Knowledge hub
-
Collection of best practices

Summary of the best practice

1. Title of the best practice (e.g. name of policy, programme, project, etc.) *

Reimagining Sustainability Engineering: A Futuristic Undergraduate Program Design

2. Country or countries where the practice is implemented *

Australia

3. Please select the **most relevant** Action Track(s) the best practice applies to *

- [ ] Action Track 1. Inclusive, equitable, safe, and healthy schools
- [x] Action Track 2. Learning and skills for life, work, and sustainable development
- [ ] Action Track 3. Teachers, teaching and the teaching profession
- [ ] Action Track 4. Digital learning and transformation
- [ ] Action Track 5. Financing of education

4. Implementation lead/partner organization(s) *

Western Sydney University, School of Engineering, Design and Built Environment

5. Key words (5-15 words): Please add key descriptive words around aims, modalities, target groups etc. *

undergraduate program; engineering; sustainable development goals; sustainability

6. What makes it a best practice? *

Environmental engineers design systems and solutions that are at the interface between humans and the environment. Traditionally, environmental engineers are trained to focus on issues, e.g., provision of water, collection and treatment of wastewater and later air, water, soil pollution control. Gradually it shifted to encompassing the ecological principles, and recently the problems related to emerging contaminants. In addressing these issues, environmental engineers adopted systems approach but usually they are limited to within the media they are dealing with. In addition, environmental engineers often find themselves in a difficult position to convince an industry/governmental organisation, as there was no incentive for an industry to invest and research in clean technology. Recent increased incidences of extreme climatic conditions, food shortages and sharp increase in atmospheric carbon concentrations globally have given a wake-up call to the public, private enterprises, and governments alike. The emerging issues as defined by UN Sustainable Development Goals or the US National Academy of Engineering's Grand Challenges demand futuristic engineering skills different from what traditional engineers are taught. For example, the consideration of food-energy-water nexus require much wider knowledge than a traditional environmental engineering degree offers. Western Sydney University has the lead in the design of such a futuristic undergraduate program on Sustainability Engineering. It addresses: Sustainable supply of food, water, and energy; Curb climate change and adapt to its impacts; Design a future without pollution and waste (Circular Economy); Create efficient, healthy, resilient cities (sustainable cities); and Foster informed decisions and actions informed by science. The proposed program has been designed as a collaborative attempt across multiple disciplines: Environmental Engineering, Civil Engineering, Materials engineering, Agricultural science, IT, Electrical Engineering, and Social Sciences. It is expected that this program will produce engineers who are future-focussed and holistic thinkers who can analyse a problem from multiple perspectives.

Description of the best practice

7. Introduction (350-400 words)
This section should ideally provide the context of, and justification for, the practice and address the following issues:
i) Which population was affected?
ii) What was the problem that needed to be addressed?
iii) Which approach was taken and what objectives were achieved? *

The welfare of future generations depends on proper management of environment and implementation of strategic frameworks for sustainable development. Environmental engineers design systems and solutions at the interface between humans and the environment. Environmental engineering has its origin as Sanitary Engineering following the Sanitary Awakening in UK and US. As such initial stages were based on treatment of water and safe disposal of wastewater, especially that arose from domestic sources. By 1970s, the realisation that more harmful and persistent industrial wastes affect water, soil and air, environmental engineering embraced those additional media (Hays, 1981). Following Bruntland's report on "Our Common Future" (United Nations, 1987), the demand for environmental engineers with broad training in systems and sustainable (i.e., social, environmental, economic) thinking has increased significantly. Yet, most environmental engineering undergraduate degrees available today are designed as an "add on" rather than a dedicated environmental engineering program (Dowling and Hadgraft, 2013).

In recent years several developments have taken place; the '14 Grand Challenges' announced in 2008 by National Academy of Engineering and '17 Sustainable Development Goals' (SDGs) adopted by the United Nations in 2015 (UN, 2015). Out of the 14 grand challenges, an environmental engineer could contribute to six - water, nitrogen, urban infrastructure, digitisation, solar energy, and carbon sequestration. Almost all the 17 SDGs are relevant for an environmental engineer. In parallel with the key initiatives addressed above, many other concepts have been introduced. These are life cycle assessment, closed loop recycling, cleaner production, industrial ecology, eco-efficiency, design for the environment, etc (Bjørn et al, 2018). By 2013, "Circular Economy" concept has been introduced. All these resulted in improvements in the way the environmental impacts are accounted for but is not commonly taught in undergraduate environmental engineering programs. While not a new concern, the impact of climate change has been repeatedly witnessed across the world in an ever-increasing frequency and intensity of climate extremes (Commonwealth of Australia, 2016). This has brought in the urgency of considering climate change in everyday life. The IPCC's Climate Change report (IPCC, 2021) brings even more urgency to the need to address climate change impacts. Many organisations and governmental agencies have started to factor in sustainability and climate aspects which is reflected in multi-fold increase in job advertisements with "sustainability" as the keyword. These global factors led to the design of a new proposed undergraduate program.

8. Implementation (350-450 words)
   Please describe the implementation modalities or processes, where possible in relation to:
   i) What are the main activities carried out?
   ii) When and where the activities were carried out (including the start date and whether it is ongoing)?
   iii) Who were the key implementation actors and collaborators? (civil society organizations, private sector, foundations, coalitions, networks etc.)?
   iv) What were the resources needed (budget and sources) for the implementation?
   *

A survey of existing undergraduate engineering programs across the globe in 2020 did not result in a single program that addresses these concerns of the future of environmental engineering. The program was developed after a thorough benchmarking against several undergraduate programs in sustainable/environmental engineering in Australia and overseas. The analysis also revealed that the proposed Sustainability Engineering program is the first of its kind in Australia.

As such a fresh new approach in designing a program on Sustainability Engineering was undertaken at Western Sydney University (WSU). The uniqueness of the new program offering compared to other environmental engineering programs is in the framing of the subjects the students take that scaffold across years 1 to 4. For example, the 'Sustainable Engineering Fundamentals' is a first-year subject that inducts students into sustainability. In this subject, the curriculum introduced major environmental issues and ecological principles are usually taught in environmental science programs, rather than engineering. In the second year, students will undertake a subject called 'Climate Science'. This brand-new unit, not typically included in environmental engineering, that will help students understand the science of climate and the impact of climate on flora, fauna, water systems, ecosystems, agriculture/energy industry. Students build on this in their fourth (final) year when they take 'Climate Smart Engineering' that addresses the emerging challenges of climate and adaptation through resilience.

One of the highlights of the new program is that it incorporates the SDGs more directly. Some of the subjects such as, Smart and Liveable Cities and Climate Smart Engineering directly reflect the SDG 11 (Sustainable Cities and Communities) and 13 (Climate Action), respectively. These subjects are unique to the Sustainability Engineering program at WSU. Besides, the program directly or indirectly incorporates SDGs 2, 6, 7, 9, 12, 14 and 15. This confirms to the ACED, 2021 vision of aligning the undergraduate engineering curriculum to the UN SDGs (ACED, 2021). It confirms to the ACED, 2021 vision of aligning the undergraduate engineering curriculum to the UN SDGs (ACED, 2021).

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9. Results – outputs and outcomes (250-350 words)
To the extent possible, please reply to the questions below:
i) How was the practice identified as transformative? (e.g., impact on policies, impact on management processes, impact on delivery arrangements or education monitoring, impact on teachers, learners and beneficiary communities etc.);
ii) What were the concrete results achieved with regard to outputs and outcomes?
iii) Has an assessment of the practice been carried out? If yes, what were the results? *

Environmental engineers design systems and solutions are at the interface between humans and the environment. Traditionally, environmental engineers are trained to focus on issues, but this has gradually it shifted to encompassing the ecological principles. This new program however goes a step further to transform the field of environmental engineering. It encompasses discipline-depth combined with the inclusion of climate science, digital transformations, and social factors, all underpinned by the SDGs. It addresses the changes in our world and equips WSU students and graduates with the capabilities and knowledge to address them systematically. It is a magnet for knowledge, talent, creativity, high-value employment, and further investment. As envisaged by ACED (Reidsema, Cameron & Hadgraft, 2021), independent and systems thinking need to be incorporated in the undergraduate program, which has been achieved through the inclusion of subjects such as Sustainable Engineering Fundamentals and Sustainable Systems Design.

Further, it provides strong industry and community engagement and maintains curriculum pathways that encourages more diverse student cohorts. Subjects such as Climate Science and Planning the City: Development, Community and Systems will help to attract student cohorts from various backgrounds outside of engineering to give the students a multi- or transdisciplinary view of the field. There will be a strong industry collaboration in the delivery of the subjects such as Waste Engineering, Water Supply Systems Design, Wastewater System Design, Smart and Liveable Cities- utilizing 'Partnership Pedagogy' to co-design and co-deliver curriculum. Overall, the proposed program incorporates some of the essential elements suggested in Engineering Futures 2035 Project report (Reidsema, Cameron & Hadgraft, 2021), MIT report (Graham, 2018), UN SDGs and latest developments in communication technologies. Hence, the program is both futuristic and visionary.

10. Lessons learnt (300 words)
    To the extent possible, please reply to the following questions:
    i) What were the key triggers for transformation?
    ii) What worked really well – what facilitated this?
    iii) What did not work – why did it not work? *

Feeling that the current program offerings in Australia were lacking in the field of Sustainable Engineering, this group of academics wanted to future proof our graduates and equip students with the foundations to take on the world's grand challenges in a holistic and systemic way. The design of the new program needed to be drafted to fit the existing university 4-year undergraduate structure and remain in line with Engineers Australia Stage 1 Competencies for professional engineers (Engineers Australia, 2019) as an accredited course. Once the key considerations were identified, a draft curriculum went through several iterations with the input from all parties involved, until an ideal program structure was developed. The participating panel members included experts in the fields of Agriculture, Electrical Engineering, Civil Engineering, Materials Engineering, Solar Engineering, Water Resources Engineering and Computer Sciences. There were some challenges with this approach, whereby the lead academics had to champion the idea of an interdisciplinary design for the new program, opposed to the standard silo design currently within Engineering.

The university's commitment to the SDGs and its focus on Education for Sustainability supported this transformation as well. Western Sydney University has acknowledged the responsibility through our teaching and learning to equip the next generation of leaders, innovators and thinkers to understand the global challenges facing the world and the role they can play in rising to meet these challenges. In becoming an educational signatory to the SDSN Australia, New Zealand and Pacific Initiative in 2017, WSU is committed to support and promote the principles of the SDGs through our teaching, research, campus operations and outreach. Our curriculum work is aligned with SDG 4.7: "By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development..." (United Nations, 2016).

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11. Conclusions (250 words)
Please describe why may this intervention be considered a “best practice”. What recommendations can be made for those intending to adopt the documented “best practice” or how can it help people working on the same issue(s)? *

This program reimagining the field of Sustainable Engineering. The new undergraduate offering differs greatly from traditional environmental engineering programs currently available and addresses the key global challenges of the 21st century. It is expected that this program, once opened to student enrolment, will provide necessary foundations for knowledge and skills for future engineers to be holistic thinkers who can analyse and solve a problem from multiple perspectives. It is proposed that engineering undergraduate course incorporate essential elements of this program – having discipline-depth combined with the inclusion of climate science, digital transformations and literacies, and social factors. It is recommended leveraging the suggestions in Engineering Futures 2035 report - such as strong links with industry and community; making the program attractive to diverse student cohorts; and directly addressing UN SDGs – be considered is a key part of the transformation of engineering curriculum for the future.

This case study has been adapted from the original publication presented at the inaugural ‘Climate Smart Engineering’ Conference in November 2021 and the original is owned by the Institution of Engineers (ISBN No: 978-1-925627-55-8)

12. Further reading
Please provide a list and URLs of key reference documents for additional information on the “best practice” for those who may be interested in knowing how the results benefited the beneficiary group/s. *

Not yet available - (ISBN No: 978-1-925627-55-8)