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ORIGINAL PAPER

Engineering Ethics Education: A Comparative Study of Japan and Malaysia

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Abstract This paper reports the findings of a comparative study in which students' perceived attainment of the objectives of an engineering ethics education and their attitude towards engineering ethics were investigated and compared. The investigation was carried out in Japan and Malaysia, involving 163 and 108 engineering undergraduates respectively. The research method used was based on a survey in which respondents were sent a questionnaire to elicit relevant data. Both descriptive and inferential statistical analyses were performed on the data. The results of the analyses showed that the attainment of the objectives of engineering ethics education and students' attitude towards socio-ethical issues in engineering were significantly higher and positive among Japanese engineering students compared to Malaysian engineering students. Such findings suggest that a well-structured, integrated, and innovative pedagogy for teaching ethics will have an impact on the students' attainment of ethics education objectives and their attitude towards engineering ethics. As such, the research findings serve as a cornerstone to which the current practice of teaching and learning of engineering ethics education can be examined more critically, such that further improvements can be made to the existing curriculum that can help produce engineers that have strong moral and ethical characters.

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Introduction

The world society is currently facing pressing issues and problems that concern the sustainability of the environment, the well-being of the human race, and world peace. Many of the issues and problems are related to the rapid but uncontrolled developments in science and technology, which affects every member of the society, including engineers. Given the nature of their profession, which directly involves many technical activities, such problems have raised a major concern among engineers. As such, engineers have to play an important role in helping to mitigate such issues by being more vigilant and responsible for keeping the world clean and safe. To achieve this noble aim, engineers need to strike an appropriate balance between their commitments to their profession and to the wellbeing of the world, in general, and work place, in particular. In this regard, engineering ethics education plays a pivotal role in preparing engineering undergraduates to become future engineers, who are not only be aware of the socio-ethical issues engulfing the society but also will take a leading role to deal with such issues more actively, as they engage in their professional practice and decision making (Harris et al. 2013).

Without doubt, many technological innovations have both positive and negative impacts on human well-being and the environment. The future engineers need to be exposed to the negative impact of such innovations and how to deal with them (Balakrishnan et al. 2013). Hence, here lies the important role of ethics education in developing responsible and caring future engineers who can discharge their duty as professionals more responsibly. In addition, it is equally important to train engineering undergraduates to think from a multi-dimensional point of view such that they will be able to make well-informed decision in dealing with a diverse range of ethical issues, which invariably may cause many harms to the society and environment.

In recognition of the importance of ethics among professionals, engineering ethics education has become a compulsory course that needs to be taught in all engineering programs as part of the requirements for accreditation in many countries all over the world. For example, Engineering Accreditation Council (EAC) of Malaysia and Japan Accreditation Board for Engineering Education (JABEE) of Japan have mandated all engineering undergraduates to take such a course in the all engineering programs, including electrical, mechanical, and civil engineering programs. Clearly, the main aim of the course is to produce holistic engineers who will be endowed with a strong professionalism, sound morals, and excellent ethics. As such, this course consists of several important relevant topics, such as the elements of the professional codes of conduct (applicable to engineers in their respective country), fundamental concepts of ethics, the wellbeing of society, and environmental protection, among others. In a nutshell, the topics help to intensify the development of highly-trained and responsible engineers.

Traditionally, lecturers rely on a number of pedagogical approaches in their teaching practice, such as large group lectures, tutorials, interactive lectures, lectures by invited guests, service learning, and other related pedagogical methods. Hence, it is hardly surprising for such pedagogical approaches to be widely used in the teaching of engineering ethics to engineering undergraduates in both countries (Balakrishnan et al. 2013; Tochinai and Kanemitsu 2016). Arguably, each different pedagogy brings different benefits for the cognitive and affective developments of students (Delany et al. 2016). Nonetheless, the issue of whether the knowledge and skills acquired by students through these approaches would help them to think and act in a responsible and in an ethical manner has raised some concerns by scholars.

Therefore, it is essential to gauge the attainment of the objectives of ethics education, as outlined by Newberry (2004), and the attitude towards socio-ethical issues among Japanese and Malaysian engineering undergraduates, who have pursued courses related to engineering ethics as part of the requirements of engineering education programs. The undertaking of this comparative study was not only timely but also important as many countries, including Japan and Malaysia, are repositioning their educational systems by focusing more on the holistic development of engineering students, notably on building strong moral and ethical characters of students. Moreover, the comparison of different impacts of engineering ethics education on engineering students between the two countries (using different pedagogical approaches) has not been widely researched to date. In addition, the findings of this study serve as a cornerstone to which engineering educators could refer in their efforts to enhance their current teaching and learning practice of engineering ethics education.

Engineering Ethics Education

As discussed, the developments in science and technology have both positive and negative impacts on the wellbeing of members of the society and the environment in which they live in. More profoundly, the misuse or abuse of such developments would gravely adverse the sustainability of peoples' lives and the future of next generations (Zandvoort et al. 2013). The same researchers have highlighted the problems confronting the global society as the result of the rapid development in science and technology. Such problems are enumerated as follows:

1. Unsustainable developments that cause harm to the environment.
2. Activities that cause harm to humankind.
3. Lack of control of the use of science and technology that leads to negative effects.
4. Unequal distribution of wealth and natural resources that negatively affect the under-privileged.

Obviously, the above problems are not new to engineers, as they have to face a multitude of such problems almost on a continual basis. Arguably, engineers can easily identify such problems, but for engineers to quantify the potential damages (in both quantitative and qualitative measures) associated with these problems is another matter altogether. Therefore, there are some concerns with the current curriculum of engineering programs as to whether the existing learning approach used is appropriate and the learning content are relevant and sufficient to help engineering undergraduates gain the necessary ability to deal with the above issues. Such concerns are echoed by Canlon (cited by Zandvoort 2008), who cautions that the current practice of engineering programs tends to focus more on the technical aspects of student development but less emphasis is given to the development of strong moral and ethical characters. Actually, many teaching practitioners have been debating whether current ethical issues are being properly discussed or highlighted during lectures or tutorials (Zandvoort et al. 2013; Balakrishnan et al. 2013). Hence, lies the need to determine the effective instructional method of engineering ethics education to help produce holistic engineers who will always be aware of the ethical, social, and environmental issues and will take the actions deemed necessary.

Nonetheless, the importance of engineering ethics education in the development of engineers of good ethics has not received the recognition it deserves from the stakeholders, especially from lecturers and students (Pine 2012). Pine (2012) cited that many of the engineering ethics education courses are narrowly structured and majority of the issues discussed are work place dilemma which is not enough to deal with current context of the emerging engineering field in which the current content of ethics education is not in-line with the pace of engineering development. Coupled with the lack of directives from relevant governing bodies and the engineering accreditation agency, this issue seems not to be solved (Troesch 2015). Such a problem seems ironic given that the need for engineering ethics is clearly prescribed in the criteria of engineering program accreditation. For example, Accreditation Board for Engineering and Technology (ABET) of the US unequivocally stipulates the need for ethics education in part 3(f) of its guidelines. In light of the above problems, Zandvoort et al. (2013) and Basart (2015) have suggested several objectives, contents, and features that should be incorporated in engineering ethics education to adequately prepare engineering undergraduates who could deal with socio-ethical issues responsibly. The suggestions for inclusion in engineering courses put forward by the above researchers are as follows:

(a) Moral philosophy, sociology and other disciplines that are pertinent to the engineering profession.
(b) Integration of macro-ethics (i.e., social responsibilities and professions) and micro-ethics (in dealing with individual's behavior) into a single pedagogical framework.
(c) Reasoning and communication skills, which include the capacity to apply critical analysis, in dealing with ethical and social issues.
(d) Awareness of the impact of science and technology on the society and the environment and of the common values shared by both local and global society.
(e) Various effective teaching methodologies that combine multi- and trans-disciplinary approaches that provide diverse activities to help improve engineering undergraduates' attitude and commitment as responsible engineers.

Moreover, Colby and Sullivan (2008) highlight that the teaching and learning of engineering ethics education have been carried out in a number of ways, namely a standalone course, engineering courses that are incorporated with appropriate ethical concepts, a set of ethics modules that will be taught from first year to final year, and service learning with community-based projects.

To date, several instructional innovations have been proposed to help improve the instructions of engineering ethics education in many countries throughout the world. For example, Berne and Schummer (2005) introduced science fiction stories in engineering ethics in the classroom; whereas Zhou et al. (2015) applied creative problem-based learning environment to teach ethics to engineering students. In addition, Hoover et al. (2009) designed an inter-disciplinary course that combines both technical and ethical components; in contrast, Lathem et al. (2011) applied service learning in the teaching and learning process of engineering ethics education.

Surely, the above examples of instructional methods underscore the efforts of educators to improve the current teaching and learning practice of engineering ethics education. In this respect, it is vital for engineering faculties to equip engineering students with sufficient socio-ethical knowledge and awareness that help them to become responsible and ethical engineers in the future. Thus, the attainment of engineering ethics educational objectives and the positive attitudes of undergraduates need to be examined to help determine the effectiveness of engineering ethics education in countries across the globe, including Japan and Malaysia.

The Practice of Engineering Ethics Education

University A of Japan

In 1996, Hiroshi Iino initiated engineering ethics education in Japan by introducing the course 'Society and Engineers', which was developed with the main aim to impart the knowledge of ethics to Japanese engineering students. Actually, having such knowledge is one of the key criteria to qualify as an engineer under the JABEE (Iino 2005; Clark 2000).

In this higher institution of learning (University A), a systematic approach has been practiced in educating its engineering undergraduates with engineering ethics to help produce engineers who can make well-informed decisions and act accordingly to benefit the society and the environment. Moreover, all curricula of this institution have been embedded with ethics education to help cultivate students with the ability to make decisions that are guided by appropriate ethical considerations.

To realize such a goal, courses such as Japanology, The Engineer and Society, and the Principle of Technology are introduced at the second and third year of study. Specifically, these courses help forges and strengthen the noble characters of undergraduates by educating them in the Japanese culture and the role of engineers in Japanese society. Interestingly, a capstone course called 'Science and Engineering Ethics' is taught in their third year of study. This is a 2-credit hours course, which is carried out through several learning approaches, such as lectures, case studies, group discussion and e-learning.

One of the unique feature of this course is the use of an e-learning platform called Agora. Essentially, Agora is a system that has been adapted for Japan's cultural and learning context, which helps undergraduates to learn and analyze case studies in a structured manner. More strikingly, this system provides step-to-step guidelines that can help improve students' knowledge of ethics and decision-making ability in dealing with ethical issues effectively.

University B of Malaysia

The Engineering Accreditation Council of Malaysia (EAC) has imposed a strict criterion requiring every engineering program in Malaysia's institutions of higher learning to offer at least one course that teaches engineering ethics to undergraduates. The emphasis of such subject matter is on educating undergraduates in the relevant engineering professional codes of conduct and public welfare. In University B of Malaysia, a stand-alone course called 'Engineers and Society' is taught to its engineering undergraduates, which covers the following main topics:

- Ethics and Professional Codes of Conduct
- Globalization and Engineering Innovation
- History of Science and Technology Development
- Impact of Science and Technology on Environment—Sustainable Development

Essentially, Engineers and Society is a 3-credit hour course with 2 h spent on lectures and 1 h dedicated to a tutorial. Both lectures and the tutorial are carried out based on a traditional pedagogical approach, which solely relies on a teacher centered approach. Additionally, an assignment is part of the coursework, which requires students to complete a project based on several case studies related to the ethical decision making of practicing engineers.

Research Models and Research Issues

Figure 1 depicts the research model used for this study, which consists of selected variables and their relations that were the focus of the investigation. The aim of this study was to measure the attainment of the objectives of engineering ethics education and the attitudes toward socio-ethical issues among undergraduates of University A and University B. In addition, this study involved a comparative

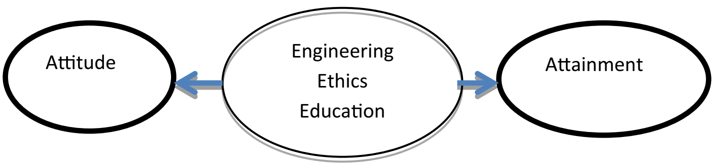

Fig. 1 Research model of the study

analysis that aimed to compare the differences in attainments of objectives and attitudes towards socio-ethical issues between the two institutions. The findings from such an analysis would help highlight the different impacts of engineering ethics education on student learning based on the different teaching methods used by these institutions.

To ensure students would develop sound moral and ethical characters, Harris et al. (in Newberry 2004) proposed nine key objectives of engineering ethics. These nine key objectives are as follows:

(a) Stimulating ethical imagination
(b) Recognizing ethical issues
(c) Analyzing key ethical concepts and principles
(d) Dealing with ambiguity
(e) Taking on ethical issues seriously
(f) Increasing sensitivity to ethical issues
(g) Increasing knowledge of relevant ethical standards
(h) Improving ethical judgment
(i) Increasing ethical will power

These nine key objectives, as outlined by Harris et al. (in Newberry 2004), cover the aspects of emotional engagement, intellectual engagement, and particular knowledge. Firstly, emotional engagement aims to fulfill the students' affective needs and to develop their ability to resolve ethical issues. Secondly, intellectual engagement aims to improve the students' critical thinking in dealing with delicate ethical issues. Finally, particular knowledge concentrates on building students' knowledge of ethical codes, principles, and cases of ethical standards. Actually, the above objectives are well aligned with the ethical education objectives of JABEE, Japan and EAC, Malaysia.

Attitude is an important element that needs to be emphasized by engineering educators, in addition to knowledge and skills. Attitude determines the proper direction to which knowledge and skills (acquired by engineering undergraduates) could be applied effectively (Lathem et al. 2011). Therefore, it is important that engineering undergraduates should be guided to develop the right attitude toward socio-ethical issues, such that they can carry out their duty responsibly and ethically. As such, the imperative to assess engineering undergraduates' attitude towards socio-ethical issues should not be overstated, as it provides a clearer view of the impact of engineering ethics education in preparing future engineers who can deal with socio-ethical issues (related to various engineering fields) professionally (Hayden et al. 2010).

To explain the concepts of attainment, King (1981, p. 19) posits that "the theory of goal attainment explains how individuals grow and develop through their lifespan and experience the changes in structure and function of their bodies over time, which influence their perception of self through gaining knowledge via learning". As such, this theory can be utilized to assess the attainment of key objectives of engineering ethics education, such as in this study. More importantly, the attainment of the objectives of engineering ethics education needs to based on a personal level, which reflect the knowledge that they have acquired in the classroom and their personal beliefs of engineering ethics.

For affective domain, the Affective–Cognitive Consistency Theory postulates that the affective component of an attitude system is changed with new information, such that an individual will undergo a change in attitude once he or she processes such new information (Zimbardo and Leippe 1991; Simonson and Maushak 1996). Hence, the engineering students' attitude toward social and ethical issues is shaped by the knowledge and skills that they have gained in the classroom. Armed with such knowledge and skills, students will be able to judge intricate socio-ethics issues more critically and act accordingly. Thus, both theories helped guide this comparative study in which the attainment of objectives of engineering ethics education and attitude toward socio-ethical issues between Japanese and Malaysian engineering undergraduates were compared and analyzed. Arguably, any differences between the above objectives might be attributed to the different learning methods used. Based on the critical review of relevant research findings and theories, which highlighted the importance of such attainments and attitude, the researchers carried out this comparative study with the following aims:

- (Ra) To examine the perceptions of engineering students of University A, Japan, and University B, Malaysia with regard to the attainment of the nine key objectives of engineering ethics education.
- (Rb) To examine the attitudes of engineering students of University A, Japan, and University B, Malaysia toward socio-ethical issues of engineering.
- (Rc) The compare the above perceptions and attitudes between engineering students of University A, Japan and University B, Malaysia.

Methodology

In this investigation, the researchers focused on Japanese and Malaysia engineering students' perceptions on the attainment of objectives of engineering ethics education and their attitudes towards socio-ethical issues. Two groups of respondents, consisting of 163 engineering students from University A, Japan and 108 engineering students from University B, Malaysia, were recruited via a random sampling process. The recruitment of these respondents was facilitated by the commitment and co-operation given by the respective lecturers and administrators of the selected universities. All respondents of this study had successfully pursued all the required course(s) related to engineering ethics.

The respondents were surveyed using a questionnaire containing several statements related to relevant ethical issues. Each statement of the questionnaire uses a 5-point Likert-type scale, ranging from "5" (strongly agree) to "1" (strongly disagree).

The first part of the questionnaire measured the students' perception of attaining the nine key objectives of the engineering ethics education. The statements of the perceptions were adopted from Balakrishnan et al.'s (2013) work, which were based on the proposed objectives by Harris et al. (in Newberry 2004). The statements for the second part of the questionnaire were formulated based on Lathem et al. (2011) to gauge students' attitude toward socio-ethical issues in the engineering field. Similar statements were adopted from the study of Balakrishnan et al. (2013), which have high coefficients of reliability.

Results and Discussion

The data collected were analyzed using the Statistical Package for Social Science (SPSS). The reliability coefficients (Cronbach Alpha Value) for the first part (which measured students' perception of the attainments of the objectives of ethical education) and the second part (which measured students' attitude toward socio-ethical issues) of the questionnaire were 0.875 and 0.873, respectively, which were deemed reliable (Creswell 2013). In addition, the data were tested to be normally distributed, thus justifying the use of parametric tests to address the third research objective.

For the comparative analysis of the differences in students' perception of the attainments and theirs attitudes between Japanese and Malaysian engineering undergraduates, paired two-tailed *t* test for each statement was conducted. Specifically, the un-pooled method was used, given that the standard deviations of Japanese students' responses were more than twice the standard deviations of Malaysian students' responses (refer to Tables 1, 2).

Tables 1 and 2 show the mean scores and standard deviations of Japanese and Malaysian students' responses to Part A and Part B of the questionnaire.

Table 3 shows the *t* values of the paired two-tailed *t* test.

As shown in Table 1, the mean scores (and standard deviations) of Japanese engineering undergraduates' perception of the attainment of nine key objectives of ethics

Table 1 The mean scores and standard deviations of students' responses to Part A of the questionnaire

Statement	Mean (Japan/Malaysia)	SD (Japan/Malaysia)
Part A		
A1: Help stimulate my ethical imagination	4.02/2.72	0.60/0.50
A2: Help me to recognize ethical issues	4.21/2.80	0.58/0.52
A3: Help me to analyze key ethical concepts and principles	4.05/3.02	0.51/0.60
A4: Help me to deal with ambiguity	3.92/2.57	0.75/0.65
A5: Encourage me to take ethics seriously	4.22/2.65	0.65/0.52
A6: Increase my sensitivity to ethical issues	3.97/2.82	0.64/0.50
A7: Increase my knowledge of relevant standards	4.21/3.70	0.65/0.77
A8: Improve my ethical judgment	4.09/2.92	0.61/0.60
A9: Increase my ethical will power	4.02/3.15	0.56/0.55

Please indicate on the scale of 1–5 (1—strongly disagree, 2—disagree, 3—neutral, 4—agree, and 5—strongly agree)

Table 2 The mean scores and standard deviations of students' responses of Part B of the questionnaire

Statement	Mean (Japan/Malaysia)	SD (Japan/Malaysia)
Part B		
B1: I am confident to solve engineering problems ethically	3.26/2.20	0.69/0.51
B2: I am aware of the role of engineers in today's society	3.83/3.10	0.66/0.62
B3: I am aware of the impact of engineering on economic issues	4.17/2.70	0.58/0.55
B4: I am aware of the impact of engineering on the environment	4.27/2.92	0.55/0.50
B5: I am aware of the impact of engineering on humankind	4.28/3.03	0.58/0.60
B6: I believe in the importance of ethics in every decision-making process	4.12/2.83	0.60/0.62
B7: I believe in the importance of being sensitive to the public's views in engineering design/projects	4.17/3.02	0.61/0.50
B8: I believe in the importance of sustainability issues in engineering design/projects	4.13/2.28	0.56/0.55

Please indicate on a scale of 1–5 (1—strongly disagree, 2—disagree, 3—neutral, 4—agree, and 5—strongly agree)

Table 3 The *t* values of the paired two-tailed *t* test

Statement	*t* value
Part A	
A1: Stimulate my ethical imagination	4.615*
A2: Help me to recognize ethical issues	4.712**
A3: Help me to analyze key ethical concepts and principles	4.017**
A4: Help me to deal with ambiguity	4.124*
A5: Encourage me to take ethics seriously	3.775*
A6: Increase my sensitivity to ethical issues	4.512*
A7: Increase my knowledge of relevant standards	3.812*
A8: Improve my ethical judgment	4.414*
A9: Increase my ethical will power	4.281*
A10: Help me to manage ethical crisis	4.335*
A11: Expose me to ethical decision making	5.032*
A12: Expose me to conflict-resolution techniques	5.119*
Part B	
B1: I am confident to solve engineering problems ethically	1.221
B2: I am aware of the role of engineers in today's society	4.314*
B3: I am aware of the impact of engineering on economic issues	4.712*
B4: I am aware of the impact of engineering on the environment	4.510*
B5: I am aware of the impact of engineering on humankind	3.919*
B6: I believe in the importance of ethics in every decision-making process	4.571*
B7: I believe in the importance of being sensitive to the public's views in engineering design/projects	3.867*
B8: I believe in the importance of sustainability issues in engineering design/projects	4.627**

*$p < 0.05$; **$p < 0.01$

education were high, ranging from 3.92 (0.51) to 4.22 (0.75). By contrast, the mean scores (and standard deviations) of Malaysian engineering undergraduates' perception of the same attainment were average, as evident by a range of mean scores from 2.57 (0. 65) to 3.70 (0.77). Evidently, the impact of engineering ethics education of University A, Japan on the positive perception of attainment among its undergraduates was significantly higher than those of undergraduates of University, B of Malaysia. Arguably, such a difference in their perceptions of attainment may be partly attributed to the different teaching mechanisms or approaches of ethics education used in respective institutions. As such, this finding helped the researchers to address the first research objective of the study.

To address the second research objective, the mean scores of respondents' attitudes were examined. As shown in Table 2, the mean scores (and standard deviations) of Japanese engineering undergraduates' attitudes toward ethical issues were high, ranging from 3.26 (0.55) to 4.28 (0.69). In contrast, their counterparts from Malaysia attained lower mean scores of perceived attitudes, which ranged from 2.20 (0.51) to 3.10 (0.62). Clearly, the attitude of Japanese engineering undergraduates' toward ethical issues was significantly higher than that of Malaysian engineering undergraduates. Again, this different finding, which favored Japanese engineering undergraduates, seems to stem from the different teaching approaches used by both institutions. More importantly, the above two findings underscore the superior impact of the teaching approach used by University of A, Japan on its student learning of ethics, as compared to that of University of B, Malaysia.

Apparently, the overall pedagogical mechanism utilized by University A, Japan, which combines both traditional and interactive case-based instructions, had a positive impact on respondents' perception of the attainment of key objectives of ethics education and attitude toward engineering socio-ethical issues. These findings are consistent with the findings of Antes et al. (2009), which led them to conclude that interactive case-based learning of ethics education is one of the key elements for meaningful learning experiences that help students to appreciate the importance of ethics in engineering profession. Another plausible reason to explain the higher perceived attainment of objectives and positive attitude of Japanese engineering undergraduates is that University A uses a systematic structure of engineering ethics education that cuts across all years of studies (from the first year to final year of study). Obviously, such longer learning span provides sufficient opportunities for its undergraduates to learn and practice good ethics throughout their study. Overall, the above findings suggest that the overall structure of engineering ethics education courses and pedagogy of ethics education of an institution will have a huge impact on the attainment of the objectives of engineering ethics education and on the development of positive attitudes toward socio-ethical issues among its engineering undergraduates.

Interestingly, the mean scores of perceived attitudes of Japanese and Malaysian respondents for statement B1 in Part B of the questionnaire (which assessed students' confidence to solve engineering problems ethically) were 3.26 and 2.20, respectively, which was in sharp contrast to the mean scores of other statements. This particular finding suggests that there is a gap existing in the engineering ethics education practices, especially in University A, Japan (which had higher mean scores for the remaining items tested in Part A and Part B). It could be reasonably argued that this peculiar finding might lie in the pedagogical method used that is seemingly less effective to improve students' confidence in solving problem.

Colby and Sullivan (2008) (in Troesch 2015) argue that a heavy reliance on case studies in engineering ethics education could impede students' decision-making process as such an approach does not impose students to think really hard in making the right choices. Moreover, Lynch and Kline (2000) assert that the standard use of "pre-packaged" case studies does not reflect the real conditions of engineers' ethical decision-making dilemmas. Surely, these revelations may entail both universities to critically review the contents of case studies used, given that in University A, Japan uses a case-study mechanism in their interactive teaching of ethics (via the e-learning platform Agora) and University B, Malaysia uses case studies for student assignments. More importantly, real or genuine case studies to help expose students to real world situations need to be embedded in the curriculum to improve students' confidence in making good ethical decisions. Likewise, more meaningful case studies could be integrated into the learning process of related technical courses to provide more opportunities for students to learn and apply good ethics in their future profession and moreover, improve the confidence level of the students.

Addressing the third research objective entailed a close examination of the differences in Japanese and Malaysian respondents' responses for all statements in Part A and Part B of the questionnaire. The paired *t* test procedure was performed to detect if such differences were significant or not. As highlighted in Table 3, the analysis revealed that almost all the differences in the respondents' item responses were significant, signifying that the perceived attainments of objectives of engineering ethics education and attitude toward engineering socio-ethical issues between the two groups of undergraduates from two different institutions differed significantly. In addition, it is worth noting that the difference between the groups' responses for item B1 of Part B (which relates to their confidence to solve problem ethically) was not significant. Coupled this with the previous related finding, it seems that engineering ethics education of both universities has less impact on building the confidence of undergraduates to help them make proper ethical decisions. In light of these revelations, it is important to re-strategize the overall mechanism of the learning approach of engineering ethics education in both countries, particularly in Malaysia. As demonstrated in this study, the pedagogy and structure of ethics education holds the key to developing a meaningful and effective learning experience that enables learners to acquire the appropriate knowledge and skills that help mold engineering undergraduates into engineers who imbibe not only strong professional principles but also sound ethical principles.

Conclusion

This study has revealed several interesting findings with regard to engineering ethics education in University A, Japan and University B, Malaysia. Firstly, the attainment of objectives of ethics education among engineering students of University A, Japan was higher than that of engineering students of University B, Malaysia. Secondly, the attitude towards engineering socio-ethical issues among the respondents of University A, Japan was far more positive compared to that of the respondents of University B, Malaysia. Finally, there were significant differences in the attainment of nine key objectives of engineering ethics education and in the attitude towards socio-ethical issues of engineering. However, such significant differences did not materialize in the confidence of engineering students of both universities in solving engineering ethical problems.

Clearly, the research findings emphasize the imperative of using a well-structured, integrated, and innovative ethics pedagogy to help students attain the objectives of an engineering ethics education and to help them develop positive attitudes toward ethical issues. Furthermore, the use of case studies to expose students to appropriate ethical decision-making processes could be further enhanced by integrating real and recent engineering problems of both local and global contexts into the learning process. Such integrated case studies could help improve students' confidence in dealing with real ethical issues as experienced by professional engineers. Overall, the research findings shed some light on the effectiveness of the current teaching and learning practice of engineering ethics education, which obviously needs further improvement. It is therefore the onus of engineering faculties, which offer various engineering programs, to re-examine deeply the current pedagogical practices of engineering ethics education, and to take appropriate actions as deemed necessary. Dereliction on the part of the stakeholders will have serious implications on the quality of teaching and learning of the subject matter.

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