89. Higher Education Student Stakeholders Voices on Sustainable Development Educational Outcomes for Engineering Education in Malaysia

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Abstract

Engineering bodies like the Institution of Engineers Malaysia (IEM) and the Board of Engineers Malaysia (BEM) stress the need for Malaysian engineering graduates to be able to integrate sustainable development in their professional practice. The 2012 Engineering Accreditation Council (EAC) manual outlines 12 outcomes that students of Malaysian institutions of higher learning offering engineering programmes are expected to develop upon completion of their studies. While institutions of higher learning are required to develop the prescribed skill sets using outcome based approaches to learning, integration measures are not specifically stipulated, perhaps to allow room for pedagogic creativity. A hypothetical education for sustainable development framework consisting 30 sustainable development learning outcomes was developed as a means of addressing the issue of integrating sustainable development outcomes within the undergraduate engineering programme curriculum. Using a private higher learning institution offering engineering programmes as a case study, the present study set out to explore the views of its main stakeholders, i.e. its final year undergraduate engineering students, on the inclusion of 30 sustainable development learning outcomes within the university's undergraduate engineering programme. Final year undergraduate engineering students' perspectives were sought through a mixed methods approach, through the use of surveys and interviews. The survey addressed respondents' views on: (a) competences they deem as important to enable them to become sustainability competent engineers when they graduate (b) competences they deem as necessary to be included as learning outcomes of engineering modules and non-engineering modules, namely language and communication, business and management modules (c) competences they deem as necessary to be included as learning outcomes of university level programmes. The one to one interviews explored students' views on pedagogies & curriculum development approaches to achieve and support sustainability education goals and issues to consider for the systemic incorporation of sustainability education within the engineering programme. The findings of the 5 point Likert scale survey indicated that the student stakeholders found the 30 learning outcomes for issues (a), (b) and (c) to be important, with mean scores ranging within the 'somewhat important' to 'very important' levels. The interview findings indicated the challenges currently faced by students in the teaching and learning of sustainable development within the undergraduate engineering programme. The paper ends with a discussion of the implications of the findings for policy and practice.

1 Introduction

There is an immense need for Malaysian engineering graduates to be sustainably competent, given the environmental, economic and social developmental concerns engulfing the nation. The EAC, in its 2012 manual, has taken heed of this issue, by recommending educational outcomes for engineering programmes to be developed around, failing which could cost institutions of higher learning accreditation of their engineering programmes. Of the 12 recommended outcomes, 8 outcomes, amounting to 66.7% of the total, are sustainability related. However, there is no compulsion for engineering institutions to develop programmes within an engineering education for sustainable development framework in mind. This observation is 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. Additionally, the suggested content for Malaysian undergraduate engineering programmes which comprises Engineering Sciences, Principles and Applications, Mathematics, Statistics and Computing, Engineering Applications, Complex Problem Solving, Complex Engineering Activities and Knowledge Profile also does not draw strong emphasis upon engineering education for sustainable development (EAC Manual, 2012: Appendix B-1 – B-8). Sustainable development learning outcomes integration measures are also not specifically stipulated in the manual. Given these shortcomings, the present study looked into ways in which sustainable development outcomes could be integrated within the undergraduate engineering programme curriculum.

2 The study

The study was conducted at a private Malaysian engineering university from July 2011 to February 2012. In its transformation journey from a teaching university to a research university by 2013, the university has implemented several changes within its research and academic agenda. Sustainable development has been identified as the overarching research agenda for the university. Changes have also been made in the academic front. Programme educational objectives and programme outcomes of all undergraduate engineering programmes offered in the university have also been modified to include sustainable development educational outcomes. As the university offers undergraduate engineering programmes in line with the requirements of the EAC, this makes it a member of the broader group of Malaysian universities which offer undergraduate engineering programmes accredited by the council. This membership makes it possible for the university to be used as an exemplifying case study for the present research. Additionally, the university's recent introduction of sustainable development in its research agenda and academic outcomes provided the insight needed to understand its student stakeholders' perceptions of the university's move.

Final year undergraduate engineering students' perspectives were sought through a mixed methods approach, through the use of surveys and interviews. The survey explored the views of the final year undergraduate engineering students on the inclusion of 30 sustainable development competences within the university's undergraduate engineering programme. The 30 items, which were developed based on a review of education for sustainable development literature and frameworks, i.e. Jucker, 2011; Sterling, 1998; Bowers, 2000, 2001, 2008, 2009; UNESCO, 2002; Jucker, 2002; Oreskes, 2004; Huckle, 2006; Selby, 2007 and Stibbe, 2009, were in relation to the sustainable development and sustainable engineering competences engineering students need to be exposed to, to enable them to practice, appreciate and understand sustainable development upon graduation. A five point Likert scale was used to obtain respondents' views for these three sub-sections. Likert scales were used to

determine the students' opinions and attitudes on the items listed. The five points of the Likert scale denoted 1, for very unimportant, 2, for somewhat unimportant, 3, for neither important nor unimportant, 4, for somewhat important and 5, for very important. A pilot study was first conducted using responses from 35 respondents. A reliability analysis was conducted for the 30 items. Assert Hair et al (1998), the generally agreed upon alpha lower limit for Cronbach's alpha is 0.70. However, this value may decrease to 0.60 in exploratory research. The reliability analysis values from the pilot study for the sustainable development competences they deemed as important to enable them to become sustainability competent engineers when they graduate was 0.90. Competences deemed as necessary to be included as learning outcomes of engineering modules had an alpha value of 0.94, while the non-engineering modules, namely language and communication, business and management modules, an social science and humanities modules had an alpha score of 0.85, 0.95 and 0.95 respectively. Competences deemed necessary to be included as learning outcomes of university level programmes had an alpha score of 0.96. Although it was a newly developed scale, all alpha values were above the 0.70 cut off point stated by Hair et al, and as such indicated that the 30 items were indeed reliable. In addition to the pilot study, an expert review was also carried out to determine the face validity of the 30 items. This expert review was conducted by a UNESCO Chair in Social Learning and Sustainable Development. Given his familiarity with the Malaysian engineering education scenario, and the outcome based education system, his review of the 30 items was instrumental for the development of the final framework within the Malaysian context. His review indicated that the 30 items were appropriate and fitted well as programme and module learning outcomes. He nevertheless cautioned that when categorizing the items as it has been, there was a risk of coming up with too many items, and this may not be ideal. However, he noted that the 30 items could be used as a foundation to assist stakeholders in recognizing the literacies related to sustainability. Further analysis in the form of a principle component analysis was therefore conducted with the aim of reducing the 30 items, to enable it to be more systematically categorized as sustainable development competences. The interviews explored students' views on pedagogies & curriculum to achieve and support sustainability education goals, and issues to consider for the systemic incorporation of sustainability education within the engineering programme.

3 Findings of the study

A total of 388 final year undergraduate engineering students took part in the survey. The rationale for conducting the survey with final year students was because they were almost finishing their studies and would thus have a better understanding of the whole engineering curriculum over the period of their four years of study at the university. Gender and programme of study are not essential variables in this study as it is not the aim of this study to explore student stakeholder perspectives by the different undergraduate engineering programmes, but rather as a concerted stakeholder voice. All 388 responses that were used for the analysis belonged to final year undergraduate engineering respondents who had completed or were taking modules from the common engineering, university requirement, English and communication, and the social science, humanities and national requirement list of modules offered by in the undergraduate engineering programme. This was in compliance with the student stakeholder criteria of the study which required only final year undergraduate engineering students as respondents. As the above modules are usually completed before the final year of studies at the university, participants would be able to comment on the outcomes of these modules as they would have taken, or were presently taking them. The findings of the survey are as illustrated in Table 1. Items 1-30 listed in Table 1 correspond with the 30 competences engineering students need to be

exposed to, to enable them to practice, appreciate and understand sustainable development and sustainable engineering. These competences are as listed below:

1. Understand people's relationship to nature
2. Hold appropriate understanding of how the economy, society and environment affect each other
3. Hold personal understanding of the environment which is derived from direct experience
4. Local to global understanding of how people continuously impact on the environment
5. Understand how science and technology has changed nature and people's effect to the environment
6. Understand how cultural and social values influence how resources are viewed
7. Analyze a sustainability issue creatively, critically and systemically using scientific, social science and humanities approaches
8. Able to consider present and future directions of society and environment, and personal role and contribution to the future
9. Think of a holistic approach to solving an engineering problem
10. Think of a holistic approach to solving real life complex problems
11. Able to participate in groups consisting individuals from many fields or disciplines of study to jointly evaluate causes, put forward and work out problems, and provide solutions to problems
12. Apply engineering skills to solve real life sustainability problems facing society
13. Apply language and communication skills to solve real life sustainability problems facing society
14. Apply business and management skills to solve real life sustainability problems facing society
15. Apply social science and humanities concerns to solve real life sustainability problems facing society
16. Able to critically reflect on own assumptions and assumptions of others
17. Able to critically reflect on issues on a personal and professional level
18. Able to manage and direct change at individual and social levels
19. Able to express personal responses to environmental and social issues
20. Ability to demonstrate and articulate sustainability related values such as care, respect, charity, social and economic justice, commitment, cooperation, compassion, self-determination, self-reliance, self-restraint, empathy, emotional intelligence, ethics and assertiveness
21. Play the role of responsible citizens at the local and global level for a sustainable future
22. Develop appreciation of the importance of environmental, social, political and economic contexts of engineering processes for sustainability
23. Consider implications of engineering processes in relation to the environment
24. Consider implications of engineering processes in relation to the society
25. Consider environmental issues in relation to the society
26. Appreciation of all living entities
27. Appreciation that current actions can impact on the quality of life of future generations
28. Respect and value cultural, social and economic and biodiversity
29. Appreciation of the variety of approaches to sustainability issues
30. Appreciation for the need for lifelong learning in relation to sustainability issues and change

Also presented in Table 1 are the mean and standard deviation values obtained from the analysis of the student stakeholders' views on the importance of the 30 competences to enable them to become sustainability competent engineers when they graduate (SD COMP ENGNR), competences they deem as necessary to be included as learning outcomes of engineering modules (ENGIN) and non-engineering modules, namely language and communication (LNG & COMM), business and management modules (BSN & MGT), social science and humanities modules (SOCSCI & HMTIES), and competences they deem as necessary to be included as learning outcomes of university level programmes (UNI PROG).

Table 1: Sustainable development competences deemed necessary by student stakeholders (n=388)

ITEM	SD COMP ENGNR		ENGIN		LNG & COMM		BSN & MGT		SOCSCI & HMTIES		UNI PROG	
	MN	**SD**	**MN**	**SD**	**MN**	**SD**	**MN**	**SD**	**MN**	**SD**	**MN**	**SD**
1	4.34	0.77	4.19	0.93	3.76	1.07	4.08	0.95	4.13	0.90	4.13	0.93
2	4.43	0.73	4.33	0.77	3.63	1.02	4.26	0.86	4.11	0.86	4.15	0.90
3	4.19	0.73	4.30	0.82	3.64	1.01	3.88	0.99	3.95	0.90	4.09	0.91
4	4.36	0.76	4.43	0.75	3.70	1.00	4.00	0.96	4.04	0.90	4.11	0.93
5	4.54	0.70	4.60	0.67	3.61	0.98	3.85	0.93	3.96	0.90	4.09	0.91
6	4.03	0.88	3.86	1.03	3.70	0.99	3.94	0.95	4.12	0.86	4.01	0.92
7	4.24	0.78	4.29	0.86	3.64	0.99	3.93	0.92	4.06	0.91	4.04	0.97
8	4.26	0.82	4.39	0.78	3.74	0.96	3.99	0.93	4.01	0.89	4.08	0.89
9	4.32	0.82	4.49	0.79	3.56	1.10	3.82	1.03	3.86	0.98	4.12	0.93
10	4.26	0.84	4.31	0.89	3.68	1.03	3.99	0.93	4.02	0.88	4.10	0.92
11	4.50	0.75	4.57	0.72	4.13	0.95	4.25	0.87	4.18	0.90	4.31	0.86
12	4.45	0.73	4.65	0.61	3.53	1.09	3.77	1.01	3.76	0.99	4.10	0.92
13	4.31	0.79	3.98	0.98	4.38	0.81	4.09	0.87	4.02	0.91	4.10	0.89
14	4.06	0.84	3.91	0.94	3.70	0.99	4.34	0.85	3.99	0.94	3.98	0.90
15	4.04	0.80	3.86	1.00	3.73	0.98	3.93	0.89	4.24	0.82	4.04	0.86
16	4.11	0.79	4.25	0.82	3.97	0.89	3.95	0.88	3.91	0.88	4.04	0.87
17	4.13	0.78	4.29	0.83	4.10	0.85	4.13	0.84	4.06	0.89	4.14	0.88
18	4.05	0.79	4.15	0.92	3.98	0.89	4.15	0.81	4.13	0.85	4.17	0.82
19	4.06	0.85	4.22	0.82	3.91	0.95	3.98	0.92	4.04	0.87	4.10	0.87
20	4.28	0.84	4.19	0.94	4.03	0.95	4.14	0.89	4.18	0.88	4.21	0.85
21	4.31	0.78	4.36	0.82	3.98	0.97	4.11	0.89	4.19	0.83	4.20	0.88
22	4.17	0.78	4.35	0.74	3.90	0.97	4.07	0.86	4.13	0.83	4.17	0.84
23	4.40	0.75	4.53	0.68	3.72	1.04	3.92	0.96	3.97	0.92	4.21	0.88
24	4.31	0.78	4.52	0.68	3.67	0.97	3.95	0.93	3.93	0.93	4.14	0.90
25	4.38	0.75	4.33	0.83	3.77	1.00	3.94	0.92	4.04	0.94	4.16	0.88
26	4.31	0.84	4.23	0.92	3.94	1.01	4.05	0.97	4.14	0.93	4.21	0.90
27	4.52	0.66	4.38	0.78	3.92	0.93	4.07	0.91	4.15	0.86	4.26	0.82
28	4.25	0.80	4.15	0.88	3.93	0.95	4.09	0.88	4.26	0.81	4.18	0.85
29	4.16	0.80	4.28	0.80	3.86	0.93	3.99	0.89	4.08	0.86	4.14	0.88
30	4.31	0.81	4.35	0.80	4.01	0.93	4.14	0.87	4.13	0.86	4.24	0.88

Note: MN is in reference to mean score, while SD is in reference to standard deviation value

Findings: Competences to become sustainability competent engineers

The findings on the importance of the 30 items to become sustainability competent engineers upon graduation indicate that all 30 items have a score of 4 and above. The highest mean score of 4.54 was recorded for item 5, *understand how science and technology has changed nature and people's effect to the environment*. The lowest mean score obtained was 4.03 for item 6, *understand how cultural and social values influence how resources are viewed*. These mean scores thus suggest that all 30 items are viewed by student stakeholders as important sustainable development competences they need to be exposed to, in order to become sustainability competent engineers upon entering the engineering workforce. The Principle Component Analysis for Competences to become sustainability competent engineers resulted in three components being extracted, namely

Component 1: Competences for comprehension, expression and demonstration of sustainable development consciousness (Items 1, 2, 4,5,19, 20 and 21)
Component 2: Competences for community based problem resolution (Items 13, 14 and 15)
Component 3: Competences for holistic problem solving (Items 9 and 10)

The institution of higher learning is therefore encouraged to include Competences for comprehension, expression and demonstration of sustainable development consciousness, Competences for community based problem resolution and Competences for holistic problem solving as key educational outcomes of its undergraduate engineering programme should it want to produce engineering graduates who are sustainability competent upon entering the Malaysian and global engineering workforce.

Findings: Competences for inclusion as learning outcomes in undergraduate Engineering modules

As for the sustainable development competences for inclusion as learning outcomes in undergraduate engineering modules, the mean scores obtained for all items indicate that four items out of the total 30 items have mean scores lower than 4.00. These items therefore fall under the neither important nor unimportant category. These items are items 6, *understand how cultural and social values influence how resources are viewed*, item 13, *apply language and communication skills to solve real life sustainability problems facing society*, item 14, *apply business and management skills to solve real life sustainability problems facing society* and item 15, *apply social science and humanities concerns to solve real life sustainability problems facing society*. Even though four of the 26 items have a mean score of less than 4.00, these scores are above the average score of 3.50, indicating that these items are important to be included in the Engineering modules. The remaining 26 items fall under the somewhat important to very important category, with mean scores higher than 4.00. The highest mean recorded was for item 12, with a mean score value of 4.65. The Principle Component Analysis resulted in four components being extracted, namely

Component 1: Competences for appreciation of the need for sustainability consciousness within engineering practices affecting society (Items 22, 24, 25, 26, 27 and 29)
Component 2: Competences for the observation of sustainable development at individual and social levels (Items 6, 13, 14, 15 and 18)
Component 3: Competences for comprehension, expression and demonstration of sustainable development consciousness (Items 1, 2, 3, 4, 5 and 7)
Component 4: Competences for holistic approach to problem resolution (Items 9 and 10)

Engineering module academicians are therefore encouraged to include *Competences for appreciation of the need for sustainability consciousness within engineering practices affecting society*, *Competences for the observation of sustainable development at individual and social levels*, *Competences for comprehension, expression and demonstration of sustainable development consciousness* and *Competences for holistic approach to problem resolution* as learning outcomes and assessment criteria of the undergraduate engineering modules they teach.

Findings: Competences for inclusion as learning outcomes in undergraduate English Language and Communication modules

In relation to the sustainable development competences for inclusion as learning outcomes in undergraduate language and communication modules, the mean scores of all 30 items indicate that five out of the total 30 items have a mean score of above 4.00. The items with mean scores above 4.00

are items 11 (mean = 4.13), 13 (mean = 4.38), 17 (mean = 4.10), 20 (mean = 4.03) and 30 (mean = 4.01). The remaining 25 items have mean scores less than 4.00. Nevertheless, these scores are all above the 3.50 average value. The lowest mean score was recorded for item 12, *apply engineering skills to solve real life sustainability problems facing society,* with a mean value of 3.53. The Principle Component Analysis resulted in three components being extracted, namely

Component 1: Competences for the comprehension of sustainable development (Items 1, 2, 3, 4, 5, 7, 8, 9, 10 and 12)

Component 2: Competences for the expression and demonstration of sustainable development consciousness (Items 20, 21, 22, 25, 26, 27, 28, 29 and 30)

Component 3: Competences for implementation of sustainable development conventions within the community at individual, societal and professional levels (Items 13, 15 and 17)

English Language and Communication module academicians are therefore encouraged to include *Competences for the comprehension of sustainable development*, *Competences for the expression and demonstration of sustainable development consciousness* and *Competences for implementation of sustainable development conventions within the community at individual, societal and professional levels* as learning outcomes and assessment criteria of the undergraduate English Language and Communication modules they teach.

Findings: Competences for inclusion as learning outcomes in undergraduate Business and Management modules

In terms of mean scores obtained for the sustainable development competences for inclusion as learning outcomes in undergraduate business and management module, the results indicate that the mean scores of all items are above the average value of 3.50. This suggests that all 30 items are important to be included in the Management modules of the undergraduate engineering programme offered by the university. The highest mean score recorded was 4.34, for item 14, *apply business and management skills to solve real life sustainability problems facing society.* The lowest mean score was for item 12, *apply engineering skills to solve real life sustainability problems facing society,* with a value of 3.77. In addition, 50% of the total items recorded a mean score value of 4.00 or greater. This is in contrast with the English and Communication modules, where only 16.67% or 5 items of the total 30 items recorded a value of 4.00 or greater. The Principle Component Analysis resulted in two components being extracted, namely

Component 1: Competences for the expression and demonstration of sustainable development consciousness (Items 20, 21, 22, 26, 27, 28, 29 and 30)

Component 2: Competences for the comprehension of sustainable development (Items 1,2,3,4 and 5)

Business and Management module academicians could therefore include *Competences for the expression and demonstration of sustainable development consciousness* and *Competences for the comprehension of sustainable development* as learning outcomes and assessment criteria of the undergraduate Business and Management modules they teach.

Findings: Competences for inclusion as learning outcomes in undergraduate Social Science and Humanities modules

In the case of the sustainable development competences for inclusion as learning outcomes in undergraduate social science and humanities modules, the mean score of the 30 items reveal that all items have mean scores higher than the average value of 3.50. A total of eight items have mean scores below 4.00, while the remaining 22 items all have mean scores of 4.00 or higher. This indicates that all 30 items are deemed as important to be included in the social science and humanities modules. The highest mean score was obtained for item 26 (mean = 4.26), *respect and value cultural, social and economic and biodiversity*. The lowest mean score was recorded was 3.76 for item 12, *apply engineering skills to solve real life sustainability problems facing society*. It is interesting to note at this juncture that item 12 also recorded the lowest mean score for in two other modules, namely the English and Communication modules as well as the Management modules. However, the same item had the highest mean value in the Engineering modules. The Principle Component Analysis resulted in two components being extracted, namely

Component 1: Competences for the comprehension of sustainable development (Items 1,2,3,4,5,6,7 and 8)
Component 2: Competences for the expression and demonstration of sustainable development consciousness (Items 26, 27, 28, 29 and 30)

Social Science and Humanities module academicians could therefore include *Competences for the expression and demonstration of sustainable development consciousness* and *Competences for the comprehension of sustainable development* as learning outcomes and assessment criteria of the undergraduate Social Science and Humanities modules they teach.

Findings: Competences for inclusion as University Programme objectives

The mean scores obtained for all 30 items within the context of university programmes suggest that the 30 items are important to be included in university programmes. The mean scores obtained for all items were above the average value of 3.50. The lowest mean score was recorded for item 14, *apply business and management skills to solve real life sustainability problems facing society*. The mean score value for this particular item was 3.98. The highest mean score value was 4.26 for item 27, *appreciation that current actions can impact on the quality of life of future generations*. The Principle Component Analysis resulted in three components being extracted, namely

Component 1: Competences for the expression and demonstration of sustainable development consciousness at individual, professional and societal levels (Items 18, 22, 23, 25, 26, 27, 28, 29 and 30)
Component 2: Competences for local and global comprehension of sustainable development using empirical and unempirical measures (Items 1,2,3,4,5,6,7 and 8)
Component 3: Competences for holistic problem resolution (Items 9, 10, 11, 12 and 13)

Organizing committee members of university wide student programmes are thus encouraged to include *Competences for the expression and demonstration of sustainable development consciousness at individual, professional and societal levels*, *Competences for local and global comprehension of sustainable development using empirical and unempirical measures* and *Competences for holistic*

problem resolution as objectives of the programmes organized to help develop undergraduate engineering students awareness on sustainable development and sustainable engineering.

The components derived from the principle component analysis are significant at several levels. Firstly, it could be incorporated as sustainable development competence categories within the learning outcomes of the Engineering, English Language and Communication, Business and Management, Social Science and Humanities undergraduate engineering modules and as University Programme goals. Additionally, these components could also serve as assessment categories in the evaluation of the extent to which sustainable development competences are included in undergraduate engineering programme modules at the institution of higher learning. The components derived from the analysis could also be used by academicians to assess the undergraduate engineering learner's level of sustainable development competence and could also be used to further understand the learner's self-perceived notions of their own levels of sustainable development competence.

4 Stakeholder interview findings

In addition to the stakeholder survey, in-depth interviews were conducted with participants to gain further insight on the pedagogies and curriculum to achieve and support sustainability education goals as well as issues that need to be considered for the systemic incorporation of sustainability education within the undergraduate engineering programme. Interviews were conducted from July 2011 to February 2012. The interviews lasted between 50 minutes to an hour on average. All interview participants' were purposively selected for the interview process. Interviews were conducted to the point of saturation. The interview analysis conducted in the present study was based upon Creswell (2003) and Bryman's (2008) approaches to thematic qualitative data analysis. Based on the thematic approach, a matrix was then developed to aid the analysis of the interview transcripts. The findings of the analysis are as presented in Table 2. A summary of the themes that emerged is also provided in the table.

Table 2: Summary of findings by category and emerging themes

Category	Themes that emerged	Summary
Pedagogies & curriculum to achieve and support sustainability education goals (19 emerging themes)	Language & communication modules	• Sustainable development issues not discussed in Professional Communication Skills and Academic Writing modules
	The problematics of learning	• Shyness, unable to understand and not wanting to interrupt lecturers result of students not asking questions • Not wanting extra work is a result of students not wanting to ask lecturers questions • Unsure how sustainable development (SD) will be applicable when learners enter the engineering workforce
	Sustainable development in the present undergraduate engineering curriculum	• Lecturers do not take SD seriously • Academicians do not connect their modules to SD • SD dealt through adjunct lectures in Mechanical Engineering • Cost & business environment aspects discussed as SD issues in management modules • Lecturers do not make connection to SD • Engineering modules place less emphasis on SD • No link made between SD and modules taught • No link made by lecturers between the university's green initiatives and modules taught • More interaction and communication needed between lecturers and students • Lecturers with industry experience not open to comments and objections from students • Students do not object lecturers views as opportunity to do so is not given • Been to a lecture where SD was mentioned but not in-depth • Impact of SD on engineering career not discussed by engineering and non-engineering lecturers • Civil Engineering Design module has SD element for students to apply

		SD competences • Lecturers with SD research and work experience mention SD in passing • SD is important although not formally approached through coursework • Industry experienced lecturers mention SD • SD not incorporated in common engineering modules • SD not discussed in non-engineering modules
	Undergraduate research assessment	• Green projects guaranteed an EDX medal even if model is not fully functional
	Improvements for the cultivation of sustainable development culture	• Non-academic SD policies are in place at the university • Lack of communication on non-academic SD policies
	Sustainable development and the engineering curriculum	• SD input obtained through student's own reading • Only 30% of university experience is SD related
	Collaborative sustainable development teaching	• Good idea for non-engineering lecturers and engineering lecturers to invite each other to their courses to teach about SD
	Professional Communication Skills (PCS) module as a collaborative teaching & learning platform	• Collaborative SD teaching not possible for all modules, except PCS, corporate communication and engineering modules
	Limitations of the Community of Practice (CoP)	• CoP outside formal academic hours challenging due to tri-semester • CoP is tied to interest
	Engineering Team Project (ETP) / Fianl Year Projecct (FYP) as a platform for CoP	• Engineering and non-engineering ETP supervisors beneficial to provide multiple input to students • Language lecturers' SD input in ETP/FYP not beneficial • Management lecturers SD input in ETP/FYP beneficial • ETP projects are focused more on output • ETP and FYP not synchronized with industry expectations • Civil students do not learn much from student collaboration through ETP
	Benefits of CoP	• CoP with non-engineering lecturers beneficial • CoP raises SD awareness • CoP able to develop projects with societal and technical aspects
	Sustainable development modules from a non-engineering dimension	• Non-technical modules seen as less important by students. Thus making SD compulsory for these modules would be challenging
	Desired Education for Sustainable Development educator qualities	Enthusiasm, expertise and style of teaching
	Collaborative teaching of sustainable development	• Co-teaching of SD between engineering and non-engineering for technical & societal views
	Sustainable development from a non-engineering dimension	• Engineering lecturers leave bigger impact on students in terms of SD • Non-engineering dimension to ETP and FYP is a good idea • SD is context dependant • May be difficult for non-engineering academicians to teach SD • PCS and Corporate Communication could be used to teach SD • Non-engineering lecturers could work on the critical and reflective dimensions of SD while engineering lecturers could work on the technical dimensions of SD
	Teaching style preferences	• Non-engineering lecturers more fun • Civil engineering lecturers open and friendly • FYP and Civil Engineering Design modules encourage active learning as they are project based
	Two way communication	• Teaching of engineering modules are more one way than 2 ways • Lectures in the university mostly one way and do not really encourage critical thinking
	Sustainable development teaching limitations	• SD not covered in syllabus
	Present teaching philosophy	• Teaching approaches in the engineering programme is more theoretical than practical • Non project based modules do not practice active learning
Issues to consider for the systemic	Methods of integrating sustainable development in the curriculum	• SD as an elective module emulating Engineers in Society, but better to integrate SD in existing modules to avoid an overcrowded curriculum • SD as a compulsory module is better • SD tested through 100% coursework • SD integrated in all modules to make it continuous • SD in certain related engineering modules • Non-engineering modules incorporating SD should make the content more reflective

incorporation of Education for Sustainable Development within the undergraduate engineering programme (8 emerging themes)		• SD should be taught through case studies and student projects, not lectures
	Bridging the gap through university-internship-workplace combination	• Gained SD exposure through internship, not university • Internship and FYP helped understanding of SD • ETP & FYP concentrate on the technical aspects of the engineering project, but in reality the industry places importance on the technical and societal aspects as well • SD was very important during internship experience
	Academicians role in embracing change towards advancement of sustainable development	• Rotation of lecturers within engineering module lectures is problematic especially in modules such as Health Safety and Environment and Engineers in Society
	Sustainability culture & awareness as a concerted institutional practice	• Creation of SD awareness is lacking in the university • More extensive measures to create SD awareness in university is needed • There needs to be more awareness of SD from lecturers • The university should practice SD
	Planning, implementation and monitoring as sustainable development enforcement initiatives	• Better enforcement needed
	Communicating sustainability to university stakeholders	• Talks and seminars by academicians are not well received by students • Talks by industry professionals addressing practical points of view well received by students • Lack of communication on university's SD initiatives • Link between university's SD initiatives and curriculum not made by lecturers • Communication lacking between university management, lecturers and students • Communication needs to be enhanced • Some civil engineering lecturers mention the university's green initiatives to the students
	Sustainable development & undergraduate learners	• Green consciousness low • SD linked to learning interest • Students need to be more passionate about SD
	Desired competences for effective practice of sustainable engineering at the workplace	• The university's teaching approach must be improved to include the importance of the modules, how it would affect the student's career path, the future generation and the environment

The student stakeholder interviews provided in-depth insight on two pertinent issues, namely the pedagogies and curriculum to achieve and support sustainability education goals, as well as the issues to consider for the systemic incorporation of education for sustainable development within the undergraduate engineering programme. A total of 19 themes emerged as a result of the thematic analysis conducted for the issue on pedagogies and curriculum, while eight themes emerged for the second issue. As seen in the summary of the findings, there seems to be mixed student stakeholder views of the two issues explored, with the issues needing improvement outweighing the rest. This is an important indication for the university to put in place constructive measures to improve academic and institutional practices so that it is in line with the philosophies of education for sustainable development as well as the aspirations of the university's main stakeholders, its students.

The findings of the student stakeholder survey and interviews conducted for this study have provided essential evidence as to the extent to which sustainable development competences are significant for the Malaysian graduate engineer. While the survey looked into student stakeholders' voices on the sustainable development competences they deem as necessary for inclusion in the present undergraduate engineering curriculum, the interviews revealed the stakeholders' perspectives on ways in which the university's present philosophies to pedagogy and curriculum development could be improved upon by undergraduate engineering academicians to enable a more effective and systemic inclusion and delivery of sustainable development competences within the undergraduate engineering programme as a whole. The findings of this study would be useful to the Ministry of Higher Education,

especially in formulating sustainability related higher educational philosophies and guidelines for public and private institutions of higher learning in the country. The findings will also be beneficial to institution of higher learning in Malaysia offering engineering programmes, as it would be able to inform university administrators and academicians of the curricula, pedagogical and even institutional aspects that need to be revisited or expanded within their respective institutions goals, engineering programmes or academic modules to make the incorporation of education for sustainable development within technical and non-technical modules a possibility.

5 Conclusion

This study looked into final year undergraduate engineering students' perspectives on sustainable development competences they deem as important to enable them to become sustainability competent engineers when they graduate. The study also addressed their views on the sustainable development competences they deem as necessary to be included as learning outcomes of engineering, English language and communication, business and management and social science and humanities modules. Perspectives were also sought on competences deemed necessary to be included as learning outcomes of university programmes. The study also highlighted their views and concerns on pedagogies and curriculum development approaches to achieve and support sustainability education goals, as well as issues to consider for the systemic incorporation of sustainability education within the engineering programme. The findings of the study indicate the value and level of importance undergraduate engineering learners of this institution place on understanding sustainable development competences as well as honing the knowledge and skills to become sustainability competent engineering graduates. While generalizability is not the aim of this case study, the findings of this study could nevertheless provide Malaysian engineering university administrators and undergraduate engineering academicians teaching engineering, English language and communication, business and management and social science and humanities modules with an understanding of higher education student stakeholders' voices on the significance of including sustainable development competences within the Malaysian undergraduate engineering programme.

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