AdvanceHE

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Guide to ESD in practice

Embedding climate change goals in engineering curricula

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Contents

1. Intended outcomes

The students should develop:

1. Practical engineering skills needed to address Sustainable Development Goals (SDGs) and climate change challenges.
2. An appreciation of the wider role of their specialist subject topic in tackling SDGs.
3. A range of transferable skills, such as abilities to search and gather information from various sources, work collaboratively, document and report the work, and argumentatively discuss the approaches taken.

A creative learning environment is created where, through problem-solving activities, students are challenged to think how the knowledge gained in engineering taught modules can contribute to sustainability, by contextualising SDGs in practical scenarios. Students engage in hands-on experience in processing and analysing visual and communications signals.

2. Participants

Students: each group contains three to five students.

A single academic ideally supported by a Teaching Assistant.

3. Activity/project

Working towards an educational aim to provide hands-on experience in processing and analysing visual signals, the students are organised into groups to work on a joint open-ended project, defined as a piece of work that requires design of an image processing method, implementation of the design, validation and testing, and critical analysis of the obtained results. Though a list of suggestions were given to the students, the students were encouraged to work as a group and creatively find problems where image processing could help towards sustainability and specify which SDG and how it is addressed. Each group comprises up to five students. The students are tasked to frame the problem tackled, identify a range of technologies that can be used, perform a critical literature analysis and put the work in the sustainability context. Furthermore, they set clear and measurable objectives and provide recommendations for the methodological steps. The students produce a poster that highlights their collective and individual learning journey, including personal learning goals, interpretation of project objectives and planned individual contribution. The students work together to creatively design an image processing system that can be used to address climate change challenges: contextualising SDG challenges, identifying the problem, relating engineering system design theory and algorithms covered in the class, proposing specific system design approaches (Semester 1) and implementing and demonstrating them ensuring reproducibility of the results (Semester 2).

Half-way through the project, the students submit a poster that highlights their collective and individual learning journey, including personal learning goals, interpretation of project objectives and planned individual contribution.

To facilitate development of transferable skills, two workshop-style sessions are organised. The first session takes place after the project goals are described and teams are formed. During the session, the students are organised into teams, with each team occupying one round table. Each team is asked to work on creating an engineering design proposal facilitated by the academic staff. At the end of the session, each team presents their idea, which is challenged by other teams. The second session takes place during the implementation phase; it is structured in a similar format but with the goal to define and respond to technical challenges, practicality of the solution, and reproducibility/open science. The students will develop a range of transferable skills during these activities, including creative thinking, working in a team, leadership, communicating ideas to others, open science principles.

Subject-specific skills are gained via providing critical analysis of the literature (including finding and selecting relevant sources, criticising existing approaches, analysing their performance), designing an engineering system capable of addressing the identified climate change-related challenge (this includes creating an engineering solution by combining various system components discussed in the class, relating the proposal to literature, modifying existing solutions, and generating new codes), implementing the designed solution, and critically discussing the results, possibly comparing them with state of the art.

4. Assessment or evaluation

At the end, the students produce a technical report that is assessed in terms of the level at which the project objectives are met, soundness of the methodology, appropriateness of implementation, experimental setup, including data acquisition, validation (justification of the metrics used) and analysis. The final outcome must be reproducible. The students submit one report per group together with the running code and user guide. They also give a short presentation where they demo their work.

Assessment criteria

Posters are assessed based on visual attractiveness, quality of the set learning goals, *motivation and context* including a clear link to climate change and SDG goals and *how engineering design can help addressing them, clarity of the proposed objectives and extent to which they are realistic*, and time-plan including distribution of tasks within the team.

Reports are assessed based on the clarity of objectives (are they measurable?), whether the project is put well in the context of engineering system design for climate change and SDGs, if the methodology is sound in terms of providing a convincing engineering solution, the depth and breadth of the literature review, suggestions to ensure reproducibility, replicability and interpretability of the results, and finally, the description of applications, future work and personal reflections.

Presentations/demonstration (oral) are assessed based on the quality of presentation (presentation structure, slide layout, organisation and clarity of the presentation, timing, smoothness of delivery and preparedness of the presenters); *technical appreciation (technical depth, engineering achievement, discussion on applicability/practicality and issues that need to be resolved prior to deployment)*, answers to questions.

The level of development of transferable skills will be assessed via presentation (oral and poster), and report (transferable skills related to the level of understanding and applying research integrity and open science principles and appreciation of SGDs and climate change goals).

Subject specific skills (visual signal processing) are assessed based on the level of achievement of subject specific skills highlighted above (in italic) as demonstrated through the poster submission, report and presentation.

5. Useful resources

Stankovic, V and Stankovic, L (2022) *Embedding climate change goals in engineering curricula*. Paper presented at International Symposium of Engineering Education (ISEE) 2022, Glasgow, United Kingdom. Available at: pureportal.strath.ac.uk/en/publications/embedding-climate-change-goals-in-engineering-curricula

6. Example of practice

The approach has been applied in teaching a fifth level Image and Video processing course. The students came up with some very exciting project ideas and implementations and reusable resources. They also provided positive and very constructive feedback.

Insights and feedback can be found in Stankovic and Stankovic (2022).

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