



Workshop report

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CODESIGNING AN EXPEDITION LEARNING SEMESTER AROUND EUROPE FOR FUTURE RESPONSIBLE ENGINEERS

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ABSTRACT

Decarbonization is a major objective of the European Union (EU) to achieve carbon neutrality by 2050. As an example, for the transport sector, shipbuilders and engine manufacturers are exploring prototypes and designs for ships powered by alternative propulsion systems to fuel energy, like wind-assisted propulsion. Higher Education Institutions (HEIs), through their science and technology curricula, must now prepare the next generation of responsible engineers to support these ecological transitions.

To guide educational program leaders and curriculum designers, the active workshop presented here permits to codesign a pan-European Master level semester on energy EU sovereignty and decarbonization. The context is a 5-month

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expedition in an imagined cruise ship, a nomadic university which provides accommodation for the students with learning and teaching workspaces. This low-carbon ship, as a floating Lab, is to travel between several European cities, to meet various academic, scientific and industrial communities during the itinerary.

This paper reviews the activities and phases of this exciting workshop, operated several times in 2024, e.g. during the SEFI 2024 conference at Swiss Federal Institute of Technology. In sub-groups, participants propose their itinerary on a given geographical map and sketch out an original joint curriculum with the aid of a canvas of nine components elaborated in a project funded by the European Commission. No prior knowledge or expertise in energy topics are needed, just openness to new ideas and creativity in collaborative curriculum design.

1 GENERAL CONTEXT

1.1 2030 Agenda for sustainable development and global risks

The context of the workshop is the challenges of climate change and sustainability, both of which are the subject of a broad consensus worldwide. According to the 2024 19th edition of the World Economic Forum (WEF, 2024), “Climate change encompasses the range of possible trajectories of global warming and consequences to Earth systems. [...] Global warming pathways will still be influenced by the speed at which decarbonization takes place, and deployment of climate solutions.”

The WEF perception survey ranked by severity and the likely impacts of risks over a 10-year period. Among the 34 risks identified, the four first ranked are environmental risks: Extreme weather events, Critical change to Earth systems, Biodiversity loss and ecosystem collapse, and Natural resource shortages. Energy is a major subject as seen with the EU objective to reduce dependence on fossil fuels and its transition to renewable energies (e.g. wind solar power, overtaken gas for electricity production in the EU). Moreover, to better face future crisis and resilience, energy sovereignty is now a challenge, its ability to control, regulate, and manage its own energy resources and systems, its independency between the EU member states.

1.2 New skills of engineering students on decarbonization

The success of a decarbonization strategy requires coordinated action at all levels, in particular HEIs through their science and technology curricula when preparing the next generation of engineers. The inclusion of Environmental and Social Transformation (EST) throughout the student's curriculum enables to train future professionals capable of integrating these issues into their future careers. Engineering education must adopt a systems-based approach that incorporates both ecological principles and societal needs. An EST competency referential is to be infused into a curriculum, e.g. (i) systematically analyse the impact of human activities and industries on ecosystems and the climate, (ii) apply a historical and forward-looking approach favouring a critical stance in the face of major resource-energy-climate issues, (iii) embody individual responsibility to act collectively at international levels, and (iv) create value chains respectful of a sustainable future.

Some challenges remain: training future EU engineers, as future actors of change and transformation, students equipped with right skills for innovative energy large-scale projects, capable to facilitate effective inter-state cooperation. Future engineers in energy fields are to learn about the energetic equations of several countries, facing the challenges of the EU energy production and consumption. Several learning goals are thus to consider for a pan-European energy program, including an interdisciplinary approach with economic implications of energy independence, politics to explore energy policies and regulations, environmental Science for energy impacts, as well as social studies to analyze the social and cultural aspects of energy sovereignty. A future-oriented thinking to envision and research future energy scenarios is important also. Future graduate students could be a force in becoming European activists and ready players of pan-European energy transitions.

2 IMAGINE AN EXPEDITION LEARNING CURRICULUM

The workshop here provides an opportunity to exchange innovative perspectives between curriculum designers, on the theme of a joint European semester with strong international dimensions. No prior knowledge is presumed. The original context is an imagined cruise ship, equipped with learning and teaching workspaces, traveling to visit both universities and large industries. The workshop mission is given to subgroups of 3-5 participants.

Expedition learning is not new. Since 1912, each year, the 'La Jeanne' mission, as a final semester, marks the end of the training course for 160 engineering cadets at the French Naval Academy. With 155 days on a warship, the young engineers round the world, can cooperate with e.g. Australian, Indonesian and Singaporean armies, both at sea and on land.

The ship here is to be also a Lab. Recently in 2024, shipbuilders and engine manufacturers are exploring prototypes and designs for ships powered by more carbon-neutral systems, like wind-assisted propulsion and alternative propulsion systems to fuel energy. The International Windship association (2022) classifies wind propulsion technologies into categories including soft sails, hard sails, Flettner rotors, suction wings, kite sails, and turbines. Several large shipping companies plan such installations as part of their goal to achieve net-zero emissions. Workshop participants are given some characteristics of such a ship to host learners: 100 meters long, 3000 square meter sails, 40% fuel reduction, up to 200 cabins and a transit time of around 400 km per 24 hours.

2.1 Workshop phases in the 1-hour format

The workshop can be held in one hour only, it has been operated in three hours. After a very short context presentation of the workshop objectives and phases, two European energy maps are used as a context. With all their controversies, the first presents geographically, per country, most used energy production, the second energy source (cf. in Figure, phase on energy sovereignty). They are based on the BP statistical review of World Energy from 2024. This energy outlook considers the

"major forces influencing global energy demand and supply flows, and the prospects for the energy transition out to 2050"².

For around 40 minutes, participants work together in subgroups. Each group elaborates on the broad lines of the final curriculum semester. Groups draw the itinerary (on a given A3 map) of the ship visiting at least 5 major universities and 5 companies around EU countries they select. Each city is to meet some EST goals, e.g. with links to strategic energy industrial activities, e.g. for decarbonization: wind power, nuclear power, geothermal or hydrogen energy. The Learning & Teaching courses can take place both during the travel at sea (ship having workspaces and invited professors and industrials on a leg) and during stopovers.

The itinerary prospection is most often done in parallel with the curriculum co-design, facilitated by a canvas with nine components (cf. Figure, phase curriculum co-design), defined in the context of a EU Erasmus+ project (Matthiasdottir et al. 2024). The canvas includes, from top-left to bottom-right: main goals and learning outcomes of the program, entry requirements, structure and contents of the program, teaching and learning methods, location of teaching and learning, interpersonal skills, assessment methods, language of instruction, and ethno- and sociographic aspects, including diversity and equity.



Fig. 1. Workshop activities and materials.

Some inputs are prefilled in the canvas, time depending and based on the profiles of participants and awareness of energy scopes. As examples, (i) areas of knowledge

² <https://www.bp.com/en/global/corporate/energy-economics.html> (consulted in September 2024).

and skills are suggested in the corresponding learning outcomes component, and (ii) broad lines of entry requirements are given. On need, 4 fully filled curriculum canvas are given for the previous semesters, somehow profiling the entry requirements, here the Building Energy Systems Engineering B.Sc. from Vilnius Tech, followed by three semesters respectively from: M.Sc. Sustainable from Reykjavik University, M.Sc. Sustainable Management Water & Energy from RWTH, or Management & Engineering of Environment & Energy from IMT Atlantique. The last M.Sc. semester on Energy Sovereignty is thus to be designed. The groups are not to fill all the component descriptions, they follow the structure to facilitate the design of their original curriculum and suggest highlights, time depending.

In the end each group displays its route and curriculum draft on the room wall. Filled Creative Commons materials are shared by email with the participants after. To close the session, in the short one hour version, remaining minutes are dedicated to group semi-structured exchange orally, before a more formal qualitative and quantitative questionnaire submitted online right after the workshop.

3 WORKSHOP ANALYSIS

The workshop has participant learning outcomes around curriculum design skills: collaborate with and learn from others, inspire others, ideate and exchange experiences, inter-connect programs, network with curriculum designers. A Likert-scale permits to verify if the participants skills were reinforced. Even though a hypothetic curriculum scenario, it has been analysed thanks to the online questionnaires and semi-directed discussions that participants of the workshop strongly appreciate the freedom that they could experience. The workshop strongly stimulates constructive and structured discussion between participants during design phases and collectively during the debriefing phase, and it *“encouraged me to think outside the box and view curriculum development in a slightly different way. The task was unusual in a good way (verbatim)”*. But *“convincing academics to do things in a slightly different way than they are used to normally (verbatim)”* is seen as an obstacle for transfer in own institution context.

The workshop duration in 3 hours is more appropriate to go deeply in the canvas components, with subgroups of 3-5. At the SEFI 2024 conference, in one hour, 11 participants in 3 groups, from Australia, Czech Republic, Denmark, Ireland, and UK, actively engaged in this workshop, all phases were covered. Participants reported that *“It would have been great to have slightly longer, nevertheless, it was a fruitful hour, and we managed to get the task done and had a useful discussion. Very good session, I enjoyed it! (verbatim)”*, and *“it was all right but I felt we could spend more time sharing our ideas and developments (verbatim)”*.

Participants most often start from the learning outcomes component, which is the usual keystone in integrated curriculum design based on constructive alignment principles. One participant wrote *“learning outcomes, it was at the beginning, and it seemed the basis for the rest of the work (verbatim)”*. For such, 4 areas of knowledge and 6 of skills and competencies are given now in the corresponding learning outcomes component of the canvas to fill. Also, the canvas has now one or two lines of description per component to answer that it *“could be helpful to add a sentence in each box with the questions to answer (verbatim)”*.

Semi-directed discussion showed also that controversial skills are to be in the learning outcomes when on energy sovereignty, challenge-based learning is an adequate model, or student teams could be re-mixed on each stops of the itinerary. Semester structure with 30 ECTS prompts to a maybe large 14 weeks project as for a final thesis or internship model (Audunsson et al., 2022). Starting and ending locations can depend on the seasons (February in North or South) or on a EU region more advanced in renewable energies to favor transfer by students in other regions later.

“It was entertaining experience (verbatim)”. Having engineering students in their last semester to travel throughout Europe to interact with universities and industries is an attractive, innovative, and exciting idea. The European Commission has proposed a blueprint for establishing a European degree, with the aim of facilitating deeper cooperation among HEIs across Europe (European University Association, 2024). In line with some SDGs and global risks, this workshop is significant in the context of educating responsible engineers and equip them with EST competencies. This context, here energy engineering, is interchangeable without modifying the workshop collaborative phases and design tools, e.g. IA, Industry 5.0 or other educational fields and sectors like STEM, business and economics, natural or social sciences, law, could be envisioned easily, could it be with rail train.

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