Assessment of Student Work Experiences in Civil Engineering

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Abstract

The Accreditation Board for Engineering and Technology (ABET) has adopted a revised set of criteria for accrediting engineering programs. Nevertheless, as in the past, civil (construction) engineering departments will be required to demonstrate proficiency in specific subject areas which are included in the ABET program criteria.

This paper investigates, according to civil engineering and construction related students, the level at which their understanding of various subject areas required by ABET has been enhanced by part-time and summer work experiences. In particular, the findings suggest that both undergraduate and graduate students believe that three areas have been greatly enhanced with engineering work. They include structural engineering, project management/scheduling and estimating, and team work. In addition, undergraduates also perceive that their understanding of health and safety issues, and ethical considerations has also increased. In contrast, graduate students believe that their knowledge of hydraulics/hydrology/water resources, constructability and economic factors has been enhanced by work experiences.

I. Introduction

The American Society of Civil Engineers (ASCE) believes that the practice of civil engineering is broad and diverse, including numerous disciplines. As a result, the breadth of the professional component of civil engineering education is necessarily broad. This precept is recognized by the ASCE Committee on Curriculum and Accreditation and has been adhered to in the development of the criteria for accreditation[6,7,8]. In this regard, numerous students and practitioners believe that being involved with part-time and summer engineering work complements the theoretical concepts developed in class. To further investigate this perception, data was obtained from a survey instrument which was distributed to graduate and undergraduate students enrolled in courses taught by the Department of Civil Engineering at Lamar University. Respondents were requested to indicate whether (and at what specific level) various design activities and academic subjects have been enhanced by gaining practical experience in civil and construction engineering. The subjects chosen are those that have been included in the criteria that has been adopted by the Accreditation Board for Engineering and Technology (ABET) and must be satisfied for a program to be accredited[1]. For comparative purposes, the findings of this investigation could be utilized by other institutions and departments that may wish to study their curriculum.

II. Practical Engineering Experience

Over the years there have been recommendations from employers and various technical and professional organizations to revise the engineering curriculum to ensure that students are prepared for the professional practice of engineering[2, 9]. Practicing engineers and educators have also indicated that they are not completely satisfied with the average engineering program in the United States[10,11,12].

One aspect that appears to be missing is the development of practical experience and leadership skills in students. However, many civil engineering departments have encouraged collaboration with industry to increase the practical outlook of their students[14]. The American Society of Civil Engineers (ASCE) has recognized this problem and established the Practitioner-in-Residence program for civil engineering departments. It has also been recommended that engineering faculty should develop their practical skills. This may be accomplished by working in industry and interacting with practicing engineers. The practical problem solving skills learned could then be imparted to undergraduate and graduate students[13].

It has also been written that professors should be rewarded for being involved in industry. In this manner, it should be possible to incorporate technology into the curriculum at all levels[3]. Today, there is a movement in engineering education toward exposing students to more realistic and practical design experiences. For example, at some schools client-sponsored design project courses are required for both undergraduate and graduate students[4]. Here, the involvement of practitioners is vital since traditional faculty often lack the depth of project experience and judgment that engineers in business and industry tend to possess[5].

III. Undergraduate Students with Experience

As a segment of a continuing review of factors related to the curriculum, a survey instrument was distributed to students enrolled in required senior and typical graduate courses offered by the Civil Engineering Department of Lamar University. The tabulated results of the study form the data base for this investigation. Specifically, the questionnaire listed various ABET civil (construction) engineering program requirements and requested respondents to indicate at which level – high, average, low, or unsure/none – each is enhanced by students involved in part-time and/or summer work experience. The subject areas chosen are among those listed in a recently adopted set of criteria for accrediting engineering programs, *Engineering Criteria 2000*[1].

Specifically, the findings suggest that undergraduate students have increased their understanding of many of the subject areas at a high level. For example, Table 1 illustrates that over 55% of the students involved with civil engineering work experiences believe that five areas are enhanced at a high category level. As shown, they include:

- Structural Engineering
- Project Management/Scheduling and Estimating
- Team Work

Table 1. Perceptions of Undergraduate Students with Civil Engineering (Construction) Work Experience

Academic Areas or Design Considerations	Enhanced Understanding of Theoretical and Design Class Work As a Percentage of Respondents: High	Avg	Low	Unsure/None	*Composite Score
Academic Subjects					
Materials Engineering	50.0	40.0	0.0	10.0	3.3
Structural Engineering	63.2	31.6	0.0	5.2	3.5
Geotechnical Engineering	50.0	40.0	5.0	5.0	3.4
Environmental Engineering	33.3	47.6	14.3	4.8	3.1
Hydraulics/Hydrology/Water Resources	42.9	38.1	9.5	9.5	3.1
Project Management/Scheduling and Estimating	70.6	23.5	5.9	0.0	3.7
Design Considerations					
Team Work	70.0	20.0	0.0	10.0	3.5
Engineering Codes and Standards	36.8	47.4	10.5	5.3	3.2
Sustainability	42.1	36.8	10.5	10.5	3.1
Aesthetics	33.3	38.9	16.7	11.1	2.9
Economic factors	38.9	44.4	5.6	11.1	3.1
Manufacturability (Constructability)	38.9	44.4	5.6	11.1	3.1
Ethical Considerations	60.0	30.0	5.0	5.0	3.5
Health and Safety Issues	55.6	38.9	0.0	5.6	3.4
Social Ramifications	41.2	41.2	5.9	11.8	3.1
Political Factors	29.4	11.8	47.1	11.8	2.6
Legal Issues	47.4	10.5	26.3	15.8	2.9

*Composite Score based upon 4.0 = High; 3.0 = Average; 2.0 = Low; 1.0 = Unsure/None

- Ethical Considerations
- Health and Safety Issues

In addition, the following three subjects are perceived to be assisted between 45 – 55% in the high level category:

- Materials Engineering
- Geotechnical Engineering
- Legal Issues

The eight areas listed above are perceived by undergraduate students to be enhanced at a relatively high level. They include the traditional subjects of geotechnical, materials, and structural engineering as well as ethical considerations and legal issues. These areas are strongly needed in project work. Team work, project management/scheduling and estimating, and health and safety issues are also considered very important. Students appear to recognize that consideration of these academic subjects and practical issues may be required for a civil engineering or construction project to be a successful operation.

Environmental engineering, aesthetics, and political factors were given low ratings. These areas were probably not considered vital for the completion of the projects on which the students were working. It is perhaps significant that team work and project management/scheduling and estimating received the highest scores. This reinforces *Engineering Criteria 2000* which stresses the concepts of team work and professional considerations as attributes that should be developed in engineering students.

IV. Graduate Students with Experience

The perceptions of graduate students who have civil engineering experience are shown in Table 2. Here, over 55% of the respondents indicate that the understanding of six subject areas have been enhanced at a high level with engineering work experience. They include:

- Structural Engineering
- Hydraulic/Hydrology/Water Resources
- Project Management/Scheduling and Estimating
- Team Work
- Economic Factors
- Manufacturability (Constructability)

Graduate students perceive that the aforementioned six subject areas are enhanced at a relatively high level. Three of these, (structural engineering, project management/scheduling and estimating, and team work), are also rated at a high level by undergraduate students with experience. As shown, graduate students also rate hydraulics/hydrology/water resources, economic factors and constructability with a high score. Apparently their experience indicates

Table 2. Perceptions of Graduate Students with Civil Engineering (Construction) Work Experience

Academic Areas or Design Considerations	Enhanced Understanding of Theoretical and Design Class Work As a Percentage of Respondents: High	Avg	Low	Unsure/None	*Composite Score
Academic Subjects					
Materials Engineering	37.9	44.8	6.9	10.3	3.1
Structural Engineering	64.5	19.4	6.5	9.7	3.4
Geotechnical Engineering	38.5	38.5	11.5	11.5	3.0
Environmental Engineering	26.7	40.0	23.3	10.0	2.8
Hydraulics/Hydrology/Water Resources	66.7	26.7	3.3	3.3	3.6
Project Management/Scheduling and Estimating	75.0	17.9	3.6	3.6	3.6
Design Considerations					
Team Work	72.7	21.2	6.1	0.0	3.7
Engineering Codes and Standards	38.5	50.0	7.7	3.8	3.2
Sustainability	27.6	55.2	13.8	3.4	3.1
Aesthetics	38.5	42.3	15.4	3.8	3.2
Economic factors	61.3	29.0	6.5	3.2	3.5
Manufacturability (Constructability)	57.1	28.6	10.7	3.6	3.4
Ethical Considerations	33.3	40.7	18.5	7.4	3.0
Health and Safety Issues	34.5	51.7	10.3	3.4	3.2
Social Ramifications	23.1	53.8	11.5	11.5	2.9
Political Factors	25.9	33.3	25.9	14.8	2.7
Legal Issues	33.3	20.8	25.0	20.8	2.7

*Composite Score based upon 4.0 = High; 3.0 = Average; 2.0 = Low; 1.0 = Low/Unsure

that these subjects are highly utilized in the design and construction of civil engineering projects. It may be noteworthy that both undergraduate and graduate students rate project management/scheduling and estimating, and team work with the highest scores. These are important subject areas which should be included in the engineering curriculum.

V. Summary and Conclusions

This paper reviews a number of recent recommendations involving engineering education. In addition, it presents the results of an investigation of the perceptions of a group of engineering students concerning the level at which various ABET accreditation requirements have been enhanced by part-time and summer work experiences. Data for the study was obtained from a survey instrument which was completed by students enrolled in various civil (construction) engineering degree programs at Lamar University. The findings of the investigation could be utilized, for comparative purposes, by other institutions and departments that may wish to study their curriculum and how it relates to engineering student work experiences.

In particular, the data suggest that both undergraduate and graduate students with civil (construction) experience believe that their understanding of three areas has been greatly enhanced. They include: structural engineering, project management/scheduling and estimating, and team work. In addition, undergraduates also perceive that their understanding of health and safety issues, and ethical consideration has increased. In contrast, graduate students believe that their knowledge of hydraulics/hydrology/water resources, constructability, and economic factors has been enhanced by work experiences. The data also show that the understanding of the following two subjects have been enhanced for both undergraduate and graduate students at a below average level: political factors and legal issues. This is unfortunate since practical input to these areas is vital for civil engineering students.

The subject areas in this investigation are required by ABET as criteria that must be satisfied for a program to be accredited. Specifically, they are included in Engineering *Criteria 2000* which was adopted by ABET and will be required by all programs for accreditation purposes in the year 2001 – 2002. It appears, therefore, that the knowledge and experience gained by students with civil engineering work experience complements the criteria required for accreditation. In addition, the activities should enhance the skills required by engineering students for a successful career involving the design and management of engineering and construction projects.

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Bibliography

1. *Engineering Criteria 2000* (1999). Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET), Baltimore, MD, http://www.abet.org.

2. *Engineering Education for a Changing World* (1994). American Society for Engineering Education (ASEE), Washington, D.C.
3. Farr, J. V. (1997). "Engineering Education: The Challenge of Reform." *Journal of Management in Engineering*, ASCE, 13 (6), 3 – 4.
4. Jones, S. A. and Houghtalen, R. (2000). "Using Senior Design Capstone as Model for Graduate Education." *Journal of Professional Issues in Engineering Education and Practice*, ASCE, 126 (2), 83 – 88.
5. Kerkes, D. J. (1995). "Arguments for Recruiting Faculty from Business and Industry." *Journal of Professional Issues in Engineering Education and Practice*, ASCE, 12 (4), 242 – 245.
6. Koehn, E. (1999). "Professional Design Component for Civil Engineering Curriculums." *Journal of Professional Issues in Engineering Education and Practice*, ASCE, 125 (2), 35 – 39.
7. Koehn, E. (1997). "Engineering Perceptions of ABET Accreditation Criteria." *Journal of Professional Issues in Engineering Education and Practice*, ASCE, 123 (2), 66 – 70.
8. Koehn, E. (1995). "Practitioner and Student Recommendations for an Engineering Curriculum." *Journal of Engineering Education*, ASEE, 84 (3), 241 – 248.
9. Long, R. P. (1997). "Preparing Engineers for Management." *Journal of Management in Engineering*, ASCE 13 (6), 50 – 54.
10. Mendelsohn, R. (1998). "Teamwork – The key to productivity." *Journal of Management in Engineering* ASCE 13 (1), 22 – 25.
11. "New Course Curriculum will Emphasize Design." (1998). *CEE at MIT*, Massachusetts Institute of Technology, Cambridge, MA, 12 (3), 1 - 2.
12. Sabatini, D. A. (1997). "Teaching and Research Synergism: The Undergraduate Research Experience." *Journal of Professional Issues in Engineering Education and Practice*, ASCE, 123 (3), 98 – 102.
13. Shewbridge, S. E. (1998). "A Suggestion to University Administrators." *Civil Engineering*, ASCE, 68 (2), 6.
14. Tener, R. K. (1996). "Industry – University Partnerships for Construction Engineering Education." *Journal of Professional Issues in Engineering Education and Practice*, ASCE, 122 (4), 156 – 162.

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