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EFFECTIVENESS OF TEACHING TECHNICS IN SUSTAINABILITY TOPICS

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Abstract

A two-stage survey has been carried out to investigate students' perception of their own understandings in sustainability topics. The stage one of survey was carried out to test students' perception *before* projects and open sessions on topics regarding sustainability issues held. Stage two, consisting of the same questions were carried out *after* projects and open sessions on sustainability held. Students were assigned a unique project in a team to find a viable solution. The cases selected were recent issues of national importance and great relevance to many individuals. The new approach replaced typical lecture session usually contains definitions, the needs and new trends in sustainability. This information regarding sustainability, usually dynamic and depends on current political, financial, environmental situations, have to be searched, discussed among students and most likely has been obtained by students in other courses. We found a 6% increase in students' comfortibility and confidence in sustainability issues after the implementation of the projects and these open sessions.

Keywords: Education for sustainable development.

1. Introduction

Sustainable development agenda is needed to tackle poverty, growing inequalities, shrinking resources and natural and human-related disasters. Sustainable development must involve the society and shaped through the

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participation of empowered populations. According to one of the reports published by the United Nations Research Institute for Social Development (UNRISD) [1], *socially sustainable development must deliver material well-being, including good health, education, and access to the goods and services necessary for decent living; and social, cultural and political achievements, such as a sense of security, dignity, and the ability to be part of a community through recognition and representation*. Educational institutions are ones of the primary areas as social drivers for achieving sustainable development. Furthermore, the shaping of attitude and values, commitment and skills needed to preserve and protect the environment begins at an early age [2]. Hence, the curriculums in all levels of education are important to shape the social structures and policies towards sustainable developments.

Activities at educational institutions alone are not sufficient to produce great impacts, the interactions of professionals in the educational system are important so that topics related to sustainable developments initiatives could be implemented more effectively [3]. Despite great needs to implement enhancements and improvements in education for sustainable development (ESD) as discussed in Harun et. al. (2013) [3], these initiatives face difficulties [4]. Among the sustainability education communities, there appears to be a growing need in 'competence approach' because of the presumed lack of relevance of current educational provision and the need to implement effective changes [4]. In contrast to drastic change to a particular curriculum, a more progressive and gradual change is more effective to integrate ESD. James and Hopkinson (2010) showed that, in science, technology engineering and mathematics (STEM), in one case at the University of Bradford, gradual, consistent and incremental changes to achieve more sustainability oriented practices received positive reactions from the students and faculty [5].

Based on the suggestions above, we have decided to replace typical lectures regarding sustainability with a new approach. Lectures regarding sustainability which usually include definitions, the needs and trend whereby references to textbooks usually took precedence were replaced with open sessions where students shared their views on sustainability based on surrounding a current issues. Students were assigned a unique project in a team to critically discuss and find a politically, financially, ethically and environmentally viable solution.

2. Methodology

A two-staged survey was conducted among students of *Engineering Ethics and Technological Advancement* course in 2014 at the National University of Malaysia. Since the size of respondents was large, an Internet-based method was used. There were three categories i.e. (i) background, (ii) understanding of design and product sustainability and (iii) understanding of related engineering ethics and technological advancement issues. This course is in year three, first semester. It is important to stress that sustainability topics might have been discussed elaborately in different courses such as design courses. The first category was also designed so that respondents could familiarize with the electronic system. The first category asked student to choose one out of four possible affiliations at the faculty. In the second and third categories, respondents will have to choose either disagree, neutral or agree.

We adopted the techniques suggested to be effective in embedding ESD in sustainability topics [6] such as the use of environmental issues as the basis for experiments or exercises. For example, we used local issues such as the needs of nuclear plants to replace fuel-powered electrical generation plants, the impact of rare-earth material processing plant Lynas, the impacts of raising water level to make way for Baram hydro-electrical plant so on and so forth. We realize the complexity and barrier to implement these initiatives. The fact that this course is in STEM, it is expected that implementing change initiatives and enhancements are more difficult (than within the social science and humanities) [4]. The difficulties in implementing the project is the access of sensitive information about the cases, the number of reviewer needed to evaluate the project and the amount of time to be spent for the entire presentations to be held. We also adopted more soft-skills approach i.e. improve the content of the lectures and presentation and improve attributes of individual lectures [7]. For example, discussions were held among lecturers before sessions or cases in sustainability topics were presented.

Figure 1 shows students from all four engineering departments participated in the survey. Students' affiliation for stage 1 survey is shown in the left hand side and marked (a). Students from the Department of Civil and Structural Engineering (JKAS) made up the most i.e. 30.7%. This was followed by the Department of Mechanical and Materials Engineering (JKMB) (27.9%), Department of Electrical, Electronics and Computer System (JKEES, simplified as Electrical) (27.9%) and the Department of Chemical and Process Engineering (JKKP) (17.1%). The percentage who turned out for this survey was 68.6% (140 out of a total of 204 students participated). In the second stage, students from the Department of Electrical, Electronics and Computer System made the majority with 29.8%, flowed by Departments of Chemical and Process Engineering, Civil and Structural and Department of Mechanical and Materials Engineering. The total number of student participating in the second stage was higher at 92.3% of class size.

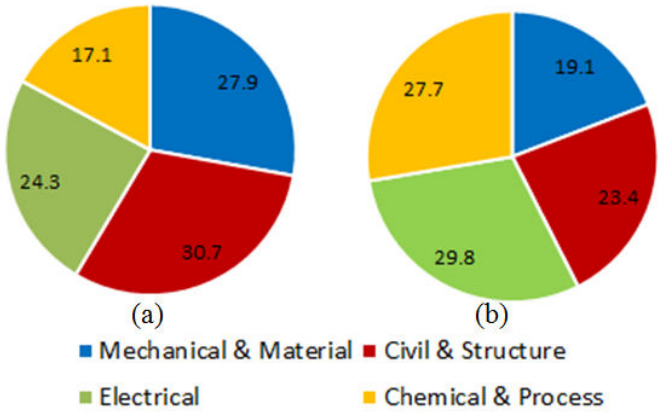


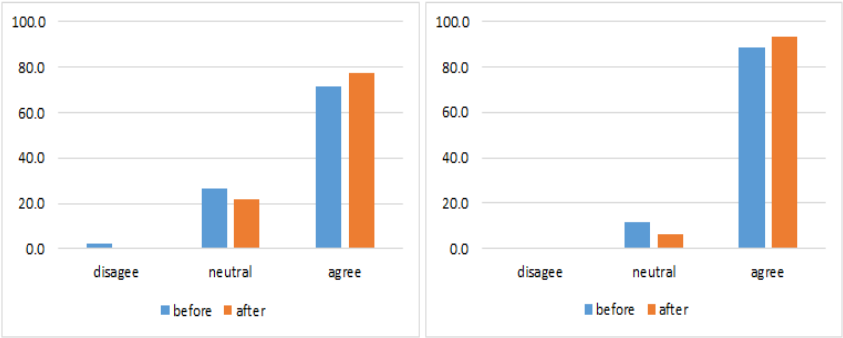
Fig. 1. Student affiliations (who participated in the survey) (a) before and (b) after sustainability topics and project are included/implemented.

The spread of affiliations is important to reflect the broad STEM scopes and engineering practice. We list here the topics and activities on sustainability that were carried out/implemented after stage one (*before*) and before stage two (*after*): (i) open session on definitions, the needs and trends of sustainability, (ii) case studies & discussions and (iii) project in teams. It is important to stress that the team member in the projects were randomly selected from all four departments to reflect practical engineering organisations. Teams were assigned with individual cases, all consisted of sustainability, ethics and environmental concerns. There were 51 unique projects where final reports and presentations in front of two panels and fellows students were required.

3. Results and Discussion

In the second category, the respondents were asked about their understandings of sustainability. Figure 2(a) shows results on question '*Do you understand about design and product sustainability?*' 2.1% and 0.5% chose disagree, 26.4% and 21.8% chose neutral and 71.4% and 77.7% chose agree for before and after accordingly. Firstly, it should be noted that about a quarter chose neutral while almost the rest chose agree. The main difference in the *before* and *after* is the shift of 5 to 6% from neutral to agree after implementation of the initiatives.

Figure 2(b) shows results on question '*Design and product sustainability is important to me'*. No respondents chose disagree. 11.4% and 6.4% respondents chose neutral for before and after respectively. It is evident that half of the votes previously in favour of neutral shifted to agree after the sustainability topics were implemented. The strong 93.6% votes for agree after the implementations is great news and it is hoped that students carry on with tendencies for sustainable solution in their careers.



(a) **(b)**

Fig. 2. Survey question on sustainability:

(a) Do you understand about design and product sustainability?
(b) Design and product sustainability is important to me.

Figure 3 shows results on question '*Would you adopt sustainable design and product although such approach incurs higher costs at the start?*' To start with, the grading of the report contains a few major elements; sustainability, ethics, health and safety (H & S), environmental issues constitutes 20% while critiques with regards to mainstream development, costs and technological transfer constitutes another 20% of the final report marks. These two elements can be viewed as contradicting each other, for example, in the *rare-earth material processing plant Lynas* case, if one chose to align with sustainability, ethics, H & S and environmental issues, she or he almost certainly has to forgo modernization and cost effectiveness of the nations. Students shall be cautious in their preference of expressing their views because of the mentioned green *versus* mainstream requirements.

A marginal 4.3% and 2.7% chose disagree for before and after, a rise from insignificant percentages in Figs. 2(a) and (b). 30.7% and 25.0% chose neutral while 65.0% and 72.3% chose agree for before and after respectively. The shift is again seen from neutral to agree constituting about 6-7% of the votes.

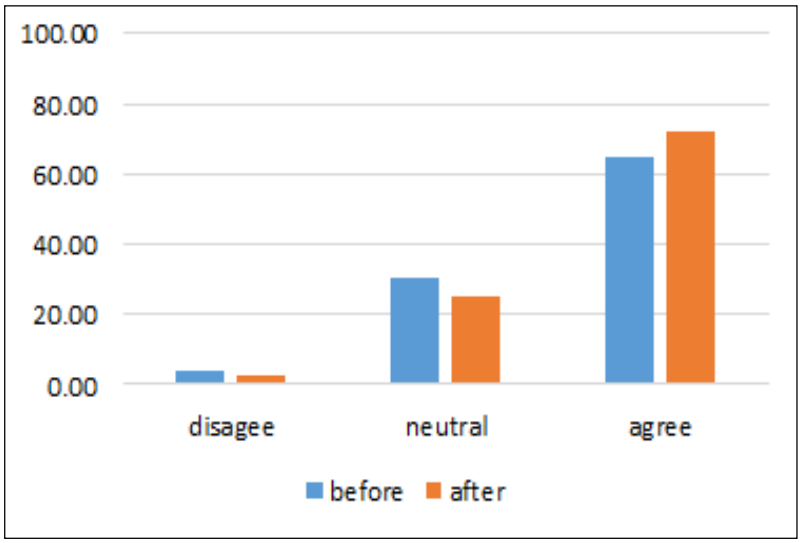


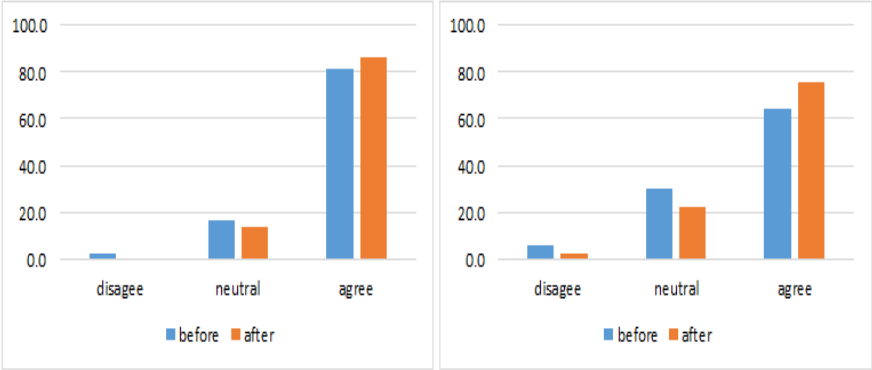
Fig. 3. Survey question on sustainability: Would you adopt sustainable design and product although such approach incurs higher costs at the start?

Figures 4(a)-(b) shows results on the third categories i.e. ethics. Although the major theme of the survey is on sustainability, these related questions were attached. The result in Fig. 4(a) shows that the majority (i.e. more than 80% of students) were confident of their understanding of ethics and technological advancement issues. The shift is seen between neutral and agree for before and after topics on sustainability were implemented.

The trend of the results in Fig. 4(a), i.e., about 6% shift from neutral to agree in both sustainability and ethics categories suggest that it was probably the implementation of project which cause such change in preference. The outcome from Fig. 3 seems to agree with finding from a recent survey across the England

and Scotland; students foresaw barrier in implementing sustainable practices [8]. These barriers in local context might be in the forms of government initiatives, peer or communities appreciations and infrastructures.

Figure 4(b) shows responses to question '*Are you comfortable to share your opinions regarding ethics and technological advancement issues?*' 5.7% and 2.1% selected disagree before and the new initiatives were implemented respectively. Generally there was a shift of 8% increase of students in favour of being comfortable in sharing their opinions regarding ethics and technological advancement after such implementation.



(a) **(b)**

Fig. 4. Survey questions on ethics: (a) Do you understand ethics and technological advancement issues? (b) Are you comfortable to share your opinions regarding ethics and technological advancement issues?

4. Conclusions

The surveys reveal an increase of 6% of students' comfortability on sustainability issues. The initiatives implemented here which were open sessions, discussions on case studies and a unique project regarding sustainability issues, have been within the descriptions of gradual and progressive initiatives in reorienting higher education towards sustainability. The similar magnitude increase of approximately 6% improvements and overall score of beyond 75% in students confidence in topics on sustainability suggest that implementation of such initiatives is effective. It is hoped that such changes address the dynamic and largely uncontrolled needs of community and the nation.

Acknowledgement

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