The Impact of Engineering Education Accreditation Systems on Curricula and Teaching Practice

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Abstract

Previous research on engineering education reform has tended to rely on quantitative data obtained from questionnaire surveys. The present study seeks to examine the impact of engineering education accreditation implementation over the past eight years from the multiple perspectives of faculty members, department chairmen and deans of colleges of engineering in Taiwan. A total of 471 valid questionnaires were collected from the deans, department chairmen and faculty members. In addition, in-depth interviews were conducted among 20 subjects from colleges of engineering located in the northern, central and southern areas of Taiwan. The results from the questionnaire survey are quite impressive with over 70% of faculty members expressing their agreement with almost all items in the questionnaire. Nevertheless, it should be noted that although the questionnaire survey responses revealed positive responses toward continuous improvement, there was a significant disparity between the questionnaire responses and the information provided during the in-depth interviews. On the basis of the findings and discussion presented above, the following two conclusions and recommendations are addressed. First of all, although engineering college faculty members did make certain adjustments to their curriculum planning and teaching activities, there is an urgent need for more professional development activities to align their professional expertise with respect to outcome-based assessing approaches, e.g. how to integrate the results of student evaluation as a basis for the continuous improvement of their courses. Secondly, accreditation could have the negative effect of leading faculty members to feel that the university authorities do not believe they are capable of doing their jobs properly. Future research in this field may involve the collection of multiple assessment resources in order to provide a paradigm of best practice for outcome-based accreditation approach.

Keywords: Engineering education accreditation; continuous improvement; curriculum and teaching

1. Introduction

Over the past decade, institutions of higher education have invested considerable amounts of time, money, faculty members, and laboratory facilities towards improving teaching quality (Brawner et al., 2001; Salegna & Bantham, 2002). The underlying goal of engineering education accreditation is to assure the quality of the graduates, and to encourage engineering departments and graduate schools to revise their curricula by utilizing outcome-based teaching and assessment.

However, for many instructors in colleges of engineering, the adoption of outcome-based accreditation system has brought problems. Firstly, instructors are often unsure as to how much scope they should give students to explore a particular theme, and what their expectations should be. In some cases, this uncertainty leads to a failure to implement in-depth study where it is needed. Secondly, many faculty members fail to see that student learning outcome are linked with faculty members' curriculum planning, teaching and assessment approaches (Harper & Lattuca, 2010). Chambers and Ferndandez (2004) suggest that sometimes faculty members who resist continuous improvement efforts do so because they had difficulty appreciating the simultaneous role of students as customers and evaluators. In some cases, accreditation can have the negative effect of leading faculty members to feel that the university authorities do not believe they are capable of doing their jobs properly (Arreola 2007). Similarly, Eijkman, Kayali and Yeomans (2009) also note that, while program refinement may provide faculty members with substantive opportunities to improve, it tends to be subject to considerable challenges and often encounters resistance and refusal.

Thirdly, many instructors in colleges of engineering assume that engineering students' learning outcome is limited to the accumulation of "hard skills." As a result, the content of traditional engineering courses tend to be limited to getting students to demonstrate knowledge of the basics by producing written or oral reports. Finally, there is the question of how, given the limited amount of class time available, instructors can manage both to inculcate the basic knowledge that students need to acquire, and also help students to develop higher-level skills such as those relating to inter-disciplinary communication.

2. Continuous Improvement of the Curriculum

Engineering education accreditation systems offer several benefits when implemented within a university. In the past, curriculum planning has generally been undertaken by individual faculty members, with each instructor making an independent decision as to what content should be presented in a given course. In this condition, it appeared almost impossible to improve a curriculum (Lattuca & Stark, 2009).

Faculty members in a college of engineering should become effective cultivators and evaluators of their students' learning in order to help their students to prepare for the changing world of the future. To be effective in this role, faculty members should be engaged in continuous, ongoing evaluation of curriculum planning, taking into account differences between individual students, and their students' learning capabilities.

However, most faculty members in higher education do not have formal training in outcome-based curriculum development and teaching approaches, and have limitied opportunities to develop their pedagogical skills (Harper & Lattuca, 2010).

Engineering education accreditation thus becomes a pivotal point and a unique opportunity for faculty members to review the way they implement their curriculum, and the way they evaluate their students' learning effectiveness.

3. Methodology

This study triangulates a questionnaire survey, in-depth interviews and non-participatory observation of accreditation teams' on-site visits in order to develop a holistic understanding of the phenomena as engineering education accreditation is being implemented. It was anticipated that the interviews and observation would make it possible to supplement the findings of survey results with additional insights and interpretation.

3.1 The Questionnaire Survey

In order to gain a clear understanding of the impact that engineering education accreditation has brought, this study compiled a questionnaire that addressed the key aspects of outcome-based teaching and assessment approaches. The main purpose of this survey was to determine the views of faculty members, department chairs and deans at colleges of engineering in Taiwan as to the impact of engineering education after the implementation of outcome-based accreditation. This study adopted the faculty questionnaire developed by Lattuca, Terenzini and Volkwein (2006). To evaluate reliability, this study used Cronbach's alpha to measure the confidence level for each construct, finding that all the confidence coefficients were higher than 0.70. The overall confidence level for the questionnaire survey as a whole was 0.966, exceeding the 0.70 reliability coefficient specified in Cronbach (1951).

By May 2011, a total of 447 departments and graduate schools in Taiwan had been conditionally accredited. Of the 1,135 questionnaires distributed to all levels of faculty members of engineering departments, 471 were completed and returned, giving a response rate of 41%.

3.2 In-depth Interviews

The aim of the in-depth interviews was to examine how the implementation of engineering education accreditation has affected teaching and assessment methods of faculty members in departments of engineering. When selecting volunteers for in-depth interviews, the following prerequisites were used:

(1) The department to which the interviewee belonged should have already entered the second cycle of accreditation.

(2) The interviewee has demonstrated a considerable level of interest and concern regarding the accreditation process.

(3) The interviewee played a key role during the accreditation process.

The rationale for using these three prerequisites was to ensure that, regardless of whether the interviewee held a positive or negative attitude towards accreditation, they were able to perceive the accreditation process from a broad and unbiased perspective.

In this section, interviews were conducted with a total of 20 faculty members from colleges of engineering, information technology or electrical engineering who were

willing to share their views frankly. To gain a more comprehensive picture of faculty members' responses to accreditation, the interviewees included faculty members who had been actively involved in the process of implementing accreditation, or who were serving as a department head. Of these, many of the interviewees had served both as a member of the accreditation committee and the dean of the college of engineering or some other administrative role within their universities.

3.3 Questionnaire Analysis

In the present study, the questionnaire data for the effective sample was coded and registered. SPSS for Windows 15.0 statistical software was used for data processing and analysis.

3.4 Interview Implementation and Analysis

Since the qualitative data were derived mainly from interviews with faculty members, department heads and deans, content analysis was performed as follows.

(1) First, the researcher read through the whole transcript, closely examining parts that were related to the present study. This preliminary reading could be used to develop and revise the research topics, while also identifying sections of the transcript not relevant to the research topics.

(2) In the coding process, the collected data was broken down into individual units, which were closely examined and compared; questions were then posed in regard to the phenomena reflected in the data.

(3) Close perusal of the interviewees' answers was combined with extended reflection on the relationship between the interview content and the research topics and on what this relationship implied.

4. Findings and Discussion

Figure 1 shows the results obtained for each questionnaire item in graphical form. The average score for each item was in the range of 4 – 4.7 out of 6 (strongly disagree=1 and strongly agree=6).

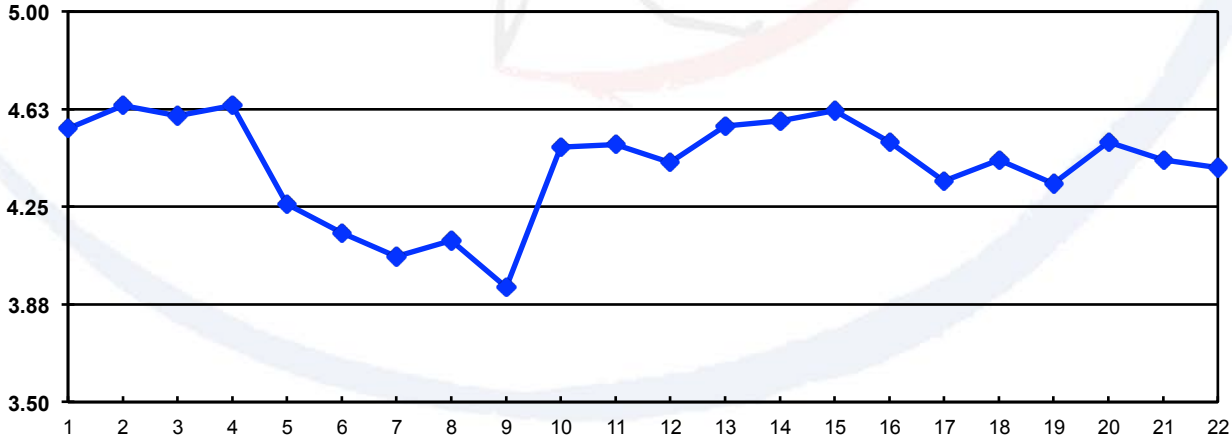

Figure 1. Average Score for Each Questionnaire Item

The highest average scores were for questionnaire items (2) "I am better able to explain to the students in the first class of the semester the capabilities they will need for the course" (M = 4.64) and (4) "I am better able to give students a detailed

explanation of the course objectives for the course they are taking" (M = 4.64). The lowest average score was for item (9) "I am more likely to use various assessment methods to enhance students' ability to read engineering drawings" (M = 3.96). These results indicate that, after the implementation of engineering education accreditation, faculty members at engineering-related departments are better able to give students a clear idea of course objectives, and of the capabilities they will need, but they seem to unlikely to implement extra assessment tools to enhance students' ability.

4.1 Curriculum Planning and Teaching

As can be seen from the figure below, over 60% of faculty members reported giving students clear information to explain curriculum design and planning. Furthermore, faculty members were generally willing to make adjustments to their teaching in line with actual circumstances in the class. This is significant since students' learning process and their incorporation of ongoing feedback are an integral part of ongoing curriculum evaluation and revision (Harper, 2008). The key issues here relate to whether faculty members in engineering departments and graduate schools perceive outcome-based curriculum planning as a process of continuous improvement.

However, we need to point out that most faculty members of colleges of engineering have never undergone formal training in curriculum design, teaching methods or student evaluation methods. Therefore, the requirements of engineering education accreditation often prompted negative comments from faculty members. Nevertheless, the qualitative results also indicated that, when asked to modify their curriculum or teaching methods in response to the needs of accreditation, some faculty members would comply with these requests and thus gradually developed their internal motivation for linking the accreditation process and continuing improvement of their teaching and assessment approaches. These professors noted that, during their process of accreditation-related change, they had benefited not only from learning more about how students learn, but also from being encouraged to examine whether there were any changes they could make to their own teaching. These results are in conformity with the findings by Harper and Lattuca (2010) that engineering education accreditation can help faculty members to achieve professional growth.

4.2. Student Evaluation and Application of Results

As can be seen from Fig. 2, around 80% of the faculty members expressed slight agreement, agreement or strong agreement with all of the questionnaire items relating to student evaluation and the application of results. This suggests that faculty members already have a high level of awareness regarding the need for various student evaluation methods and understand how to apply the evaluation results to improve their courses. By and large, faculty members appear already to have a good grasp of what is required for evaluation.

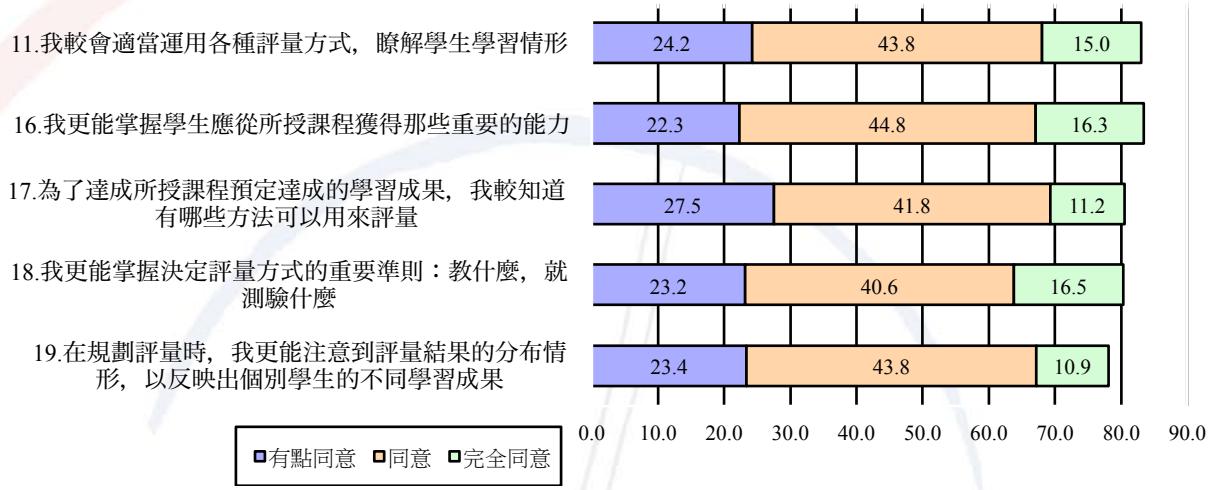

Fig. 2 Percentage of Faculty members Expressing Agreement with Items Relating to Student Evaluation and Application of Results

The interview results, however, showed a somewhat different picture from that suggested by the survey results. During the interviews, some faculty members felt that the evaluation methods they used had not changed significantly. Most of the faculty members reported that the method of evaluation they used depended on the nature of the class. In cases where a written test was the most appropriate evaluation method, they would continue to use written tests, and this applied particularly to basic theory classes. Depending on the nature of the class, some faculty members used a "competition" approach emphasizing creativity instead of conventional exams for end-of-semester evaluation.

One point that is quite clear is that most of the faculty members who were interviewed had received their Ph.Ds in engineering, and therefore had not undergone formal training in pedagogical knowledge of teaching and assessment. As a result, they were unfamiliar with different evaluation methods and the functions of each method. As noted in Harper (2008), faculty members often lack the training to extend their assessment activities beyond traditional measures such as exams and term papers.

[Q: Are you making less use of written tests?] "No, no I'm not, and given the nature of the class I probably won't be doing that." (B)

[Q: Is there any difference in the evaluation methods you use?] "I haven't changed the methods I used, and I don't think other people have changed theirs much … In my case, the evaluation I perform takes the form of two mid-term exams and one end-of-term exam, something along those lines …" (L)

"Of course, it depends on the nature of the course. We do have a competition for creative mobile phone handset design, and there are some experimental classes where

the students have to perform a demonstration at the end of the semester. In the past, the experimental classes didn't make so much use of demos, but now … they seem to have taken off … but you still need a written test so you can check whether the students have acquired the fundamentals … (I)

As can be seen in Fig. 2, in the case of item 19, "When planning student evaluation, I pay more attention to the question of evaluation results distribution, so as to be able to reflect the different learning outcomes of different students", the percentage of faculty members expressing slight agreement, agreement or strong agreement was relatively low. Faculty members seem to feel it is pointless to implement further analysis of students' learning performance based on their student evaluation results. The interview results confirmed that teachers mainly viewed evaluation results as something just to be kept on file.

"How can you verify that your students have acquired the necessary competences? All the instructor can do is to hand out lecture notes; lecture notes can demonstrate that the instructor has actually taught the material. Also, there are written exams; written exams can show what you expected students to learn. And when the students have finished the exam, we keep the examination papers on file …" (B)

"We haven't really tried to analyze any of that … Actually, I should say that, what it asks us to do, what we are asked to do, we do all of that, but the other stuff, the analysis, we haven't been doing that … It's really a case of we just don't have the manpower available to do it, so we can only cover the basics." (H)

Instructor B felt that students' competencies could be evaluated simply by submitting their lecture notes together with the students' written exam papers and transcripts. He assumed that any further analysis could be left to the assessment committees. This is understandable, as few faculty have training in curriculum development or revision, making it difficult for them to implement the feedback they receive about student learning (Wankat, Felder, Smith & Oreovicz, 2002; Harper, 2008).

In the vast majority of departments, faculty members have only submitted student transcripts and grade reports to the accreditation committees and never gone beyond that to explain their students' learning performance or the extent to which the students have succeeded in acquiring competencies. However, if faculty members do not implement further analysis of the evaluation results, it would be difficult for them to maintain continuous improvement.

Many faculty members mentioned that they were attending regular meetings to discuss the curriculum. This is similar with the study of Lattuca et al. (2006) that found 60% of faculty members at colleges of engineering reported having regular curriculum discussion meetings with their departments. However, these meetings all took the form of curriculum planning meetings to discuss the launch of new classes, rather than end-of-semester evaluation meetings, or meetings to brainstorm how to improve the curriculum based on the multiple sources contained in the evaluation results and the key principles of continuous improvement.

The present study differs from that by Lattuca et al. (2006) in that it draws more precise distinctions between curriculum planning, teaching methods and the use of

multiple evaluation methods. Nevertheless, there are similarities between the two studies. Lattuca et al. (2006) found that over three-quarters of department heads felt that they had done the best they could to integrate the elements such as communication skills, teamwork skills, utilization of modern tools, lifelong learning and engineering design in the curriculum mapping. In addition, between one-half to two-thirds of faculty members reported having increased their use of teaching strategies to enhance students learning in a more active manner. This finding is similar to the results reported by Lattuca, Yin and McHale (2010).

The disparity between these studies in terms of the questionnaire survey results lies in the fact that Lattuca et al. (2006) found over 90% of the faculty members reported making a deliberate effort to improve their student evaluation methods, and that over half of the faculty members felt they personally had made a significant improvement in this regard. Similarly, Lattuca, Yin and McHale (2010) reported a substantial increase in the share of faculty members using activity-based assessment methods. By contrast, though the questionnaire survey results from the present study did show that faculty members had a reasonable grasp of multiple assessment methods, during the interviews some interviewees reported that it was necessary to continue relying on written exams as the direct measures of their students' learning.

While the research undertaken by Lattuca was largely based on quantitative data, qualitative data constitutes an important source of evidence in the present study. What appears from the questionnaire survey to be quite impressive results (with over 70% of faculty members expressing agreement with almost all questionnaire items) is in some cases undermined by the information provided by the in-depth interviews. For example, it appears that the reported increase of practical applications and teamwork by faculty members is mainly attributable to the need to be able to demonstrate that this is being undertaken (for accreditation purposes). And though faculty members appear from the survey results to be using a diverse range of evaluation methods, the interviews suggest that, in reality, this is not the case. An even more significant point is that faculty members are apparently finding it difficult to implement the analysis and discussion of student evaluation results.

5. Conclusions and Implications

The goal of stimulating continuous improvement in engineering education through the accreditation process is a mission-driven approach. The emphasis is on constantly-improving processes, as well as the alignment between teaching and assessment. In other words, student learning outcomes should be systematically linked with faculty members' curriculum planning, teaching and assessment approaches. To develop the curriculum mapping, this process of continuous improvement also stresses faculty members' continuing professional development and training, as well as collaborative decision-making within their departments.

The present study examines the impact of engineering education accreditation implementation on continuous improvement. This study uses a questionnaire survey, in-depth interviews and a literature review to analyze and explore the benefits, and challenges relating to the implementation of engineering education accreditation. On the basis of the findings and discussion presented above, the following conclusions and recommendations are described below.

As a result implementing engineering education accreditation, these programs have begun to pay more attention to what elements faculty members need to include in their teaching plans, e.g. educational objectives, teaching strategies, corresponding learning outcomes and evaluation methods. Faculty members also need to be aware of whether their teaching objectives and course content are properly aligned. As regards actual teaching, many faculty members reported that, because of accreditation, they are now more likely to assign practical and hands-on work for their students, and to incorporate more cooperative learning activities into their courses. However, some faculty members still rely on written exam and other traditional evaluation methods.
While the questionnaire survey results showed that most faculty members reported positive changes in their curriculum planning and teaching following the implementation of engineering education accreditation, this was not fully supported by the data obtained through the interviews. For example, the interviews showed that although faculty members did seek to expand the amount of time for hands-on practices, group discussion, team work, or global issues in the classes they taught. In fact, they appeared to have made these modification largely to fulfill the requirements of accreditation, and only a minority of faculty members had changed their teaching strategy from their own internal motivation. As regards evaluation, in the interviews the faculty members displayed a lack of familiarity with different evaluation methods, and evaluation results were merely kept on file without further analysis or attempts at continuous improvement.

The underlying goal of engineering education accreditation is for all accredited departments to undertake continuous improvement, and the core prerequisite for continuous improvement is to ensure close linkage between curriculum, teaching and evaluation. This study found that although engineering college faculty members did make some adjustments to their curriculum planning and teaching activities, their limited understanding of the significance of engineering education accreditation and their lack of formal training in either curriculum design or teaching prevented them from implementing a more proactive approach to teaching, and from using the results of student evaluation as a basis for continuous improvement. There is an urgent need for professional development activities to align their professional expertise with respect to outcome-based curriculum planning and teaching, e.g. how to integrate the results of student evaluation as a basis for the continuous improvement of courses.

Finally, according to the results of this study, accreditation could have the negative effect of leading faculty members to feel that the university administration does not believe they are capable of doing their jobs properly. Future research in this field could involve the collection of multiple assessment resources in order to provide a paradigm of best practice for outcome-based accreditation approach and how student evaluation results can be used to revise future curriculum. If this can be achieved, it should support the development of a holistic perspective on how to implement continuous improvement in curriculum planning and teaching.

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