

# Managing Education by Reviewing Civil Engineers' Perceptions about Their Undergraduate Courses

Aysen Bakioglu<sup>1</sup>, Gozde Bakioglu<sup>2</sup>, Gokce Bakioglu<sup>2</sup>

<sup>1</sup>Marmara University

<sup>2</sup>Istanbul Technical University

**Abstract:** Purpose of this study is to find out perceptions of civil engineers about their undergraduate education in terms of disaster related courses. Today world is rapidly changing that have some challenges such as safety regulation, homeland security, and disaster engineering and so on. Engineering practice might not be using only the well-known routine solutions that arise from traditional engineering analysis and optimization. Rather they demand development of non-routine solutions, they simply demand engineering creativity might fostered by their alumni's perceptions about their undergraduate education when they encounter the practical problems at work, they did not find solution with their knowledge and skills they gained in those years of their undergraduate course. A group of civil engineering graduates were interviewed via interview schedule was devised by the researchers. Schedule were prepared by reviewing literature and by pilot interviews. After transcribing interviews, content analysis was undertaken and the findings were reported. Briefly it appeared that most of the interviewees were not happy with health and safety related courses, they found awareness of the disaster in the courses were inadequate. Neither disaster related courses nor disaster related subjects in the courses exist. Since the most important causes of the civil engineering disaster is insufficient knowledge (%36), so their education should be reviewed by a professional organizations such as ABET. Civil engineering disasters occur because of human factors, design flaws, materials failures, miscommunication, extreme conditions or environments and combinations of these reasons. Civil engineering is a precise discipline and in order to be precise, communication among project developers is pertinent for a successful product. There were several forms of miscommunication that might lead to civil engineering disaster in the system, so communication related case studies might assist, the analysis pointed out.

Most of those factors related to engineers' undergraduate courses should be examined related to the disasters occurred related to engineers' fault. Faculty administration, head of departments should come together nationally and internationally in congress and workshops to discuss engineers fault related issues in terms of undergraduate programs. Moreover teaching methods might be discussed in those kind of work, since problem based learning and project based components may be the best way to satisfy industry and accreditation needs. Training lecturers by let them gain expertise by PhD, about disaster related issues and new courses should be established to add knowledge and skills to candidate engineers' education in disaster related issues. For preventing undergraduate course differences between engineers who were graduated with and without taking earthquake or other disaster related courses, every civil engineering faculty and department heads should work together and update their education programs.

**Keywords:** Educational management, civil engineering, undergraduate courses, abet, quality criterias, disaster

## 1. Introduction

The subject of educating and training of civil engineers for the construction industry is becoming increasingly important for the economy. It is obvious that the necessary amount of property might be built only with the appropriate quantity and quality providing of the construction industry by human resources. In

consideration of future, it is important at the outset to make the right choice of the institution where people like to receive higher education in the field of construction.

Civil engineering is one of the main engineering sciences and it takes its name from its importance. The scope of civil engineering is wide so it requires expertise in different branches. Every kind of buildings, airports, dams, roads, harbors, canals, industrial complexes are in scope of civil engineering. And civil engineers must consider disasters and resistance of these constructions. Also earthquake is one of these disasters. Different hazards form different expertise branches. Most important of these are; structural engineering, foundation engineering, hydraulics engineering, materials science, transportations etc. In every study that made in these branches, if earthquake risk is high, earthquake engineering plays the most important role. Directly, an undergraduate program called Earthquake Engineering which is based on Structural mechanics and structural engineering, computer programming, main sciences like mathematics, physics, chemistry etc., social sciences like sociology, economy, physiology etc. risk and disaster management, architecture will make earthquake education better [1].

Earthquake engineering, which is a general issue, works together with geophysics sciences. The earthquake issue is in scope of many sciences but especially civil and geophysics engineering. At this point data sharing is very important. Civil engineers study the characteristic behaviors of earthquakes and use geological maps. Also they use Spectrum curves. Structures are not totally rigid, they are designed to sway during earthquakes. For this reason all these data affect structural design. Codes and regulations are prepared in all countries for this important issue. It is impossible to construct a safe building without considering earthquake effects. An earthquake education program in undergraduate programs will prove more resistant constructions and designs. Although Turkey is an earthquake country, civil engineering and architecture departments in Turkey cannot satisfy needs [1].

Pedagogical Content Knowledge for engineering students is an area of research that allows engineering faculty to formalize the processes that students use in learning and internalizing the fundamentals skills that are critical to making good engineering decisions. In light of increased assessment desired by engineering accreditation groups, PDK may see more universal implementation throughout many areas of engineering education. In seismic engineering, this research is in preliminary stages, in the phases of identifying observed phenomena, defining critical variables and developing suitable instrumentation. Engineering students are expected to be a suitable forecaster of the knowledge skills of entry-level engineers, particularly those who do not do extensive amounts of engineering design work related to earthquakes.

The use of a multi-week instructional module for graduate-level structural design students does show improved understanding of the basics of plastic mechanics and did result in students providing higher self-evaluative comments about their confidence in both general and specific areas of plastic analysis. However, while students did master much of the basic concepts, they still struggled to use cohesive plastic models in forming a basis for engineering design decisions. In addition, a self-reflection by the course instructor identified areas of the course where the instructor had high expectations for the students but did not provide students opportunities to strengthen their skills [2].

Alumni's mostly one of the resources of revising engineering undergraduate program. By eliciting their opinions about their education especially after years, might get shed in to the subjects of developing undergraduate programs since alumni's' experience various kind of applications and cases, that they did not aware of them before.

## 2. Method

This research was conducted to find out civil engineers' perceptions about their undergraduate education related to disaster related courses. Open ended questionnaire was prepared by the researcher to investigate a group of engineers' perceptions, who have been working for 0-10 years in various areas of civil engineering. 25 engineers were replied and all the answers were transcribed and subjected to content analysis by researchers themselves without using any program. By reading many times first data coded and headings and subheadings were determined.

The research group sex was 40% is female and 60% is male, job experience is 12% of the group was on duty less than 2 years, 48% of them has got 2-8 years of experience, 28% of research group engineers have got more than 8 years of experience.

As mentioned above, 60 % of the research group was male, just 40 % was female that was not manipulated by the researchers, it is a desirable situation both sex was presented nearly equally. Almost half of the research group has 2-8 years of experience that maybe in these period after graduation make easier to remember undergraduate years. Nearly one fourth of the group have more than eight years of experience as civil engineer.

### 3. Findings

Most of the engineers in research group reported that their education was satisfactory.

“In terms of civil engineering, it was a quality education. The instruction was full of theoretical context and practical application relatively inadequate, it was the disadvantage of my education, it was lack of creativity and leadership and also individual development”

“It was, productive, delightful and successful.”

“It was fine but it would have been better”

Alumni’s find their undergraduate education as great after a period of time, might be an enjoyable situation, on the other hand it might be questioned, whether their criteria relate to educational quality or their sense of success.

Nearly one fourth of the group (23%) criticized their education as being so theoretical

“It was too theoretical”

“It was not in relation with the field work”

“Instruction is not recognized in industry so the most of the knowledge are not being using”

One fourth of the research group found their undergraduate education as satisfactory. 16% of the group thinks that lack of practice was a problem.

“I have learned to learn our lectueres has got large experiences and knowledgeable, i like my profession so incidently the development occur”

“ I have learned analitically and rational thinking style, frequently made faults in the industry”

“Working hard, limit the social life and when starting the job, teamworking, social activities, making presentation was remain limited”

“ We didn’t meet the companies and hardly know innovations in the sectors.”



Fig 1. Assesment of earthquake related classes

As exhibited on Figure 1, 21% reported that they neither had earhquake related classes nor it was mentioned in other classes. One third of the classes was related eartquake despite this nearly one third of the research group found the classes is sufficient in relation with eartquake. Only 5% of the group found disaster classes or units in other classes related to earthquake was sufficient.

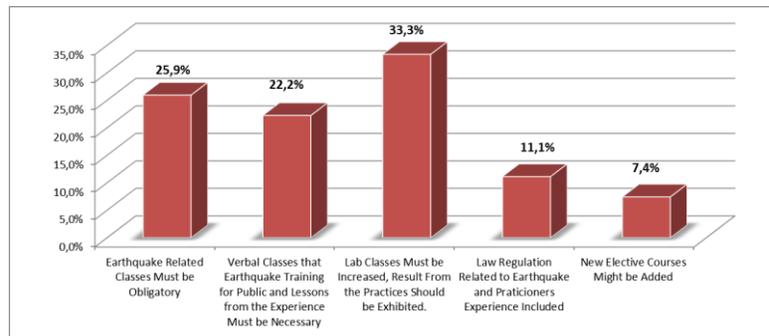


Fig 2. Comments about earthquake related courses

As could be seen on Figure 2, one third of the group thinks that lab classes must be increased, result from the practices should be exhibited. In addition, one fourth of them claims that earthquake related classes must be obligatory.

Clearly, the computer has changed the instructional laboratory greatly over the last few years. It can be used to control experiments; acquire data; and analyze, correlate, and present results. While this level of automation might remove students somewhat from the direct process of the laboratory experience, it can be argued that it has also extended them into areas heretofore impossible to explore. There will undoubtedly be many further developments in this area [3].

Laboratory courses have also been developed to teach students to develop their own data-acquisition systems. One such course at the sophomore level uses interdisciplinary teams to design and implement computer-based systems for measuring temperature and strain and evaluating a temperature controller [4].

Certainly the central purpose of engineering is still to modify nature ethically and economically for the benefit of humankind, but engineers do this increasingly from a computer terminal and not from the workshop floor or a field truck. Nonetheless, most engineering educators agree that students must have some contact—or at least be made to believe they have had contact—with nature. Continuing discussions and further research are needed to determine the most efficient, effective way to bring this about [3].

From the beginning of engineering education, laboratories have had a central role in the education of engineers. While there has been an ebb and flow in the perceived importance of laboratory study versus more theoretical classroom work, it has never been suggested that laboratories can be foregone completely. At times, however, they have been taken for granted to a considerable extent [3].

22 % of research group pointed out that verbal classes that earthquake training for public and lessons from the experience must be necessary.

“The more site applications and site visit, the better we learn because of the integration of real knowledge and visual one. In addition, the effect of the variety of disaster might be demonstrated in laboratory as a prototype”

There is a relationship between employability and quality training of students. Employability of graduates is closer to the higher education. So, higher education institutions are under pressure to improve the employability of their graduates across geographical boundaries and cultural borders [5]. As the rapidly changing labor market is becoming increasingly knowledge-based, employability is an increasingly important consideration in the most students’ life. Graduates must be encouraged to recognize and develop a set of key skills and reflect their wider experiences at the university to help them identify relevant skills. That should be one of the strategic key directions for high [6]. For realizing this strategic direction, the cooperation between the companies and the universities has vital importance.

“Earthquake Engineering Research Institute should be constructed and each term 1 courses relating disaster and earthquake must be exist. In addition to obligatory courses, various elective courses should be added. The disaster related course should include not only numerical analysis, but also verbal content regarding lessons learned from experience and earthquake training for public”

“Realistic approach is important for managing disaster. Applicable standard and law regulations related to disasters should be taught in the class.

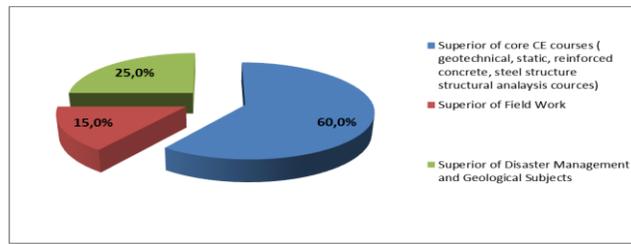


Fig 3. Comments on the lecturers qualifications

As seen Figure 3, 60 % of the group preferred that lecturer of disaster related classes should be an expert of core CE courses. One fourth of group thought that their lecturer should has knowledge of disaster management and geological subjects. In compare with these, 15% of them preferred that superior of field work as lecturer relating to disaster courses.

“Lecturer of disaster related classes should be superior of practice experience and having knowledge of some project related disaster and earthquake in order to explain various real examples in the class”

“Academic who teach the disaster related course should be expertise of fundamental civil engineering courses such as reinforced concrete, structural analysis and geotechnics”

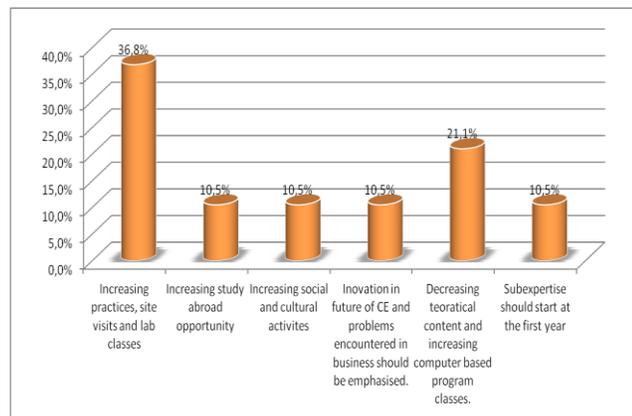


Fig 4. Recommendations of research groups about civil engineering course

As seen on Figure 4, if the research group may manage their education, more than one third of the group thought that they would increase practical applications, site visits and lab classes. 21% reported that they would decrease theoretical content and increasing computer based program classes.

The computer can play a useful and important role in the teaching and learning of civil engineering concepts and applications. Depending on the type of software used, the professor can design the course such that the computer can be used advantageously to increase the understanding of engineering concepts and to develop sound judgement in students. Since the development of faster and more affordable computers will be the trend, it is necessary that civil engineering schools should increase the awareness in students on the significant role computers play in education and in the industry [7]. Computer software, specifically for engineering, have become more powerful, robust and user friendly. Consequently, it has become clear that integrating the use of computer software in the curriculum will be to the advantage of the students who will become future civil engineers [8].

The rest of the research group would make the regulation of increasing study abroad opportunity, social – cultural activities and emphasizing innovation in future of CE and problems encountered in business.

“Each student should determine their specialization and take the course in respect of them. Therefore, having expertise in specific subject should start at the first year, thus, at the end of the education, students obtain variety of knowledge about their expertise area”

“If I managed my education, I would increase study abroad opportunity, job training abroad opportunity for students and I would give an example about ongoing real projects and making site visit for realizing visual based learning”

An important conclusion related to pedagogy and the pressing need for a rigorous investigation of how to leverage the Project-Based Learning (PBL) and Case-Based Learning (CBL) paradigms for enhancing the learning experiences of civil engineering students. While these paradigms have been studied extensively in the past, how their principles and best practices may be transformed for enhancing the civil engineering education still requires considerable exploration. Further, we believe that a critical missing element is to be able to transform any case or project into a “Creative Design Problem,” and address these in the realm of “Design”. In this manner students will learn to appreciate that their careers will have to focus on creative design applied to all problems associated with complex multi-domain civil engineered systems such as infrastructures. Some suggestions were made related to the computer based education: (a) Integration of computation, modeling and simulation, physical laboratory and a real-life living infrastructure laboratory into the curriculum; (b) Emphasize computational thinking and the art of observation and conceptualization in all courses in conjunction with PBL and CBL; (c) Make creative DESIGN the centerpiece of the education, making sure that most problems from freshmen to graduate education are selected and formulated in the realm of DESIGN problems. The ability to design creatively is the essence of all engineering [9].

### **It looks necessary to change civil engineering faculty, despite different methods fail to do so;**

Two strategies for faculty change do not work: (1) those whose philosophies and policies focus on distributing change from top down, and (2) those that only focuses on developing best practices without directly addressing adoption with faculty. Rather, effective change strategies address individual beliefs, intervene across longer periods, and address compatibility to existing systems inherent within higher education [10]. It was directly addressed one of these strategies by providing insight into existing beliefs of faculty members working within civil engineering education. Through the provision of personas, common beliefs shared by a diverse set of engineering faculty are identified [11].

## **4. Recommendations**

1. Civil engineering degree programs should be accredited through the Accreditation Board of Engineering and Technology, ABET, a non-governmental, non-profit agency. ABET-accredited degree programs are also the first step for civil engineers who wish to gain state licensure. Accreditation is a quality control and assurance procedure that based on self regulation and self assessments that means; catching the targets not having certain standardisation. Engineering education standards were reported in detail somewhere [12].
2. Two aspects of the support needed for a quality civil engineering education are examined: Services, including staff and operations; and facilities, particularly as related to equipment needs. At major research universities, facility needs for civil engineering are greater than those for electrical and mechanical engineering. Civil engineering's laboratories serve as this nation's applied technology laboratories, which is not the case for electrical and mechanical engineering. Only a dynamic "hands-on" educational program produces graduates that are knowledgeable technically, responsive socially, and programmed for change in both areas [13].
3. Civil engineering education should contain not only theoretical content but practical experience such as site visits, field work applications and example of various real project as well. Thereby, students enable integration of imaginary and real one to understand courses well. It can also improve discernment, creativity and management ability.
4. Structural analysis and geotechnical based programs (Sap, 2000, GeoSlope, Sta4Cad, ext.) must be taught in the course, in this way, students are accustomed to working conditions and to overcome faced problems.
5. In addition to civil engineering education, social and cultural activities should be increased.
6. Lecturers should have opportunity to produce publications, train and retrain in abroad, have projects and should mention about innovation in the future of CE and problems encountered in work life in the course. Lecturers should have expertise in core subjects should lead earthquake related courses.
7. Earthquake related course should include reinforced concrete knowledge and geotechnical one and to be supported lab courses. In the lab courses, stable concrete should produce under the light of earthquake law

regulations. Geological survey should also be learned. Thus, strong and stable buildings might be constructed by well-educated civil engineers.

8. Faculty management should conduct seminars about opportunity of study and job training abroad. Faculty managers, head of departments and experienced engineers should come together nationally and internationally in the congress to discuss engineers' fault related issues to reflect them to the curriculum of civil engineering undergraduate programs.
9. Disaster related courses should be increased and a variety of examples should be emphasized such as earthquake and other disasters training and lessons from some experience in the lecture.
10. HSE and earthquake law regulation knowledge should be placed in the curriculum.

## 5. Acknowledgement

Authors wish to thank for the supports of following Universities;

Marmara University, Scientific Research Project Foundation, Istanbul, TURKEY

Istanbul Technical University, Scientific Research Project Foundation, Istanbul, TURKEY

## 6. References

- [1] Doğan, M. (2010) Earthquake Education In Civil Engineering Departments Of Universities Of Turkey, European Journal of Educational Studies 2 (1).
- [2] McMullin K. (2014) Defining Misconceptions in Earthquake Engineering Education, Structures Congress, ASCE <http://dx.doi.org/10.1061/9780784413357.099>
- [3] Feisel, L. D., Rosa, A.J. (2005)The Role of the Laboratory in Undergraduate Engineering Education, Journal of Engineering Education, June 2005. <http://dx.doi.org/10.1002/j.2168-9830.2005.tb00833.x>
- [4] DeLyster, R.R., Quine, R.W., Rullkotter, P., and Armentrout, D., “A Sophomore Capstone Course in Measurement and Automated Data Acquisition”, to be published, IEEE Transactions on Education.
- [5] Ahmed,A,F.(2009) The Employability of Graduates in Competetitive Organizations, Business Intelligence Journal. August, 2009.Vol.2.NO:2.pp.288-318.<http://www.saycocooperation.com/saycoUK//BIJ/Journal/Vol.2.No.2/article.pdf> (accessed 20.06.2012)
- [6] Worldbank (2007). “Turkey-Higher Education Policy Study.” Report No: 39674-TU, Volume I: Strategic Direction for higher Education in Turkey.
- [7] Oreta, A. W. C. (2000) “Teaching Software Development at Undergraduate Level,” ACECOMS News & Views, July – December, Vol. N25-0211-0700, p. 40
- [8] Wankat, P. and Oreovicz, F. (1993) Teaching Engineering, New York: MacGraw-Hill, Inc.
- [9] Aktan, E., Pradhan A., Sjoblom K., Moon F., Bartoli, I., Bayleyegn Y., Cohen B., Kotsos A., (2014) Challenges in Educating the Millenial Civil Engineers, Structures Congress, ASCE
- [10] Henderson, C., Beach, A., & Finkelstein, N. (2011). Facilitating change in undergraduate STEM instructional practices: An analytic review of the literature. Journal of Research in Science Teaching, 48(8), 952-984. doi:10.1002/tea.20439 <http://dx.doi.org/10.1002/tea.20439>
- [11] Brown, S., Asce M., Bornasal F., Brooks, S., Martin P., (2015) Civil Engineering Faculty Incorporation of Sustainability in Courses and Relation to Sustainability Belief, J. Prof. Issues Eng. Educ. Pract. 2015.141.
- [12] Bakioglu, A., Baltacı R. (2010) Akreditasyon Egitimde Kalite, Nobel Akademik Yayıncılık, Ankara.
- [13] Hawkins N.M. (1986) Assuring Quality Civil Engineering Education, J. Prof. Issues in Engrg. 1986.112:3-14. ASCE [http://dx.doi.org/10.1061/\(ASCE\)1052-3928\(1986\)112:1\(3\)](http://dx.doi.org/10.1061/(ASCE)1052-3928(1986)112:1(3))