

Innovations in Construction Engineering Education: Rudiments of a Senior-Level Topics Course

Virendra K. Varma, Ph.D., P.E.
Missouri Western State College

Abstract

There is an urgency for reform in engineering education. The new accreditation criteria EC2000, and TC2K of the Accreditation Board for Engineering and Technology (ABET) for accrediting engineering and technology programs respectively, encourage innovations in curriculum design. The criteria are outcomes-based, and non-prescriptive. However, there are constraints in what educational institutions can and can not do, as for example, there are limits to the number of hours that institutions can require for a baccalaureate degree. Additionally, the accredited programs must comply with accrediting agency's criteria. The TC2K criteria, for instance, states, ".....the technical content is limited to no more than 2/3 the total credit hours for the program." This puts a tremendous strain on the program faculty to devise curriculums that are state-of-the-art, current in content, and relevant in terms of technological advancements in their particular field. Since a new course for every new advancement cannot be realistically created, it almost becomes mandatory to design a current topics course under a broad umbrella of that particular field. Such a course design is discussed in this paper. The name of the course is Current Topics in Construction, and the description of the course has been deliberately kept loose and flexible to accommodate new developments occurring in the construction field. Issues such as advancements in materials, construction methods and techniques, project delivery systems, performance-based specifications, certain court decisions, etc. have been given coverage in the past in this course. Some questions faced by engineers and contractors in the day-to-day problem-ridden practice are routinely discussed in the class to keep students up-to-date and current to form a strong fundamental body of knowledge. The students enjoy the format of the course which in essence, is that of a Senior Seminar course. The students are immersed in the research aspect of the course, and are actively involved in learning. This course has not stopped evolving since its inception because it is designed to evolve and change with time. In that sense alone, the course is a success.

Introduction

For years, the American Society of Civil Engineers (ASCE) has been working on Policy Statement 465 which states that , "admission to the practice of civil engineering at the professional level should occur at licensure and that this admission should require the acquisition of a body of specialized knowledge comprising a bachelor's degree , a master's degree or its equivalent, and appropriate experience." (1) The body of knowledge points to the knowledge, skills, and attitudes necessary to become licensed as a professional engineer. It is expected that existing undergraduate and graduate programs will be revised to reflect this body of knowledge and that new programs will be created.

The ASCE board established the Task Committee on Academic Prerequisites for Professional Practice in the fall of 2001 and charged it with developing a plan for implementing Policy Statement 465. That committee has been pursuing three parallel long-term (20 years and beyond) initiatives for implementing the Policy 465: one on the body of knowledge and appropriate curricula, a second on licensure, and a third on accreditation. The body of knowledge (BOK) initiative is being addressed by a subcommittee of the overall Task Force, and is considered to be extremely intense. But the important aspect of this work is that the body of engineering knowledge is beginning to take shape.

In the construction engineering discipline, unlike the civil engineering discipline in which a professional engineering (PE) license is mandatory to the practice of civil engineering, few practicing constructors possess certified professional constructor's (CPC) certification. A CPC certification is less well known, and is not required for the practice of construction engineering. However, the requirements for the knowledge base of construction professionals is just as rigorous as that of civil engineers. Therefore, logically speaking, the construction engineering education programs must also address the BOK initiatives for construction with the same zeal and enthusiasm. However, these BOK initiatives for construction are lacking.

No decisions have yet been made as to what the BOK for civil engineering should exactly be, but BOK for civil engineering has begun to take shape. The department heads of civil engineering programs are communicating round the clock to make BOK initiatives a success. No one knows the final outcome but one outcome is guaranteed that civil engineering educators are truly developing the most appropriate curricula for our future civil engineers.

The construction engineering discipline needs to follow in the footsteps of civil engineering. The ASCE Board has a vision for the various institutes that have been established with in its bounds. All the institutes, namely, The Construction Institute (CI), The Structural Engineering Institute (SEI), The Geotechnical Institute (GI), etc. have education as an important element in their mission. The relevancy of practice of the profession to theory, and education of students are inter-twined. In other words, the curricula of the educational programs have to be most appropriate, and content of courses relevant to the practice of the profession.

This paper addresses the need for an integrated construction curriculum and specifically addresses the need for a Senior Level Topics course which synthesizes the fundamental body of knowledge of construction, and develops the research skills of senior students. Among the requirements for content of the senior level course, important links need to be developed between the textbook content and the latest reported research in journals and anecdotal and current happenings in the profession. Important current topics need to be explored and students given appropriate guidance to reach their potential. This paper addresses the design and presentation of a Current Topics course in Construction. The essential elements of the course are referred to as the Rudiments of the course in this paper.

Criteria for Excellence in a Course Design – The Essential Rudiments

There are at least six Quality Parameters in an instructional course design:

1. Relevant Course Description
2. Student/Faculty Interaction & Collaboration
3. Student Support – Making Learning Meaningful
4. Current Technology Usage
5. Technical Currency in the course
6. Assessment

Relevant Course Description

In a recent review of a Physics course by a newly-hired faculty member at a university, it was found that the course description of the course had not been changed since the 1980s. “A major portion of the course was not taught in this course but in the second course on Physics,” so said the faculty member. (2) How did it happen? The simple answer lies in the fact that sometimes faculty who have been involved in teaching the same courses over and over again seldom take the time to review the course description which appears not only in the course syllabus but also in the university catalog. Since the students have the right to see the course syllabus before they sign up for the class, and some students do see the course syllabus, it would appear extremely irresponsible on the part of faculty not to compare what is being taught to what is being shown in the course syllabus and the university catalog.

In my teaching of the course on Current Topics in Construction at our institution, this senior level course which is a senior level seminar-cum-capstone course, the description of the course has been given a broad description: “Study of selected topics, such as underground construction, underpinning, formwork and other project support requirements; evaluation and review of current practices in construction. The course includes study and research in a specific area that combines major elements from previous construction engineering technology courses culminating in an integrating experience through individual and/or group projects, technical reports and presentations.” (3).

The emphasis in the above description is on selected topics which can vary from year to year, and on evaluation and review of current practices in construction. The evaluation and review requires students to read construction-related periodicals and journals, summarize and discuss articles of interest in the class. The course requires team work in group projects, and team presentation of their research paper. The students get to evaluate each other in confidentiality, and are required to be active contributors in the group projects. Ethics are an integrated part of group work, and students are made aware at the outset of the course.

Student/Faculty Interaction & Collaboration

A good syllabus is not a complete reflection of how the course is delivered by the faculty, nor does it tell how well the course is received by the students, nor does it reflect on the quality of student/faculty interaction in the overall teaching-learning environment of the

course. A course syllabus is a road map that may or may not be completely followed in totality by the faculty. If the objectives of the course are learner-centered, then student-faculty interaction is extremely important, and so is the collaboration among students and faculty. Not all the learning and teaching takes place in the classroom but it happens outside the classroom as well. Therefore faculty availability to students is of utmost importance, whether through emails, electronic discussion boards, or simply face-to-face question-answer discussions. In a Senior-Level Capstone/Topics course, student-faculty interaction is very important because of the research element of the course, and also because it requires students to put a total project together. Synthesizing information and body of knowledge from the foundation-level courses is a prerequisite to doing research. Undergraduate students are generally awed by research and are, therefore, are to be guided by faculty in a fundamentally-sound approach.

Assessment

The best time to assess a course is to assess its effectiveness right after the course is taught by the faculty. Some basic questions that ought to be asked in assessment of a course are:

- What tools are used to assess the course?
- Were the objectives of the course met?
- Is the University Catalog description of the course relevant? Does it need to be changed?
- Are the prerequisites to the course relevant?
- Is this a stand-alone course in the curriculum? If yes, why?
- Is the course integrated with the rest of the curriculum?
- After the assessment of the course, do you think this course deserves a place in the curriculum? Do we need to delete it? Do we need to replace it with a more relevant course?

Individual course assessment is part and parcel of an overall continuous quality improvement plan for an educational program; therefore, should be treated with utmost care and attention. Assessment of a single course has far reaching effect on the total curriculum of the program. Assessment of a senior-level topics course may lead to teaching of the course in a totally different format altogether. In my case, Lecturing method proved counter-productive to the objectives of the course. I had to adopt Case studies, guided design, and Problem Based Learning (PBL). (4)

Learner Support

There is a saying that in the classroom, students and teachers learn from each other. But, in reality, classrooms are designed for a place for students to come to learn from the teachers. Faculty have the role of teachers and mentors, and constitute a support system for student learning, whether inside or outside the classroom. In the context of undergraduate student research, of which a senior-level current topics course in construction is an essential component, faculty have a major responsibility to lend support to the struggling undergraduate students. Construction engineering is not as well known for fundamental basic research as is Civil Engineering as a discipline or a

profession. But there is now a paradigm shift. Research in construction engineering is vital to designing and constructing economical and efficient structures. The ‘why’ behind decision-making in construction is becoming just as important as ‘why’ behind selecting a particular design criteria in design. Our construction students need to be trained in the principles and applications of research, and one such place in the undergraduate construction curriculum is at the senior level topics course.

Some Suggestions for Relevant Topics in a Course on Current Topics in Construction: The Author’s View Point

- A course on Current topics in Construction must require Readings in construction-related journals and periodicals. For example, “years ago, millions of construction workers were exposed to asbestos on the job. The first personal injury cases reached the courts in the 1970s. People who are not actually sick and may never become ill have filed many of these claims. Some estimates indicate that as many as 80 to 90 percent are filed by people who are not sick, clogging the courts and diluting the monies available for the truly sick. The beneficiaries of these claims are not the victims, but the plaintiff’s attorneys and experts who are sucking up to 50 percent of the money awarded by the courts.”(5) There is a need for a legislative solution so that people who expect compensation may receive financial assistance during their lifetime. The AGC of America supports U.S. Senate Bill 1125, the Fairness in Asbestos Injury Resolution (FAIR) Act. Students of construction ought to be aware of the asbestos horror, and not be unaware of the dangers that restoration work in construction can bring to a contractor’s door.
- While engineers and architects are utilizing High Performance and High Strength Concrete in building a variety of structures, the initiatives toward Performance-Based specifications for concrete are slow. “While concrete technology has evolved with significant innovation in production methods, product technology and decorative options, a large share of concrete shipped is most likely the 3000 psi, 5-bag mix, thereby keeping alive the ‘concrete is a commodity’ paradigm. Specifications for concrete continue to follow the prescriptive or mixed prescriptive-performance format with add-on clauses that make the requirements nebulous, contradictory, unachievable, and for the most part, unenforceable.” (6) Are our students aware of this initiative toward performance-based specifications for concrete?
- There can be differences in interpretations of specifications. It is important that our students be taught the value of correct interpretation of specifications to avoid legal challenges and court cases. Construction specifications can be misinterpreted just as simply as the design specifications. When in doubt, students ought to be told, to seek clarification, and to not proceed without securing appropriate authorization from the appropriate source. In a recent case, a right-handed door was installed where the contract specifications called for a left-handed door. This could have been avoided had the contractor been more careful. There can also be differences of opinions, like for instance on an Australian boiler

support structure for a coal-fired power plant, the Australian Code calculated the capacity of a clip angle connection as 79 Kips whereas the American Code calculated the capacity as 91 kips, thereby giving a difference of 12 kips. Of course, if the project is in Australia, and the designer is from the USA, it would be more than prudent to rely on a more conservative figure of 79 kips as the capacity of that clip angle connection. The essence of this discussion is to raise the awareness of students toward better plan reading skills and correct interpretation of specifications.

- Important court cases in construction-related work should be opened for discussion in the class. Students ought to be taught that contractors do not always get what they think they deserve. In a recent case, “the board of contract appeals concluded that the contractor was not entitled to Eichleay damages because it failed to show the government’s changes and delays caused it to be on standby.”
- (7) Contract law and contract administration are important for students of construction, and faculty have an obligation that students are well-versed in the fundamentals of contract law.
- Students should be reminded and made aware about the advancements in materials, such as High Performance Steel, a switch from A36 to A 992 steel in steel design and construction, and High Performance Concrete in addition to four basic structural materials namely wood, masonry, concrete, and steel. Developments in construction methods and techniques including construction equipment, and project delivery systems, as for example, a shift from design-bid-build to design-build, etc. should also be discussed. The instructor has to maintain flexibility in coverage of current topics and should cover what is appropriate at the time.

It is important to realize that a four-year degree in construction is usually a 124 credit hour program, and not every topic pertaining to construction engineering and concrete technology can be covered with in the bounds of 124 credit hours. However, it is equally important to realize that all students graduating with a baccalaureate degree in construction need to be equipped with the fundamental knowledge of the latest trends relating to the field of construction; that should be the goal of every program in construction that seeks excellence. The accreditation guidelines and policies of ABET encourage creativity and innovations. With the adoption of EC 2000 and TC2K criteria for accreditation of engineering and technology programs, sky is the limit for innovations in individual course and program designs.

Conclusion

Just as a freshman seminar provides students with gradual transition into the program, the senior seminar as a capstone course in the format of a Current Topics in Construction provides students an opportunity for exposure to the latest trends in their field. It gives them a sense of completeness in comprehending their profession of construction through self and faculty-directed readings, summarizations, and oral and written presentations of

their research papers. Investment in education is thus maximized by students, their time is well spent, and return on their investment in education is stronger and better. Faculty can address issues such as , ‘what makes a project sustainable and how to ensure longevity in the built environment,’ to ‘Evolution of construction documents,’ to ‘Perfect Construction Drawings,’ in Current Topics one year, and address ‘Digital Specifications,’ and ‘How the Courts Interpret Specifications’ the next year under the same course description which is flexible enough to accommodate current trends and events occurring in the field of construction. It serves the interests of students and faculty equally well, and affords the educational program as a whole an opportunity to excel in terms of creativity and innovation.

Bibliography

1. ASCE Policy Statement 465, ASCE News, Volume 28, Number 10, October 2003
2. Personal Communication with Faculty
3. 2003-2004 MWSC Catalog Description of Current Topics in Construction
4. Wankat, P., and Oreovicz, F. “Teaching – Getting Out of Your Box.” ASEE PRISM, Vol. 13, Number 3, November 2003
5. Indiana Constructor, AGC/Indiana, December 2003
6. Lobo, C. “An Initiative Toward Performance-Based Specifications for Concrete.” Concrete Technology Today, PCA, December 2003.
7. Parvin, C. “Law – The Contractor’s Side.” Roads & Bridges, December 2003.

VIRENDRA K. VARMA, Ph.D., P.E., F. ASCE

Virendra K. Varma, is Chairman of the Department of Engineering Technology, and Professor of Construction at Missouri Western State College. He has over 25 years of design and construction experience in professional and managerial capacities ranging from a bridge designer to a project manager and a partner in an engineering company. He has published and presented extensively in engineering journals and conferences. He is a Past President of ACI-Missouri, and a Past President of NW Missouri Chapter – MSPE of the National Society of Professional Engineers (NSPE).