

A COMPARISON OF CIVIL ENGINEERING EDUCATION AT THE UNIVERSITY OF FLORIDA AND THE CATHOLIC UNIVERSITY OF THE NORTH, CHILE

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ABSTRACT

This paper discusses and compares the teaching-learning methods used by instructors and applied to Civil Engineering undergraduate courses at the University of Florida (UF) and the Catholic University of the North (UCN), Chile. The main aspects taken into account in this comparison are: type of classes, lecture methodologies and teacher-student communication. Differences in the teaching methods are strongly influenced by the different functions that both universities comply, augmented by the duration of the programs and the type and quantity of classes. The application of the Project Led Learning (PLL) method at the UCN as a pioneer project is expected to produce notable enhancement in the teaching-learning process in the civil engineering undergraduate courses.

INTRODUCTION

A variety of teaching methods is being applied currently in the civil engineering colleges around the world, most of them adapted to the socio-economic scenario, culture and available resources of the countries. This paper compares the teaching-learning methods between two conceptually different programs, with the purpose to show the differences in the civil engineering education in countries that are culturally distinct. The comparison is also extended to the teaching evaluation methods and the roles of teachers and students in the education process.

University of Florida (UF) was founded in 1853 and it has grown into one of the largest universities in the Southeast of the USA. With 20 colleges and schools, it is one of the most broadly based universities in the United States. UF accounts for more than 40,000 undergraduate and graduate students, who may choose from 114 majors in 52 undergraduate degree programs. The College of Engineering, created in 1910, has grown to include more than 3,500 undergraduate and graduate students and more than 300 faculty members, totaling 10 departments. The Department of Civil Engineering (CE) was established in 1905 and it merged with the Department of Coastal Engineering in 1999. Currently the Department of Civil and Coastal Engineering (CCE) has 44 faculty members in 10 technology areas. The program offered by the CCE department has more than 450 undergraduate students and is considered among the top in the USA [1]. Catholic University of the North (UCN) was founded in 1960 and it is divided in 16 Departments. The Civil Engineering Department (CED) was created in 1981 along with the creation of Civil Engineering Undergraduate Program. UCN accounts for 6,000 undergraduate students, 350 of them are enrolled in the civil engineering undergraduate program [2].

At the UF, the first-year courses are oriented to prepare students in basic sciences such as mathematics, chemistry, and physics, which represent the foundation for the engineering degree and are known as pre-engineering courses. Additionally, in the first two years, students take a number of basic engineering courses like Structures, Mechanics and Materials, to complete the core curriculum required of all

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engineering students. In the later years, students concentrate on their major field of study, choosing among different specialties in civil engineering, such as: structures, geotechnics, transportation, hydraulics, general civil engineering, civil engineering materials, surveying sciences, and construction engineering. The duration of the undergraduate courses at the UF is 4 years.

At the UCN, civil engineering undergraduate courses have a duration of 6 years. The first two years are oriented to basic science courses in a common plan with all the rest of engineering students. Basic engineering courses like Structures and Materials are taken in the third year. The last three years are completely dedicated to professional courses without a specific orientation, but covering a wide variety of engineering areas such as: geotechnics, structures, hydraulics and construction. It must be emphasized that in Chile, universities give the engineer license, whereas in the USA, the license for working as a professional civil engineer is issued by an external institution other than the university, after passing a Professional Engineering (PE) Exam. This explains the differences in the duration of the programs and the variations in the teaching methods mainly in the later years.

CIVIL ENGINEERING UNDERGRADUATE PROGRAMS

The duration of the programs along with the issued license represents the most significant aspect that emphasizes the differences in the teaching methodologies. Whereas UF prepares bachelors so that they gain experience in the real world, UCN must provide as much practical training as possible, for producing a very prepared professional as soon as they finish their undergraduate program. Before comparing the teaching methodology, a discussion of complementary aspects is done, considering duration of programs, teacher hierarchy and available facilities. These aspects strongly influence the teaching-learning process in both universities.

Curriculum and program duration

The undergraduate civil engineering courses at the UF have, as mentioned above, a duration of 4 years, including one summer term, totaling 131 credit hours. During seniors' years, civil engineering students at the UF will take the Engineering-In-Training (EIT) Exam. Furthermore, they are also eligible to take PE Exam after having five years of work experience in an engineering outfit. They will receive their PE license after passing the PE Exam. Recent studies show that a low percentage of the American engineers is registered. The main reason for this is the fact that they usually work for big companies, where the responsibility lies with the company and not the individual, unlike Chile where the engineers tend to work alone and therefore have to bear full responsibility for any errors. The minimum time for a student in the undergraduate degree program at the UCN is 7 years, which includes 6 years of regular undergraduate courses and 1 year for a comprehensive report. The professional courses at the UCN are strongly practical-oriented, because, unlike UF, students from the UCN get their engineer's licenses after finishing all the undergraduate courses and passing a final examination based on the completion of a comprehensive research report.

Curriculum of the civil engineering program at the UCN is very rigid. Students can only take courses if the pre-requisites are satisfactorily completed. There is no possibility of eliminating prerequisites without the authorization of the Program Director. This aspect along with the rate of repetition, results in the program at UCN to have an average duration of 8.5 years, without considering the final research report. By considering this final activity, the total duration could become greater than 10 years. This issue produces a very negative impact on the economy, due to excessive costs that both society and state must bear for producing professionals. At UF, prerequisites can be eliminated by consent of instructors, which favorably facilitates the student's progress. Low rate of course repetitions is appreciated in the undergraduate courses at UF and students commonly finish their courses in the pre-established time duration.

Instructional hierarchy

Teachers at UCN have the designations of Full Professor, Associate Professor or Assistant Professor. The different designations are associated with both the experience and the academic ranking of the teacher. The condition of Full Professor is reserved for teachers with more than 25 years of experience in either the academic or professional field. Also, he or she has to have a PhD or MS degrees. Associate Professors are teachers with more than 15 years of experience and at least have master's degree. Assistant Professors are professionals with great experience in different fields of civil engineering. As civil engineering undergraduate courses lead to a professional qualification, teachers with practical experience are very important to the university. The university has the mission to supply the necessary experience to students, so that they are immediately able to work as an engineer after finishing the program, with professional responsibilities. The faculty members in the CED are only concerned with the undergraduate program. As the major objective is to prepare professionals with a practical approach, teachers with rich practical experience are not only important but also necessary. They are not required to have a master or PhD degree, but several years of experience in companies or government. As CED starts to dictate graduate courses in the near future, the number of academics with master and PhD degrees will increase, but the practical experience will always be a requirement for teaching in the CED.

Several professional designations exist at UF: Full Professor, Associate Professor, Assistant Professor, Adjunct Professor and Instructor. Classes at UF can be given only by teachers with a PhD degree or by a graduate student (PhD candidate) supervised by a Professor, Associate Professor or Assistant Professor. Faculty members in the CCE are concerned with both undergraduate and graduate courses. Almost all of them have PhD and conduct research that notably enhances the teaching-learning process, by providing new knowledge and feedback.

Facilities and computer support

Higher educational institutions, equipped with modern learning facilities, play an important role in the teaching-learning process by providing the environment and the means to support the education process. The CED at UCN has some laboratory facilities, which can be incorporated in the classes. There is a Materials Testing Laboratory, which includes testing on soil, concrete, asphalt, steel and welding. The Computer Laboratory for civil engineering students is equipped with Internet. The Computer Assisted Research Laboratory (CARL) is equipped with the technology for GIS application and advanced research. There is also a basic Hydraulics Laboratory. Also, the CED has two classrooms with large screen projection equipment, apart from those classrooms shared with the other programs. The departments that are responsible for the basic science courses have their own laboratories such as Chemical Analysis, Math and Physics Laboratory.

The Material Testing Laboratory needs to be upgraded with modern equipment. The equipment is appropriate only for being used for basic material classifications. Devices for more analytical applications are not available.

The UF provides many computer facilities around campus, which are available to any UF student (e.g. Center of Instructional and Research Computing Activities, CIRCA). One CIRCA facility is located in the CCE department. Also, the CCE department has three major computer facilities, which are exclusively for civil engineering students. These include one PC lab and two workstation labs with Internet and e-mail access, in addition to specialized programs used in various classes taught in the CCE Department. Each division within the department operates its own small PC lab with specific software for special applications. There are several classrooms with large screen projection equipment. The CCE Department also has a local area network using Ethernet and the TCP/IP [3].

Technical laboratories include Structures, Hydraulics, Coastal and Materials, labs apart from those related to basic sciences. All of them are equipped with the latest technology to support not only the undergraduate courses, but also the graduate students in their research. Several others, like the Transportation Research Center (TRC), also provide the opportunity for students, especially undergraduate students, to experience

real projects and to work with real data. This aspect is one of the strongest perks in the UF undergraduate program, since students have access to the latest technology that notably improves their practical experience.

Application of advanced engineering software is a common practice in both universities. According to the course contents, modeling and data analysis are performed to reinforce the concepts. CAD is extensively used in both UCN and UF, at the undergraduate level courses.

TEACHING-LEARNING METHODOLOGY

In this paper, the teaching methodology is compared and discussed based on three major aspects: type of classes, teaching technique and teacher-student communication.

Type of classes

At the UCN, courses include three kinds of classes: lectures, exercise classes and laboratory classes. Even though not all courses have these three components, almost all have lectures and exercise classes. Lectures are given by Professors, Associate or Assistant Professors. Exercise classes are given by senior students, supervised by the teacher and they mainly consider the development of numerical examples or cases, directly related with the topics seen in lectures. Laboratory classes are given by either an Assistant Professor or a senior student. Experiments are carried out during the laboratories in direct relation with the topics discussed in classes. For better comprehension, laboratory classes are divided in two or three small groups. Labs are evaluated by means of quizzes and reports.

At UF, courses are composed of lectures and exercise classes only in the initial years. Due to large number of students, courses are divided in several small ones, for better comprehension. In the senior years, courses are taught exclusively by professors with a PhD degree. One to four 50-minutes classes are given per week, depending on the registered credit-hours. Laboratory classes are separate courses with one or three credit-hours. Some courses incorporate certain hours for lab experiments, but they are included in the total lecture hours. Lab classes are evaluated by means of quizzes and reports. A comparative analysis of the civil engineering curriculum at UF and UCN indicates that students at the UCN have more than triple hour-classes than UF students, considering all type of classes, and double in the case of lectures only.

There is a great difference between class duration at UCN and UF. At UCN, classes have a duration of 45 minutes, but the entire period always comprises two classes, so each period lasts 90 minutes. These classes are given from two to four times per week, depending on the type of course. Recent studies performed in other Chilean universities indicate that a 50-minute class is optimum for student comprehension and longer classes do not benefit student's understanding, and are in fact counter productive. At UF, on the other hand, classes extend for 50 minutes, one to four times per week, depending on the registered credit hours. Class duration of 50 minutes has proved adequate for both teachers and students.

The fact that students at UCN have extensive exercise classes has both advantages and disadvantages. On one hand, students receive more classes directly related to solving engineering problems for better comprehension of the subjects. On the other hand, students get used to with being provided by study material and they are not encouraged to obtain the information on their own. Both the excessive class-hours that students have to attend and the number of assignments per course greatly overburdens him/her and affects his/her progress adversely.

Teaching methods

At UCN, the CED offers majority of the civil engineering courses. At the beginning of the program, students are taught by faculties of the Mathematic and Physic Departments. These courses are taught differently depending on the student's previous knowledge of the subject. In the initial years at the UCN, students attend classes that can have more than 150 students. Some technology is applied to get better results, like rooms equipped with adequate visual and sound systems and dividing courses into four or more small groups to achieve exercise sessions in solving problems. At UF, courses with as many as 250 students are very common in the earlier years and the technique of dividing the courses into small sections is practiced.

Professional courses offered by the CED at the UCN are taught using different methods. PowerPoint presentations are very common, but chalk and board application is still used. The use of videos for showing practical experience has become a very useful tool for advanced courses. Explanations are accompanied by discussions in classes with students' participation. Work in groups is a common practice at UCN for assignments and projects. The teacher/student ratio in basic engineering courses is 1/50 and for professional courses, the ratio is 1/25. Very similar explanation methods are used currently at UF, with more emphasis in group work with a final report presentation. The interaction between students and teachers is greatly facilitated at UF. The first year courses at UF depict teacher/student ratio of 1/50, whereas in later courses, this ratio ranges from 1/15 to 1/20.

At UCN, there are two specific courses (Project I and Project II) that prepare students to develop projects as professional work. The objective of these courses is to allow students to experience a real-life example of civil engineering design process. The courses are divided into two stages, the first one for developing a real project from the viewpoint of feasibility, applying project evaluations techniques for alternative solutions. The second stage requires the development of detailed engineering maps for the alternative selected in the previous stage. The entire process starts with the formation of design teams of no more than 5 students, to develop a unique civil engineering project to determine an optimal solution. They must prepare proposals, carry out the project and present it before a group of instructors. These courses help students gain experience needed for their future professional endeavors. These courses are essential in the program that finally issues license, permitting students to work as a practicing civil engineer. In addition, students must complete a total of three training sessions in the industry, as part of the preparation for their professional carrier. These training sessions are a requirement for completing the undergraduate courses and they include a report and a presentation. These aspects are some of the strongest advantages of the civil engineering undergraduate program at UCN, since they render a comprehensive preparation for students to face real engineering problems in their professional work. The diverse approach that both curriculum and teaching methods provide to students, encourage them to get involved in any field of the civil engineering. This also produces some negative effects, since more specific and comprehensive knowledge is required in some areas, which are not completely covered by the undergraduate courses. Experience has shown that even though students assimilate an appropriate knowledge during the undergraduate program, practical experience gained after finishing their program is the base for their successful performance.

Some experimentation has been done in the USA for preparing students for the real-life experience through project-oriented courses [4]. At UF, some courses offered by the CCE department are project oriented (e.g., Construction Methods and Project Visualization). In these courses students are separated into small groups and they are required to perform projects using real data.

Field trips are considered essential in both universities to complement courses with dominant practical segment, like construction methods or geotechnical analysis. Along with reports, they form part of the teaching methodology in several undergraduate courses in both institutions.

A special case is given at UCN with the comprehensive research that corresponds to the final activity. This consists of one-year research in any field of civil engineering, supervised by a teacher. Students must produce periodic reports in advance and present a final report before a group of instructors. This activity accounts for 40% of the final undergraduate-course grade at UCN.

At UCN, tests are almost always in-class with a duration of 90 minutes, on average. Very few courses consider open-book tests, however, take-home tests are common as complement to the in-class tests. Grades, generally, take into account the exams, assignments, and final examination. In some cases, a project is

considered as one of the important components of the grade. In the CCE Department at UF, an average of two tests is given to students, plus a final examination. In some courses, assignments are part of the grade and final projects are alternatives to the final exams. Assignments have proved to be a useful method of study, above all if they are assigned in an adequate number with fine content, prior to tests. Term paper is another common task included in the grading of some courses at UF and students are often asked to present their work at the end of the semester. The scale of grades at UCN ranges from 1.0 to 7.0 with a minimum pass mark of 4.0. At UF grades range from F to A, C being the minimum grade for passing courses. Usual average final grades at UCN, in professional engineering courses, range from 3.5 to 5.5, whereas a C to B range is observed at UF. As a result of the duration of the programs and grading methods, success rates are different in both programs. Only 50% of the students entering the civil engineering program at the UCN finish their bachelor's degree, whereas more than 80% of the freshmen at UF successfully complete the undergraduate program. The rate of students repeating courses at the UCN is 30% in the initial years and 15% in the professional courses. As stated earlier, this has a negative impact in the program duration due to the fact that courses are offered annually.

Modes of communication

One of the most important aspect to take into account in the teaching-learning process is the communication between teachers and students. In this content tools like WebCT ("Web Course Tools") at the UF and TIS (Teaching Information System) at the UCN help in the educational process, not only by facilitating the information sharing, but also by providing a meeting place where both teachers and students can express their points of view. WebCT at the UF helps educators to build a web-based learning environment in a very easy way. However, not all the instructors are using this powerful tool. The situation at the UCN is somewhat similar. The TIS was created for providing a space for direct communication between educators and students, but it is used only in the 50% of the courses. Several communication channels can be found in this kind of intranets, such as forums, internal e-mails, grading, assignments, etc. Obviously, this complements the traditional class and office interaction, considering that the most effective technique in the teaching-learning process is the communication. The extensive use of Internet to complement these systems has had a favorable impact on both civil engineering programs. Students have rapid access to the information and they can apply this method in their professional work, allowing them to be more productive. Internet has become the main tool to access information in almost all areas of the civil engineering. By using the web, students enhance their learning, by interacting with other institutions and sharing information.

UCN Future Plan

By recognizing some deficiencies in providing enough practical preparation to the students and in improving skills other than technical knowledge, important changes are going to be implemented in the teaching-learning process in the civil engineering undergraduate courses at UCN. From 2003 onwards, improvements in the civil engineering education will be applied by introducing the Project-Led Learning (PLL) Methodology [5]. This method involves several changes in the education concept, starting with a complete revision of the course contents and incorporating drastic changes in program structure. Its main objective is to apprise students of the engineering problems at an early stage through projects [6]. With the use of the PLL, students are encouraged to assume responsibility for their own learning and to shift from a passive to more active learning attitude. In this process, the role of the teacher also shifts from a simple information transmitter to a learning facilitator. Students must solve technical problems, producing designs based on experimentation involving real data. This will allow students to get involved in their carrier path at early stage.

The PLL (also known as PBL) methodology is being applied in some engineering colleges in both Europe [7] and the USA [8]. Even though there are pros and cons in the application of this methodology, recent studies have shown the advantages of the PLL method overweighs disadvantages. According to these studies,

knowledge gained by working in projects has over 80% of retention after one year, whereas information derived from lectures has less than 20% rate retention after the same time period [7].

With the application of this methodology, the education process in the civil engineering undergraduate courses at UCN will provide the necessary practical experience for students, especially when in Chile, the universities are responsible for the issuance of the civil engineering license, which is a requirement to work as a professional. It is expected that these changes will also improve the rate of success in the civil engineering program.

CONCLUSIONS

In this paper, we made a comparison of the teaching methods applied in the civil engineering undergraduate programs at UF (USA) and UCN (Chile). The main difference in the teaching-learning methodologies between both universities is the fact that UCN issue license to students upon graduation that enable them to practice as professional engineers. As a result students in the CED at UCN obtain the CE License in addition to a BS degree in more than seven years. On the other hand, the CCE department at UF issues BS degrees after four years. Similarities were found in the use of traditional methods as a base for the learning process in earlier years. These methods include teacher presentations using chalk and board, slides, digital presentations and videos, followed by class discussions. Assignments and projects, involving extensive use of software and experimentation, are also used in later courses in both programs. Considering the ultimate purpose of issuing the CE License, UCN emphasizes on project-oriented courses at the end of the program. Main differences exist in both the amount and the types of classes offered by both universities, with students at UCN registering for more than double the class hours as compared to UF students. Such excessive course load carried by UCN students, along with their rigid curriculum, have detrimental effect on their progress. Any delay in students graduation time, create shortage of skilled professional that directly affect national economy. It is pertinent to mention that UF has the state of the art laboratories that provide students with an exceptional opportunity to get hands on experience relating to their course work. UCN lacks such modernized laboratory facilities and hence UF has a clear edge over UCN in this respect. Communication between teachers and students are facilitated by the use of local network systems and the Internet. The latter has proved to be an effective tool for facilitating access to information by both teachers and students, and therefore for improving the teaching-learning process. At present, Project-Led Learning (PLL) has been adopted by the CED at the UCN. This new educational concept will have a great impact in enhancing teaching-learning process in engineering education at UCN.

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