Sustainability invisibility: moving beyond technical rationality

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Abstract

Education for Sustainable Development (ESD) is regarded as a key enabler for all the 17 Sustainable Development Goals. Higher Education Institutes have been slow in adopting a holistic approach to ESD in undergraduate engineering curricula. The aim of this research is to explore how tertiary subject coordinators understand and envision sustainability and how that subsequently manifests in their teaching curriculum design.

A qualitative inquiry approach was adopted to explore the rationalities of ten academics within the School of Civil and Environmental Engineering at an Australian university. In a previous study in the School, the researchers identified a low percentage of ESD integration across the curriculum. The interviews showed that these academics perceive sustainability as a technical concept, presumably taught by someone else in the curriculum. As a result, sustainability is mostly invisible within undergraduate engineering curricula.

Results elsewhere show that for ESD to be effectively implemented at a tertiary level, academics must come to understand and accept what ESD aims to achieve, which is to educate engineering students to encourage them to integrate sustainability decision making in their future engineering practice. Engineers Australia's Code of Ethics requires: *Balance the needs of the present with the needs of future generations*.

The difficulty is that these behaviours are difficult to detect in engineering curricula, which are strongly focused on technical problem solving. This research will identify and

disseminate good practice in curriculum design for sustainability at both unit level and program level. This paper represents an early part of the research program.

Conference Key Areas: Curriculum Development, Sustainable Development Goals in Engineering Education, Educational and Organizational Development

Keywords: Education for Sustainable Development, Qualitative Inquiry, Undergraduate Engineering Curriculum

INTRODUCTION

Education for Sustainable Development (ESD) is regarded as a key enabler and achiever for all the 17 Sustainable Development Goals (SDG) [1], [2]. Nevertheless, Higher Education Institutes (HEIs) have been slow in adopting a holistic and transformational approach to Education for Sustainable ESD [3, p.392-393], [4, p.341].

Results elsewhere show that for ESD to be effectively implemented at a tertiary level, academics must come to understand and accept what ESD aims to achieve, which is to educate engineering students to encourage them to integrate decision making for ESD in their future engineering practice [5], [6]. Additionally, Engineers Australia's Code of Ethics requires that professional engineers: *Balance the needs of the present with the needs of future generations* [7].

The difficulty is that these behaviours are difficult to detect in engineering curricula, which are strongly focused on technical problem solving. Indeed, in a previous stage of this project, the authors identified a low level of ESD integration across the curriculum in all engineering programs at this Australian university [8]. The low level of ESD in the curriculum and inconsistencies between claimed and achieved learning outcomes led us to question how subject co-ordinators understand sustainability and how that subsequently manifests in their teaching through curriculum design. In addressing this question, we focus on subject co-ordinators in the Civil and Environmental Engineering program.

1. BACKGROUND

In a previous study, an ESD assessment framework was established to analyse the engineering curriculum at an Australian university. The framework was developed through a meta-analysis, which identified twelve highly-cited articles recommending different sets of Education for Sustainable Development competencies. Individual competencies were given a frequency of occurrence. Similar competencies were grouped together under an overall competency. Finally, overall competencies were ranked according to the overall occurrence of each of the competencies. The resulting set of seven Education for Sustainability competencies is shown in Table 1. For more details on the framework and curriculum assessment process please see [8].

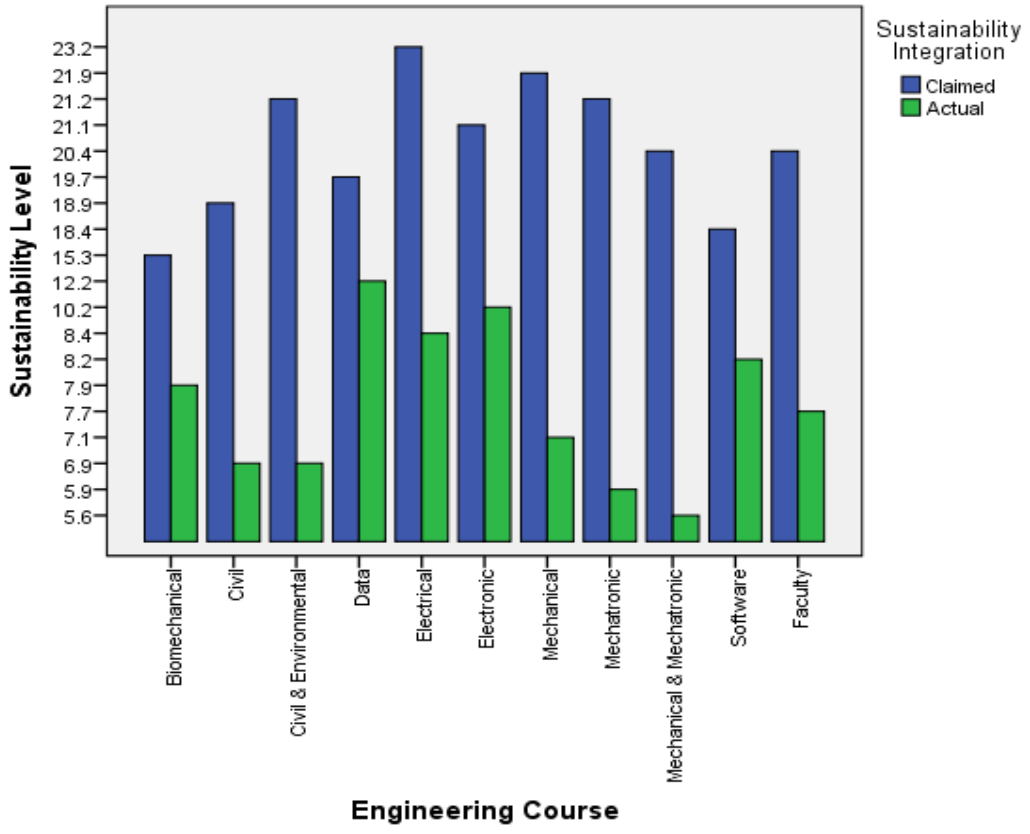
The set of seven ESD competencies complies with the holistic approach towards a sustainable education. It engages the head, heart and hands as recommended by [9]. Moreover, critical thinking was incorporated into each of the seven collective competencies within the set. Brown and Keely [10, p.3] state that: '*Critical thinking consists of an awareness of a set of interrelated critical questions, plus the ability and willingness to ask and answer them at appropriate times'.* Subsequently, critical thinking is essential to any type of thinking or acting [11] [12]. The set of seven competencies incorporating critical thinking was then used in a framework.

The framework was used as a tool in a document analysis of subject outlines to investigate where ESD was integrated into the curriculum of engineering programs. An initial assessment of the engineering curriculum showed that ESD learning outcomes made up around 25% of the overall claimed course learning outcomes. A more detailed evaluation showed that ESD related learning outcomes were included in subject assessment task criteria in only a third of the claimed outcomes within the curriculum. Figure 1 illustrates both claimed and actual sustainability integration. The low level of sustainability related learning outcomes and the differences between claimed and actual sustainability learning outcomes led us to wonder how subject co-ordinators thought about sustainability and hence to the study reported in this paper.

Table 1. Sustainability of 7 learning outcomes incorporating critical thinking

Competency	**Overall Frequency**
Change management and Envisioning a better future	18
Value-based thinking, self-awareness and global responsibility	18
Complexity & Systems thinking (TBL)	17
Stakeholder Engagement & Collaboration	16
Life-long learning and continuous reflection	13
Lifecycle Analysis	12
Decision making for sustainability in an interdisciplinary setting	11

Figure 1. Engineering Courses percentage of sustainability evident in the curriculum



2. DATA COLLECTION

The undergraduate Civil and Environmental Engineering program was the focus of the study reported in this paper. This program offers 32 subjects which are coordinated by 24 academics. Of these 24 academics, 10 agreed to be interviewed for this study. Participating in this research was voluntary and the authors acknowledge that this means that participants are likely to be those subject co-ordinators who are interested in the research since the interview was expected to take up to one hour. Given their busy schedules this could be a major consideration for the subject co-ordinators who chose to opt out.

Consequently the authors were sensitive to the risk of bias and considered this in the analysis of interview transcripts. Participants were categorised into four groups according to the claimed and achieved sustainability in their subjects, based on the results of the previous analysis referred to in the Background section [8]. This included content analysis of Subject Outlines associated with each subject coordinator's subject to determine whether they were claiming and achieving ESD learning outcomes or not. The four groups are listed in Table 2 below:

Table 2. Group numbers and description based on ESD outcomes

Group	Description
1	Subjects that claimed and achieved at least one ESD learning outcome
2	Subjects that did not claim but achieved at least one ESD learning outcome
3	Subjects that claimed but did not achieve any ESD learning outcomes
4	Subjects that did not claim and did not achieve any ESD learning outcomes

In the Civil and Environmental Engineering program, subject coordinators were categorised according to which group they belonged to. As a result;

3 subject co-ordinators were categorised in group 1, another 3 in group 2, 12 were in group 3 and 6 were in group 4. It is worth noting that some subject co-ordinators co-ordinate more than one subject within the school. However, their subjects did not belong to more than one of the four groups. This emphasised consistencies between subject co-ordinators' perceptions and ESD integration within their subjects. Keeping in mind the diverse subject-Coordinator groups, the researchers carefully designed an interview protocol.

The interview protocol included open-ended questions to allow for a wide exploration of participants' attitudes towards the inclusion of sustainability related learning outcomes. The advantage of such questions is that they lead researchers in new directions. Some of these outcomes will be highlighted at a later stage of this research. All subject-coordinator interviews were recorded and the audio files were transcribed so that the text could be used for analysis.

3. DATA ANALYSIS

A qualitative inquiry approach was adopted to analyse the collected data. This approach is defined by [13] as *"a research process that uses inductive data analysis to learn about the meaning that participants hold about a problem or issue, by identifying patterns or themes".* The authors then triangulated the analysed data from

the interviews with the overarching group the participants belonged to. Participant groups were highlighted in Table 2.

In this preliminary analysis we focus on participants' responses to the following two questions and triangulate the data with existing subject-coordinator groups:

Question 1: Do you think that the engineering curriculum sufficiently covers sustainability?
Question 2: Can sustainability education be applied to your subject?

Several themes were highlighted through the analysis and triangulation of the subject-coordinators' interviews.

Analysing **Question 1** of the academic interviews led to the following themes:

There was an overwhelming consensus amongst participants (8 out of 10), that belonged to groups 1, 2, 3 and 4 that sustainability is not adequately integrated into the Civil and Environmental Engineering program:

Personally, no; I think as a whole, everyone has a slightly different definition of sustainability. Often it comes down to people thinking about the environment, but it's a lot broader than that now. (Academic 1)

I believe we're still lacking. That's my belief. I'm not sure how much of the fact is there. (Academic 2)

Honestly, no, at the moment. Honestly. We should work on that, and I would say I'm very fan of that part, really (Academic 7)

One of the Two subject co-ordinators in both groups 3 & 4 i.e. subjects that do not achieve ESD learning outcomes, responded that they did not have the expertise to make the judgement:

I don't know. I know my subject covers this topic but I'm not sure others because I think most of the other subjects - so the coordinator defines sustainability in different ways. Yeah, so for me it's quite a technical term so I defined based on the content in what I teach, so like that (Academic 8)

I'm not in the field of sustainability directly - it's not my expertise. (Academic 10)

Overall, it is worth noting that all six subject co-ordinators that coordinated subjects which achieved at least one ESD learning outcome (Groups 1 & 2) agreed that the engineering curriculum does not sufficiently cover sustainability. In Contrast, a similar consensus could not be achieved in Groups 3 & 4.

Analysing **Question 2** of the academic interviews led to the following themes:

Group 1: Three participants co-ordinate subjects that both claim and achieve ESD outcomes. These academics were able to describe how sustainability is manifested in their subjects with responses varying from:

Sustainability is built within the design of the subject. (Academic 3); to

Students are actually assessed with their projects with a sustainability lens. (Academic 1).

Although traces of sustainability were found in all three subjects, only one subject provided a strong holistic focus on sustainability.

Group 2: Three participants co-ordinate subjects that do not claim sustainability related learning outcomes but achieve aspects of them in the criteria used in assessment tasks. In their responses these subject co-ordinators claimed that either they were not interested in implementing it:

So, although I might have elements of that - of those in there, that was not my intent (Academic 5);

or faced resistance from students:

I constantly try and embed it but there are so many challenges. My challenge is more so about convincing the students that this is something they need. That's where I get stuck. (Academic 4).

Group 3: Two participants co-ordinate subjects that claim sustainability related learning outcomes but did not assess students on the related skills. One of these subject co-ordinators demonstrated a flawed understanding of sustainability by limiting it to consideration of environmental issues:

Sure, sure. Both of them, closely. Both of my subjects closely involved with the environment. (Academic 7);

While the other claimed to be integrating sustainability in their subject because they taught “advanced technologies” (Academic 8).

Group 4: The two participants that did not claim sustainability learning outcomes nor did their subjects achieve them perceived that education for sustainability should be implemented in other contexts.

Not the subject. It’s part of the design thread (Academic 9).

When it comes to being able to resist environmental aspect, then it comes down to maybe material science (Academic 10).

4. DISCUSSION

All subject co-ordinators from Groups 1 and 2 participated in this study. This points to an interest in sustainability and Engineering Education for Sustainability Development within Groups 1 & 2. On the other hand, Groups 3 and 4 had the lowest participation rate amongst academics. 2 academics out of 12 (Group 3) and 2 out of 6 (Group 4) were involved in the interview process. Overall, 4 out of 18 participants had no sustainability integration within their subjects (group 3 & 4). These results emphasise the diversity in academic perceptions towards sustainability. For any future interventions within the School of Civil and Environmental Engineering to be successful, there is an undeniable need to take into consideration the wide range of ESD perceptions held amongst subject-coordinators. This finding re-emphasises the same concepts discussed by Barth and Rieckmann [6].

Combining Group 1 & 2 answers, we can see that participants are equipped with the appropriate sustainability perceptions. However, these perceptions do not necessarily lead to deliberate sustainability integration within the curriculum. Moreover, the holistic approach to integrating sustainability within curriculum is only visible in one of the undergraduate engineering subjects. An institutional ESD intervention within the two Groups (1 & 2) could build on existing sustainability perceptions to promote a holistic approach in Engineering ESD. This concept is discussed within literature; Sipos, Battisti and Grimm [9] argue that for ESD to succeed it must be transformative whilst adopting a holistic approach.

Combining groups 3 & 4 answers, we may say that sustainability is missing as it is either being envisioned as a technical aspect commonly mistaken for environmental considerations or assumed as being addressed by someone else leaving room to emphasise technical considerations.

4.1 Engineering Technicality

25 out of the 32 subjects which belong to groups 3 & 4 did not cover sustainability. It was argued by academics that these subjects cover “technical” aspects of Civil and Environmental Engineering. This concept emphasises the overwhelming subjective approaches to current engineering education [14]. In most cases, these approaches remove the social and environmental aspects of engineering problems.

Social and environmental aspects make up two of the three pillars of sustainability. Without considering the social and environmental aspects of engineering problems fails sustainability education generally and the goals sustainability education sets out to achieve. As a result of the dominant technical rationality within the undergraduate engineering academics, the civil and environmental engineering curriculum lacks Education for sustainable development integration.

5. CONCLUSION

The interviews showed that the vast majority of academics perceive sustainability as a technical concept, presumably taught by someone else in the curriculum. As a result, sustainability is mostly invisible within this undergraduate engineering program. Academics that implement sustainability within undergraduate engineering curricula do not necessarily adopt a holistic approach. Curriculum assessment results showed that a holistic approach to ESD was adopted in only 1 out of 32 subjects.

Academic views varied on Education for Sustainable Development. However, general consensus was achieved around one question. Eight out of ten participants agreed that the current engineering curriculum within the Australian university does not sufficiently cover sustainability. This consensus can be used as a conversation starter for curriculum change towards ESD within the program.

Finally, for a tertiary engineering ESD intervention to be successful, it needs to take into account the wide range of academic perceptions. A major hurdle to overcome lies within current academic perceptions of sustainability. For adequate ESD integration within the engineering curriculum academics must move beyond technical rationality.

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