33rd Annual Conference of the Australasian Association for Engineering Education (AAEE 2022)
4 - 7 December 2022 – Sydney, NSW

Exploring a tertiary civil engineering curriculum program to envision engineering education for sustainability (EEfS)

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ABSTRACT

CONTEXT

In recent decades, engineering curricula have undergone various changes in response to initiatives that seek to ensure engineering education addresses sustainable development (SD) aims and, more recently, sustainable development goals (SDGs). These changes are widely described in a growing body of literature, including case studies. However, while previous case studies have mainly been limited to documenting changes in course maps, this research focuses on the purpose of these changes not only in the explicit curriculum but also in the implicit curriculum.

PURPOSE OR GOAL

This study explores how sustainability has been approached in a tertiary civil engineering curriculum by evaluating educational features and responses in relation to a sustainability education model presented by Sterling (2015). Sterling describes three progressive response levels (i.e., consistent with *education about, for, and as SD*). These levels seek to differentiate and explain learning stages and features experienced by individuals in a specific system transformed towards sustainability. In brief, this research explores diverse forms of data in a civil engineering curriculum and analyses the presence and absence of evidence for each learning stage.

APPROACH OR METHODOLOGY/METHODS

The research is part of a doctoral thesis that develops an instrumental/exploratory case study undertaken at a Group of Eight Australian University. It involves a literature review and semi-structured interviews with fourth/fifth-year students and educators of the units that claimed to address sustainability as part of the accreditation system in the tertiary civil engineering curriculum. Data was collected in mid-late 2021 and was analysed using realist synthesis.

ACTUAL OR ANTICIPATED OUTCOMES

The research shows how engineering curricula have been transformed to contribute to sustainability in general terms and in the case study. Mechanisms for each learning stage are described and examined. We also highlight insights about interventions that could be useful to foster higher and deeper levels of learning when approaching sustainability in engineering.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

Findings from this research reveal a serious commitment of the case study engineering faculty to embedding sustainability into the civil engineering curriculum. Recommendations for educational providers, policymakers and practitioners are discussed to propose visions for the future of engineering education for sustainability, building on what has been done in the last few years.

KEYWORDS

Engineering education, environmental and sustainability education, sustainability.

Background

The volume, diversity, and breadth of research about engineering education for sustainability (EEfS) in universities have increased rapidly in recent decades (Gutierrez-Bucheli, Kidman, et al., 2022). Engineering curricula have undergone various changes in response to initiatives that seek to ensure engineering education addresses sustainable development (SD) aims and, more recently, sustainable development goals (SDGs). These changes are widely described in a growing body of literature, including case studies. For instance, Lamere et al. (2021, p. 1) have reported a "mapping exercise of the undergraduate mechanical/automotive engineering curriculum" at the University of the West of England, followed by curriculum redesign strategies to ensure that students are equipped with sustainability skills and competencies. Likewise, Gómez-Martín et al. (2021) have reviewed unit handbooks of the civil engineering curriculum at Universitat Politècnica de València (Spain) to find which units aligned more with SDGs principles, proposing teaching and learning actions. In the Australian context, Arefin et al. (2021) have reviewed articles and university websites to evaluate the incorporation of sustainability in the engineering curricula. Nevertheless, while previous case studies have mainly been limited to documenting changes in course maps, this research focuses on the purpose of these changes not only in the explicit curriculum but also in the implicit curriculum.

This research develops an instrumental/exploratory case study at a leading research-intensive Australian University. It analyses educators' and students' experiences and views in the explicit and implicit curriculum to explore how sustainability has been approached in engineering education. By taking the levels of response and learning proposed by Sterling (2003; 2015) that represent the learning stages experienced by individuals and/or students and the level of adoption in educational institutions towards sustainability, this research explores diverse forms of data in a tertiary civil engineering curriculum analysing the presence and absence of evidence for each learning stage.

Theoretical lenses

Sterling (2015, p. 57) categorised educational responses to sustainability in three levels: "from accommodation through reformation to transformation" (consistent with *education about, for, and as sustainability*–see Figure 1). He uses the same three levels also to describe individual learning stages. The lowest or most basic stage (*education about sustainability*) aims to prepare students for their future professional live with specific knowledge and skills (i.e., cognitive (Granados-Sánchez, 2022)). It demands the least effort within the system because it stays stable with no drastic changes (Sterling, 2003), such as covering new sustainability concepts in current units. According to Sterling, this stage adopts quantitative outcomes and control measurements to frame curriculum renewals.

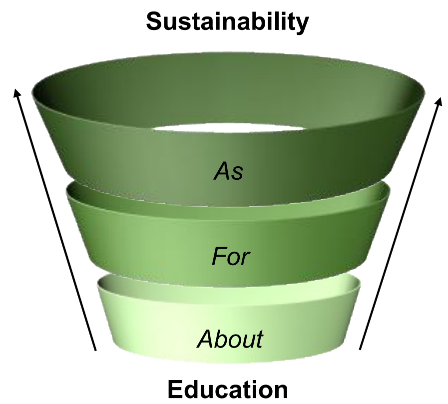

Figure 1: Sterling's (2003; 2015) framework.

In contrast, *education for sustainability* promotes students' engagement under social regulations (i.e., cooperative learning (Granados-Sánchez, 2022)). Therefore, while the system experiences a significant change, especially to promote social learning, students start to learn from metacognition. That is, they become more aware of their own learning processes and more active in the learning activities (Sterling, 2003).

Finally, the highest level, *education as sustainability*, exposes learning as transformative. It is where students and educators question assumptions and create new principles, values, and beliefs working with others. This highest level demands two-fold requirements for the individual and the institutions. First, the individual/student should experience "learning sustainability from creating, experiencing and living it" (Granados-Sánchez, 2022, p. 15). Second, the system is rebuilt or redesigned to boost an education paradigm change (Sterling, 2003).

Research design

This research has been framed as an instrumental/exploratory case study aligned with the research question and aim. The purpose of the case study is to analyse the data beyond the case to understand a broader problem (Stake, 2005). In other words, the case study has been undertaken at a Group of Eight Australian University to provide insight into how sustainability has been approached in tertiary engineering programs. This university, particularly its tertiary civil engineering curriculum, has been selected as one of the largest research-intensive universities in Australia. It has adopted changes into the curriculum towards sustainability since 2015, following recommendations of Engineers Australia (i.e., Stage 1 competency standards (Engineers Australia, n.d.)). Based on the accreditation system, approximately 30% of the units in the civil engineering program have sustainability content (percentage calculated based on the compulsory units, without considering minor and technical elective units).

Evidence from this case study then helps examine the problem using different participants' accounts, recognising that learning experiences and mechanisms are enclosed in complex social situations (Kyburz-Graber, 2016). To do this, we conducted semi-structured interviews with educators of the units that claimed to address sustainability as part of the accreditation system in the tertiary civil engineering curriculum and fourth/last year civil engineering students. While educators were contacted by email, students were recruited by email, through an announcement in the learning management system, or by referral sampling. All interviews were conducted by Laura (PhD student) on zoom because of COVID restrictions during that time in Australia. It is worth noting that ethical approval for this research was obtained through the University Human Research Ethics Committee. Participants' names have been changed to maintain confidentiality. The data associated with this research could be requested from the lead author.

Five educators from four units accepted to participate in the research (see Table 1). Educators' interviews lasted about 45 mins to 1 hr 5 mins. Educators' interview protocol was designed to analyse their personal understanding of sustainability, expected learning outcomes, teaching and learning activities, and their interactions with students.

Table 1: Educators' profile.

Educators Name	Position	Time working at university (years)	Unit Discipline/Type
Penelope	Associate Professor	7	Capstone unit
Billy	Lecturer	4	Water engineering
Nicholas	Senior Lecturer	3,5	Transport engineering
Michael	Associate Professor	4	Construction engineering
Oliver	Associate Professor	0,5	Capstone unit

In contrast, ten students participated in the research (see Table 2). These interviews lasted about 30 mins to 50 mins. Students' interview protocol was designed to document their personal understanding of sustainability, their previous learning concerning sustainability, learning experiences, and interactions in the units.

Table 2: Students' profile.

Student name	Study year	Enrolment	Double program
Sarah	5	Domestic	Commerce
Tiffany	4	International	
Otis	5	Domestic	Science, Geology
Claire	4	Domestic	Commerce
Chloe	5	Domestic	Architecture
Santiago	4	Domestic	Commerce
Scott	4	Domestic	
Dylan	5	Domestic	
Mike	5	Domestic	Commerce
Caroline	4	Domestic	

In line with the case study's purpose, we have decided to use realist synthesis as an analytic method (Pawson et al., 2005). Realist synthesis is commonly implemented to explore dynamic complex social interventions finding out "what works for whom, in what circumstances, in what respects and how" (Pawson et al., 2005, p. 1). Thus, the idea is to determine how interventions work in particular contextual settings by identifying causal relationships between three different variables: Context (C), Mechanism (M), and Outcome (O) (Gutierrez-Bucheli, Reid, et al., 2022; Rycroft-Malone et al., 2012). Then, CMO configurations are distinguished to nourish a theory about how something should (is) work(ing) (Rycroft-Malone et al., 2012). In this case study, we initially selected the framework provided by Sterling (2015) to see how interventions in EEfS have been implemented to determine what enablers (or barriers) make them work (or not).

Results

This section is divided into three sub-sections that present features found in the evidence to describe each learning stage based on CMO configurations (Table 3).

Table 3: CMO configurations according to each response level/learning stage

Response level / learning stages	Context (C)	Mechanisms (M)	Outcomes (O)	Enablers	Barriers
Education *about* SD	Technical and design units Laboratories External seminars High supervision	Educator-led activities Understanding industry case studies Introduction to standards and certifications Visualisation software	Technical and theoretical knowledge Technical and qualitative thinking Problem-solving	Accreditation Content contextualised in practice Students' previous research experience	Few opportunities for application Explicit/implicit connection between sustainability and engineering content

Response level / learning stages	Context (C)	Mechanisms (M)	Outcomes (O)	Enablers	Barriers
Education *for* SD	Design and capstone units Multidisciplinary environments Extracurricular activities High student-student interactions	Active student participation Unit or real-life projects Role-playing projects	Systematic thinking Decision-making Collaboration skills Communication skills Negotiation skills Multi-perspective thinking Cultural perspective	Collaboration with different stakeholders Real-life environments	Low freedom and autonomy
Education *as* SD	Capstone unit Interdisciplinary environments Extracurricular activities Personal contexts	Conceptual design projects Real-life projects Student-led initiatives Discussions	Emotional intelligence Self-motivation Values and beliefs Awareness	Creativity Problem-definition Unknown and undetermined solutions	Few learning opportunities

Education about SD

CMO configurations in this stage highlight the importance of introducing students to sustainability-related technical and theoretical content (see Table 3). In most units, this context was included as a response to accreditation requirements aligned with specific learning outcomes (i.e., knowledge or competencies). Initially, educators introduce theories, techniques, or tools (e.g., resource recovery from wastewater, life-cycle analysis, or structural design in wood) related to sustainability that can be implemented in an engineering solution (commonly developed in higher learning stages). In some units, this content also includes standards or certifications implemented in the industry to ensure that projects follow sustainable principles (e.g., Green Star).

Educators define and guide learning activities from a theoretical and technical background, generally framed as calculation-based problems with specific solutions. Although there are no real-life or complex applications to engineering projects in this stage, other learning activities, such as laboratories or external seminars (e.g., Engineers Australia workshops or laboratories), could be promoted to incorporate new sustainability-related content.

The introduction of additional sustainability-related content also demands contextualisation in the industry context. This contextualisation is required to communicate how things are done in the industry and prepare students for future professional experiences. For instance, students pointed out that field trips and virtual tours allowed them to understand the applicability of sustainability principles in real-life case studies. In cases where these learning activities are hard to promote, guest lectures with industry experts become an excellent opportunity to share industry examples and initiatives. Educators and students suggested that guest lecturers complement traditional lecturers by providing real-life feedback and introducing actual industry facts.

Some barriers were also identified as part of this stage. While educators described a comprehensive list of topics as part of the sustainability-related content introduced in this stage, students still perceive that the sustainability load as part of each unit is low compared with the discipline-related content. Students believe sustainability is only incorporated in one or two weeks without integration with the rest of the content. This difference of views occurs because there is no explicit connection between the sustainability-related and discipline-related content. For instance, one educator explained how important it is to design high-quality pavements to reduce the likelihood of accidents and enhance public safety. In addition, the educator described why this was important in sustainability to foster a social perspective in engineering projects. Nevertheless, no evidence confirmed that students connect quality/safety principles with sustainability. Thus, findings suggest that educators should introduce discipline-related content explicitly connecting with sustainability principles.

Education for SD

In this stage, CMO configurations show how students are introduced into real-life environments where they have the opportunity to implement and apply what has been learned in the previous stage (see Table 3). Learning activities commonly promoted at this level relate to unit projects or capstone units, characterised by more complex interactions and broader scope. As a result, learning activities rely exclusively on student-student interactions to promote a collaborative environment. Besides these types of interactions, students described how valuable it was to work with other stakeholders, such as real clients or technical mentors, to enhance their discipline-based knowledge and incorporate different perspectives in their engineering designs.

Additionally, students must consider different streams and contextual constraints to frame sustainable engineering designs rather than acquire knowledge from a specific civil engineering stream (e.g., transport, structural, water resources, etc.). These constraints are commonly oriented to sustainability and framed under different sustainable goals. For instance, educators explained how students should use systematic thinking to evaluate different trade-offs when developing unit projects incorporating not only an efficiency mindset but also thinking of public safety and environmental constraints. This implies that students foster their multi-perspective thinking, decision-making and negotiation skills to determine what aspects will be considered in sustainable engineering design.

In addition to the learning activities as part of the explicit curriculum described above, some students describe how extracurricular activities allowed them to understand the importance of designing sustainable engineering solutions according to specific contextual and cultural settings. For example, one student recognised that she realised that sustainable engineering solutions should be culturally appropriate thanks to the experience acquired in a case study developed with Engineers without Borders. She also mentioned that when developing a project, she had to think about the technical design and how a solution would be implemented and used by the community and users. This experience recovered the cultural perspective required in sustainable engineering.

While this stage engages students in real-life environments generating unprecedented learning outcomes, educators and students agreed with some barriers presented. Educators mentioned that the sustainable solutions developed in unit or capstone projects are weak and vacuous. This occurs because students should define sustainable strategies (e.g., water recycling systems or solar panels) as part of a project once the technical aspects are defined. For instance, the capstone unit is divided into conceptual and technical design. Yet, students noted that it is in the technical design that they should define the sustainability strategies involved in the project. Likewise, the nature of these strategies is not conditionate to specific project characteristics; instead, students promote 'green' strategies that would work for any engineering project.

Education as SD

CMO configurations in the highest stage emphasise the relevance of empowering students to lead the learning activities as they become more autonomous and define the scope of the learning outcomes achieved in this stage. While the nature of the learning activities in this stage is quite similar to the previous one, students have more freedom to decide which types of sustainable solutions they will develop as part of unit and capstone projects. The difference, therefore, is related to the student's autonomy. Although it is up to each student to put more effort into reaching this stage, educators are responsible for facilitating the transition. For instance, what is particularly noticeable in this stage is that students are not pushed to develop specific sustainable strategies/solutions; instead, educators encourage students to create unknown and undetermined solutions by critically evaluating particular project characteristics. In most circumstances, this implies learning activities that involve problem-definition analysis, where students must deeply understand the challenges that sustainable solutions aim to address. To illustrate, educators and students have described the conceptual design developed as part of the capstone unit as critical because it demands that students evaluate stakeholders and community needs to define engineering strategies. Nevertheless, as we have argued earlier, this scope of the conceptual design has typically oriented towards a discipline-technical approach rather than a sustainability approach.

Additionally, the types of interactions commonly involved in this stage are more complex and substantial. Students are required to interact not only with students from the same discipline but also work collaboratively with students from other engineering backgrounds or disciplines (i.e., environmental engineering, architecture, commerce, etc.). Educators and students described the value of these interdisciplinary interactions because students are immersed in deeper relationships where they share views and perceptions with others, who bring different expertise when developing the projects. For instance, units with enrolled students from various disciplines generate diverse and unconventional learning spaces where new ideas arise.

Key learning outcomes are achieved when civil engineering students must collaborate with environmental students in the capstone unit to develop sustainable engineering solutions. On the one hand, educators mentioned that environmental students started to recognise that working in sustainable engineering projects requires influence and connection with others (in this case, civil engineering students). On the other hand, civil engineering students mentioned that they have learned from others' expertise, enhancing their sustainability understanding. These interdisciplinary interactions generate that students start to construct their own meaning of sustainability, framing values and beliefs.

Despite the enormous learning outcomes achieved in this stage, evidence suggests that few learning activities are presented in the curriculum to foster these mechanisms. This lack indeed occurs because this stage demands more students' freedom. As a result, educators have less control over learning outcomes.

Discussion: Enablers and visions for the future of EEfS

The previous section explained how each learning stage has involved educational mechanisms influenced by particular contextual settings to achieve specific learning outcomes. Simultaneously, it was possible to establish enablers and barriers for each stage by identifying CMO configurations (see Table 3). Using data from each CMO configuration, this section discusses visions for future steps in EEfS, building on our theoretical framework (Sterling, 2003) and on what has been done in the field in the last few years.

Our findings corroborate previous claims by UNESCO and ICEE (2021), which have said that engineers would require a different set of competencies and skills to address sustainability challenges and, consequently, achieve the SDGs. This, of course, increases the complexity of curriculum development, realignment and/or renewal towards EEfS. While the future panorama of EEfS looks complex, uncertain, and challenging, we have identified some enablers presented in Figure 2 that would help EEfS become meaningful, resilient, and transformative.

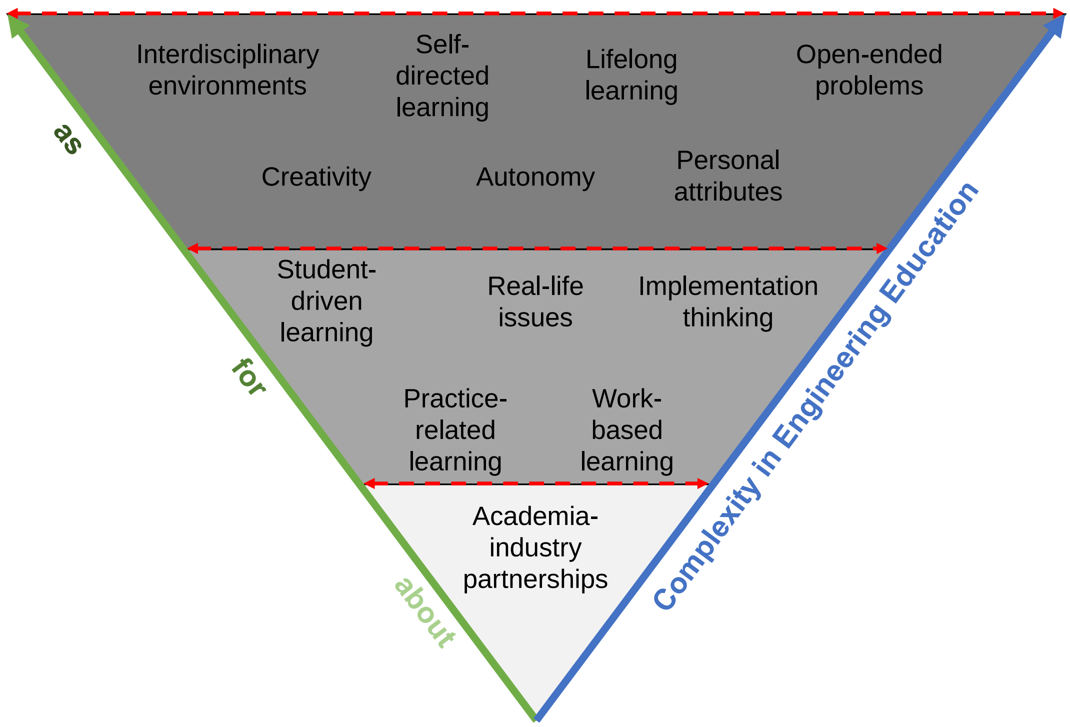

Figure 2: Visions for Engineering Education for Sustainability

Findings from the first learning stage (i.e., education about sustainability) reveal the importance of contextualising sustainability-related context from an industrial and practical perspective. The theoretical and technical content aligned with sustainability and introduced in engineering units should go beyond traditional lectures. Students appreciate and value that educators use industry-based examples or promote learning activities (e.g., field trips or virtual tours) where they have chances to see what the industry is doing concerning sustainability. This contextualisation is in good agreement with suggestions provided by Burnett et al. (2021). They have noted that engineering education must balance theory and practice to prepare engineering students for real-world complexities.

Therefore, future steps in EEfS should ensure that students are equipped with the necessary technical skills consistent with current trends in the industry (UNESCO & ICEE, 2021). For this, it is vital to consolidate partnerships between the industry and academia. Besides incorporating guest lectures, EEfS must engage industry and community in learning activities. For instance, the case study shows that having industry mentors in the teaching staff team brings enormous learning benefits to introducing students to real-life experiences. Similarly, the academia-industry partnerships could also be used in unit projects to build real-life issues where students have the opportunity to interact with other stakeholders (see e.g., Lockrey & Bissett Johnson, 2013). Students must evaluate different constraints as part of sustainable solutions from these interactions.

Results also demonstrate that students could benefit from learning activities based on practice-related learning or work-based learning to enhance professional knowledge and skills. While students value new sustainability-related content, it was also noticed that few students could connect this content with engineering practice. This disconnection is even more significant if educators do not have enough professional experience. To tackle this, UNESCO and ICEE (2021) have suggested that incorporating mechanisms of practice-related learning or work-based learning into the engineering curricula would help prepare students with appropriate job-related skills required to address sustainability challenges. Although we agree with this, we also believe that accreditation requirements should be constantly updated based on sustainability and industry demands to foster changes in EEfS faster and collectively (see Burnett et al., 2021).

Our study provides further evidence for promoting student-driven learning activities in EEfS. The second and third stages prove that student-led mechanisms like self-directed learning are critical to recovering students' autonomy and creativity (Gutierrez-Bucheli, Kidman, et al., 2022). As we have argued previously, student-led mechanisms require that students establish their own learning goals and plans. So it is, therefore, when students will build lifelong learning depending on what they want to do and achieve. However, educators should facilitate the process by giving opportunities to students to develop open-ended problems. Open-ended problems demand interdisciplinary interactions and active learning (UNESCO & ICEE, 2021), where students foster systematic thinking to create unknown and undetermined solutions. It is worth noting that while these learning activities would promote more students' freedom, learning outcomes would not be able to be measured or controlled.

Conclusions

This research has presented a case study at a leading research-intensive Australian University to explore how sustainability has been approached in engineering education. Using different participants' views, this research has analysed the presence and absence of evidence for three learning stages towards sustainability. Findings can be summarised as follows. First, incorporating sustainability-related content into the engineering curriculum demands industry and practical contextualisation. Partnerships between the industry and academia should support this to bring more real-life feedback into the learning spaces. In addition, engineering curricula should foster more student-led learning activities where students have more opportunities for problem definition, problem solving, and problem management (implementation), prioritising sustainability thinking (Siller et al., 2016). Finally, engineering projects developed in EEfS learning activities should be characterised as open-ended. This would help to recover creative thinking in the engineering practice.

References

Arefin, M. A., Nabi, M. N., Sadeque, S., & Gudimetla, P. (2021). Incorporating sustainability in engineering curriculum: a study of the Australian universities. *International Journal of Sustainability in Higher Education*, 22(3), 576-598.

Burnett, I., Cameron, I., Crosthwaite, C., Foley, B., Goldfinch, T., Hadgraft, R., Hargreaves, D., King, R., Lamborn, J., Lawrence, R., Reidsema, C., Symes, M., & Wilson, J. (2021). Engineering change: The future of engineering education in Australia. http://ecite.utas.edu.au/144443

Engineers Australia. (n.d.). Stage 1 Competency Standard for Professional Engineer. Retrieved July 4, 2022, from https://www.engineersaustralia.org.au/sites/default/files/2019-11/Stage1_Competency_Standards.pdf

Gómez-Martín, M. E., Gimenez-Carbo, E., Andrés-Doménech, I., & Pellicer, E. (2021). Boosting the sustainable development goals in a civil engineering bachelor degree program. *International Journal of Sustainability in Higher Education*, 22(8), 125-145.

Granados-Sánchez, J. (2022). Levels of Transformation in Sustainable Curricula: The Case of Geography Education. *Sustainability*, 14(8), 4481.

Gutierrez-Bucheli, L., Kidman, G., & Reid, A. (2022). Sustainability in engineering education: A review of learning outcomes. *Journal of Cleaner Production*, 330, 129734.

Gutierrez-Bucheli, L., Reid, A., & Kidman, G. (2022). Scoping reviews: Their development and application in environmental and sustainable education research. *Environmental Education Research*, 1-29.

Kyburz-Graber, R. (2016). Case study research on higher education for sustainable development: epistemological foundation and quality challenges. In M. Barth, G. Michelsen, M.

Rieckmann, & I. Thomas (Ed.), *Routledge Handbook of Higher Education for Sustainable Development* (pp. 126-141). New York: Taylor & Francis Group.

Lamere, M., Brodie, L., Nyamaofene, A., Fogg-Rogers, L., & Bakthavatchaalama, V. (2021). *Mapping and Enhancing Sustainability Literacy and Competencies within an Undergraduate Engineering Curriculum.* Paper presented at the Research in Engineering Education Symposium & Australasian Association for Engineering Education Conference, Perth, WA.

Lockrey, S., & Bissett Johnson, K. (2013). Designing pedagogy with emerging sustainable technologies. *Journal of Cleaner Production*, 61, 70-79.

Pawson, R., Greenhalgh, T., Harvey, G., & Walshe, K. (2005). Realist review - a new method of systematic review designed for complex policy interventions. *Journal of Health Services Research & Policy*, 10(Suppl 1), 21-34.

Rycroft-Malone, J., McCormack, B., Hutchinson, A. M., Decorby, K., Bucknall, T. K., Kent, B., Schultz, A., Snelgrove-Clarke, E., Stetler, C. B., Titler, M., Wallin, L., & Wilson, V. (2012). Realist synthesis: illustrating the method for implementation research. *Implementation Science*, 7(1), 33.

Siller, T. J., Johnson, G. R., & Troxell, W. O. (2016). What Do Sustaining Life and Sustainable Engineering Have in Common? In W. Leal Filho and S. Nesbit (Ed.), *New Developments in Engineering Education for Sustainable Development* (pp. 273-282). Switzerland: Springer International Publishing.

Stake, R. (2005). *Multiple Case Study Analysis.* New York: Guilford Publications.

Sterling, S. (2003). *Whole systems thinking as a basis for paradigm change in education: explorations in the context of sustainability* University of Bath. Bath, England.

Sterling, S. R. (2015). *Sustainable education: re-visioning learning and change*. Totnes: Green Books for The Schumacher Society.

UNESCO, & ICEE. (2021). Engineering for sustainable development: delivering on the Sustainable Development Goals. Retrieved July 4, 2022, https://unesdoc.unesco.org/ark:/48223/pf0000375644.locale=en

Acknowledgements

This research is supported by an Australian Government Research Training Program (RTP) Scholarship. Special thanks to the Faculty of Education and Monash University for promoting transdisciplinary research toward sustainability. Additionally, the authors would like to extend their deepest gratitude to all participants who took part in this research.

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