Assessment of Educational Objectives in Chemical and Petroleum Engineering Programs

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Abstract: Within the Chemical and Petroleum Engineering (CPE) programs, establishing and reviewing educational objectives is part of the assessment and continuous improvement cycle for the programs. This paper describes a process for the establishment and assessment of the educational objectives set by the CPE Department at the United Arab Emirates University. This process is initiated by defining the CPE programs outcomes to match the ABET (A-K) EC2000 criteria and from these outcomes the program educational objectives are derived. Next, the assessment tools are defined and these include Alumni and Employer surveys and special formats are prepared to achieve this purpose. The Alumni Survey is designed to provide the information needed by both programs to continuously measure the degree to which the concluded educational objectives are attained. The Employer Survey is designed to assess how well the graduates of the two programs meet the educational objectives from their employers' perspectives. The results of the two surveys are averaged using a weighting factor designed to provide some judgment on the importance, quality, and number of feedbacks of each tool. It may generally be concluded that the overall educational objectives of both programs have been largely met with average score for each objective between 4 and 4.4 out of 5.0 and that incremental enhancements could help achieve further improvements.

Keywords: symposium, engineering education, program objectives, assessments

1. INTRODUCTION

The Accreditation Board for Engineering and Technology (ABET) is a professional accrediting organization in USA that accredits engineering, technology, computing and information science, and engineering related programs in the United States and internationally (Petrova et al., 2006). The objectives of ABET accreditation are to serve the public, industry, and the profession by stimulating the development of improved engineering education, encouraging new and innovative approaches to engineering education, and assuring that graduates of an accredited program are adequately prepared to enter and continue the practice of engineering. The new developed criteria of ABET for accrediting engineering programs EC 2000 (A2K) have changed the way that engineering programs prepare their graduates (Bai and Pigott, 2004). In order to survive in the future, each program has to develop a strategy to meet the new requirements specified in the EC2000 (A2K).

The philosophy of EC 2000 is to allow institutions and engineering programs to uniquely define their mission and objectives to meet the needs of their constituents. In addition, the new ABET system focuses on continuous improvement of program based on the results of the assessment process for program objectives and outcomes and on the input of constituents (Whiteman, 2003).

The CPE programs at the United Arab Emirates University were established in 1980. The mission of these programs is to meet the educational, research, and service needs of UAE society by providing programs and services of the highest quality. Also it contributes to the expansion of

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knowledge by conducting quality research and by developing and applying modern engineering tools and techniques that could play a significant role in the technical and economic development of the country. The CPE programs' educational objectives were designed to meet the UAEU mission and to fulfill the ABET requirements. These objectives were intended to serve new graduates by providing them with:

- Adequate skills including, understanding of scientific and engineering concepts, effective oral and written communication, ability to participate in life-long learning, diverse and global professional careers, project management and decision making.
- Strong foundation in engineering principles and practices, based on the learning of fundamentals of engineering, ability to use advanced techniques, and participation in relevant engineering interactions.
- Enhanced problem-solving skills that involve designing and conducting experiments, analyzing and interpreting laboratory as well as field data, innovation and conceptual thinking, and applying engineering through research and/or industrially oriented projects.
- Ability to understand important issues, such as knowledge and appreciation of the codes of ethics, awareness and appreciation for health, safety and environmental issues, integrating ethical, social, health, safety, and environmental issues into practical projects, economic evaluation and risk assessment, awareness of international standards and specifications.
- Working skills in multi-disciplinary teams; functioning with peers from other disciplines, integrating information and data from multiple sources, participating in technical seminars and industrial/professional functions and events, and adaptability to different working environments.

This paper describes a process for the establishment and assessment of the educational objectives set by the CPE Department at the United Arab Emirates University. This process is initiated by defining the CPE programs outcomes to match the ABET (A-K) EC2000 criteria and from these outcomes the program educational objectives are derived. Next, the assessment tools are defined and these include Alumni and Employer surveys and special formats are prepared to achieve this purpose.

2. PROGRAM CONSTITUENCIES

The CHME and PETE Programs educational objectives stated above must be based on the needs of the program's various constituencies. The College of Engineering, the Chemical and Petroleum Engineering Programs have identified seven constituencies.

2.1 Internal Constituencies

1. Students: the UAE University has dedicated the eight goals of its 1998-2008 strategic plans to provide high-quality education to students. Student feedback thus is very important and is conveyed to the chemical and petroleum-engineering programs through a variety of assessment tools.
2. Alumni: alumni are a resource to the programs providing feedback on its competitiveness with other chemical and petroleum engineering programs, in the U.A.E. and abroad. They keep in touch with the faculty during the department open house activities or they meet them at the Abu Dhabi Petroleum Exhibition and Conference (ADIPEC), which is held every two years, and in meetings of the Abu Dhabi or Dubai chapters of SPE.
3. Faculty: being responsible for delivering the skills, knowledge, and competencies to students, the relevant university faculty and particularly the CHME and PETE faculty members are directly involved in the educational process.
4. University Administration: being responsible on behalf of the government and the public to provide the high-quality education in the different University programs, the University

administration is an important constituency to the CHME and PETE programs.

2.2 External Constituencies

1. Employers: petroleum and chemical companies that hire the CHME and PETE graduates have certain needs in skills and competencies of graduates from the UAEU.
2. Industrial Advisory Board (IAB): in October 2003 the College has formed an Industrial Advisory Board composed of several key managers in different petroleum and engineering companies, and government authorities. They are charged with providing advice to the College programs in light of their experience and company needs. They are considered a constituency because they represent a cross section of leading companies that hires the CHME and PETE graduates.
3. Industrial Training Supervisors: the internship program for students in the College of engineering is carried out over a full semester with each student trainee supervised by a faculty member and a company supervisor. Thus, the internship supervisors are directly involved in the students' education and also the evaluation of their skills at the junior level, thereby making Internship Supervisors a valuable constituency.

In addition to these seven constituencies, the CHME and PETE programs get valuable advice and feedback from the Academic Advisory Board (AAB), formed in 2001 from leading U.S. academicians with one representative for each program. The AAB has last reviewed the engineering programs Assessment and Continuous Improvement plans in March/April 2008 and provided valuable feedback.

3. PROCESS FOR ESTABLISHING PROGRAM OBJECTIVES

In this work the CHME and PETE programs educational objectives were revised to become more consistent with EC-2000 criteria and to meet the constituencies' needs. The process was initiated by reviewing the current program objectives, fine tuned them in an attempt to generally provide high-quality education, research, and service (the three pillars of the university), and finally came up with the revised educational objectives. These new program objectives are intended to serve new graduates as well as graduates after three years of graduation. The adjusted PEO's are shown in Table 1.

Within the Department of Chemical and Petroleum Engineering, establishing and reviewing educational objectives is part of the assessment and continuous improvement cycle for the CHME and PETE programs, the elements of which are shown in the block diagram in Figure 1. The process started by defining the program outcomes to match the (A-K) EC-2000 criteria, since program outcomes are the most important part of the educational process and must foster attainment of program educational objectives. Thus, from the program outcomes, the program educational objectives are defined so that they encompass the program outcomes.

Next, the assessment tools were defined. Currently, the CHME and PETE programs have defined and used the following assessment tools.

- Alumni Survey: It is designed to provide the information needed by the Chemical & Petroleum Engineering Department to continuously measure the degree to which the concluded educational program objectives are attained.
- Employer Survey: This survey is conducted to assess how well the department graduates meet the educational program objectives from their employers' perspectives.

Results of these surveys were considered in conjunction with discussions of the Open House meetings.

Table 1: Program Objectives for Chemical and Petroleum Engineering

Objective	Chemical Eng. Program	Petroleum Eng. Program
1.	Produce graduates who possess a working knowledge of mathematics, science and chemical engineering fundamentals, and have the ability to integrate these disciplines to function as competent chemical engineers	Produce graduates with a broad knowledge of petroleum engineering and their applications.
2.	Produce graduates who are capable of utilizing principles and techniques from engineering, science, engineering planning & project management, and the natural & social sciences to develop and evaluate alternative design solutions to engineering problems with specific constraints	Produce graduates with the knowledge and critical thinking skills required to design and analyze petroleum engineering problems, taking into account, safety, environmental and societal impacts.
3.	Produce graduates with a broad enough base that they may pursue graduate studies if they choose, and be ready to pursue a successful professional career in traditional and new areas such as biochemical, pharmaceutical, food processing, polymers, environmental protection, nanotechnology, and advanced materials areas, or as managers in business, governmental careers, and engineering consultants.	Produce graduates who are effective communicators with the ability to convey and acquire technical ideas, information, and recommendations in a multi-disciplinary environment.
4.	Produce graduates who exercise professional responsibility and sensitivity to a broad range of societal concerns, such as ethical, environmental, economic, regulatory, and global issues.	Produce graduates who have been exposed to current and emerging technologies, and have the ability to pursue life-long learning through continuing education or post-graduate education.
5.	Produce graduates who work effectively in a team environment, communicate well, and are aware of the necessity for personal and professional growth.	Produce graduates with appreciation for the value of continuing professional development in maintaining their professional competence, through participation and leadership in professional organizations such as the SPE.
6.		Produce graduates who are exposed to professional ethics and who have a commitment to public welfare and the environment.

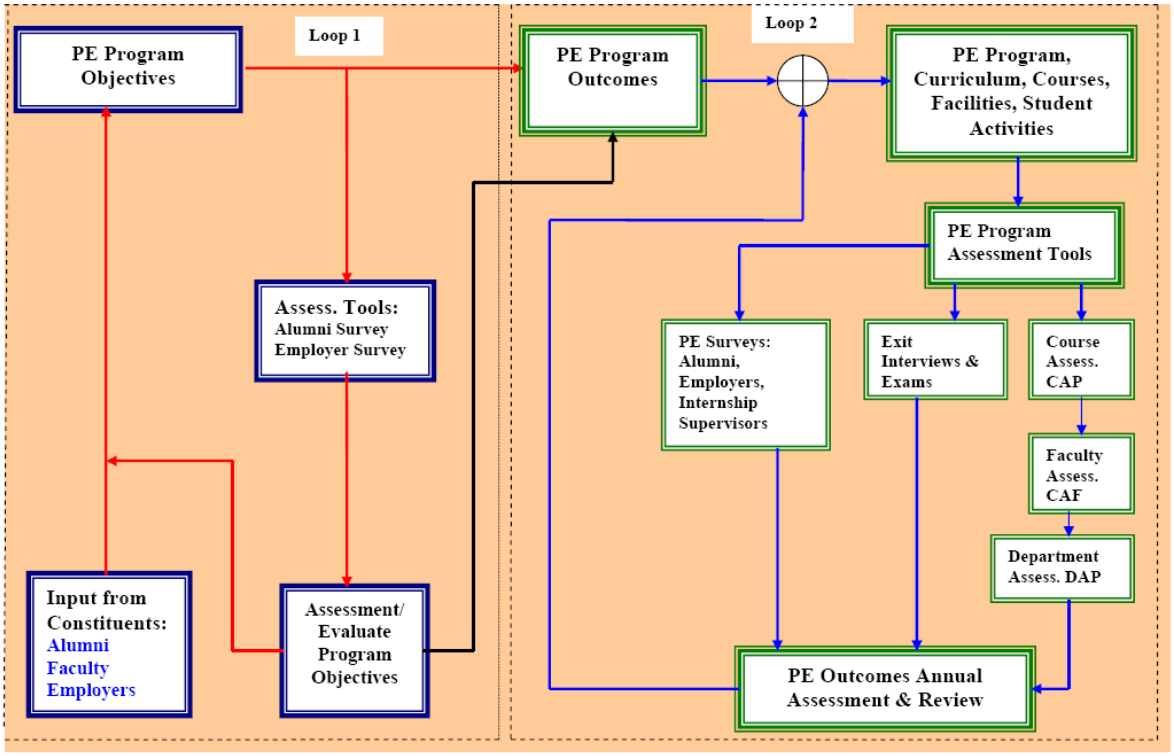

Fig. 1: PETE Assessment Outcomes and Objectives Framework

4. ACHIEVEMENT OF EDUCATIONAL OBJECTIVES

The CHME and PETE Programs educational objectives were evaluated through the assessment of two surveys, namely, the alumni survey and the employer survey. These surveys were gathered from the first and second "Open House" feedbacks which were arranged by the Chemical & Petroleum Engineering Department and held in Al-Ain in April 2007 and April 2008, respectively, and also from electronically gathered responses.

4.1 Overall Performance Index for Educational Objectives

To get a better picture of performance, the two assessment tools that were conducted to evaluate the CHME and PETE programs objectives were averaged using a weighting factor designed to provide some judgment on the importance, quality, and number of feedbacks of each tool and as follows.

Assessment Tool	Importance level	Weight %
Employer survey	**External Evaluator, highly important.**	**50**
Alumni Survey	**Equally Important, engineers take the survey very seriously.**	**50**

The results of alumni survey for year 2008 are shown in Figures 2 and 3 for Petroleum and Chemical programs, respectively. While the results of the employer survey in the same year are presented in Figure 4 and 5..

4.2 Overall assessment

The overall assessment of PETE and CHME Programs Educational Objectives based on the above two surveys are illustrated in Figure 6 and 7, respectively, showing the weighted average score for each objective. From this one can generally conclude that the overall educational objectives of the PETE program have been largely achieved with average assessment results for each objective between 4 and 4.4 out of 5.0. On the other hand, the overall educational objectives of the CHME program have largely been achieved with average assessment results for each objective between 3.83 and 4.14 out of 5.0. Thus, the CHME and PETE program have satisfied all of its educational objectives, and incremental enhancements could help achieve further improvements.

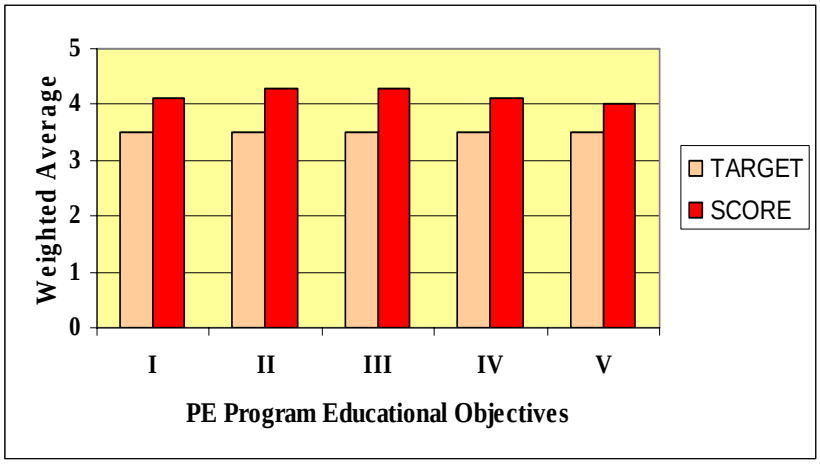

Fig. 2: Results of Alumni Survey (PETE); year 2008

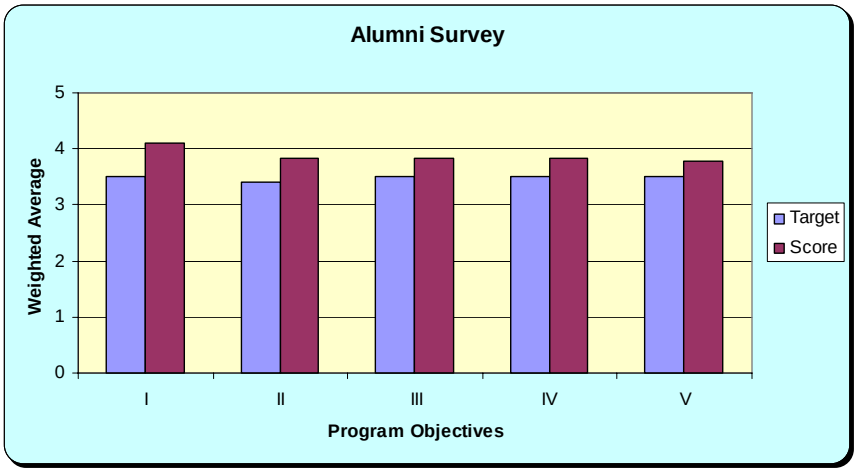

Fig. 3: Results of Alumni Survey (CHME); year 2008

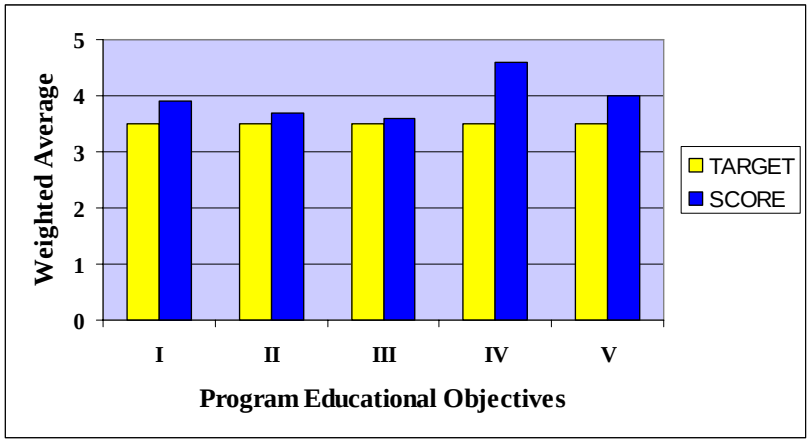

Fig. 4: Results of Employer Survey (PETE); year 2008

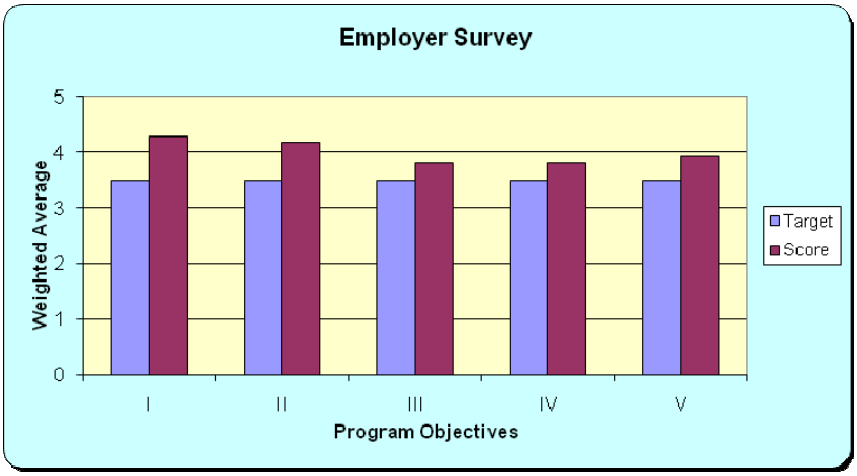

Fig. 5: Results of Employer Survey (CHME); year 2008

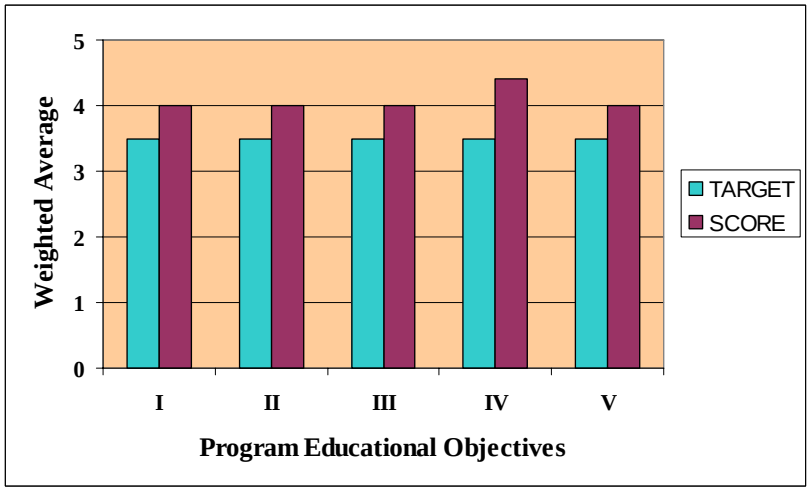

Fig. 6: Summary of PETE Program Objectives' Assessment, year 2008

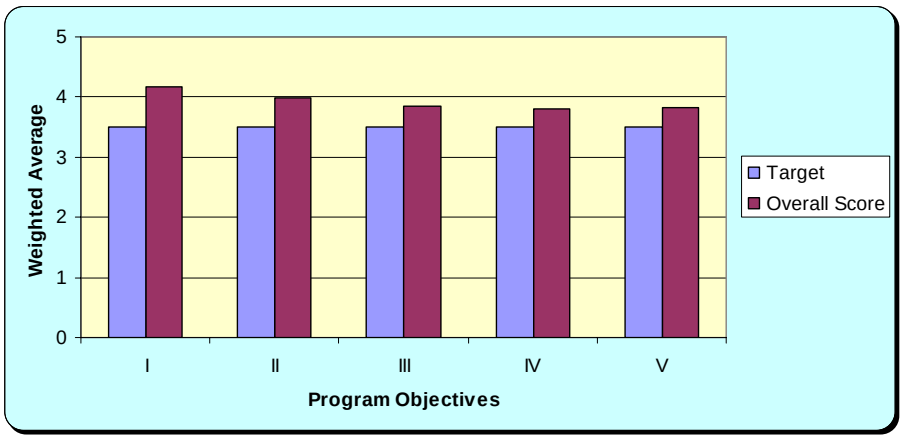

Fig. 7: Summary of CHME Program Objectives' Assessment, year 2008

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