Global J. of Engng. Educ., Vol.11, No.1
Published in Australia

Business Classes to Complement the ABET Requirements for Civil Engineering Students

Efrossini C. Kalkani
School of Civil Engineering, National Technical University of Athens
9 Iroon Polytechniou, Zografou, 157 80 Athens, Greece
Leda G. Boussiakou
King Saud University, PO Box 2454, Riyadh 11451, Saudi Arabia

The research presented here refers to the attitudes of civil engineering students regarding their skills and preparation for the profession, as well as their expectations of the faculty and school. The students participating in this research felt that they had obtained engineering knowledge and skills, but they wanted more engineering practice and training in communication, business and managerial skills. Also, the students expect the faculty to teach time management, organisational management, human resources management, leadership and crisis management. The students expected from the department specific plans for graduation, emphasis on new technologies and innovation, courses teaching practical knowledge, as well as safety issues, specifications and codes, communication and managerial skills, and preparation for the Engineer-in-Training (EIT) examinations. The students could take business courses on organisational behaviour, organisational management, accounting and finance to gain confidence and become ready to enter the workplace.

INTRODUCTION

The Engineering Criteria 2000 (EC 2000) of the Accreditation Board for Engineering and Technology (ABET) are the basic guidelines to be followed by those engineering departments that are interested to get accreditation [1]. The general criteria for the basic level programmes number eight, which refer to students, educational objectives of the programme, programme outcomes and assessment, professional component, faculty, facilities, institutional support and financial resources. This includes programme criteria, cooperative educational criteria and general criteria for advanced level programmes [1].

The cooperative education criteria refer to the professional component of the programme, which may be part of the accreditation process, while the general criteria for the advanced level programmes require, beyond the criteria mentioned previously, one additional year of study plus an engineering project or research resulting in a report that demonstrates mastery of the subject and communication skills.

For more than 70 years, the process of accreditation seeks to assure that graduates of accredited programmes are prepared for professional practice. ABET's Engineering Criteria 2000 emphasise learning outcomes, assessment and continuous improvement, rather than detailed curricula specifications. These criteria, along with international agreements for the mobility of engineers, presented initial results for a multiyear study of the impact of the EC 2000 on engineering education:

- Establishing mechanisms to obtain input from various constituents;
- Formulating objectives on the basis of these inputs;
- Formulating outcomes for each objective;
- Establishing a range of assessment mechanisms to evaluate the programme and outcomes;
- Establishing feedback mechanisms to use the results of the assessment for improving the programme [2][3].

Various researchers have tried to overview the accreditation process and clarify the confusing array of terms associated with it (objectives, outcomes, outcome indicators), provide guidance on the formulation of course learning objectives and assessment

methods, identify and describe instructional techniques that should effectively prepare students to achieve those outcomes by the time they graduate, and propose a strategy for integrating programme level and course level activities when designing an instructional programme to meet the requirements of the ABET EC 2000 [4].

In this research, the competences obtained by civil engineering students are presented, along with the competences needed, the expectations from faculty and the school, the business school curriculum, and what business classes are needed in order to complement the ABET requirements for civil engineering students.

DESCRIPTION OF THE RESEARCH

The research presented in this article refers to the attitudes of civil engineering students regarding their abilities and preparation for the profession. A questionnaire was given to the 42 students of the *Hydraulic Design* class at the Department of Civil and Environmental Engineering of San José State University in San José, USA. The class included fourth year civil engineering students, who were graduating that semester with bachelor degrees. These students had finished most of their coursework and were adding a few courses before their graduation. Most students were working full-time or part-time in engineering companies and some had work experience during the summer or previous semesters. The course was given in the evening, 18:00 to 21:00 hours, so that the students could attend the classes after their work.

The research refers to the Engineering Criteria 2, 3, 4 and 5. The questions given to the students are shown in Table 1. The researchers wanted to assess the feelings and thoughts of the students regarding the requirements of Criterion 3, the preparation for the requirements of Criterion 4, the expectations of the students from the faculty of Criterion 5, and the knowledge and skills missing in getting prepared for the profession of Criterion 2.

COMPETENCES OBTAINED BY STUDENTS

Criterion 3 refers to the outcomes and assessment of the programme, and requires that graduates demonstrate the following abilities:

- Apply knowledge of mathematics, science and engineering;
- Function in multidisciplinary teams;
- Design and conduct experiments, and analyse and interpret data;
- Design a system, component or process to meet design needs;
- Identify, formulate and solve engineering problems;
- Have an understanding of professional and ethical responsibility;
- Communicate effectively;
- Understand the impact of engineering in a global and societal context;
- Recognise the need to engage in life-long learning;
- Know contemporary issues;
- Use techniques, skills and modern engineering tools necessary for engineering practice.

Table 1: Questionnaire on engineering criteria used in this research.

Question	Description
Criterion 3: Programme Outcomes & Assessment	Describe the competences you obtained in your civil engineering studies, which you consider important tools that will lead you to a successful professional career
Criterion 4: Professional Component	Indicate the competences that are needed in professional life, which are not taught or practiced at the university classroom
Criterion 5: Faculty	Describe educational behaviours, techniques and strategies from your engineering professors that you consider successful in learning
Criterion 2: Educational Objectives	Describe what you consider important to be included in civil engineering curricula that will be useful in the civil engineering profession

The programme needs to have assessment undertaken using documented results, which include student portfolios, design projects, examinations, alumni surveys on accomplishments, employment surveys and placement data for graduates.

Regarding the answers of the surveyed students, as listed in Table 2, there is an indication that the students are able to deal with the knowledge obtained, practice problems, conduct research, design systems and perform in a multidisciplinary team. Students are also able to solve engineering problems and understand issues of ethics, practice communication skills in the school, see the societal effect of projects, use modern engineering tools, understand the commitment of life-long learning and know present issues. In addition, students suggested

Table 2: Student answers relevant to ABET Engineering Criteria 2000, Criterion 3.

#	Criterion 3: programme outcomes and assessment	Student answers regarding the competences obtained that make them able to:
(a)	Apply knowledge of mathematics, science and engineering	• Realise the importance of accuracy in their work • Perform hard work with quality and completeness • Work with increased speed when using maths and science
(b)	Design and conduct experiments, analyse and interpret data	• Display good critical thinking skills • Practice analysis of problems and perform research
(c)	Design a system, component or process to meet design needs	• Demonstrate the ability to design civil engineering systems • Know the procedure of examining the cause and effect
(d)	Function in multidisciplinary teams	• Apply group work to stress accountability and integrity • Perform design and competition projects, lab work • Work with people for projects that impact others • Use teamwork skills as members and leaders
(e)	Identify, formulate and solve engineering problems	• Tackle problems in a logical sequence with a variety of approaches, systematically and step-by-step • Understand the rationales of basic engineering (rules of thumb, estimation), open-ended problems • Demonstrate skills in the design of structures, assumptions, professional practice and breaking up complicated problems • Search for information (books, journals, Internet, people, etc)
(f)	Have understanding of professional and ethical responsibilities	• Show a good understanding of being more responsible • Show respect for peers at school and at work
(g)	Communicate effectively	• Demonstrate writing skills by preparing a project report • Display presentation skills by performing public speaking • Participate in group performance as a group member or leader • Communicate ideas effectively and be understood
(h)	Understand the impact of engineering in a global and societal context	• Understand the basic knowledge of some projects in the world and their significance
(i)	Recognise the need to engage in life-long learning	• Be committed to life-long learning
(j)	Know contemporary issues	• Answer questions about issues that make human life better
(k)	Use techniques, skills and modern engineering tools necessary for engineering practice	• Display skills in using computer programs • Apply tools like *Excel*, *AutoCAD*, *PowerPoint*, etc • Use spreadsheets for complex designs • Use software for maths to understand concepts • Apply software for calculations and design
**	Additional skills obtained on safety	• Consider safety assumptions first in the design • Accept that mistakes from false assumptions cause failures

the danger existing from false assumptions in design and the importance of safety in civil engineering projects.

The programme outcomes and assessment designed for all types of engineering does not contain certain but very important issues that are necessary in civil engineering. Civil engineers should be taught regulations and codes (structural and environmental), as well as how to apply economics and safety in their structures and projects. Some of these issues, especially safety issues, are stressed adequately to students, while other issues, such as economics and regulations, are not.

Other researchers point out that outside the *hard* engineering skills, ABET requires six professional skills, specifically: communication, teamwork, understanding ethics and professionalism (process skills) and engineering within a global and societal context, life-long learning, and knowledge of contemporary issues (awareness skills) [5]. Researchers have described

how the process and awareness skills can be taught and learned, and the difficult issues in assessing these skills [5].

Since engineering design requires a team effort, the variables affecting team performance have been studied by various researchers. These variables include team composition, female-to-male ratio, teamwork skills training. Professors are challenged to find new methods to train students with the skills needed in the constantly changing workplace, so creative collaboration is needed. Higher design performance is achieved as an effect of guided external research during the concept generation phase [6].

Researchers used the Alpert-Haber Anxiety Achievement Test and the debilitation score from the test to identify students suffering from examination anxiety. This anxiety was related to a short or long-term emotion and the student's self-image, and not to study skills, problem-solving skills or avoidance in engaging in difficult problem-solving tasks [7]. The anxiety levels were found to be lower in cases where teachers used measures of student performance that were different from the final examination (eg term work, projects, self-assessment, etc).

Researchers have found that students display differences not only in the levels of motivation and attitudes towards teaching and learning, but also in their different responses to specific classroom environments and instructional practices [8]. The better professors understand these differences to better meet the diverse learning needs of the majority of students by using the categories of learning styles, approaches to learning and intellectual development levels. Models have been developed for each of these categories that outline their pedagogical implications [8].

Design competition projects contribute to students' learning. Research was undertaken to determine which engineering institution consistently won student competitions, and what factors supported their wins, although no one institution was the winner of a particular competition all the time. This shows that success was attributed to a dedicated faculty advisor, or the close alignment of the competition with the curriculum. The quality of students and the availability of resources also impacted on the results. However, no conclusions were drawn on whether student competitions increase student learning [9].

Researchers have also examined the four types of knowledge (tacit, explicit, created and shared in teams) and how these types of knowledge are applied to engineering students [10]. Specific issues in civil engineering education, such as teaching regulations and codes, economics and safety, are not frequently found in the educational literature.

COMPETENCES NEEDED BY STUDENTS

Criterion 4 refers to the professional component requirement for specified subject areas, but not for prescribed specific courses. Students must be prepared for engineering practice through a major design project based on the knowledge and skills they acquired in their coursework, and incorporating engineering standards and constraints (economic, environmental, sustainability, manufacturability, ethical, health and safety, social and political). The professional components include the following:

- One year of a combination of college level mathematics and basic sciences (some experiments);
- One and a half years of engineering topics consisting of engineering sciences and engineering design;
- A general education component to complement the technical one that is consistent with the programme and institutional objectives.

The students' answers, shown in Table 3, indicate that the students felt the need to be taught courses to develop more engineering knowledge in handling civil engineering problems (assumptions, design and redesign, decision-making), public speaking, coping with ethical issues and failures, practicing managerial skills for projects and teams, entrepreneurship, and passing the professional examination, while they did not have interests in political issues, environmental issues, sustainability, health and safety issues.

When interpreting the students' responses, the need for courses taught in the business school is obvious. Courses such as organisational behaviour, time management, human resources management, crisis management, negotiations, entrepreneurship, accounting and finance are needed by students before they feel ready to enter the workplace.

In an alumni survey that was designed to evaluate an engineering programme's success, the researchers asked alumni to rank the importance and level of preparation they had in the 11 main desired outcomes of the Engineering Criteria (EC 2000). The survey provided insight into the different perspectives by a degree programme, career path and other demographic groupings [11].

Researchers found that learning the language of the workplace is a different process from attending a university engineering curriculum, which certainly does not consider skills as interpersonal relationships, crisis management and objectivity. Success in the workplace needs not only the core technical knowledge, but also other skills, such as those taught in a new interdisciplinary

Table 3: Student answers relevant to ABET Engineering Criteria 2000, Criterion 4.

#	Criterion 4: professional component	Student answers regarding additional knowledge that is needed to make them able to:
(a)	Engineering knowledge	• Search the resources to find the *where* and *how* • Make assumptions on design criteria and calculations • Design and build with basic, sound knowledge • Practice continuous rethinking and decision-making • Display the ability to analyse new technology, share knowledge
(b)	Engineering skills	• Deal with different problems that have many parameters • Seek more real life examples and real situation scenarios • Obtain hands-on design experience and role playing • Handle requirements and changes in the original design • Face aspects of pilot, national or international projects • Obtain specialised skills to deal with certain situations
(c)	Economic and legal issues	• Learn project accounting and pricing
(d)	Environmental issues	
(e)	Sustainability issues	
(f)	Manufacturability	
(g)	Ethical issues	• Apply ethical competences that are important • Introduce ethics regarding decision-making • Stay open-minded to different ideas
(h)	Health and safety	
(i)	Social issues	• Use communication skills to express ideas effectively • Speak with confidence and use engineering terms correctly • Display social skills when dealing with people and the public • Work with people from many different backgrounds • Deal with professionals, including networking with professionals • Deal with bosses and co-workers, plus office politics • Be patient when dealing with colleagues who are hard-headed
(j)	Political issues.	
(k) **	Professional exam	• Take a course on how to pass the EIT exam • Pursue to pass the EIT exam needed by the employer
(l) **	Coping with failures	• Avoid failures of projects and failures in construction • Obtain experience in handling failures
(m) **	Project management	• Know project management and time management • Have management skills, people skills and leadership skills • Know types of organisations for design and construction • Work in groups and be persistent when solving problems • Perform tasks with confidence • Take responsibility for people and projects
(n) **	Entrepreneurship	• Know types of organisational structures and working methods • Work under pressure and have practical knowledge • Learn to use professional engineering design software

teaming course at Auburn University [12].

Very often in organisations and companies, those people who display successful performance levels are found to have developed – beyond their technical skills – emotional intelligence skills that help them achieve their successes [13-15]. People in higher positions in organisations have most of the competences in the emotional intelligence domain along with other distinguished skills, such as technical and cognitive abilities [16].

In educating managers placed in different positions, the importance of emotional intelligence is considered, and special training is given for understanding the importance of emotional intelligence and being able to prevent or handle emotional situations. Especially in the process of applying changes in the workplace,

leaders' emotional intelligence helps lower the reactions and cynicism of employees to these changes [17].

Social scientists who use the model of emotional intelligence realise that the four directions – two personal (self-knowledge and self-management) and two social (social knowledge and social management) – that involve emotional skills along with the mental skills, are those used by professionals to perform successfully in the workplace [18]. The emotional development of people working in an organisation or company is important for the development of the emotions of the organisation, as if the organisation is a living organism that has emotions [19].

EXPECTATIONS FROM FACULTY

Criterion 5 refers to faculty that have to be of a sufficient number and who have the competences required to cover all the areas of the curriculum, advising and counselling, service to the institution, professional development, plus interaction with professionals in industry and student employers. Faculty have to provide guidance, evaluation and the development of the programme. The competences of faculty are judged by their education, diversity of background, engineering experience, teaching experience, ability to communicate, enthusiasm in developing programmes, level of scholarship, participation in professional societies and registration as professional engineers.

The students' answers, listed in Table 4, indicate that students expect from the faculty certain attitudes, skills and behaviours. Faculty should show promptness and punctuality, display planning and organisation of their work, reveal perfect knowledge of the material, have a good knowledge of the applications of the theory, teach updated material, employ computers and software in teaching and homework, give explanations and clarifications, encourage group work and invite class participation, display agreeable personality characteristics, practice excellent communication skills, and be able to handle difficult situations.

The skills and abilities that the students expect from the faculty, beyond their technical skills in their field of engineering and the continuous updating of the material and tools they use, are taught in certain classes of the business school, such as time management, organisational management, human resources management, leadership and crisis management.

Criterion 5 refers to faculty needing to be of a sufficient number and have the competences to:

- Work on guidance, evaluation and the development of the programme;
- Teach courses of the curriculum;
- Provide advice and counselling service to the institution;
- Participate in professional development;
- Develop interactions with industry professionals;
- Create interaction with students' employers.

The above requirements do not indicate the skills required to perform their tasks and those skills are taught in the business schools' classes.

Researchers have studied students' course satisfaction levels, gains in learning outcomes, and perception on selected skills and attitudes in relation to faculty teaching practices, classroom climate, students' perceptions of their gains in communication skills, problem-solving skills, occupational awareness and engineering competence. Research has shown that faculty interacting with, and providing constructive feedback to, students was positively related to student gains in design and professional skills [20].

Elsewhere, researchers indicate that the significant outcome is in faculty development:

- Design projects to help students make connections between subjects, materials and applications;
- Implement integrated curricula to help expand the use of cooperative learning and student teams in the design projects;
- Prove the successful outcomes of integrated programmes: improved retention, learning of disciplinary content and expansion into non-disciplinary skills;
- Understand the complexity of large-scale curricular changes by scaling the programme from initiating a pilot programme to a programme that addresses a diverse student population, to a programme sustaining an institutionalised curriculum [2].

Furthermore, researchers argue that the suggestions to faculty for improving the classroom environment focus on planning the course (set of instructional objectives, syllabus of the course goals, establishing a grading policy, feedback of grade performance to students, etc) and conducting the course; the latter includes describing the relevancy of course in the first session, establishing office hours, respecting students' time in the classroom, distributing copies of key theories, leaving gaps for students to complete, utilising alternative methods of delivering course materials, setting realistic expectations from students and encouraging questions, facing the student audience plus speaking slowly and clearly, assessing the progress of the course throughout the semester, periodically updating the course contents to reflect evolving technology, relating the curriculum to real life problems

Table 4: Student answers relevant to ABET Engineering Criteria 2000, Criterion 5.

#	Criterion 5: Faculty Component	Student answers regarding the competences they value in faculty that make them able to:
1	Punctuality in activities	• Show promptness, arrive in class and always be on time • Be on time to class to let students into the classroom • Follow schedule, time frame and use lecture time efficiently
2	Planning and organisation	• Organise all the coursework for the semester in advance • Organise the everyday schedule systematically • Make clear homework and course requirements
3	Preparation	• Be well prepared for class, reflected from notes and lectures • Have a concise knowledge of key subjects • Demonstrate applications of formulae and perform calculations
4	Knowledge of course materials	• Know and understand what he/she tries to teach others • Describe his/her working experience on the subject • Love his/her subjects so much as to conduct own research • Be energetic about the topic so that students want to know more
5	Applicability of course materials	• Give many examples and show important points clearly • Show applications in real life situations and real scenarios • Give advanced construction knowledge • Solve problems and talk about current events
6	Updating of course materials	• Provide updated codes of practice • Provide advanced technical strategies • Emphasise safety when teaching structures • Invite professionals as guest speakers on real life projects
7	Introducing computers and software	• Give assignments based on *Excel* spreadsheets • Give examples of computer-based design
8	Giving explanations and clarifications	• Speak and teach very clearly, and invite questions • Induce active thinking and accountability to pay attention • Be patient to answer questions and clarify doubts
9	Encouraging group work	• Allow several ideas to develop in each group • Help communicate information from one group to another • Encourage group discussions for brainstorming
10	Inviting class participation	• Encourage dialogue and participation of students • Ask students to select topics, work on them and make presentations • Require research or design projects at the semester's end
11	Personality characteristics	• Show intelligence, and be straightforward, open and approachable • Have a pleasing personality and create a positive atmosphere • Be concerned about students' needs regarding learning • Be flexible with homework and avoid pressure on students
12	Communication skills	• Treat and help all students in a professional manner • Welcome students to his/her office at any time • Understand and address students' different learning styles • Establish a mailing list to communicate issues and challenges
13	Handling difficult situations	• Acknowledge his/her misunderstandings or mistakes • Resolve conflict and clarify misunderstandings • Deal with unexpected events and still give a good lecture

and current events, drawing from personal experience and using student examples for practical applications, providing suitable activities that appeal to each learning style, understanding personal learning styles, encouraging class participation, and using active or cooperative learning after careful design [21].

Researchers found that the teaching evaluations of the students are one critical component of the instructor and course evaluation in a university. In teaching evaluations, the accessibility of the instructor

outweighs other factors, such as perceived course workload and expected grade in the course, and there is a strong correlation between the instructor's rating and the instructor's accessibility [22].

Other researchers in similar situations found that challenges for both professors and their institutions in engineering education are to create faculty who will learn new approaches in teaching and learning, and will generate more powerful forms of engineering education [23]. The four components of education are the professor's interaction with students, students' lesson engagement, narrative notes and research-based measures of effective teaching [24].

EXPECTATIONS FROM THE SCHOOL

Criterion 1 refers to students and requires the quality performance of students and graduates, with the responsibility of the institution to evaluate, advise and monitor students to meet programme objectives. Policies are needed to accept and transfer students, validate courses taken elsewhere, and procedures that all students meet programme requirements.

Criterion 2 refers to the programme, which has to have:

- Published educational objectives that are consistent with the mission of the university;
- A process to determine and periodically evaluate the objectives (based on the constituencies of the programme);
- A curriculum and process to ensure the achievement of these objectives;
- A system of ongoing evaluation to demonstrate the achievement of the objectives and improve the effectiveness of the programme.

Criterion 6 refers to facilities, including the classrooms, laboratories and associated equipment that have to be adequate for the programme objectives, and create an atmosphere conducive to learning. Also, facilities to foster faculty-student interaction are needed to help create climate of professional development and activities, plus computer and information areas need to be made available to support the activities of students and faculty.

Criterion 7 refers to institutional support and the financial resources that are needed to:

- Assure the quality and continuity of the programme;
- Attract, retain and provide well-qualified faculty;
- Acquire, maintain and operate facilities and equipment for the programme;
- Provide adequate support personnel.

Criterion 8 refers to the programme criteria that are needed for the interpretation of basic level criteria; in the case of two programmes, overlapping criteria are satisfied once regarding the topics of the curriculum and faculty qualifications.

The answers of the students, as shown in Table 5, indicate that the department and the school should take certain measures. The suggestions for the efficient operation of the department refer to the classes and time offered, first year and four-year plans for graduation, procedures for advising students, improving the teaching abilities of the faculty, giving emphasis to engineering design, employing new technologies, teaching practical knowledge and safety issues, explaining specifications and codes, emphasising field experience and innovation, teaching more communication and management skills, and preparing students for the Engineer-in-Training (EIT) examinations, the profession and the workplace.

Researchers have categorised the following opportunities for developing learning objectives:

- Assessment and integrative learning outcomes, such as concept maps, solving integrated problems, design process evaluation and transfer-associated outcomes from one course to another;
- Longitudinal studies with a few short-term indicators of success in implementing an integrated curriculum;
- Evaluating alternative integrated curricular approaches, so that alternative integrated curricula might be implemented and analysed;
- Metacognitive outcomes and instructing students about the reason of integration, and allowing students to reflect on the reasons [2].

Furthermore, researchers have analysed the forces limiting institutionalisation:

- Integrated curricula that combine or connect materials from two or more courses;
- Integrated curricula that depend on multiple factors that are changed simultaneously;
- Integrated curricula that seek to help students make connections across topics and courses [2].

Elsewhere, researchers initiated a discipline-specific advanced communication programme over a decade ago. They used an assess-revise-assess strategy for curriculum improvement, and incorporated interpersonal communications, teamwork, engineering research, professional ethics, management and professional development skills, critical and creative

Table 5: Student answers relevant to ABET Engineering Criteria 2000, Criterion 6

#	Criteria 1, 2, 6, 7 and 8: Educational objectives, programme, facilities and institutional components	Student answers indicating what education is needed to be offered to students, as well as what activities, to:
1	Curricula	• Enrol engineering freshmen in a year-plan, schedule an annual educational day, advise and help incoming students • Advise students to take the classes they need to graduate and make sure it is feasible to graduate in four years • Offer more classes during the semester and offer summer classes • Arrange classes with co-requirements in the same semester
2	Teaching abilities	• Prepare lectures, class notes and homework in advance • Match materials to the time taught, and update and add new material • Know students' needs and teach in a simplified manner • Give a reasonable amount of material and stay within limits • Avoid teaching theory without practical applications
3	Analysis and synthesis	• Place emphasis on analytical reasoning • Approach problem-solving with a certain methodology
4	Engineering design	• Introduce current versions or revisions on related topics • Show design projects or calculations by using real world parameters, and show how to make assumptions and work in groups • Show how to apply formulae, variables and constants
5	New technology and engineering software	• Teach software packages related to industry • Implement interactive multimedia techniques • Introduce the latest technologies used in the field
6	Specifications and codes	• Teach design specifications • Teach important rules, requirements and codes
7	Practical knowledge	• Provide applications of theory and problem-solving practices • Provide real examples from engineering practice • Provide subjects that are easily applicable in the real world
8	Field experience	• Add more practical classes, such as field engineering laboratories • Consider applications and enhance subjects with field trips • Include real field work experience in engineering curricula
9	Innovation	• Develop the ability to innovate and stay open-minded • Introduce design competition projects and foster creative thinking • Design curricula that engage students and integrate research
10	Communication	• Add more technical writing and oral presentations • Ask for many short reports rather than just one long report
11	Management	• Develop and practice management skills and teambuilding • Consider economics, and the legal, social and environmental aspects
12	Safety issues	• Design for the worst combination of conditions • Understand and practice safety above all
13	Preparation for the profession	• Produce professional awareness to students • Teach an understanding and appreciation of the workplace • Emphasise the safety and risks for peoples' lives
14	Preparation for the workplace	• Teach how to search for jobs and how to talk to companies • Teach what students will be asked to undertake in the workplace
15	EIT exams	• Aim curricula at passing EIT exams • Make required courses subjects that are included in the EIT

thinking, and engineering design in the programme instruction [25].

Researchers have also reported that engineering courses offer students multiple resources for learning.

However, it is unclear how much time students can devote or how effective students are in mastering course materials, why students favour some resources more than others when the resources were mutually supportive for instruction, if they significantly correlate with each other and with academic performance, and how they can assist in course and curriculum planning [26].

BUSINESS SCHOOL CURRICULUM

Curricula in business schools consider the functional areas of management, information systems and marketing, finance and accounting, and human resources. Today, business programmes are given by business schools, universities and other institutions across the world. The methods of teaching and study vary from full-time attendance, part-time in the classroom, and modular and distant learning. All the different available options are to the benefit of students to choose not only what is needed for their profession, but also which method to choose for their study that will be convenient to them regarding their place of living and the requirements of their work.

By taking business classes, engineering students not only increase their responsibilities within the workplace, but also open new career opportunities, promote their interests and responsibilities, and extend their personal network of professionals. Business courses can help young engineers to develop their personal skills, and extend their knowledge in the management disciplines needed to lead and work with people other than engineers, such as lawyers, economists, business people, health professionals, educators, social scientists, environmentalists and artists.

By taking business classes at a university, students will find that the knowledge is directly transferable to the workplace. Experienced professors in business courses transfer their experience and enthusiasm to students, broaden students' understanding and develop students' skills that make them ready for the challenges and changes in the workplace and the job market.

The courses taught in business curricula are shown in Table 6 along with a short description of the content of the course. The information in Table 6 is taken from the Web site of the College of Business at Idaho State University. Each course is compared to the students' comments from Table 3 to indicate what courses might be useful to engineering students.

The business courses listed in Table 6 cover a large area of knowledge for people who are going to be managers in the workplace. Since engineering students will be asked to perform management in the workplace, some of the courses in Table 6, when connected to the students' answers in Table 3, will be useful to the civil engineering students and make them confident to enter the profession. These courses, indicated with a *YES* in Table 6, are *Financial Reporting*, *Accounting*, *Managerial Decision Making*, *Government Regulations*, *Business Ethics*, *Entrepreneurship*, *Organizational Behavior*, *Business and Society*, *Human Resource Management*, *Labor and Employment Law*, and *Multinational Corporations*. Students can search and find courses taught with materials that are closer to their needs; however, certain courses are essential, including role-playing practice in the classroom, for solving problems in the workplace.

Some of the essential courses are *Organizational Behavior*, *Organizational Management*, *Accounting* and *Finance*. These courses will help students to be confident with the engineering knowledge they gained at university, and become ready to contribute to the workplace by having learned the rules of the organisational environment they enter. Some essential business classes are useful to other professionals graduating from universities, not only in engineering, but in the sciences as well. Also, faculty and leaders in the academic environment can profit from business school classes and be able to perform their tasks in a consistent and efficient manner by avoiding situations of stress and conflict.

Researchers found that actions to develop students' skills to succeed within innovative, product-focused cross-disciplinary teams are as follows:

- Assess the programme early;
- Encourage students to define new products with huge potential to meet product needs;
- Define the quality of the product;
- Venture ideas;
- Ask students to work in diverse teams;
- Perform high pressure presentations;
- Answer tough questions from entrepreneurs;
- Learn to create new products, companies and strategic alliances for the benefit of all stakeholders (students, researchers, the institution, etc) [27].

It has also been found that the practice of civil, environmental and geological engineering shares many common ethical dilemmas due to its extensive interaction with clients and regulatory agencies, while dealing with unpredictable earth materials for design and using uncertain design parameters. A series of exercises was developed to teach issues that dealt with *grey* ethical areas, concepts of advocacy and the use of compromise, relating specific stories to global concepts,

Table 6: List of business classes and an indication of classes for civil engineering students.

#	Course Title	Course Description	Student Needs (Table 3)
1	*Applied Economics*	Applied principles and techniques in microeconomics and macroeconomics	NO
2	*Financial Reporting, Accounting*	Integrates accounting concepts with an understanding of financial reports, and the use of accounting information in managerial decision-making and control	YES
3	*Human Behavior in Organizations*	Study of human behaviour in organisations, decision-making and problem-solving, interpersonal relations and communications, and negotiations	NO
4	*Marketing*	Analysis of forces producing changes in business, principles of market-driven decision-making, and applications to marketing management decisions and marketing strategies	NO
5	*Managerial Decision Making*	Study of the environment in which managerial decisions are made, organisational change, leadership, values, regulation, corporate culture and processes, and organisational diversity	YES
6	*Finance Integrated Environment*	Integrated analysis of company decisions with an emphasis on the financial aspects	NO
7	*Marketing in an Integrated Environment*	Integrated analysis of the firm's decisions with an emphasis on the marketing and distribution aspects, and an analysis of product development and market strategies	NO
8	*Information Technology*	The management of information technology and its use in strategic plans	NO
9	*Managerial Control Systems*	The managerial and strategic use of control systems, and the impact on organisational behaviour and decision-making	NO
10	*Policy/Strategy in the Global Environment*	Strategic management of the company with an emphasis on cultural diversity, industry analysis and strategy formulation	NO
11	*Business Simulation and Application*	Simulation of company operations in teams and interaction with different stakeholder groups with a focus on understanding complex business operations	NO
12	Accounting graduate electives	Tax planning and concepts, legal issues, auditing, managerial accounting, international accounting, and strategic cost management	NO
13	*Computer Information Systems*	Information security and privacy, systems security administration and management, certification, risk analysis, computer languages, multimedia, support systems, electronic commerce, databases, system analysis, networks and communication, and information systems	NO
14	Finance graduate electives	Financial modelling, real estate, financial management, corporate finance, investments and portfolio management	NO
15	Marketing graduate electives	Marketing research and communication, e-marketing, sales force management, purchasing and materials management, new product development, marketing channels and logistics, international marketing, and competitive intelligence	NO
16	Other graduate electives	Planning for e-commerce, advanced financial modelling, security analysis and portfolio management, group and decision support systems, artificial intelligence and expert systems, business models, statistical models, innovation and technology management, organisational development, and environmental management Multinational corporations, government regulations, business ethics, entrepreneurship, organisational behaviour, business and society, human resource management, and labour/employment law	NO YES

proper behaviour in the corporate environment, and the influence of corporate culture on ethical decisions [28].

Further research on core competences in ethics and communication was integrated into students' research experiences outside of formal courses. A simple mapping assessment, at the beginning and end

of the semester, suggested that students made gains in both directions; in ethics, students indicated greater awareness of key concepts, respect for persons, beneficence, justice and integrity, while in communication, students indicated that they understood the importance of audience and the multifaceted nature of technical communication. These results indicate that students can obtain competences outside of taking formal courses by using the model: audience → tone → purpose → message → audience, and backwards [29].

Research has been conducted on how undergraduate students conceive themselves as professionals, how the course on engineering ethics affects the student's professional identity, how students benefit from cases of actual incidents and from classroom activities that encourage diverse perspectives on moral problems to build self confidence in moral issues. It was realised that students eventually understand professional responsibility, not only as liability for blame, but also for the stewardship of society [30].

Two approaches of a full semester ethics course and an engineering course, which included an ethics module, was researched using the Defining Issues Test to compare improvements in students' moral reasoning ability in each class and compare it to a control class. The ethics course showed improvements compared to the module class, but was not significantly different from the control class. No effect of gender or age was present, but the educational level had an influence. The recommendation is that ethics should be delivered in multiple courses in the curriculum and incorporate specific discipline context [31].

CONCLUSIONS

The research presented in this article refers to civil engineering students' attitudes to their abilities and preparation for the profession, and, more specifically, to the ABET Engineering Criteria 2000 with regard to students, programme, the outcomes and assessment of the programme, professional component requirement, faculty and institutional support.

Regarding the answers of students in this study, there is an understanding that the students obtained engineering knowledge; they know how to solve problems and conduct research, design systems and perform in teams. Also, students understand issues of ethics, obtained communication skills, recognise the societal effect of projects, know how to apply modern engineering tools, understand the commitment to life-long learning and know current issues. However, civil engineering students should also be taught regulations and codes, as well as how to apply economics and safety into their designs.

Also, the students felt the need to be taught courses to develop more engineering knowledge in handling civil engineering problems (assumptions, design and redesign, decision-making, etc), and more communications knowledge in public speaking, coping with ethical issues and failures, managerial skills for projects and teams, entrepreneurship, and passing the professional examination. This strongly indicates that courses like organisational behaviour, time management, human resources management, crisis management, negotiations, entrepreneurship, accounting and finance are needed by students before they would feel ready to enter the workplace.

The students expected certain attitudes, skills and behaviours from faculty. As such, faculty should apply time management, plan and organise their work, know the course materials perfectly, teach applications and updated material, apply computers and software, give explanations and clarifications, encourage group work and class participation, display an agreeable personality and excellent communication skills, and be able to handle difficult situations. The skills and abilities that the students expected from faculty correspond to business school classes, such as time management, organisational management, human resources management, leadership and crisis management.

The students indicated that the measures expected from the department refer to the classes and semester offered, student advice and plans for graduation, improving the teaching abilities of faculty, emphasising engineering design, employing new technologies, teaching practical knowledge and safety issues, explaining specifications and codes, placing emphasis on field experience and innovation, teaching more communication and managerial skills, and preparing students for the EIT examination. Civil engineering students can search for business courses with materials that are closer to their needs, although certain courses, such as those in organisational behaviour, organisational management, accounting and finance, are essential. By taking business classes, engineering students, as well as other schools' graduates and faculty members, gain confidence and become ready to successfully contribute to the workplace.

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BIOGRAPHIES

Efrossini C. Kalkani has a PhD degree in civil engineering from Purdue University, an MSc degree in civil engineering from Purdue University, an MSc degree in geophysics from Stanford University and a Master in Business Administration from San José State University. Dr Kalkani obtained professional experience in the design, construction and exploitation of hydropower projects by working 32 years in several engineering positions at the Public Power Corporation of Greece. Dr Kalkani has taught at the NTUA, the University of Minnesota and San José State University, delivering courses in hydropower, hydraulic structures and dams, renewable energy engineering, project management, hydraulic design, water resources engineering, and engineering professional issues.

Dr Kalkani, who belongs to the editorial board of *Engineering Geology* (Elsevier) and *Dam Engineering* (Wilmington Press), is the author of various research papers on hydropower and dams, as well as papers in engineering education. Dr Kalkani is a Fellow of the ASCE, a member of the IAHR, and a participant in several European Union (EU) projects.

Leda G. Boussiakou has a PhD degree in theoretical physics from the University of York, and BSc and MSc degrees in physics from the University of Essex. Dr Boussiakou is the recipient of the York Scientific Research Prize, 2003, and the Alan Gibson Prize for Science at the University of Essex, 1996. Dr Boussiakou is presently an assistant professor in theoretical physics at King Saud University, Riyadh, Saudi Arabia, and teaches courses in special relativity, quantum physics, and higher order differential equations.

The scientific interests of Dr Boussiakou are in theoretical physics, mathematics and education.