Some Misconceptions in the Process of Developing Engineering Education Accreditation Program

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Abstract

The main purposes of accrediting engineering programs are to assure quality and to foster the systematic pursuit of improvement in the quality of engineering education. Many universities in Korea are currently working for the development of assessment systems for the accreditation. Generally this assessment system is composed of (1) written statements of expected learning outcomes (PEO, PO, CO, etc), (2) design of learning experiences that enable students to achieve these learning outcomes (curriculum), and (3) implementation of appropriate measures of student achievement on the learning outcomes (assessment plan, e.g., rubrics), and (4) using assessment results to improve teaching and learning. In the process of developing an assessment system, some engineering educators misunderstand of several key concepts that are used in ABET and ABEEK criteria. Those are
(1) interrelationship among PEO, PO and CO, (2) concept and function of performance assessment, and (3) the notion of CQI (Continuous Quality Improvement), especially in the contexts of systems approach. Better conceptual understanding on the assessment system among the engineering educators will help to promote program quality and may lead to contribute to improved quality in engineering education.
Key word: Engineering education accreditation program, performance criteria, CQI

1. Introduction

Traditionally engineering instructor's job was lecture on the topics in the syllabus, give the assignments and tests, and grades. If the syllabus was covered, the course was considered successful, regardless of whether or not anyone learned anything.

This system did not work well as far as student learning is concerned. As Felder (2008) said, the correlation between academic performance in engineering school (as measured by GPA) and success in engineering practice was found to be close to zero. People in industry complained that engineering graduates were seriously deficient in skills such as teamwork, communication, critical thinking and creative thinking. But academicians did not hear the complaints and take them seriously until the end of the 1980s. In the period that followed, growing numbers of engineering school administrators and faculty members initiated curriculum reforms designed to equip students with a board array of new skills. In the most dramatic sign of change, the Accreditation Board for Engineering and Technology (ABET) switched to an outcome-based program evaluation and accreditation system. The switch began on a pilot basis in 1996 and became universal in 2001(Felder, 2008, x).

ABET is the organization that accredits most U.S. engineering, computer science, and technology program through assessment. ABET also provides substantial equivalency evaluations to programs internationally (Spurlin, Rajala & Lavalle, 2008, x•£). Accreditation Board for Engineering Education of Korea (ABEEK) was founded modeling after the ABET in 1999 (ABEEK, 2009). ABEEK's basic goals are to ensure the quality of educational programs in engineering and related disciplines, and to enhance the professional competence of the graduates of those programs in Korea.

ABEEK reflects some minimum elements that are needed to produce quality and competitive graduates for promotion of engineering education development. ABEEK does not focus on positivism that is usually explained direct relationship between knowledge and practice ("Practice is derived from knowledge"), but emphasize critical theory that knowledge is embedded in practice (Tom & Valli, 1990). Students are judged how well they are applying their knowledge and skill to industrial and work place.

ABEEK program consists of educational objectives setting, curriculum design, implementation, and assessment. “Educational objectives are usually relatively specific statements of student performance that should be demonstrated at the end of an instructional unit” (McMillan, 2007, p28). There are three levels of objectives in the ABEEK program; PEO (Program Educational Objectives), PO (Program Outcomes), and CO (Course Outcomes). Curriculum refers either to a plan for educating youth or as a field of study (Gay, 1991). We could say that any kind of curriculum is designed for achieving learning objectives effectively. It is measured how much students were doing well compare with those objectives after curriculum implementation. Finally assessment in the school can be defined as the collection, evaluation, and use of information to help teachers make decisions that improve student learning (McMillan, 2007, p8). So assessment is more broad term then testing or measurement.

Above four elements of ABEEK program consider two components. They assess the achievement of PEO, PO, CO or not through student's performance compared with objectives for guarantee of engineering education quality (product). Second, ABEEK program is judged systematically and continuously whether it is operated well or not for improvement of engineering education quality (process).

2. Problems in Implementation

Many universities in Korea are currently interested in accreditation system (ABEEK system) to improve engineering education quality, and receiving increased prestige for graduates entering major companies in Korea. However, most engineering accreditation programs that are inquired and examined are not yet made well, and there are some engineering educators' misunderstand or shortcoming in comprehending on the several key concepts that are used in ABET and ABEEK criteria. These challenges are the focus of this paper.

1) Ambiguous understanding of relationship among PEO, PO and CO

There are three different levels of objectives in accreditation system, PEO, PO and CO. ABET (2009) defines PEOs are “board statements that describe the career and professional accomplishments that the program is preparing graduates to achieve.” PEOs are the broadest and least changing elements of the educational program, typically covering a two-to four-year period. POs are defined as “statements that describe what students are expected to know and be able to do by the time of graduation” (ABET, 2009). POs relate to the skills, knowledge and behaviors that students acquire in their matriculation through the program. CO means what students should achieve after completion of certain courses. It is important to consider how to teach students to acquire the skills implicit in these COs. So COs should be described including students' needs, elements of learning environment and all dependent things with completion of course as it can possible. Generally each course has three to five course learning outcomes / objectives related to one or more of the POs. What is emphasized here is PEOs and POs must be directly linked to the curriculum and to COs.

Each three objectives are given a grade of rank by abstraction or concreteness. CO, PO, PEO are setting orderly then it should be abstractive and general more and more from CO to PEO, and the other side, from PEO to CO, it is more concrete and specific. PEO is accomplished by PO's achievement, and PO is also attained automatically by completion of the most subordinate objective (CO) in the same way as PEO's achievement.

After reviewing the program manuals developed by each department of Hanyang Univ., the authors of this paper concluded that the level of abstraction or concreteness among objectives is ambiguous. It is caused shortly understanding the relationship among objectives. First of all clearer objectives should be set with deepen comprehension about them. It should be explained concretely how CO is related with PO, what kind of activities are needed for achievement of those COs, etc. Curriculum mapping to outcomes is more effective to represent PEO, PO, CO and it is helpful to understand three objectives' relationship for improving program quality.

2) Performance assessment related concerns

“Performance assessment is one in which the teacher observes and makes a judgment about the student's demonstration of a skill or competency in creating a product, constructing a response, or making a presentation” (McMillan, 2007).

Examples of performance assessments include observations, exhibitions, oral presentations, experiments, portfolios, interviews, and projects. Performance assessment has several characteristics. Those are (1) Students perform, create, construct, produce, or do something, (2) Deep understanding and / or reasoning skills are needed and assessed, (3) Involves sustained work, often days and weeks, (4) Multiple criteria and standards are prespecified, (5) There is usually no single "correct" answer, and (6) If authentic, the performance is grounded in real-world contexts and constraints. ABET program emphasizes performance / authentic assessment (Spurlin, Rajala & Lavalle, 2008; Moskal, 2008). It is not focused on "What you know" but "How much you can do", so ABET program's important point is how students can put their knowledge in practice effectively. This is based on the belief that the artifacts students made with their knowledge help to know how they are working well in the field. But most programs designed by the engineering educators are not developed with fully understanding the concepts of performance assessment. Assessments are still focused on the knowledge and assessment methods are not appropriately matched with learning targets. The limitations of using performance assessment like low reliability and time-consuming will be another reasons that it is not well disseminated in the field of engineering education.

Rubrics have been used for a broad range of subjects and are usually employed when a judgment of quality is required. A rubric is a descriptive scoring scheme that guides the analysis of a student's work on performance assessments (Olds & Miller, 2008; McMillan, 2007). Rubrics formally defined guidelines consist of pre-established criteria in narrative format, typically arranged in ordered categories specifying the qualities or processes that must be exhibited for a particular evaluative rating. Among the advantages of using rubrics are (1) the assessment can be more objective and consistent, (2) the amount of time faculty spend evaluating student work is reduced, (3) valuable feedback is provided to students, faculty, and the program, and (4) rubrics are relatively easy to use and explain(Olds & Miller, 2008).

When designing or using rubrics, the dimensions within each rubric need to be designed or operationalized to relate clearly to the POs. But rubrics developed by the engineering faculties are not very clear how they are related to POs and COs. They are not seemed to keep the principles of rubrics development.

There are two basic types of rubrics: holistic and analytic. A holistic rubric scores the process or product as a whole, without separately judging each component. In contrast, an analytic rubric allows for the separate evaluations of multiple factors with each criterion scored on a different descriptive scale. Almost all of the rubrics currently used in engineering education are holistic scales. Holistic scale has some advantages: Its simplicity and the ability to provide a reasonable summary rating. But if the purpose of the assessment is formative, not summative, then analytic rubrics should be used even though they take longer to create and score. Because analytic scores provide specific information about what the student did well and what needs further improvement. At the same time many rubrics should be developed to measure high level of learning targets, like reasoning, deep understanding and affective traits.

3) CQI (Continuous Quality Improvement) related concerns

ABEEK (2006) emphasizes CQI as the means of educational improvement. Here, CQI refers to the cycle of objectives – implementation – measurement (evaluation) – revision / improvement, but it mainly related to feedback based on the evidence collected through assessment to enhance curriculum and program activities. It is seemed that CQI is originated from systems approach.

Systems approach is a way of looking at a complex reality in the awareness that it is not completely controllable in a deterministic manner as many simpler mechanical systems might be (Romiszowski, 1970). So, systems approach involves the careful analysis of interrelationships existing between interacting subsystems and the interpretation of these interactions in terms of predicting what may happen in other parts of the system if certain changes are made in a particular part. It also implies that complexity cannot be planned and implemented successfully the first time around, but only by an iterative process where a first-attempt solution is followed by evaluation of what worked and what did not, and by revision and reevaluation (Romiszowski, 1994).

To design and development of a program using systems approach, systemic thinking and systematic problem-solving is needed. Systemic thinking means the ability to visualize the system's structure and the internal relationships between the component subsystems. This is very important because this makes it possible to maintain a "systems view" or "big picture" while engaged on detailed analysis or design of one of the components. Systematic aspect of the systems approach is related to its focus on the analysis and solution of problems in complex and probabilistic systems. Another words, the term "systematic" refers to the scientific, procedural method applied to design and development of complex system. Dick, Carey & Carey's (2009) "The Systematic Design of Instruction" will be the representative case that embodied the systematic, procedural aspects of the systems approach.

If we review the program manuals developed by the engineering faculties, we could easily find that they are well accustomed to systematic aspects of the systems approach. But systemic aspects are neglected in the context of program design and development. Also, we could find that developers do not pay much attention to the macro context of organizational analysis (other types of training / development activity, actions such as organizational change, modified students selection procedures, etc.). Another thing program developer should remember is the whole process is heuristic rather than algorithmic, creative rather than mechanistic, and systemic rather than merely systematic.

3. Conclusion

Three suggestions were made in this paper. They are (1) setting clear and accurate relationships among PEO, PO and CO, (2) appropriately use of varied rubrics for performance assessment and (3) right understanding the CQI in the context of systems approach and correct adaptation it in the program development.

These are not formal criteria for the ABEEK accreditation but essentials for the performance / authentic assessment. The authors hope this paper is helpful to promote program quality and contribute to engineering education.

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