EUSTEPs

Enhancing Universities' Sustainability TEaching and Practices through Ecological Footprint

Intellectual Output 5

IO.5- Guidelines for setting-up transdisciplinary sustainability courses

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Abstract

This report, developed by the ERASMUS+ project EUSTEPs (*Enhancing Universities' Sustainability TEaching and Practices*), presents Guidelines for the creation of a Sustainability Course. It proposes a transdisciplinary curricular unit that can be included within all University degree programs (both bachelor and master).
The document includes possible reasons, procedures, contents, and opportunities connected to such didactic initiative, with the aim of creating an approach that can be replicated in many Universities around the world interested in its implementation. It builds on the multi-year experience of the University of Siena (Italy) as a reference point, and the positive feedback from the EUSTEPs' academic consortium members (namely Aristotle University of Thessaloniki, University of Aveiro and Universidade Aberta). Thanks to its flexibility, every University can interpret the proposal presented in this report in a different way and proceed according to its own preferences, conditions, knowledge, and rules.

1. Introduction. Guidelines for the EUSTEPs Sustainability Course

1.1 Sustainability: Key ideas, elements and approaches

The concept of sustainability helps identify the possible ways in which we can live on our planet – the only one we have – in harmony with nature and other people and communities.
To identify sustainable lifestyles, activities, and solutions for humanity, we must shed light on the multidimensional aspects of the relationship between humans and the environment, the latter being - in a wide sense - what surrounds or encircles us: in brief, the context in which humans continuously operate and live, not necessarily limited to nature and ecosystems. In this sense, we propose a wider representation, rather than a further definition, of the concept of sustainability to acknowledge the urgent need for an overall picture, from daily practices to the dynamics of the entire Earth System, through appropriate knowledge and tools.
Sustainability becomes the discipline of connections and gives us the opportunity to talk about humankind. In particular, the study of sustainability is the study of the relations between humankind – its individual and collective expressions – and its context. The context can be extremely variegated: physical, environmental, social, economic, political, urban, juridical, territorial, etc., every one of which claims for different approaches. Some examples are shown in table 1:

Table 1 - Relationships with various contexts

Context	Relationships with	Examples of issues
Economic	Economic systems and subjects; money	Supply chain, trade, competitivity, globalization

Context	Relationships with	Examples of issues
Environmental	Nature and resources	Resource availability and exhaustion, climate change, ecosystem services
Societal	Other people and communities	Social inclusion, inequalities, wealth distribution, migration
Urban	Cities and infrastructures	Housing, mobility, building manufacturing and maintenance
Juridical	Rules at sub-national, national, and international level	Laws, treaties, international agreements
Political/institutional	Policy makers and representative bodies	Tools for decision making and citizen engagement
Territorial	Natural and built environment; Landscape; human settlements	Planning, land use
Technological	Science; Innovation	Advances in energy production and consumption and/or waste management, artificial intelligence, big data, education

The correct approach to study in-depth all these mutual relationships is the transdisciplinary approach, which implies at least two necessary – though not sufficient – conditions:

- No one is totally self-sufficient; no one can tackle the argument 'sustainability' alone; communication, cooperation, coordination, organization and merging are important ways to break down prejudices and even creating new disciplines (Pulselli et al, 2008[1]);
- The boundaries of disciplines, which are often artificial, must be overcome. According to Daly and Farley (2004[2]) "[…] *the disciplinary structure of knowledge is a problem of fragmentation, a difficulty to be overcome rather than a criterion to be met. Real problems do not respect academic boundaries. We certainly believe that thinking should be 'disciplined' in the sense of respecting logic and facts, but not 'disciplinary' in the sense of limiting itself to traditional methodologies and tools that have become enshrined in the academic departments of neoclassical economics*".

To summarize, three key points can be highlighted: 1) the shared (holistic) picture of the reality (i.e., what should be sustainable?) demands a transdisciplinary approach to encompass the several dimensions of the context in which we live; 2) the purpose (i.e., why should we be sustainable?) is to create and maintain the conditions for durably living better and in harmony with nature and the other individuals; and 3) the critical assessment of how we can reach these conditions (i.e., how can we be sustainable?)

[1] Pulselli, F. M. (2008). The road to sustainability: GDP and future generations (Vol. 18). WIT Press.

[2] Daly, H. E., & Farley, J. (2011). Ecological economics: principles and applications. Island press.

requires new frameworks to evaluate progress towards the desired change (Pulselli et al, 2016[3]).

The sustainability concept thus includes the system under study and the variegated context in which it is placed, lives or operates, and implies the adoption of a transdisciplinary approach and a multidimensional representation. The ecological, social, and economic dimensions are traditionally considered to represent sustainability, but these are not interchangeable. These should be put together in a holistic picture in which the logical, physical, relational, and thermodynamic order (i.e., environment –> society –> economy) is acknowledged and should be identified, evaluated and represented by appropriate indicators. In this sense, Lovins et al. (2014[4]) observed: "*The linear flow of money and stuff is only a fragment of the larger real economy, embedded in human society. The economy and society are both embedded in the rest of nature. Without intact ecosystems and the services they provide us, neither can long survive*".

The mutual relationships among the three dimensions of sustainability can be visualized by means of a three-storey pyramid (Fig. 1a). The base of the pyramid represents the natural assets, which form the crucial and primary inputs to the whole system; the intermediate level is the human society and its organization and structure; the top level of the pyramid, is the real economy of the system, that should produce the ''useful'' output of the system. Let us now rotate the pyramid clockwise and orient the succession of the stages (Fig. 1b): a flow of material and energy inputs, generated by the available stock of Natural Capital, feeds (is captured by) the system. These resources are necessary for the elements of the system (namely, the society and its organizational units) to operate (act, live, survive); the level of organization of the society influences the degree of utility/satisfaction derived from processing/ using/ consuming resources. An organized society is supposed to be able to achieve better economic results providing outputs from its productive processes. In this case, the three dimensions are not simply juxtaposed, but the logical structure of the pyramid shows how the three compartments work together through relations, interactions, feedbacks, etc. Two main considerations may emerge from this picture, among others: i) the succession of stages highlights interdependencies and, in particular, indicates that only dealing with the economic system as the only important one, isolated from the context, is definitely myopic; and ii) the social and economic spheres may generate both positive and negative feedbacks: in particular an economic system that thrives at

[3] Pulselli F.M., Moreno Pires S., Galli A. (2016). The need for an integrated assessment framework to account for humanity's pressure on the Earth System. In Magalhães P., Steffen W., Bosselmann K., Aragão A., Soromenho-Marques V. (Eds.) The Safe Operating Space Treaty: A New Approach to Managing Our Use of the Earth System. Cambridge Scholars Publishing.

[4] Lovins, L.H., Morton, D., Costanza, R., Kubiszewski, I., 6 June 2014. Economy on the Edge: Seeking a World that Works for the 100%. theguardian.com.

the expense of social stability and environmental quality is not able to survive indefinitely (Pulselli et al., 2015[5]).

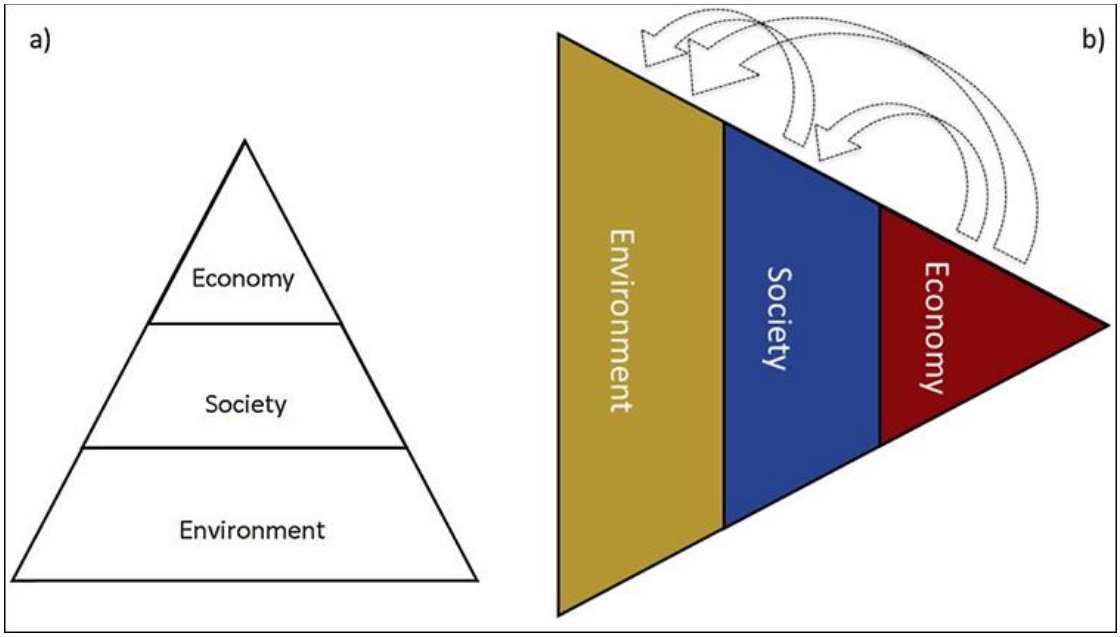

Figure 1 (a and b) - The pyramid of sustainability (modified after Pulselli et al., 2015)

The above-mentioned representation, though limited to the three spheres of sustainability, highlights interdependencies and connections among elements which are crucial for human life and sustainability. The multiplicity of connections is even more evident if we consider the relationships shown in Table 1. All these elements become objects of research, communication, involvement, awareness and, ultimately, education in the field of sustainability.
The overall purpose of this proposal is to identify and suggest structure, content, possible organization and evaluation for a hypothetical transdisciplinary university course of sustainability. This proposal also briefly explores some practical solutions on administrative issues, as well as on types of educators, types of students, and form of evaluation.

1.2 Sustainability competencies and pedagogies

In recent years, considerable research has been devoted to sustainability competencies. Table 2 summarizes some of the proposed sustainability competences, meaning a way of describing desired educational outcomes for sustainability. Those competences

[5] Pulselli, F. M., Coscieme, L., Neri, L., Regoli, A., Sutton, P. C., Lemmi, A., & Bastianoni, S. (2015). The world economy in a cube: A more rational structural representation of sustainability. *Global Environmental Change*, 35, 41-51.

include *"cognitive, functional, ethical, and personal dimensions and link complex knowledge, skills, and attitudes"* (Lozano et al., 2019)[6].

[6] Lozano, R., Barreiro-Gen, M., Lozano, F. J., & Sammalisto, K. (2019). Teaching sustainability in European higher education institutions: Assessing the connections between competences and pedagogical approaches. *Sustainability*, 11(6), 1602.

Table 2 - Summary of Education for Sustainable Development (ESD) Competences (Source: Adapted from Lozano et al., 2017[7], and Vare et al., 2019[8])

Sustainability Competences	Aim	Description and principles	Authors
Systems-thinking and handling of complexity	Help learners to develop an understanding of the world as an interconnected whole and to look for connections across the social and natural environments and consider the consequences of actions	- Analysis of complex systems across different scales and domains of inquiry - Empirical verification and articulation of a system's key components, structure and dynamics - Attention to systemic features (e.g., feedback, inertia, stocks and flows, and cascading effects) - Understanding of complex systems phenomena, including unintended consequences, path dependency, systemic inertia, and intentionality - Understanding of connectivity and cause-effect relationships - Application of modelling (qualitative or quantitative)	Wiek, Withycombe, & Redman, 2011; Rieckmann 2012; Lambrechts et al., 2013; Lozano et al., 2017; Vare et al., 2019
Anticipatory thinking or futures thinking	Help learners to explore alternative possibilities for the future and to use these to consider how behaviors might need to change	- Envisioning, analysis and evaluation of possible futures, including scenarios with multi-generational timescales - Application of precautionary principle - Prediction of reactions and dealing with risks and changes	Wiek, Withycombe, & Redman, 2011; Rieckmann, 2012; Vare et al., 2019; Lambrechts et al., 2013
Normative competences	Help learners to collectively map, specify, apply, reconcile and negotiate sustainability values, principles, goals and targets	- Assessing the (un)sustainability of current and/or future states of social-ecological systems and collectively creating and crafting sustainability visions for these systems - Acquiring normative knowledge (concepts of justice, equity, social-ecological integrity and ethics)	Wiek, Withycombe, & Redman, 2011

[7] Lozano, R., Merrill, M. Y., Sammalisto, K., Ceulemans, K., & Lozano, F. J. (2017). Connecting competences and pedagogical approaches for sustainable development in higher education: A literature review and framework proposal. *Sustainability*, 9(10), 1889.

[8] Vare, P., Arro, G., De Hamer, A., Del Gobbo, G., De Vries, G., Farioli, F., ... & Zachariou, A. (2019). Devising a competence-based training program for educators of sustainable development: Lessons learned. *Sustainability*, 11(7), 1890.

Sustainability Competences	Aim	Description and principles	Authors
Strategic competences	Help learners to collectively design and implement interventions, transitions and transformative governance strategies toward sustainability	- Ability to design, implement interventions, transitions and transformations for sustainability - Active and responsible engagement in sustainability innovative projects and activities - Development and application of ideas and planning and executing projects/strategies - Ability to reflect on, and deal with, possible risks - Organization, leading and controlling processes, projects, interventions and transitions - Identification of scopes of creativity and participation - Taking responsibility for motivating others	Rieckmann, 2012; Wiek, Withycombe, & Redman, 2011; Lozano et al., 2017
Interpersonal competences	Help learners to work responsively and inclusively with others, remaining aware of their personal beliefs and values	- Participatory and collaborative approaches to solving problems or conducting research - Skills and understandings in deliberation, negotiation, empathizing, leadership and collaboration - Ability to deal with conflicts and learn from other perspectives - Participation in community processes and cooperation in (heterogeneous) groups	Rieckmann, 2012; Wiek, Withycombe, & Redman, 2011; Lozano et al., 2017; Vare et al., 2019
Critical thinking and analysis	Help learners to evaluate critically the relevance and reliability of assertions, sources, models and theories	- Ability to challenge norms, practices and opinions - Reflection on one's own values, perceptions and actions - Understanding of external perspectives	Rieckmann, 2012; Lozano et al., 2017; Vare et al., 2019
Empathy and change of perspective	Help learners to develop their self-awareness and their awareness of others	- Ability to identify own and external perspectives - Ability to develop emotional intelligence (transcultural understanding, compassion) - Understanding and sympathy for the needs, perspectives and actions of others - Ability to deal with internal and external value orientation - Compassion, empathy and solidarity with others across differences, transcultural understanding - Accepting and embracing a diversity of opinions, experiences or perspectives	Rieckmann, 2012; Lozano et al., 2017; Vare et al., 2019; Lambrechts et al., 2013
Transdisciplinary work	Help learners to act collaboratively both within and outside of their own discipline, role, perspectives and values	- Appreciation, evaluation, contextualization and use of knowledge and methods of different disciplines - Ability to work on complex problems in interdisciplinary contexts	Rieckmann, 2012; Lozano et al., 2017; Vare et al., 2019

Sustainability Competences	Aim	Description and principles	Authors
Communication and use of media	Help learners to understand the use and impact of different information and communication technologies	- Ability to communicate effectively in intercultural contexts - Ability to use appropriate information and communication technologies - Critical consideration and evaluation of media	Rieckmann, 2012; Lozano et al., 2017
Assessment and valuation	Help learners to understand the importance of and the differences among evaluation frameworks	- Develop assessment and evaluation standards and guidelines - Independent evaluations of conflicts of interest and goals, uncertain knowledge, contradictions	Rieckmann, 2012; Lozano et al., 2017
Justice, responsibility, and ethics	Help learners to understand philosophical perspectives on ethics, social justice and community-building	- Application of concepts of ethics, justice, social and ecological integrity and equity - Description, negotiation and reconciliation of principles, values, aims and goals for sustainability - Responsibility for one's actions - Ethics and sustainability of personal and professional behaviour	Lambrechts et al., 2013; Lozano et al., 2017
Personal involvement	Help learners to take action in a proactive and considered manner	- Participation in creating sustainability initiatives - Willingness and ability to acting fairly and ecologically and to learn and innovate - Self-motivation - Initiation of own learning	Rieckmann, 2012; Lambrechts et al., 2013; Lozano et al., 2017; Vare et al., 2019
Tolerance for ambiguity and uncertainty	Help learners to act in a cautious and timely manner even in situations of uncertainty	- Coping with conflicts, competing goals and interests, contradictions and setbacks - Leading with ambiguity and frustration tolerance	Rieckmann, 2012; Lozano et al., 2017; Vare et al., 2019

Regarding pedagogies for sustainability, it is critical to understand the usage and effectiveness of different pedagogical approaches. According to Lozano et al. (2019: 1602)[6] *"pedagogy is defined as 'the art or science of teaching' and the choice of pedagogical approaches depends on each particular pedagogical and educational goal, target group (students, teachers or administrative staff), learning environment and other contextual factors".* Filho et al. (2018)[9] stress that the individual values of academics influence the content, learning outcomes and pedagogy used in teaching.

Sterling (2012)[10], building on the work of Cotton and Winter (2010)[11], reports a set of 15 strategies or methods for the teaching and learning of sustainability, including role-play and simulations, group discussions and dialogue, stimulus activities (e.g., use of photos, videos, newspapers), debates, dairying, critical incidents (presenting critical events and asking what students would do), case studies, reflexive accounts, personal development planning, critical reading and writing, problem-based learning, fieldwork, modelling good practice, futures visioning, worldview and values research, and action research. Besides the above mentioned ESD pedagogies, Moreno Pires et al. (2020)[12], in their mapping of sustainability competencies and pedagogies also mention lecturing, jigsaw/interlinked teams, eco-justice and community, place-based environmental education, supply chain/Life Cycle Assessment (LCA), traditional ecological knowledge, disorienting dilemma, summer schools, as well as mind, cognitive and concept maps as key approaches to teach sustainability within Higher Education Institutions. The same ESD pedagogies are also proposed in the review of Lozano et al. (2017), and Kapitulčinová et al. (2018)[13].

Moreover, Evans and Ferreira (2020)[14], in their review study about the impact of sustainability pedagogies in initial teacher education, identified additional pedagogical methods that reach beyond Sterling's (2012)[10] and Moreno Pires et al. (2020)[12] framework, like worksheets, brainstorming, thinking hats and peer teaching.

[9] Filho, W. L., Raath, S., Lazzarini, B., Vargas, V. R., Souza, L. De, Anholon, R., Quelhas, O. L. G., Haddad, R., Klavins, M., & Orlovic, V. L. (2018). The role of transformation in learning and education for sustainability. *Journal of Cleaner Production*, *199*, 286–295. https://doi.org/10.1016/j.jclepro.2018.07.017

[10] Sterling, S. (2011). Transformative Learning and Sustainability: Sketching the conceptual ground. *Learning and Teaching in Higher Education* 5: 17–33.

[11] Cotton, D., and J. Winter. (2010). It's Not Just Bits of Paper and Light Bulbs': A Review of Sustainability Pedagogies and Their Potential for Use in Higher Education. In Sustainability Education: Perspectives and Practice across Higher Education, edited by P. Jones, D. Selby, and S. Sterling, 39–54. London: Earthscan.

[12] Moreno Pires, S., Nicolau, M., Mapar, M., Ferreira Dias, M., Ramos, D., Bacelar Nicolau, P., Caeiro, S., Patrizi, N., Pulselli, F.M., Galli, A. & Malandrakis, G. (2020) How to Integrate Sustainability Teaching and Learning in Higher Education Institutions? From Context to Actions for transformation towards SDGs implementation: A Literature Review. UA Editora. https://doi.org/10.34624/6gq8-9480.

[13] Kapitulčinová, D., AtKisson, A., Perdue, J., and M., Will. (2018). Towards integrated sustainability in higher education – Mapping the use of the Accelerator toolset in all dimensions of university practice. *Journal of Cleaner Production* 172: 4367–4382. https://doi.org/10.1016/j.jclepro.2017.05.050

[14] Evans, N., and Ferreira, J.-A. (2020). What does the research evidence base tell us about the use and impact of sustainability pedagogies in initial teacher education? *Environmental Education Research* 26 (1): 27–42. https://doi.org/10.1080/13504622.2019.1703908

Furthermore, Evans (2019)[15], ranked 16 literature-identified sustainability pedagogies to probable high, medium, or low priority, based on the percentage of mentions each received relative to the total of 172 references to pedagogies she recorded. Probable high-priority sources where those ranked at around 10% or higher relative to total references and include (i) project/problem-based learning (in an organization/community), (ii) active learning (in class), (iii) collaborative learning, (iv) experiential learning, (v) project/problem-based learning (in class), and (vi) integrative learning (inter and transdisciplinary). Medium priority pedagogies were those referenced in approximately 4–9% of sources and refer to (vii) reflexive learning, (viii) critical text/information analysis/interpretation, (ix) service-learning, (x) internships and apprenticeships, (xi) research-based learning, and (xii) creative work/expression. Finally, low priority pedagogy references comprised approximately 2–3% of the references and include (xiii) case studies, (xiv) discussion-based learning, (xv) learning communities, and (xvi) writing-intensive learning.
Furthermore, Lozano et al. (2019)[6] linked the use of pedagogical approaches with competences for sustainable development in European Higher Education Institutions, reporting that the pedagogical approaches with the most likelihood to develop sustainability competences were that of eco-justice and community, project- and/or problem-based learning, community service learning, inter-disciplinary team learning, mind and concept maps, jigsaw/interlinked teams, and place-based environmental education.
In all the above studies, the term 'sustainability pedagogies' is used to describe the teaching approaches implemented, although with various degrees of specificity, ranging from general methodologies (e.g., project-based teaching, participatory action research) to much more specific methods and techniques (e.g., concept maps, worksheets).

2. Structure and content of the Sustainability Course

The content of a transdisciplinary sustainability course should reflect the variegated aspects of the sustainability concept as described in the introduction section. To this aim, lessons should cover the foundations of sustainability (biophysical, juridical, economic, social, and ethical) and include the EUSTEPs module (see I.O. 2 and I.O. 3 for the content and the didactics of the module entitled *"Sustainability around us: from theory to practice … and back"*). To complete the picture of the sustainability approach, a list of other possible themes is also provided. The whole duration of the proposed Sustainability course is equal to 48 hours of face-to-face lessons/seminars (corresponding to 6 ECTS). The course must be open, understandable, and available to all the students, regardless of their degree course and seniority.
The proposal presented here includes contributions given by several teachers from different disciplines. In this way, the basic foundations as well as different aspects of the sustainability concept will be handled. In addition, the large involvement of the academic community in this course will help overcome institutional and disciplinary barriers to meet the goal of increasing sustainability awareness and knowledge within university *campi*.

[15] Evans, T. (2019). Competencies and Pedagogies for Sustainability Education: A Roadmap for Sustainability Studies Program Development in Colleges and Universities. *Sustainability* 11 (19): 5526. https://doi.org/10.3390/su11195526

In the following paragraphs, more details in terms of the topics, hours, and academic background suggested for each lesson will be given, with the understanding that – aside for its core part – the list of themes proposed can vary every year, also depending on the University and societal priorities of that year.

The very first lesson should be a general introduction given by the responsible for the course. During this lesson, broad-spectrum information, including bureaucratic, administrative, logistic ones, should be given along with an overall presentation of the rationale behind the selected arguments and an overview of the sustainability practices already implemented within the University, if any. At the same time, indications on course timeline, materials, references, and form of evaluation (i.e., exam) should be also provided. The other lessons can be structures as follows: the core part of the entire course proposal (20 hours) is constituted by the 14 hours of Foundations (Table 2) and the 6 hours of the EUSTEPs module (Table 3), which can be complemented by various lessons inspired by the list presented in Table 4.

2.1 *Foundations*

We identify 7 lessons aimed at defining the foundations of the Sustainability concept, corresponding to a total of 14 hours. Table 3 presents the list of the fundamental lessons, including possible topics and the academic background required for their implementation.

Table 3 (Content #1) - The foundations of the Sustainability Course

UNIT and length (academic hours)	TITLE and SESSION TOPICS	ACADEMIC/EXTERNAL BACKGROUND REQUIRED FOR THE EDUCATOR
1 (2 hours)	**Biophysical foundations of sustainability** • Sustainability definition • Sustainability representation • Pillars of sustainability	Environmental chemistry, Ecology
2 (2 hours)	**Economic foundation of sustainability** • Growth vs development • Globalization: definition and evolution • Environmental and resource economics	Economics, Environmental economics
3 (2 hours)	**Social foundations of sustainability** • Social dynamics and sustainability • Equity • Social Inclusion	Sociology, Statistics
4 (2 hours)	**Juridical foundations of sustainability** • International environmental legislation • Environment and economy as pillars of the environmental legislation • Historical evolution of the environmental legislation	Sustainable Development Law, Environmental and international law
5 (2 hours)	**Ethical and philosophical foundations of sustainability** • Human Behaviour • Values and Principles • Ethics and nature	Philosophy, Epistemology
6 (2 hours)	**Energy and sustainability** • The basics of thermodynamic	Physical chemistry, Engineering

	• The energy issue • Renewable energy sources	
7 (2 hours)	**How to measure sustainability** • Sustainability principles • Sustainability indicators • Examples of sustainability indicators applications (territorial and/or production systems)	Environmental chemistry, Ecology

2.2 The EUSTEPs MODULE ("Sustainability around us: from theory to practice … and back")

The module titled ("Sustainability around us: from theory to practice … and back", developed by the ERASMUS+ project EUSTEPs (*Enhancing Universities' Sustainability TEaching and Practices*), was developed to equip EU university students with science-based knowledge, multidisciplinary skills, and the trans-disciplinary mindset needed to play a critical role in the societal effort towards sustainability.
The module is made highly effective by the adoption of the concept of Ecological Footprint (EF), a well-known and widespread quantitative approach to study, assess and understand sustainability and related concept. It can be thus included in the proposal.
The module embraces a hands-on, experiential approach to sustainability teaching: by presenting sustainability within the context of everyday life rather than through a mere abstract teaching of intangible theories and concepts, the goal of the module is to allow students to understand, realize, and learn the full complexity of the economy-society-environment relationships, and help them grasp how sustainability relates to the whole spectrum of daily life. The EUSTEPs module is composed of 7 units, and it foresees classes and home exercises. However, the implementation of the EUSTEPs module within the Transdisciplinary Sustainability Course needs some adaptations concerning the original proposal. As such, within the course, at least 3 out of 7 units should be implemented for a total of 5-6 academic hours. The materials for the implementation of the units can be freely downloaded from https://www.eusteps.eu/resources/material.

Table 4 reports the list of the lessons selected from the whole EUSTEPs module, including the main topics of each one and the reference class exercise suggested.

Table 4 (Content #2) - Reformulation of the EUSTEPs module within the Sustainability Course

UNIT of the EUSTEPs module and the corresponding (academic hours)	TITLE and SESSION TOPICS
1 (1 hour)	**Ecological Overshoot** • Groups' identification • 'Fisher for an hour' – Game (Class Exercise) • Results discussion around 4 key concepts: Equity, Sustainability, Knowledge, Cooperation • Introduction to Ecological Overshoot and connection with daily life
2 (2 hours)	**Ecological Footprint Introduction** • Basics of the EF methodology • Equations (optional topic) • Global EF and biocapacity (BC) trends and results • Discussion

3 (2-3 hours)	**Your Personal Ecological Footprint** • Students' use of the personal Ecological Footprint calculator (http://www.footprintcalculator.org/) (Class Exercise) • Data collection • Results discussion

2.3 *Other possible topics*

A list of other additional topics (2 hours each) is provided in Table 5 to tackle the sustainability aspects of the course and to complete the number of hours corresponding to 6 ECTS. However, the number of ECTS depends on the needs and rules determined by each university. The themes proposed derive from the experience implemented at the University of Siena since the academic year 2013-2014 (8 editions). The arguments cover the environmental, social, economic-political, corporate, and communications dimensions of sustainability.
In general, each lecture/seminar corresponds to a different teacher, who can manage the arguments by virtue of his/her competency, background and experience. In order to provide a variegated menu, a number of educators must be involved in advance, also to fix dates and to plan the agenda of the course.

Table 5 (Content #3) - List of possible themes that can be included within the course. Arguments can be grouped together or further disaggregated.

#	TITLE and SESSION KEY TOPICS	SUSTAINABILITY DIMENSION(S)
1.	**Global change** • Climate history and its changes over time. • Human-driven changes into biogeochemical cycles.	Environmental
2.	**Ecology and sustainability** • Ecology (definition and its connection with humans). • Human impact on ecosystems (terrestrial, marine), air, water and soil.	Environmental
3.	**Waste management and sustainability** • Laws regulating waste classification and management. • Waste generation and management systems and technologies.	Environmental
4.	**Impacts of plastics in the marine environment** • Macro and microplastics in the marine environment: an emerging environmental problem. • Consequences of plastic pollution for local and global marine environment.	Environmental
5.	**Planetary boundaries and sustainability** • Complexity and biophysical limits. • Planetary boundaries and biogeochemical cycles (carbon, nitrogen, water, phosphorus).	Environmental
6.	**Sustainability of water resources** • Water: resource, risks, and planning. • Natural water cycle and the anthropic interferences.	Environmental
7.	**Emerging pollutants** • Ecology and ecotoxicology: points of contact and differences. • Emerging pollutants (pesticides, plastics), a threat to the ecosystems.	Environmental
8.	**The climate, energy and food nexus: a global perspective** • Anthropocene and the great acceleration concepts.	Environmental

	• How climate, food, and energy are connected.	
9.	**Nanotechnology and environmental safety** • Environmental implications of nanotechnologies: why does it matter? • Marine ecotoxicology and its role in risk assessment of engineered nano materials.	Environmental
10.	**Sustainability and climate history** • Humanity and climate. • The history of the climate and climate change study from Arrhenius to the Gaia theory.	Environmental
11.	**Sustainability and ecotoxicology** • The role of ecotoxicology in highlighting the human pressure on ecosystems. • Bioindicators and biomarkers.	Environmental
12.	**The concept of Sustainability in the history of economic thought** • The origins of terms and concepts. • Modern thought on sustainability.	Economic-political
13.	**Biodiversity and the Doughnut economy** • The Doughnut Economy concept. • The biodiversity in the Anthropocene.	Environmental/Economic-political
14.	**Sustainability and digital technologies** • Digital technologies, artificial intelligence, and humans. • Fab-Labs and the embryo of innovation.	Social
15.	**Environmental perception: the role of the media** • The importance of environmental communication to avoid spreading fake news. • The role of the media and the "Not In My Back Yard" (NIMBY) and Not In My Terms of Office NIMTO syndromes.	Dissemination
16.	**Sustainability and communication** • How to communicate the sustainability concept in the newspapers. • The role of newspapers within the environmental communication.	Dissemination
17.	**World geography explained through sustainability indicators** • Geographicalness: space, territories, and environment. • Sustainability indicators and their ability to depict the world geography.	Environmental/Economic-political
18.	**Sustainability and tourism** • How to connect the sustainability concept and tourism. • The eco-tourism as an example of sustainable tourism.	Environmental/Economic-political
19.	**Green economy and sustainability** • Green economy and its relevance. • How to achieve a green economy: the role of the public policies.	Environmental/Economic-political
20.	**Sustainable development and human rights** • Human rights and the 2030 Agenda for Sustainable Development. • Sustainability and human rights. Protection at the European level.	Environmental/Economic-political
21.	**Finance and sustainability** • Implications of the financialization process. • Environmental, social, and governance (ESG) criteria and their implications in the finance sector.	Environmental/Economic-political
22.	**Food Systems** • Sustainability of food systems and nutrition • Food systems governance	Environmental/Economic-political
23.	**Measuring food sustainability** • Society, nutrition, and environment. • Indicators to assess the sustainability of food, food chain, food choices, food waste.	Environmental/Economic-political

24.	**Sustainable and resilient cities** • What makes a city sustainable and resilient? • Solutions to transform cities towards sustainability	Environmental/Economic-political
25.	**Education for sustainable development** • The *scoolfood* experience: origin, rationale and implementation (https://www.scoolfood.it).	Environmental/ Social
26.	**Equity and sustainability** • Connections among society and environment. • Calculating inequality**.**	Economic-political/ Social
27.	**Economics of Happiness** • Causes of unhappiness (decline of relationships, social crises, consumerism). • How to redesign our society towards happiness (city redesign, changes in schools, societies and work).	Economic-political/ Social
28.	**Mobility and sustainability** • Sustainability and mobility. • Policies for sustainable mobility.	Economic-political/ Social
29.	**Constitutions and sustainability** • Sustainability and Constitutions. The Constitutional State and the Dilemma of Future Generations. • Sustainability clauses in modern Constitutions.	Economic-political/ Social
30.	**European law on agriculture and environment** • Relationship between agriculture and the environment. • The European Law on agriculture.	Environmental/Economic-political/ Social
31.	**Complexity and sustainability** • The analogy between the concepts of sustainability and complexity. • The need to understand the concept of complexity and tools to implement actions that move towards sustainability.	Environmental/Economic-political/ Social
32.	**Health and sustainability** • The World Health Organization (WHO) definition of health (Physical, mental, and social well-being and not merely the absence of disease or infirmity). • The concepts of global health and sustainability.	Environmental/Economic-political/ Social
33.	**Citizen science and sustainability** • Definition of citizen science. • The contribution of citizen science to sustainability implementation.	Environmental/Economic-political/ Social
34.	**Sustainability and Genetically Modified Organizations (GMOs)** • What GMOs are? • GMOs and issues on biodiversity, health safety, ethics, and social equity.	Environmental/Economic-political/ Social
35.	**Native species and molecular biodiversity: impacts on the environment and the agriculture production** • The language of plants. • Characteristics, properties, vulnerability, and selection of plants.	Environmental/Economic-political/ Social
36.	**Sustainable Development Goals (SDGs) and the UN 2030 Agenda** • The UN 2030 agenda. • SDGs and their role in the society.	Environmental/Economic-political/ Corporate
37.	**How to integrate sustainability in the business management mechanism** • Non-financial accounting and the Sustainability report of enterprises. • Sustainable management system.	Economic-political/ Corporate

To increase the number of possible arguments and integrate theoretical approaches with more practical experiences, external speakers have been invited, for example, from the

industry sector, other Universities or National or International Research Centres. Additionally, some specific topics have been presented by external experts. For instance, the topic *"Biodiversity and the Doughnut economy*" was presented by the Scientific Director of WWF Italy, while the *topic "The climate, energy and food nexus: a global perspective"* was introduced by an Italian delegate within the IPCC. In addition, lessons devoted to present the role of the media were carried out by Italian journalists; entrepreneurs and managers from industries were invited to present the point of view of companies that are dealing with social corporate sustainability; one or two sessions were devoted to present emerging topics within the sustainability domain. In one edition, a teacher from the Vatican was invited to present the "*Laudato si*" encyclical. In another edition, some people belonging to the *"Friday for future"* movement – mainly university students – presented the movement and its activities. Finally, members of the *"Good practices office"* gave a lesson to present the sustainability practices implemented at the University of Siena.
The list provided, though wide and representative of 8 years of sustainability didactics, is not exhaustive nor complete. It should inspire other universities to try to include as many aspects as possible within the Sustainability course. The Sustainability Course should overcome disciplinary, faculty, and academic boundaries to be transdisciplinary, open, available for a large and variegated audience, even external auditors (i.e. private citizen, interested people, industrialists, journalists, etc), to make the University an open cultural hub of sustainability for the whole society.

2.4 Sustainability e-learning course

The course proposed in this document can be fully available in an e-learning regime. Presently, the second part of the course, the module on *"Sustainability around us: from theory to practice … and back"* was already successfully offered in e-learning (as a pilot course) and positively evaluated (covering five dimensions: general expectations; learning quality; teaching resources, pedagogical tools, and evaluation; acquired competences in education for sustainable development; satisfaction and interactions), at Universidade Aberta, during the EUSTEPs project (Malandrakis et al.[16], 2021).

The e-learning pedagogical model underlying this course is based on four major principles: (i) student-centred learning, (ii) flexibility (access to learning without pressure of time and space, with predominance for asynchronous communication), (iii) interaction (student-teacher, student-student, and student-learning resources), and (iv) digital inclusion (Modelo Pedagógico®; Pereira et al., 2008[17]). Herein, the teacher's education role, and the program contents and goals are achieved through transdisciplinary approaches, innovative teaching methods and e-learning technologies. The assessment of the learning process and the competences /skills development is accomplished through continuous assessment, including

[16] Malandrakis, G., Papadopoulou, A., Moreno Pires, S., Pulselli, F.M., Patrizi, N., Caeiro, S., Bacelar-Nicolau, P., Galli, A., Theodossiou, N., Zachos, D., Mapar, M., Nicolau, M. (2021). Improving students' understanding of ecological footprint within the context of everyday life, ESERA 2021- Fostering scientific citizenship in an uncertain world, 30 august-3rd September, Braga, Portugal.

[17] Pereira, A., Mendes, A. Q., Morgado, L., Amante, L., & Bidarra, J. (2008). Universidade Aberta's pedagogical model for distance education © (p. 109). Lisbon: Universidade Aberta.

individual and collaborative activities and Problem based learning (Azeiteiro et al., 2015[18]; Bacelar-Nicolau et al., 2012[19], 2015[20]; Martinho et al., 2016[21]). Through open learning environments, the learner controls its learning process which allows for self-guidance and tools that facilitate individual and collaborative exploration of concepts and benefits from flexibility (time and space), teaching guidance, collaborative learning, and a great sense of community and interaction among peers, as well as with teachers, thus promoting a strong learning community.

E-learning in higher education institutions has been proved to be of great relevance in the effective life-long learning education for sustainable development, particularly to the population of students who are simultaneously also full-time employees (Azeiteiro et al., 2015; Bacelar-Nicolau and Caeiro, 2019[22]).

3. Practical suggestions

Based on the experience gained at the University of Siena (when the Sustainability course was implemented for its 8th edition during the academic year 2020-21), some practical suggestions are given below on how to implement the Course, how to create and provide didactical material and how to implement exams.

a) WHO SHOULD ATTEND THE COURSE?

It is highly recommended to make the sustainability course open to all. Since its first edition, at the University of Siena, the sustainability course has been made available to all students (of all degrees from Bachelor to Master and Ph.D. students), as well as to technical-administrative staff. The course is currently available for external students as well. For regular students, the course is part of the free-choice credits, and the authorization of the teaching committees of the different degree courses is required. For this reason, all the Teaching Committees should have been informed in

[18] Azeiteiro, U. M., Bacelar-Nicolau, P., Caetano, F., & Caeiro, S. (2015). Education for sustainable development through e-learning in higher education: Experiences from Portugal. Journal of Cleaner Production, 106, 308–319. doi:10.1016/j.jclepro.2014.11.056.

[19] Bacelar-Nicolau, P., Martinho, A. P., Amador, F., Caeiro, S., & Azeiteiro, U. M. (2012). Online learning for sustainability: The student perception in an environmental science post-graduation. In F. Gonçalves, R. Pereira, W. Leal Filho, & U. M. Azeiteiro (Eds.), Contributions to the UN decade of education for sustainable, Peter Lang, 33: 281–294.

[20] Bacelar-Nicolau, P., Caeiro, S., Martinho, A. P., & Azeiteiro, U. M. (2015). Attitudes, barriers and motivators as factors for sustainability of higher education e-learning programmes at Universidade Aberta, Portugal. In Leal Filho, W., Brandli, L., Kuznetsova, O., & Paco, A. (Eds.), Integrative Approaches to Sustainable Development at University Level: Making the links, Springer ISBN 978-3-319-10689-2, pp 567–582. doi:10.1007/978-3-319-10690-8_39.

[21] Martinho, A. P., Caeiro, S., Caetano, F., Azeiteiro, U. M., Bacelar-Nicolau, P. (2014) "Training and Employability, Competences from an e-learning undergraduate programme in Environmental Sciences". *In* U.M. Azeiteiro, W. Leal-Filho, S. Caeiro (Eds.) *E-learning and Sustainability*, Peter Lang, 47-58 pp. ISBN 978-3-631-62693-1 hb. http://dx.doi.org/10.3726/978-3-653-02460-9.

[22] Bacelar-Nicolau, P. and Caeiro S. (2019) Massive Open Online Courses (MOOCs) and Their Role in Climate Change Education. In: Leal Filho W., Azul A., Brandli L., Özuyar P., Wall T. (Eds.) Climate Action. Encyclopedia of the UN Sustainable Development Goals. Springer, Cham. ISBN 978-3-319-95884-2 https://doi.org/10.1007/978-3-319-71063-1_32-1.

advance and their buy-in secured. At the same time, sustainability should be considered as a strategic value for the whole university and its policy, which is a fundamental prerequisite for the sustainability course to be effectively implemented and successfully attended by all students. For this reason, the Rector and other university institutions should be aware of the initiative.

b) HOW TO CHOOSE THE DAY?

The promoter/organizer, responsible for the Sustainability Course implementation, needs to choose a fixed day in which the course could be implemented without overlapping with other academic lessons. For instance, at the University of Siena, the Sustainability Course takes place during the spring semester every Friday afternoon (as Friday afternoons are supposed to be less crowded in terms of simultaneous classes).

c) TEACHING PLAN

Each meeting of the Sustainability Course consists of one or two seminars (2 academic hours each). The ideal teaching program should plan the Fundaments of Sustainability at the beginning of the course.

Each seminar should include the final 20 minutes for a Q&A session. This teaching program can be implemented with online lessons as well.

d) HOW TO CREATE THE DIDACTIC MATERIAL

Given the diverse range of lessons that can be implemented every year, there can be no textbook to represent the variety of topics covered in the course. The professor in charge of organizing the course should ask each lecturer for a few pages of notes (about 10 to 15 pages), with a reference section and possible further reading. In this way, by assembling all the material collected, it will be possible to create a specific handbook for students every year.

e) HOW TO BE INNOVATIVE WITH THE PEDAGOGICAL APPROACH FOR THE COURSE?

A project-based learning (PBL) or a challenge-based learning (CBL) approach could be adopted so that students would have to work on a concrete real situation and apply, in groups, the different knowledge acquired during the course. For instance, a possible case study can be the university campus (i.e. infrastructure, organization, solutions, etc.) to find ways to make it increasingly sustainable. Moreover, different teaching techniques and pedagogies (see section 2.1) can be adopted within one or more lectures/lessons; the decision is up to either the organizer/promoter or each individual teacher. For example, the EUSTEPs module included in this sustainability course (see section 2.2) proposes lectures made of frontal lessons (45 min.) and practical exercises or dynamic discussions with students.

f) HOW TO ASSESS THE LEARNING OUTCOMES?

Since the course is made of lessons given by different educators, the final evaluation will be a test. The professor in charge of organizing the course should ask each lecturer/educator for a set of questions and corresponding answers. The test should be made of 20 to 30 questions (one or two per topic) mixed among closed and open

ones. Open questions will highlight and better appraise the level of understanding and knowledge of students. Evaluation sessions must be different from each other, having a set of questions for each topic. This way to implement evaluation applies if the course is implemented adopting traditional didactic (namely, lessons given by different educators).

Whereas, if the course is implemented adopting PBL or CBL approach, the final evaluation should be made by a multidisciplinary group of 3 professors, together with the professor in charge of the course. They should assess the presentation of each group project and a final written report on the project. The best project can be made visible in the whole University and receive a symbolic award. All the teams should be nominated as sustainability ambassadors.

4. Perspectives

For many years, the literature has recognized and emphasized the role that universities play in disseminating the principles of sustainable development (Stephens et al., 2008[23]). Therefore, universities, being social institutions, have the responsibility of designing and influencing the future of our planet, of our society and therefore also of young people. Society assigns to university institutions the task of developing concepts, corroborating them with empirical evidence, then defining values and involving students so that they can contribute to social progress and knowledge advancement. Universities have, therefore, a profound responsibility to act as sources of vision, a mission that goes beyond technical knowledge. It is not surprising that many universities have responded to this challenge by identifying sustainability as a central dimension of university programs, research activities, and service to the community (Calvano, 2017)[24].

This effort, in Italy, has been championed by the RUS - Network of Universities for Sustainable Development, with the support of CRUI - Conference of Italian University Rectors, established in July 2015 as the first experience of coordination and sharing between all Italian universities committed to the issues of environmental sustainability and social responsibility. The main purpose of the RUS Network is the promotion of sustainability knowledge and good practices, both inside and outside the universities, by sharing skills and experiences. The network will increase the benefits of the activities carried out by single universities, while strengthening the recognition and value of the Italian experience at the international level.

The recent 2019-20 Report of Activities highlights a decisive increase in the attention and commitment of the RUS Network Universities on sustainable development issues, not only as a reference in strategic plans (70% in 2017 - 90% in 2020) but also in the establishment of offices in charge of engagement and capacity building activities (39% in 2017 - 64% in 2020) (Lombardi, 2021[25]). We believe that this achievement is the result of decades of research,

[23] Stephens, J.C., Hernandez, M.E., Roman, M., Graham, A.C., Scholz, R.W., 2008. Higher education as a change agent for sustainability in different cultures and contexts. *International Journal of Sustainability in Higher Education*, 9 (3), 317-338.

[24] Calvano, G., 2017. Educare per lo Sviluppo Sostenibile. L'impegno degli Atenei Italiani: esperienze in corso e buone pratiche. Roma: Aracne.

[25] Lombardi, P., 2021. Transizione ecologica e sviluppo sostenibile dei territori: il ruolo dell'Università. Ingegneria dell'Ambiente, 8(1). https://doi.org/10.32024/ida.v8i1.329

involvement and communication made by single pioneers of the concept itself (both within and outside the academic environment). It must be also noticed that sustainability is right now a very common and well-known concept that cannot be ignored any longer.
The Sustainability Course implemented at the University of Siena in 2017 has been awarded by the RUS network as one of the 5 best innovative practices for Sustainability didactics among Italian Universities. In this Intellectual Output we have proposed a framework inspired by such experience, even though variations, amendments and improvements can be adopted by everyone in different Universities and countries.

The implementation of a Sustainability Course within a University is in line with what is recalled by major international players in the Education for Sustainable Development (ESD) such as the Sustainable Development Solution Network (SDSN), the European University Association (EUA) and UNESCO, among others.

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