greenhouse gases; sources of greenhouse gases)

At the end of this learning part, students will be able to:

-   Name the greenhouse gases.
-   Explain their characteristics and impacts.
-   Distinguish the sources of greenhouse gas emissions.

Part 3. Greenhouse effect (radiation balance; radiative forcing)

At the end of this learning part, students will be able to:

-   Describe the radiation balance of the earth and radiative forcing.
-   Clarify the earth's atmosphere and greenhouse effect.
-   Make inferences about the greenhouse effect.

Part 4. The differences between weather and climate

At the end of this learning part, students will be able to:

- Explain the weather and climate.
- Differentiate weather and climate.
- Interpret weather and climate in different artistic ways/ genres.

Part 5. Climate system (major components; driving factors)

At the end of this learning part, students will be able to:

- Explain the major components of the climate system.
- Demonstrate the climate system.
- Compare and contrast the factors influencing the climate system.

Part 6. Climate Change vs. Climate Variability

At the end of this learning part, students will be able to:

- Discuss climate change vs climate variability.
- Separate climate change and climate variability.
- Investigate the examples of climate variability.

Module 4 – The Impacts Of The Environmental Problems And Climate Change (Part 1 – Ecosystems)

This module aims to study ecosystems and discuss human impact, environmental problems, and climate change within the context of ecosystems.

Recommended Duration: 12 lessons

Topic/Concepts: Ecosystems.

Part 1. Ecosystem Complexity (roles; relationships; population dynamics)

At the end of this learning part, students will be able to:

- Clarify population dynamics in an ecosystem.
- Integrate roles and relationships in an ecosystem.
- Analyze and evaluate the ecosystem complexity.

Part 2. Aquatic/marine ecosystems (aquatic ecosystems; marine ecosystems)

At the end of this learning part, students will be able to:

- Discuss marine ecosystems
- Observe the changes in marine ecosystems and assess the risks marine ecosystems face.
- Develop an action plan to protect marine ecosystems.

Part 3. Terrestrial ecosystems (land use change; agriculture and food supply; forestry)

At the end of this learning part, students will be able to:

- Explain terrestrial ecosystems and their characteristics.
- Consider the changes in land use, gather data, and analyze the data to draw conclusions.
- Create an action project on the sustainability of terrestrial ecosystems.

Part 4. Freshwater ecosystems (water cycle; water use; hydrology)

At the end of this learning part, students will be able to:

- Identify and explain hydrology – water cycle and water use.
- Explain water ecosystems.
- Design a water project.

Part 5. Ecosystem services (ecosystem services; conservation projects)

At the end of this learning part, students will be able to:

- Discuss ecosystem services.
- Express and reflect on various experiences, perspectives, and worldviews on the benefits of ecosystem services.
- Follow and /or participate in conservation projects.

Part 6. Human impact on ecosystem integrity (ecosystem integrity; human impact)

At the end of this learning part, students will be able to:

- Describe ecosystem integrity.
- Make inferences about human actions and their impact on ecosystem integrity.
- Analyse cause-and-effect relationships.

Module 5 – The Impacts Of The Environmental Problems And Climate Change (Part 2 – Climatic And Environmental Challenges)

This module aims to explore some of the challenges and implications associated with climate change and environmental issues. It complements Module 4, which focuses on ecological impacts, by analysing and examining the impact of climate change in its social, cultural and economic aspects.

Recommended Duration: 12 lessons

Topic/Concepts: Climatic and Environmental Challenges

Part 1. Economic Consequences (disruptions to agriculture; energy demand; infrastructure damage from extreme weather events; healthcare costs)

At the end of this learning part, students will be able to:

- Explain the economic consequences of climate change and environmental problems.
- Infer about disruptions to agriculture, increased healthcare costs, energy demand, and infrastructure costs and connect them with climate change and environmental problems.
- Anticipate the future economic consequences derived from climate change and environmental problems.

Part 2. Displacement and Migration (fisheries; climate refuges)

At the end of this learning part, students will be able to:

- Discuss the impacts of climate change, such as extreme weather events and sea-level rise, on migration.
- Observe the changes in settlements.
- Assess the risk of climate refugees in different regions**.**

Part 3. Health Risks (pollution; infectious diseases)

At the end of this learning part, students will be able to:

- Explain the direct and indirect impacts of environmental problems, including pollution and climate change, on human health
- Reach data and analyse the data to draw conclusions about the diseases derived from pollutants.
- Combine infectious diseases with disasters and analyse them within the cause-and-effect relationship.

Part 4. Global Implications (disasters; community resilience)

At the end of this learning part, students will be able to:

- Explain the global implications of climate change and environmental problems.
- Give examples of interconnected global implications and predict the future implications.
- Develop projects for community resilience in the face of disasters.

Part 5. Environmental Injustice (environmental services, indigenous communities, urban sprawl)

At the end of this learning part, students will be able to:

- Make inferences about environmental injustice.
- Discuss and assess the threats to indigenous communities based on environmental problems and climate change.

- Compare the services offered to urban sprawls with those offered to urban consolidation.

Part 6. Cultural and Educational Disruption (cultural and educational disruption; cultural practices and traditions; cultural identity and heritage)

At the end of this learning part, students will be able to:

- Express and reflect on cultural and educational disruption connected to climate change and environmental problems.
- Analyse the threats to cultural practices and traditions derived from climate change and environmental problems.
- List environmental and climate change impacts on cultural identity and heritage.

Module 6 – Sustainable Development And Solutions To Environmental Problems And Climate Change

This module aims to study and explore sustainable development, focusing on solutions to environmental problems and climate change.

Recommended Duration: 12 lessons

Topic/Concepts: Sustainable development and solutions to environmental problems and climate change.

Part 1. Sustainable Development (pillars of sustainable development; sustainability measurement)

At the end of this learning part, students will be able to:

- Define sustainable development and explain its principles.
- Explain the environmental pillar of sustainability and make connections with economic and social pillars.
- Explore the tools and indicators to measure sustainability.

Part 2. Stewardship and Restoration of Ecosystems (preservation of ecosystems; conservation of biodiversity)

At the end of this learning part, students will be able to:

- Give examples of human practices affecting ecosystems' sustainability and contributing to ecosystems' diversity.
- Interview with old people to discover peoples' first knowledge and other traditional ecological knowledge in sustaining biodiversity.
- Apply first peoples' perspectives and knowledge and local knowledge to create a conservation project.

Part 3. Mitigation and Adaptation Strategies (mitigation and adaptation strategies; local environment)

At the end of this learning part, students will be able to:

- Experience and interpret the local environment and consider the changes over time.
- Clarify the changes in the local environment related to climate change.
- Discuss mitigation and adaptation strategies to cope with the impacts of climate change.

Part 4. Renewable Energy and Technological Innovations (renewable energy sources; green technologies)

At the end of this learning part, students will be able to:

- Evaluate the role of renewable energy sources and energy efficiency in mitigating climate change.
- Discover and utilise emerging technologies for sustainable development and understand the role of innovation in addressing environmental issues and climate change.
- Construct arguments and discuss the benefits and challenges of adopting green technologies.

Part 5. Lifestyle Choices and Consumer Behavior (recycling; energy saving nutrition; reducing carbon emission; consumption; water footprint; values of the food pyramid)

At the end of this learning part, students will be able to:

- Evaluate their own lifestyle choices and consumer behaviour.
- Summarise the importance of green careers.
- Appreciate the importance of intergenerational equity in their own lifestyle choices and consumer behaviour.

Part 6. Policy and Governance (community-led sustainability projects; sustainable practices)

At the end of this learning part, students will be able to:

- Examine the role of national and international policies in promoting sustainable development.
- Analyse the role of local governments and communities in implementing sustainable practices.
- Judge advocacy and civic engagement for environmental policy change and analyse case studies of successful community-led sustainability projects.

4. E-CURRICULUM STRUCTURE AND TOPICS

The e-Curriculum has six modules, each comprising six parts containing one or two lessons. Its contents are determined holistically and by the specific learning objectives for Cognitive, Affective, and Psychomotor development.

The structure of 6 modules and their parts are as follows:

Module 1 – Human And Nature

1. The interaction between human and nature
2. The effects of unplanned settlement, industrialisation, transportation and other actions.
3. The positive and negative effects of nature on human beings. The natural and artificial environments.
4. The roles of producers and consumers in the natural balance
5. Maintaining the natural balance (Social awareness-raising projects)
6. The environmental ethics and dilemmas/Case studies on ethics and dilemmas.

Module 2 – Cyclical Nature

1. Naming various natural resources within their qualifications
2. Grouping the natural resources on Earth
3. Sustainability and responsible use of natural resources
4. The difference between the matter cycle and the energy flow in an ecosystem
5. Ultimate source of energy and the form of energy while leaving the ecosystem.
6. The effects of exploitation of natural resources.

Module 3 – Nature And Climate Change

1. Ecological footprint.
2. Greenhouse gases
3. Greenhouse effects.
4. The differences between weather and climate.
5. Climate systems.
6. Climate Change vs. Climate Variability

Module 4 – The Impacts Of The Environmental Problems And Climate Change (Part 1 – Ecosystems)

1. Ecosystem complexity.
2. Aquatic /marine ecosystems.
3. Terrestrial ecosystems.
4. Freshwater ecosystems.
5. Ecosystem services.
6. Human impact on the ecosystem.

<u>Module 5 – The Impacts Of The Environmental Problems And Climate Change (Part 2 – Climatic And Environmental Challenges)</u>

1. Economic Consequences.
2. Displacement and Migration.
3. Health Risks.
4. Global Implications.
5. Environmental Injustice
6. Cultural and Educational Disruption

<u>Module 6 – Sustainable Development and Solutions To Environmental Problems and Climate Change</u>

1. Sustainable Development.
2. Stewardship and Restoration of Ecosystems
3. Mitigation and Adaptation Strategies
4. Renewable Energy and Technological Innovations
5. Policy and Governance
6. Global citizenship, policy learning, lifestyle choices, and consumer behaviour

5. E-CURRICULUM: TEACHING PROCESSES

The e-curriculum is designed based on constructivism, connectivism, and progressive education principles. These approaches oppose rigid understanding of the discipline in educational settings, are based on an active learning approach, consider individual differences, and focus on learning by reflection, active participation and collaboration. This curriculum includes student-centred methods, techniques, and teaching methods, which follow the idea of reaching sustainable development goals in cooperation. Thus, many activities are designed for pair and group work, including discussion questions and project-based work. Some activities are taken individually, though. One sample activity is included in Annex 1.

Each module lesson should use a 5E learning cycle and instructional model: Engage, Explore, Explain, Elaborate, and Evaluate (Bybee, 1997) or its adaptations (such as Engage, Explore, Explain, Extend, and Evaluate; see VanTassel, 2024). This model is usually used in inquiry-based short online courses and science online teaching and requires active student participation.

E-CURRICULUM: EVALUATION PART

An approach using continuous and multiple assessment tools has been adopted. Continuous evaluation and general developmental and outcome-related assessment are essential in this approach.

Each e-Curriculum module has its specific objectives, which are followed by the recommended learning content. The achievement of these objectives may be evaluated by the teacher selecting and adapting recommended resources or other preferred methods. Projects, presentations, e-portfolios, reflective journals and performance evaluation scales are the main assessment methods suggested for use; however, teachers may adapt them to their needs, according to the subject and student age. In addition, practical seminars, poster presentations, interviews, debates, case studies, concept maps, and other assessment methods and tools may be used.

Evaluation Criteria: Students are recommended to be assessed on their understanding of environmental concepts, critical thinking skills, communication abilities, and active participation in class activities and collaboration in projects. Tests are not recommended to be used for student evaluation, but rather as a self-check option on the progress or understanding.

That e-curriculum has been designed for environmental education and climate change for high school students (focusing more on 15-year-old students). Each module objective has been studied in one or two lessons, comprising 12 hours of learning content for each module (6 modules contain approximately 72 hours of learning content). The e-curriculum suggests taking as a stand-alone obligatory/ optional course of 6 modules, which can be either taken 4 hours per week as a one-term course or 2 hours per week as a two-term course.

Conclusion and Discussion

The Czech Republic's largely coniferous forests face the worst bark beetle infestation. The lower house of Parliament has discussed emergency and long-term measures to combat the voracious insect that kills spruce trees. The amount of spruce wood damaged by bark beetles has risen steadily. Experts warn that the nation's forests could be wiped out unless some actions are taken. For the Czech Republic, the problem is the forests getting smaller, and for some other countries, it is the ice getting thinner, but the fact is whatever the problem, 'a storm is brewing' for all of us.

In its summary for policymakers of the fifth assessment report, the IPCC (2014) stated that it is "extremely likely that more than half of the observed increase in global average surface temperature" from 1951 to 2010 was caused by human activity. It is also stated that human actions have all sorts of triggering effects on environmental consequences, from flooding to disappearing lakes. Regardless of the information supplied by IPCC (2014, 2023), LeMoon project partners also surveyed to understand how responsible high school students, who are the scientifically explained optimal group for environmental education, feel about their environmental actions. During the following group discussions, students and experts were asked what kind of environmental education there is a need for and why.

The discussions ended up with a general remark: 'You can't appreciate what you don't know about.' That project is based on the high school students' need to know more about the environmental issues and possible solutions. It aims to provide the necessary knowledge, skills and values to inspire positive behavioural change. EU suggests that effective environmental education is essential in fighting climate change and solving environmental problems. Unless effective environmental education is provided to all segments of society, environmental issues will continue to be the most crucial problems of the 21st century, specifically for those at risk of being unable to rebuild their lives after environmental disasters due to poor conditions. Despite the need for that education, a great majority of schools include environmentally related topics in some subjects, and a minority have stand-alone lessons on environmental studies. LeMOON aims to develop an online environmental education for all individuals to understand the ecological balance and their roles in this balance. It also aims to help individuals gain sustainable perspectives on correct environmental management and the necessary skills to be active participants who report higher levels of concern for environmental issues.

LeMOON project partners designed this education programme (Environmental Education and Climate Change e-Curriculum) focusing on the 21st-century must-acquire skills, such as *life and professional skills*, *learning and innovation skills* and *information media and digital/technology skills* in a lifelong learning perspective. LeMOON project follows the principle "engage – understand – act" and recognises the need for collaboration of pupils, parents, and the broader community to make changes and become climate neutral by 2050. Recognising the need for an efficient education that may engage and foster action, the e-curriculum has been designed to inspire teachers to use the developed resources aiming at a better future.

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Sample Activity (This activity is from Hungerford, H. R. et al. (1978) Investigation and Action Skills for Environmental Problem Solving. Champaign, Illinois, Stipes Publishing)

Consumer Product Need and Environmental Cost Assessment

Aim of the activity: To analyse environmental issues and the associated value perspectives (Learning objectives - Investigation and Evaluation Level)

Ages: 15 +; Content Area: Social Studies, Home Economics, and others

Expected learning outcomes: Upon or during the completion of the product need and environmental costs assessment activity, students will be able to:

- State six questions (criteria) which must be answered to assess the environmental impact of a product.
- State three considerations (criteria) to be made in assessing the need of a product.
- Apply the criteria of product need and environmental cost to a product which he/she consumes, and give reasons for the final assessment decision.
- Explain the roles of information (knowledge) and values (feelings) in determining the product need and environmental cost.
- Identify, locate and utilize reliable sources in making a thorough search for information needed in the application of environmental cost criteria.
- Based on his/her own product assessment, identify at least three alternative actions concerning the product for further evaluation (e.g., boycott, conservative use, substitution).

Instructions:

The specific approach to be used here depends upon the context of the activities used. However, several basic guidelines may be described to make the learning experience effective. For purposes of this discussion, assume the activity is being used in an EE class which has been involved in the study of cultural impact on the environment. The approach taken here is to present students with an overall concept, then model the criteria to be applied, and finally allow students to apply the criteria to a product of their own choosing. The activity might also be used in an inquiry (inductive) mode which would allow large or small groups to generate their own criteria as well as apply them to products.

In the approach used here, the following student materials should be prepared and distributed. When students have interacted with the reading and activity, the materials should be discussed to prepare students to achieve objectives 3, 4, 5, and 6, Finally, students (individually or in small groups) will identify their own product for assessment and apply the criteria.

Student Materials

Consumer Product Need and Environmental Cost Assessment

As consumers of services and products, we take consumer actions every day which affect our environment. Consider the following list of products (*Most of these you probably use at least occasionally):*

- soft drinks (pop) in disposable cans
- electric hair dryers
- plastic sandwich bags
- automobiles
- refrigerators
- hamburgers in disposable containers

Certainly, you could add many other products to this list. Are the effects of these products on the environment negative or positive?

Actually, it is nearly impossible to classify a product as completely good or bad for the environment. Instead, a comparison must be made between the harmful effect the product has on the environment (ENVIRONMENTAL COST) and the NEED for the product. The flow chart which follows suggests an approach which can help in selecting a positive consumer action.

- Assess the Product's Environmental Cost
- Assess the Need for the Product
- Determine the Appropriate Action
- **TAKE ACTION**
- Assessing Environmental Costs of Products

Assessing the damage a product may do to the environment is not an easy task. To help in making an assessment of environmental cost, a list of questions is presented below. Consider each of these. As an example of how the questions may be used, they are applied to the disposable pop can.

1. Is the product made from natural resources which cannot be renewed?

FOR POP CANS: Pop cans require a number of metals in their manufacture. Since metals cannot be replaced once they are mined from the earth, the answer is definitely YES, they do require non-renewable resources,

2. When the natural resource (or product) is taken from the environment, does it change the environment in any permanent and undesirable way (damage the environment)?

FOR POP CANS: Metal for producing cans must be mined. Mining operations always have a measurable effect on the environment. The wastes produced by the mine may

pollute water ways; the earth is often scarred permanently. Of course, there is also the matter of the energy it takes to remove minerals from the earth.

3. If the change (damage) is not permanent and can be repaired, is it being repaired?

FOR POP CANS: Unfortunately, much of the damage remains because repair (recovering the mined land and cleaning polluted waters) is So expensive.

4. Does the manufacture, transport, and/or storage of the product damage the environment?

FOR POP CANS: The transport of canned pop is no more destructive to the environment than transport of bottles. However, the manufacture of pop cans causes pollution - air as well as water - and uses tremendous amounts of energy. This is especially significant, since the can is intended to be used only once. In 1971, the energy involved in making and transporting pop (and beer) containers exceeded the combined energy needs of 15 countries in Africa, Asia, and Central America. Throw-away cans require three times as much energy as returnable bottles to make, use, and dispose of.

5. Does the use of the product damage the environment?

FOR POP CANS: The actual "use" of the can does not.

6.Does the disposal of the product after use pose a problem for the environment?

FOR POP CANS: This is one of the biggest problems with pop cans. Although it is becoming economical to recycle the metals in pop cans, most will be thrown away.

Americans consume over 380 soft drinks per person per year. About 65% of these come in non-returnable cans and bottles. That means that millions of cans will end up either as litter in the environment or as solid waste in a landfill or other garbage dumps.

Pop Can Assessment Summary

A summary of the pop can assessment might appear as follows:

Question no.	Cost Assessment of Pop Cans
1	High
2	High
3	High
4	Very High
5	None
6	Very High
Total Assessment	High

Total Assessment Decision: The pop can represents a high cost to the environment,

Assessing Product Need

Even when an environmental cost assessment has been made for a product, a consumer decision cannot be made until the NEED for the product has been determined. Below are three guidelines for assessing product NEED. After you have read and thought about them, apply these guidelines to determine your need for pop cans.

Guidelines for Assessing Product Need

1. Does the product serve a real need? An imagined need?

2. Are there environmentally desirable (or at least less damaging) substitutes available?

3. Do you value the benefits of the product greater than the costs to the environment?

Assessing the Need for the Pop Can.

Answer each of the above questions with respect to your personal need for the pop can. Some space has been provided for your reasoning.

Question 1: Does it serve a real need? An imagined need?

Reasoning:

Question 2: Are there environmentally desirable (or at least less damaging) substitutes available?

Reasoning:

 Question 3: Do you value the benefits of the product greater than the cost to the environment? . Reasoning:

How do your responses compare to those of your classmates? Do your responses reflect your values in any way? Your classmates? How?

Possible Actions

Identify 3 actions (behaviors) which you feel you should consider and evaluate as a result of the pop can assessment.

1.

2.

3.

Applying Your Skills

Now that you have completed the product need and environmental cost assessment of pop cans, choose a product which you regularly consume (use) and apply the criteria to that product. (Note: student materials should include forms with stated criteria and spaces for writing out findings.

Evaluation (for teachers)

Objectives 1, 2 and 4 may be evaluated as part of a written or oral examination. Objectives 3 through 6 however, are higher level objectives and may be more accurately assessed by evaluating students' work on the module. Criteria for determining level of achievement may include the following.

1. Has the student thoroughly and accurately researched available sources for information?

2. Has the knowledge been objectively applied to the product cost assessment?

3. Has the student made sufficient attempts to understand his/her own feelings with regard to product need?

4. Are the identified actions consistent with the student's reported assessment findings?

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