Institutional Practices Versus Student Needs and Its Implications for the Development of a Holistic Engineering Education for Sustainable Development (EESD) Framework

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Abstract

Sustainable development (SD) competences feature prominently in the 2012 Malaysian Engineering Accreditation Council (EAC) manual. The manual outlines 12 outcomes that undergraduate engineering students of Malaysian universities are expected to develop upon completion of their studies. These 12 outcomes, specifically those in relation to SD competences, are open for interpretation, in accordance to the vision, mission and educational philosophies of the respective universities and undergraduate engineering programmes. This paper highlights a Malaysian private engineering university's endeavours to include SD competences within its undergraduate engineering programmes. The paper first focuses on the extent to which SD is featured within the institution's programme educational outcomes and common modules. This was explored through qualitative means, namely manifest and latent content analysis. This is followed by a survey, to explore the present pedagogical practices within the undergraduate engineering programme to ascertain the extent to which it conforms

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to philosophies of education for sustainable development. Also highlighted are student stakeholders' views on approaches best suited to teach sustainable development within the undergraduate engineering programme. The paper then discusses findings of a thematic analysis of open-ended survey responses on students' needs that should be considered to help develop the desired sustainability learning experience in the university. A total of 12 categories were identified as a result of this thematic analysis, of which eight of these categories encompassed the common engineering modules i.e. (i) Practical versus Theoretical, (ii) Real sustainable development issues and situations, (iii) Sustainable development learning activities and assessment, (iv) The need for heightened exposure and awareness to sustainable development post-graduation, (v) Teaching and learning of sustainable development via knowledge of current technological trends, (vi) Sustainable development awareness through exposure within the engineering industry, (vii) Sustainable development content within current learning modules and (viii) Approach to teaching sustainable development. The remaining four categories identified were for the common non-engineering modules, namely (i) Communication and sustainable development, (ii) Approach to teaching sustainable development for non-engineering modules, (iii) Bringing real life sustainable development issues and situations into non-engineering modules and (iv) Relating engineering aspects with human and societal aspects. The paper ends with a discussion of the implications of these findings for the development of a holistic engineering education for sustainable development framework.

Keywords

Engineering education · Engineering education for sustainable development · Malaysia · Higher education · Whole institution approach · Institutional approach to sustainable development

1 Introduction

Malaysian undergraduate engineering programmes are developed in line with the criteria set by the Engineering Accreditation Council (EAC), in its Accreditation Manual. Interestingly, 66.7 %, or eight out of these 12 criteria are related to sustainable development competences (EAC Manual 2012). However, also apparent is that the EAC Manual has not been developed within the philosophy of engineering education for sustainable development (EESD). This conclusion was drawn based on the lack of evidence in the manual which suggests that sustainable development must be made a compulsory context within which all 12 undergraduate engineering programme outcomes must be developed.

In 2009, a study was carried out to look into the views of the Malaysian engineering industry employers on the present and expected competencies of the country's engineering graduates. Employers feedback were sought on 13 competencies, namely (a) 'ability to acquire and apply knowledge of engineering fundamentals, (b) theoretical and research engineering, (c) application and practice oriented

Table 1 Summary of main findings

Item	Competency	Current level of competency (%)	Expected level of competency (%)
1	Ability to acquire and apply knowledge of engineering fundamentals	54.3	83.6
2	Having the competency in theoretical and research engineering	47.4	73.2
3	Having competency in application and practice oriented engineering	52.4	85.5
4	Ability to communicate effectively, not only with engineers but also with the community at large	49.5	86.7
5	Having in-depth technical competence in a specific engineering discipline	48.8	82.5
6	Ability to undertake problem identification, formulation and solution	48.1	84.6
7	Ability to utilise a systems approach to design and evaluate operational performance	55.7	78.9
8	Ability to function effectively as an individual and in a group with the capacity to be a leader or manager as well as an effective team member	55.7	85.1
9	Having the understanding of the social, cultural, global and environmental responsibilities and ethics of a professional engineer and the need for sustainable development	51.2	80.3
10	Recognising the need to undertake lifelong learning, and possessing/acquiring the capacity to do so	49.3	80.1
11	Ability to design and conduct experiments, as well as to analyse and interpret data	42.4	74.6
12	Having the knowledge of contemporary issues	47.9	75.4
13	Having the basic entrepreneurial skills	24.4	57.6

(Azami Zaharim et al. 2009, pp. 411–414)

engineering, (d) communicate effectively, (e) in-depth technical competence in a specific engineering discipline (f) undertake problem identification, formulation and solution, (g) utilise a systems approach to design and evaluate operational performance, (h) function effectively as an individual and in a group with the capacity to be a leader or manager as well as an effective team member, (i) understanding of the social, cultural, global and environmental responsibilities and ethics of a professional engineer and the need for sustainable development, (j) recognising the need to undertake lifelong learning, and possessing/acquiring the capacity to do so, (k) design and conduct experiments, as well as to analyse and interpret data, (l) knowledge of contemporary issues, and (m) basic entrepreneurial skills' (Azami Zaharim et al. 2009, p. 411). The detailed findings of the study are illustrated in Table 1.

As presented in Table 1, findings on engineering graduates present level of competencies indicate that only five out of the 13 competencies listed a satisfaction level of 50 % and more. Competence 7 and 8 recorded the highest percentage at 55.7 % each, while the lowest was recorded for competence 13 at 24.4 %. These percentages are considered rather low, and suggest that engineers need to improve significantly in areas listed. As for the expected level of competencies, communicating effectively was listed as the competency most expected of Malaysian engineers, while least expected was entrepreneurial ability. In terms of sustainability competencies within the profession, only 51.2 % of the employers were satisfied with their engineers' present abilities in understanding 'social, cultural, global and environmental responsibilities and ethics of a professional engineer and the need for sustainable development' (Azami Zaharim et al. 2009, p. 411). This shows that almost half of the 422 employers surveyed thought their employees lacked this competence. Additionally, 80.3 % of the employers also indicated that they expected their engineers to be sustainability competent. These findings are significant, as it suggests that Malaysia's engineering education programmes are not adequately preparing its graduates to be sustainability competent. It also indicates a serious mismatch between the expectations of the industry of its engineers, and the quality of sustainability competent graduates produced by local universities.

In addition to the abovementioned 2009 study, there has also been much research conducted to better understand the Malaysian engineering education landscape. This is apparent in studies conducted by Ab Rahman et al. (2009), Omar et al. (2009), Azami Zaharim et al. (2010), Abd Hamid et al. (2005), Rohani et al. (2005), Johari et al. (2002), and Abdullah et al. (2005). Our review of these studies however indicates that undergraduate engineering education research in Malaysia has mainly focused on three specific areas. These are (i) engineering graduates' employability skills and other skills relevant for the engineering workplace, (ii) pedagogies for engineering education and (iii) studies on the development of a Malaysian engineering education model. It was also found that most research is not contextualized towards sustainable development or education for sustainable development (ESD). Research on the importance for engineering students to be sustainability aware, however, is evident through studies conducted by Azmahani et al. (2012), Sharipah et al. (2012), and Arsat et al. (2011).

To date, there is little evidence of EESD research conducted in Malaysia to address problems faced by universities and academicians to holistically integrate sustainable development within undergraduate engineering programmes. The focus areas of the studies highlighted in this paper, and the apparent lack of sustainable development integration guidelines provided by the EAC, is evidence of this limitation. The present study thus proposes to bridge this gap, through an investigation of the present educational practices and needs for sustainable development within the university. The implications of these findings, in light of the development of a holistic Malaysian undergraduate EESD framework, are also discussed. The paper first focuses on the extent to which sustainable development permeates within the institution's programme educational outcomes and common modules. This is followed by an investigation of the present pedagogical practices within the

undergraduate engineering programme to ascertain the extent to which it conforms to philosophies of EESD. Also highlighted are student stakeholders' views on approaches best suited to teach sustainable development within the undergraduate engineering programme. The paper then discusses findings of a thematic analysis of open-ended survey responses on students' needs that should be considered to help develop the desired sustainability learning experience in the university.

2 Transformative Learning and EESD

Literature on pedagogies related to EESD within the higher education context have mostly highlighted the processes and strategies related to teaching and learning. In 2011, the United Nations produced the United Nations Decade of Education for Sustainable Development (DESD) Monitoring and Evaluation Report on currently accepted learning processes aligned with ESD. These processes, namely (i) collaboration and dialogue, (ii) engaging the whole system, (iii) innovation through transformative practice and (iv) active and participatory learning (Tilbury 2011) were also discussed from the perspective of processes and strategies of teaching and learning. Additionally, notions of learning such as experiential learning, deep learning, transformational learning, transdisciplinary and multidisciplinary learning, problem based learning, inquiry based learning, applied learning, active learning, participatory learning, critical emancipatory pedagogy and the use of environment and community as learning resources have also informed much of the research on pedagogies for ESD. Many of these notions of learning have also informed research on EESD. Cooperative learning, student-centred learning, deep learning and problem-based learning are some of the instances of these pedagogical notions apparent in EESD.

The pedagogical notions surrounding sustainable development are indicative of teaching and learning approaches associated with the theory of constructivism. The rationale behind this observation is the evident emphasis placed upon engagement and interaction between learners, as well as between learners and teachers, within a community of learning that promotes student centeredness, reflexivity and transformation. The need for educators to be facilitators and motivators of learning processes which advocate the need for learners to understand multiple perspectives, and be immersed in learning situated within the context in which it will be applied, is further evidence and indication of constructivism. Strongly linked to these philosophies of teaching and learning is the transformative pedagogy, an adult learning theory deeply rooted within constructivism.

Transformative learning has been described by Taylor as 'uniquely adult, abstract, idealized, and grounded in the nature of human communication' (2002, p. 5). According to McEwen et al. (2011), 'transformative learning is learning that takes the learner's knowledge and skills into a new domain, with a change or in cognitive and affective processes. It recognises that learning is not necessarily gradual, progressive and linear, but may have significant thresholds for change in understanding, and emotional intelligence' (p. 37). Learning from a transformational perspective is seen

to manifest when learners are prompted to critically assess the very premises of their perception of the problem. In understanding transformative learning, Imel (1998) states the importance of considering the manner in which it can be cultivated within the learning context, the educator and the learner.

The theoretical orientation of the present study is thus informed by transformative pedagogies. This is due to several reasons. Transformative pedagogical notions are strongly linked to constructivist orientations. These orientations are seen as dominant in pedagogies related to ESD. The close association between the goals of ESD and transformative education which advocate the importance of being critical and reflective is another significant reason for this choice. Transformative pedagogies are also seen as the more significant preference, given its focus on adult education and teaching and learning processes within the context of higher education. As the present study is set within the context of higher education, the transformative paradigm thus serves as a fitting platform to better understand the pedagogical issues that surface from the findings of the study.

3 Exploring Institutional Practices and Student Needs Through Qualitative and Quantitative Approaches

Using an exemplifying case study approach, qualitative and quantitative means were used to explore the aims of the study. The study was conducted at a private engineering university located in Perak, Malaysia.

Qualitative analysis, namely manifest and latent content analysis proved useful in assessing the extent to which sustainable development features within the practices of the university. Content analysis can be pursued in two ways, namely through its manifest content or its latent content. However, note Fraenkel and Wallen (2000), the best method is to use both forms if possible. The manifest content of a communication refers to the 'obvious, surface content-the words, pictures, images, and so on that are directly accessible to the naked eye or ear' (Fraenkel and Wallen 2000, p. 475). An example would be to count the number of times a certain word appears in the particular type of content. Latent content on the other hand refers to the underlying meaning of the communication. An example would be to read through the whole communication and assess the extent to which the issue investigated is present in the communication. The interpretation of content analysis data is commonly conducted through the counting of 'frequencies and percentages or proportions of particular occurrences to the total occurrences' (Fraenkel and Wallen 2000, p. 475). They also note that a 'base or reference point for counting' (2000, p. 477) must also be recorded to enable comparisons to be made against the counted occurrences.

The quantitative approach used in the study was the survey approach. As the sole purpose of conducting the survey was to gauge perceptions, the data obtained from the survey was used for the purpose of understanding and describing the respondents' views. Likert scales of 1–5 (strongly disagree–strongly agree) were used as it

aided with the determination of the students' opinions and attitudes on the questions posed in the questionnaire.

Respondents of the study were 388 final year undergraduate engineering students. The respondents comprised of 372 Malaysian students and 16 international students from Middle Eastern, African and Asian nations. Respondents ranged between the ages of 20–26, with 94.1 % of them within the age range of 21–23. The respondents were from five engineering programmes, namely Electric and Electronic Engineering, Chemical Engineering, Civil Engineering, Mechanical Engineering and Petroleum Engineering.

4 Findings on the Extent to Which Sustainable Development Is Featured Within the Educational Practices of the University

In assessing the extent to which sustainable development features within the university's educational practices, the following university documents were subjected to manifest and latent content analysis:

(i) vision and mission statements
(ii) research vision and mission statements
(iii) undergraduate engineering programme educational objectives
(iv) undergraduate engineering programme outcomes
(v) common undergraduate engineering and non-engineering module learning outcomes

The purpose of the analysis was to ascertain the extent to which the educational practices of the university were in accordance to sustainable development competences and EESD competences. The findings of the analysis are discussed below.

4.1 University's Vision and Mission Statements and Research Vision and Mission Statements

There is an absence of manifest content, but the presence of latent content related to sustainable development competences and EESD competences in the university's vision and mission. In relation to the university's research vision and mission, there is an absence of manifest content but the presence of latent content in relation to sustainable development competences and ESD competences.

4.2 Undergraduate Engineering Programme Educational Objectives of Chemical Engineering, Civil Engineering, Electrical and Electronic Engineering, Mechanical Engineering and Petroleum Engineering

The university's main programme educational objective was initially *To produce technically qualified well-rounded engineers and technologists with the potential to become leaders of industry and the nation*. This objective was later modified. The modified version presently consists of two objectives, namely *To produce technically qualified engineers with the potential to become leaders of engineering industries* and *To produce engineers who are committed to sustainable development of engineering industries for the betterment of society and nation*. The programme educational objectives and programme outcomes of all undergraduate engineering programmes offered in the university had been modified to include sustainable development outcomes. The former programme educational objectives of all undergraduate engineering programmes offered in the university did not contain any manifest or latent references to sustainability competences. However, the modified programme educational objectives of each programme contain one manifest and one latent reference. The phrase sustainable development indicates a manifest representation, while the phrase betterment of society and nation on the other hand denotes latent representation.

4.3 Undergraduate Engineering Programme Outcomes of Chemical Engineering, Civil Engineering, Electrical and Electronic Engineering, Mechanical Engineering and Petroleum Engineering

There are evidences of manifest and latent sustainability competences in all undergraduate engineering programme outcomes. However, the percentages of sustainability competences within all programmes differ in the former and modified outcomes. There has been an increase in sustainability competences in the programme outcomes of the Civil, Electrical and Electronic, Mechanical and Petroleum Engineering programmes. The Chemical Engineering programme however recorded a decrease. The results also suggest that the Mechanical Engineering programme has the highest difference in the percentage of sustainability competences in its former and modified programme outcomes, i.e. 29.5 %. This is followed by the Electrical and Electronics Engineering programme, Petroleum Engineering programme and finally the Civil Engineering programme with an 11.6, 10.1 and 9.1 % increase respectively.

In relation to the difference between the institution's current sustainability competences percentage and the Engineering Accreditation Council's sustainability competence percentage of 66.7 %, all engineering programmes recorded lower percentages, with the Chemical Engineering programme having the highest decrease at 22.3 %.

Table 2 Sustainability competences learning outcomes percentage in common undergraduate engineering modules

Name of module	Sustainability competences (%)
Introduction to oil and gas industry and sustainable development	44.4
Engineers in society	40
Engineering team project	40
Health, safety and environment	33
Engineering economics and entrepreneurship	0
Probability and statistics	0
Introduction to management	0
Professional communication skills	0
Academic writing	0
Malaysian studies	0

4.4 Common Engineering and Non-engineering Module Learning Outcomes

10 modules were identified for the analysis. Of the 10 modules, five non-engineering modules, namely *Engineering Economics and Entrepreneurship, Introduction to Management, Professional Communication Skills, Academic Writing* and *Malaysian Studies* are offered by the Department of Management and Humanities. The remaining five modules are offered by the Engineering departments. Table 2 depicts the summary of the results of the percentage of sustainability competences within the learning outcomes for all 10 modules.

As illustrated in Table 2, four of the 10 modules contain learning outcomes related to sustainability competences. The *Introduction to Oil and Gas Industry and Sustainable Development* module contains the highest percentage of sustainability competences with 44.4 %. This is followed by the *Engineers in Society* module and the *Engineering Team Project* module which each contain 40 % of learning outcomes related to sustainability competences. *Health, Safety and Environment* contains 33.3 % of learning outcomes related to sustainability competences. It can thus be summarized that 40 % of the total 10 common modules have learning outcomes related to sustainability competences.

5 Findings on Present Pedagogical Practices Within the Undergraduate Engineering Programme

This section describes findings from the survey which gauged respondents views on the pedagogical approaches currently practiced at the university. More specifically, the questions sought to determine if current pedagogical practices at the university

reflected pedagogies related to the teaching of sustainable development. A total of 24 items were constructed. A five point Likert scale was used to obtain respondents' views. The scale used was an agreement scale. The five points of the scale denoted 1, for strongly disagree, 2 for disagree, 3 for undecided, 4 for agree and 5 for strongly agree. The mean score of each item indicates the level of agreement for the items.

The first item was *My engineering programme promotes the importance for all students to practice sustainability*. The results from the responses of the final year undergraduate engineering students seem to suggest that they agree that their respective engineering programmes do promote the importance for all students to practice sustainability. This is evident through the higher frequency of responses recorded under the agree (48.5 %) and strongly agree (22.2 %) categories. Nevertheless, there were 18.3 % of the students who were unsure if their respective engineering programmes did promote the importance for all students to practice sustainability, while 1.0 and 10.1 % of them indicated that they strongly disagree and disagree respectively with the statement. The mean score for this item was 3.81, indicating agreement.

Item 2, *My engineering lecturers discuss the importance for engineering students to practice sustainability through the courses they teach*, also indicated high responses for the agree and strongly agree categories with 46.6 and 16.5 % of responses recorded for these two categories. 24.2 % of the responses were undecided, 1.5 % strongly disagreed while 11.1 % disagreed with the statement. The mean score for this item was 3.65, indicating agreement.

The third item was *My language and communication lecturers discuss the importance for engineering students to practice sustainability through the courses they teach*. Interestingly, the highest number of responses for this statement was for the category undecided, instead of the agree or strongly agree categories. The frequency of responses for this category was 34.3 %, suggesting final year undergraduate engineering students were unsure if their English language and communication lecturers did discuss the importance for engineering students to practice sustainability in these modules. 33.0 % agreed while 12.6 % strongly agreed with the statement, while 14.7 % and 5.4 % responded that they disagreed and strongly disagreed respectively. The mean score for this item was 3.32, indicating disagreement with the statement.

My management lecturers discuss the importance for engineering students to practice sustainability through the courses they teach was the fourth item in the question. The results indicate that 42.8 and 19.8 % of the responses received were for the categories, agree and strongly agree respectively. 20.6 % of the responses received were for the undecided category, 3.9 % was for strongly disagree and the remaining 12.9 % was for the disagree category. The mean score for this item was 3.62, indicating agreement.

The next item was *My social science/humanities lecturers discuss the importance for engineering students to practice sustainability through the courses they teach*. 42.0 % of the responses received were for the category agree, 13.4 % for strongly agree, 30.4 % for undecided, 10.6 % for disagree and 3.6 % for strongly

disagree. The mean score for this item was 3.51, indicating borderline agreement. The results suggest that of the Engineering, English Language and Communication, Management and Social Science and Humanities modules, the percentage of responses received for the undecided category was highest for the English Language and Communication modules. The results thus suggest that final year undergraduate engineering students are of the opinion that their English Language and Communication lecturers are the least to discuss the importance for engineering students to practice sustainability through the English Language and Communication modules. The Social Science and Humanities lecturers were the second least to discuss the necessity for engineering students to practice sustainability through their modules. The results further suggest that the lecturers who discussed it most were the Engineering lecturers, followed by the Management lecturer. These results are reflected in the low mean scores recorded for these items.

The next item was *Engineering and non-engineering lecturers should practice sharing of knowledge on best approaches to teach sustainability to engineering students*. The results indicate that the 388 respondents were of strong agreement for their engineering and non-engineering lecturers to do so. 58.5 % of the respondents strongly agreed with the statement, while 33.5 % agreed. 6.7 % of them were undecided, while the remaining 1.3 % disagreed. No response was recorded for the strongly disagree category. The 1.3 % disagreement suggests the need for the collaboration between the engineering and non-engineering lecturers for the aim of imparting sustainability knowledge to the engineering students. The mean score of 4.49 indicate agreement.

Engineering and non-engineering lecturers should invite each other to their courses, to teach and discuss about sustainability issues and ideas with engineering students was item seven in the question. Only 1.3 and 4.6 % of the respondents strongly disagreed and disagreed to this statement, while 16.8 % were undecided. The highest percentages were recorded for the categories agree and strongly agree with 31.7 and 45.6 % for each category respectively. The mean score of 4.16 indicate agreement to the statement.

Items 8, 9, 10 and 11 sought to gauge respondents' agreement on whether the *Engineering, Language and Communication, Management and Social Science and Humanities modules advocated the need to apply knowledge that I learn in the classroom, to explain engineering issues or problems related to the environment*. For the Engineering modules, the results indicate that 45.4 and 37.4 % of the respondents agree that these modules require them to do so. In the case of the English Language and Communication modules, 40.2 and 24.2 % of the respondents are is agreement of the statement. The Management courses recorded 42.5 and 18.8 % for the categories agree and strongly agree, while the Social Science and Humanities modules recorded 43.6 % for agree and 17.3 % for disagree respectively. Overall, the results for items 8, 9, 10 and 11 suggest that all four modules do require application of knowledge from the modules to discuss engineering issues or problems in relation to the environment. The mean scores recorded for these four items were 4.14, 3.72, 3.63 and 3.59 respectively, indicating agreement.

The next four items, i.e. items 12, 13, 14 and 15 intended to obtain respondents' extent of agreement on whether the Engineering, Language and Communication, Management and Social Science and Humanities modules taught them to reflect upon issues and new ideas they had learnt from real environmental problems. Their responses were to be based upon their perspective as humans, and not as engineering students or future engineers. Of the four modules, the Engineering modules recorded the highest frequencies for the agree and strongly agree categories with a combined agreement of 73.7 % for the said categories. This was followed by the Social Science and Humanities modules with a combined agreement of 61 %, the Management modules with a combined agreement of 58.7 %and lastly by the English and Communication modules with a combined agreement of 50.5 %. The results thus indicate that the English and Communication module content and lecturers were the least to teach engineering students to reflect upon issues and new ideas they had learnt from real environmental problems, from the perspective of a human being. The mean scores recorded for items 12, 13, 14 and 15 were 3.87, 3.40, 3.57 and 3.61 respectively. Item 13, language and communication courses I have taken/am taking teach me to reflect on issues and new ideas I learnt from real environmental problems, from the perspective of a member of the human race, again registered a mean score value below the 3.50 average value, indicating disagreement. This low mean score was also apparent in item 3, my language and communication lecturers discuss the importance for engineering students to practice sustainability through the courses they teach, indicating the respondents found the English Language and Communication module content and lecturers to be lacking in terms of disseminating the importance of sustainability through these modules.

Items 16, 17, 18 and 19 focused upon respondents' agreement on whether the Engineering, English Language and Communication, Management and Social Science and Humanities modules taught them to reflect upon issues and new ideas they had learnt from real environmental problems, from the perspective of a future engineer. The results once again indicate that the Engineering modules are the most to do so with a combined agreement of 87.3 %. This is followed by the Management modules with 65 % combined agreement, the Social Science and Humanities modules with 56.4 % and lastly the English Language and Communication modules with 55.9 %. Overall, the results indicate that the Engineering module content and lecturers were the most to give input on reflecting upon issues and new ideas from real environmental problems, from the perspective of a future engineer. The least to do so were the English Language and Communication module content and lecturers. The results suggest that the English Language and Communication modules seem to pay less attention to the reflection of issues and ideas from real environmental problems from the human and future engineer points of view. These results are once again reflected in the mean score values obtained for these four items. Of the four items, item 17, *language and communication courses I have taken/am taking teach me to reflect on issues and new ideas learnt from real environmental*

problems, from the perspective of a future engineer, recorded the lowest mean score (3.47). This value is lower than the 3.50 average mean, indicating respondents disagreed that the language and communication modules taught them to reflect on issues and new ideas learnt from real environmental problems, from the perspective of a future engineer.

During lessons, students from different engineering programmes are given the opportunity to reflect on activities collaboratively (together) to share knowledge as a group was item 20. The highest percentage of frequencies recorded for this item were 41.2 % for agree, followed by 2.2 % for strongly agree. 18.3 % of the respondents were undecided, while 4.9 and 13.4 % of the respondents strongly disagreed and disagreed respectively. The mean score for this item was 3.62, indicating agreement.

The next item, item 21 was *Learning approaches in this university focus on experiences gained from my direct involvement in a particular learning situation involving environmental issues*. Although the highest frequency, 40.2 % was recorded for the category of agree, 31.2 %, the second highest frequency was made up of undecided responses. A combined disagreement of 17.8 % was recoded for this item. The mean score for this item was 3.40, indicating disagreement.

The subsequent item, item 22 sought to gauge respondents' agreement on real world learning opportunities. The statement was phrased as *Learning approaches in this university encourage students to apply ideas they have learnt and experienced through real world learning situations involving environmental issues*. Results for this statement indicate that 46.4 % (agree category) and 16.2 % (strongly agree category) of the respondents are in agreement that the university does encourage students to do so. However, 22.2 % were undecided, while 3.6 % and 11.6 % of the respondents strongly disagreed and disagreed to the statement. The mean score of 3.60 indicates that respondents agreed to the statement.

Item 23, *Learning activities in this institution require students to be actively involved in their own learning involving environmental issues* recorded most responses for the agree category, with 44.8 %, followed by 24.7 % for the undecided category. 2.1 and 11.1 % of the responses received were or the categories strongly disagree and disagree respectively. The mean score of 3.64 indicates agreement.

Item 24, the last item sought to gauge respondents' agreement to the statement *My university promotes the importance for all students to practice sustainability*. The results indicate that 39.9 % of the respondents agreed to the statement, while 23.7 % were undecided. These were the highest and second highest frequencies recorded for this statement. Nevertheless, the results also indicate that 3.6 and 11.9 % of the responses received were in disagreement that the university promoted the importance for students to practice sustainability. The 3.63 mean score recorded for this item indicates agreement.

6 Findings on Student Stakeholders' Views on Approaches Best Suited to Teach Sustainable Development Within the Undergraduate Engineering Programme

Undergraduate engineering students' preferences towards the teaching of sustainable development in the undergraduate engineering programme at the university were also gauged. A five point Likert scale was used to obtain respondents' attitudes and preferences. The scale used was an agreement scale. The five points of the scale denoted 1, for strongly disagree, 2 for disagree, 3 for undecided, 4 for agree and 5 for strongly agree. The mean score of each item indicates the level of agreement for the items. The summary of responses is as illustrated in Table 3.

Item A sought to determine respondents' preferences on whether sustainable development input should be taught as a separate engineering module on its own. The mean score of 3.32 recorded for this item however indicates that respondents were not in agreement with the teaching sustainable development in the undergraduate engineering programme as a separate engineering course on its own.

Item B focused on seeking respondents' preferences for sustainable development input to be taught as a separate non-engineering module on its own. The results suggest that respondents' preferred sustainable development input to be taught as two separate modules in the undergraduate engineering programme at the university. Once again, the lower than average mean score of 3.29 indicates that it should not be taught as a separate non-engineering course on its own.

Item C on the other hand sought to determine final year undergraduate engineering students' responses to whether sustainable development input should be provided through all engineering modules only. These include all courses, be it a common module, or otherwise. The mean score of 3.27 obtained for this item indicates that respondents were in disagreement of this approach.

Table 3 Approach to teaching sustainable development in the undergraduate engineering programme

Item	Statement	Mean	SD
A	As a separate engineering course on its own	3.32	1.24
B	As a separate non-engineering course on its own	3.29	1.17
C	Through all engineering courses only	3.27	1.19
D	Through all non-engineering courses only (language and communication, business/management and social science/humanities)	3.29	1.16
E	Within all engineering and non-engineering courses	4.06	0.92
F	The engineering lecturers should teach sustainability related content	4.34	0.72
G	The language/communication lecturers should teach sustainability related content	4.03	0.94
H	The management lecturers should teach sustainability related content	4.15	0.83
I	The social science/humanities lecturers should teach sustainability related content	4.18	0.85

Item D aimed to determine respondents' preferences to the teaching of sustainable development input through all non-engineering modules, i.e. language and communication, business/management and social science/humanities modules. The 3.29 mean score value obtained indicated disagreement in using this approach to the teaching of sustainable development in the undergraduate engineering programme.

Item E was on providing sustainable development input through all engineering and non-engineering modules, irrespective of if the module was a common module or otherwise. The 4.06 mean score value obtained indicates agreement to this approach.

The final four items sought to understand the 388 respondents' preferences on the lecturers who should teach sustainability related content to the undergraduate engineering students. Respondents were asked to indicate the extent to which the Engineering, English Language and Communication, Management and Social Sciences and Humanities should teach sustainability content. In the case of Engineering lecturers, 0.5 % of the responses indicated strong disagreement, 1.3 % indicated disagreement while 8 % denoted undecided responses. Higher percentage of the responses were recorded for the agree and strongly agree categories, with 45.4 and 44.8 % of responses accordingly. In relation to the English Language and Communication lecturers, a combined response of 77.6 % was recorded for the agree and strongly agree category. 14.4 % of the responses were undecided, while 1.5 and 6.4 % of the responses were in strong disagreement and disagreement respectively. For the statement The management lecturers should teach sustainability related content, only 1.3 and 2.8 % of the responses were recorded for the strongly disagree and disagree category respectively. 11.3 % of the responses were undecided, while the highest responses were for the agree and strongly agree category, with 48.2 and 36.3 % respectively. As for the Social Science and Humanities lecturers, most of the responses were for the agree and strongly agree categories, with 44.1 and 39.7 % of responses accordingly. 11.9 % were undecided responses, while the remaining 4.4 % were for the strongly disagree and disagree category. These results thus suggest that the respondents prefer all lecturers, regardless of their academic background to provide them with sustainability input. The mean scores obtained for these last four items were 4.34, 4.03, 4.15 and 4.18 respectively. These high scores indicate that respondents were in agreement that all lecturers regardless of their expertise should teach sustainability related content within the undergraduate engineering programme.

7 Students' Needs that Should Be Considered to Help Develop the Desired Sustainability Learning Experience in the University

In addition to Likert scale type items, the survey also consisted of an open-ended question. The purpose of the open-ended question was to elicit respondents' views on teaching and learning issues that should be considered to help develop the desired sustainability learning experience in the university.

Table 4 Open-ended responses categorized by type of module

Engineering modules		Communication/language/management/social science and humanities modules	
Categories	Number of references coded	Categories	Number of references coded
Practical versus theoretical (more practical exposure desired)	19	Developing communication skills for sustainable development	12
Inclusion of real sustainable development issues and situations	19		
Sustainable development learning activities and assessment for real world preparation	13	Approach to teaching sustainable development for non-engineering modules to be in accordance with the principles of education for sustainable development	50
The need for heightened exposure and awareness to sustainable development post-graduation	6		
Teaching and learning of sustainable development via knowledge of current technological trends	14	Bringing real life sustainable development issues and situations into non-engineering modules	13
Sustainable development awareness through exposure within the engineering industry	11		
Content within current learning modules should be sustainability driven	13	Relating engineering aspects with human and societal aspects	19
Approach to teaching sustainable development to be in accordance with the principles of education for sustainable development	30		

The section that follows describes the results of the NVivo analysis conducted to categorize the views provided by the respondents. A total of 219 open-ended responses were noted. The qualitative software NVivo version 10 was used to categorize these responses by type of module, i.e. engineering and non-engineering.

As seen in Table 4, a total of 12 categories were identified from the open-ended responses provided by the survey respondents. Eight of these categories were from the responses obtained for the Engineering modules, and the remaining four, for the non-engineering modules. Under the Engineering modules grouping, the category, *Approach to teaching sustainable development to be in accordance with the principles of education for sustainable development* had the highest number of responses, i.e. 30. The least number of responses were for the category *The need for*

heightened exposure and awareness to sustainable development post-graduation, with six responses in total. As for the non-engineering modules grouping, the most number of responses were once again centred upon the category *Approach to teaching sustainable development for non-engineering modules*. A total of 50 responses made up this category. *Developing communication skills for sustainable development*, which had 12 responses, was the category which had the least number of responses under the non-engineering modules grouping.

8 Discussion on Implications of Findings for the Development of a Holistic EESD Framework

From the perspective of the undergraduate engineering curriculum, it appears that sustainable development and EESD do not feature prominently within the institution's academic and research vision and mission. Undergraduate programme outcomes indicate a moderate increase in the former and modified programme outcomes related to sustainable development competences. Findings on the extent of the inclusion of sustainable development and EESD learning outcomes of common undergraduate modules also suggest that there is inadequate emphasis of these outcomes, as merely 40 % of the common modules have learning outcomes related to sustainable development and EESD. The university is thus recommended to intensify its endeavours to make sustainable development and EESD more prominent within its undergraduate engineering curriculum. Having said that, these low percentages nevertheless indicate that the university is moving towards the goal of advancing sustainable attitudes through its undergraduate engineering curriculum.

In terms of sustainable development being made a learning context within the undergraduate modules, the findings of the study suggest that it does not feature within 90 % of the common modules. Additionally, none of the common non-engineering modules have learning outcomes related to sustainability. These findings are a cause for concern, as a narrow curriculum can be a hurdle to the implementation of sustainable development within the undergraduate engineering curriculum. In terms of pedagogy and practice, there seem to be attempts to use transformative teaching and learning approaches within the undergraduate engineering modules. The use of collaborative and active learning strategies, case studies, problem solving, individual activities and group based activities is an indication of its use. Open-ended findings however indicate that these activities have not been approached within a transformative and ESD pedagogical framework in mind, or with the aim of developing sustainability competences within the undergraduate engineering students.

EESD is also not seen to feature holistically within the university's educational practices. Sustainable development does pervade through the curriculum, but is not obviously emphasised. Pedagogically, attempts are made to approach the teaching and learning of sustainable development using methods aligned to the philosophies

of transformative learning and EESD. However, as indicated in the findings of the study, these too are selectively practiced at the university. The university is therefore recommended to look into these gaps to enable effective development and implementation of EESD outcomes within its educational practices.

The findings clearly show that the university has taken some steps to include sustainable development in its undergraduate programme. However, sustainable development does not form part of the core curriculum across all engineering disciplines offered in the university's undergraduate engineering curriculum. In relating these findings to the context of higher education and EESD, it can thus be concluded that the university, has, at a rudimentary level, included sustainable development outcomes within the curriculum of the undergraduate engineering programme. This inclusion is however a result of the university's adherence to the accreditation guidelines stipulated by the Engineering Accreditation Council and not an initiative driven by the university's conscious effort to integrate sustainability in relation to the principles and practices of EESD. Findings of the present study suggest that the inclusion of sustainable development within the undergraduate curriculum has intensified as a result of adherence to accreditation policies set by the Engineering Accreditation Council. Yet, with merely 40 % its common undergraduate modules learning outcomes relating to sustainable development, the university has to formally institutionalize sustainable development and EESD within its undergraduate engineering curriculum.

There is also evidence of discipline bias, prescriptive content and cognitive learning approaches in the modules taught in the undergraduate engineering programme. These evidences point to a curriculum uncharacteristic of educational philosophies and practices that are transformative and sustainable in nature. It can thus be noted that the university is seen to espouse mechanistic and transmissive ideologies which are not in tandem with the philosophy of EESD. The university can therefore be categorized within the stage of accommodation, where the teaching and learning of sustainable development is conducted for the purpose of education about sustainability, and not for, or as sustainability. Although findings point to the use of EESD teaching and learning approaches such as case studies, problem solving activities and collaborative group discussions, there is nevertheless limited emphasis on the use of reflective and reflexive teaching and learning practices and real life problem solving approaches. This can be a continuous quality improvement (CQI) area for the university to look into, to promote transformative teaching and learning amongst its academicians and students.

As found through this study, the curriculum and pedagogical philosophies of a university hold the key to the development of a holistic EESD framework. The implications discussed in this paper highlight the significance of these criteria in establishing a successful EESD programme. It also provides vital pointers to universities, academicians and researchers working towards the development of a holistic EESD framework for their institutions. Hence, institutions of higher learning are recommended to look into these key areas in developing a holistic EESD framework for their institutions.

The findings of this study are also seen to be instrumental to the Ministry of Education. It will be particularly useful in formulating sustainability related higher education frameworks for the country's public and private engineering institutions of higher learning. The findings will also benefit institutions of higher learning in Malaysia that seek to introduce EESD within its undergraduate engineering programmes. Findings obtained from this study would allow university administrators and academicians make informed decisions on the curricula, pedagogical and institutional aspects that need to be revisited or expanded within their institution, so the incorporation of EESD could be carried out in a holistic manner.

9 Conclusion

This study looked into the educational practices and needs for sustainable development within a private engineering university in Malaysia. The paper first explored the extent to which sustainable development is featured within the institution's programme educational outcomes and common modules. Following this was an investigation of the pedagogical practices within the undergraduate engineering programme and students views on approaches best suited to teach sustainable development within the programme. Implications of these findings were also highlighted.

As with all research, the present study was also conducted within several limitations. The study was conducted as a single case study of a private Malaysian engineering university. Given the aims of the study and the stipulated duration to complete this research, the single case study approach was deemed to be the most suitable approach to adopt to obtain the data required within the permissible time frame of the study. Additionally, the study was limited to the Malaysian undergraduate engineering context. The postgraduate engineering context was not included in the study, given the time frame of the study. Data gathering through undergraduate module learning outcomes was limited to the common undergraduate modules as these were compulsory modules all engineering students had to complete to be able to graduate from the undergraduate engineering programme.

Several recommendations are suggested as future work for the present study. Researchers wanting to take up a similar study may also want to explore perspectives of first, second and third year undergraduate engineering student stakeholders, instead of those in the final year of their studies. A comparison between final year and non-final year undergraduate engineering students could be a possible angle to investigate using this approach. Researchers may also want to focus on postgraduate engineering students perspectives on the issues explored in this study. As the present study focused upon a single case study of a private Malaysian engineering university, future research can look into conducting the same study in other private engineering universities in the country, using a multiple case study approach. Alternatively, the study could also be conducted at Malaysian public universities that offer engineering programmes. Comparisons could then be made between findings from the public and private universities.

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