

The Engineer of 2020: Case Studies of Organizational Features of Effective Engineering Education

Introduction

Over the past several years various academic and governmental reports, professional societies, and industries have called for the improvement of engineering education. In particular, *The Engineer of 2020* (National Academy of Engineering, 2004) provides a strategic look into the future and identifies the attributes and skills that engineers will need if the U.S. is to maintain its economic leadership and sustain its share of high-technology jobs. In our study we focus on three particular attributes identified in the Engineer of 2020 report: 1) design and problem solving skills, 2) interdisciplinary competence, and 3) contextual competence. We focus on these three attributes for several reasons. Design and problem solving is the core of most, if not all engineering work. Interdisciplinary competence is a relatively unexplored domain and we seek to extend the literature by examining the development of interdisciplinary competencies such as synthesis and evaluation of interdisciplinary knowledge. Finally, we focus on contextual competence, or students' abilities to understand the constraints and impacts of social, cultural, environmental, political, and other contexts on engineering solutions. Despite its importance in the field of engineering, employers and students agree that new graduates are not well prepared to address contextual issues (Lattuca, Terenzini & Volkwein, 2006).

The current work consists of two phases 1) identifying six engineering schools that are currently producing graduates who (compared to those from other programs) most closely resemble the engineer of 2020, and 2) performing case studies of the six schools to identify and analyze the curricular, pedagogical, cultural, and organizational features of those programs. Our goal is to understand how these institutions support high-quality and innovative engineering education that is well-aligned with the goals of the *Engineer of 2020*. The study is designed to not only identify who is doing well in preparing students as the engineers of 2020, but to also discover *why* and *how* their organizations are effective. We identified our six high-performing schools based on a previous study that produced a nationally representative dataset of engineering schools (Lattuca, Terenzini, & Volkwein, 2006). The current paper focuses on the case studies of two institutions that are part of the overall six: MIT and Howard University. This paper compares and contrasts specific features of these two schools' engineering programs using a conceptual framework that characterizes the college experience.

Theoretical and Empirical Underpinnings and Conceptual Framework

The conceptual framework used in this study focuses on three major dimensions – organizational context, peer environment, and student experiences, see Figure 1. The organizational context consists of the interrelated features of administrative structures and policies, curricular practices, and faculty culture. The peer environment encompasses several aspects of students' in-class and out-of-class experiences. This conceptual model assumes the peer environment is a central mediating force in student learning. For example, Astin (1993) concluded the peer group “is the single most potent source of influence on growth and development during the undergraduate years” (p. 398). The evidence on student learning in college indicates that students' cognitive development is shaped not only by what happens in the classroom, but also by their experiences outside the classroom. We are using the model illustrated in Figure 1 to organize our findings for each of our case studies, and to analyze our data across the six institutions.

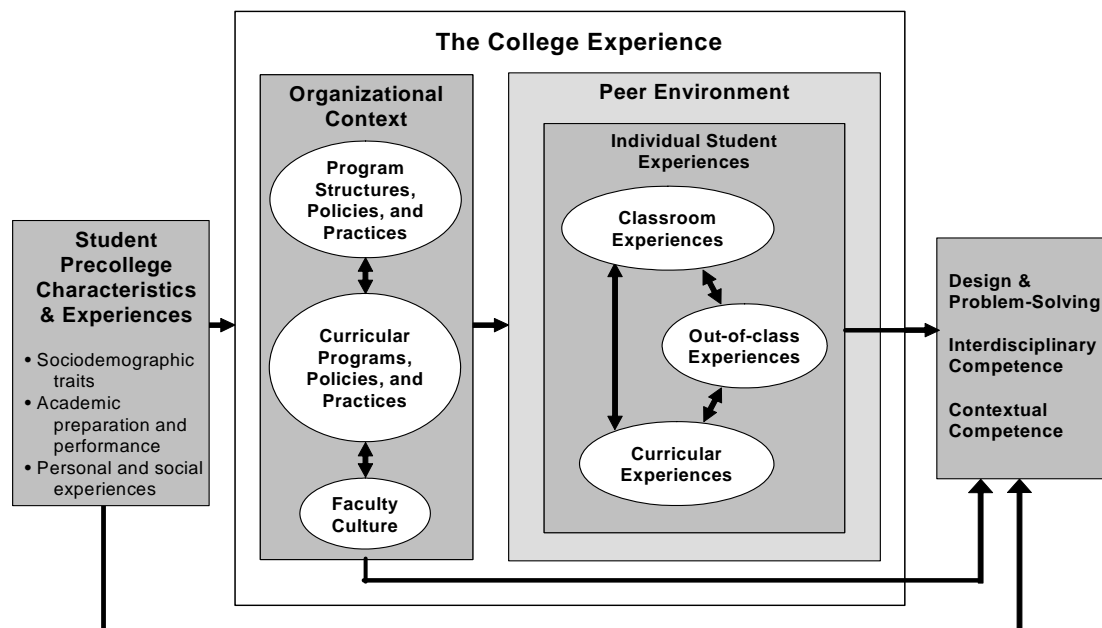


Figure 1. Comprehensive framework of influences on student learning and persistence (Terenzini & Reason, 2005).

Details of Research Procedures

Selection of Case Study Sites

From the “EC2000” database we selected two key criteria to guide site selection: track records of student achievement and breadth of achievement. We identified institutions that are currently producing superior outcomes and that have been particularly effective with women students as well as with students from historically underrepresented groups. The six schools selected for in-depth case studies are Arizona State University (Main and Polytechnic Campuses), Harvey Mudd College, Howard University, MIT, University of Michigan, and Virginia Tech.

Case Study Procedures

Each case study involves two visits by a five-person team, each visit concentrating on salient features that shape the engineering school’s teaching and learning culture. The research team is composed of engineering and education faculty and graduate research assistants. The first visit examines organizational and curricular structures and policies, as well as the faculty culture at the site. During this site visit, the research team identifies faculty and educational experiences to be studied more intensively during the second site visit. The second site visit will be dedicated to intensive study of these student experiences and faculty members’ classroom activities.

The site visits include interviews with deans and program chairs, faculty members, and students to discover not only the factors or forces that shape students’ learning, but also the organizational and programmatic features that enhance that learning through the kinds of student experiences they facilitate. In addition to interview data we are collecting relevant documents (e.g., syllabi, grant reports, faculty publications). When possible, team members also conduct observations of

courses, meetings, and events that have been identified in the first site visit as promoting excellent student outcomes. The qualitative strategy allows continuing data collection through follow-up contacts with faculty, administrators, and students at each site.

Preliminary Results

The study has completed the first phase; i.e. we have selected the six institutions for in-depth case studies. The team has completed four (out of six) of the first site visits and based on information obtained during the first site visit we have identified two specific features of the framework that appear to have substantial impact on the teaching and learning experience of engineering students. Specifically, we have identified several administrative policies that support recruitment and retention of underrepresented (including women) students and faculty. These policies are part of the organizational culture as identified in the model provided in Figure 1. Furthermore, we have identified specific out-of-class experiences that lead to student engagement and impact not only their success in college, but also prepare them for their careers post-graduation. The full presentation will provide specific details about these two features and, using the framework provided in Figure 1, will compare and contrast these features across two of our case study sites.

Acknowledgments

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