

Panel - Solving Engineering Problems in Context: Preliminary Results from Case Studies of Six Exemplary Engineering Programs

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Abstract - This panel discussion will provide preliminary findings from a National Science Foundation funded project, *Prototyping the Engineer of 2020: A 360-degree Study of Effective Education* (P360). The study explores how the educational practices of six diverse institutions (Arizona State University, Harvey Mudd College, Howard University, MIT, University of Michigan, and Virginia Tech) promote the development of engineering students' contextual competence. Contextual competence is defined as an engineer's ability to anticipate and understand the constraints and impacts of social, cultural, environmental, political, and other contexts on engineering solutions and vice versa. In this session, we share case study findings that reveal a variety of curricular and co-curricular experiences intended to cultivate contextual competence. These include general engineering programs, first-year programs, design-focused curricula, client-based capstone courses, hands-on laboratory courses, project and problem-based learning activities, design competitions, undergraduate research programs, and student clubs. In addition to describing these curricular, instructional, and co-curricular experiences, the session will demonstrate how the institutional cultures, practices, and policies support the development of contextual competence in undergraduate engineers.

Index Terms – Contextual Competence, Engineer of 2020, Engineering Curriculum, Engineering Co-curriculum.

In today's world, engineering problems cannot be solved in a vacuum devoid of any considerations of environmental, social, economic, historical, global, or political consequences. Computer engineers, for example, not only worry about increasing the processing speed of a chip, but also its life-cycle because of the potential environmental impact. Solutions to engineering problems must be technically sound (i.e., when designing a bridge), and, appropriately, undergraduate engineering programs are heavily loaded with technical content courses such as thermodynamics and physics. Developing a technically sound solution, however, does not ensure that it will be feasible or desirable given contextual considerations. Contextual competence, then, is defined as an engineer's

ability to understand the constraints and impacts of social, cultural, environmental, political, and other contexts on engineering solutions and vice versa. The National Academy of Engineering reports regarding “the engineer of 2020” suggest that engineers not only be proficient technically but also be able to understand the contextual issues of their work [1, 2].

This panel discussion will provide preliminary findings from a National Science Foundation-funded project, *Prototyping the Engineer of 2020: A 360-degree Study of Effective Education* (P360), which is exploring how the educational practices of six diverse institutions promote the development of their undergraduate engineering students' contextual competence.

STUDY METHODS

Using a nationally representative database created for a study of the impact of the EC2000 accreditation criteria on student learning [3], researchers identified engineering schools that demonstrated superior performance in one or more of the following areas: developing students' design and problem-solving skills, contextual competence, interdisciplinary competence, and/or recruiting and graduating women and underrepresented students. The six institutions selected for study include Arizona State University, Harvey Mudd College, Howard University, MIT, University of Michigan, and Virginia Tech. Three teams of researchers composed of faculty members and graduate students in engineering and education conducted the case studies.

GOALS AND PRELIMINARY FINDINGS

In this session, we share case study findings that reveal a variety of curricular and co-curricular experiences intended to develop undergraduate engineering students' contextual competence. In addition to describing these conditions, practices, and experiences, the session will examine how institutional cultures, practices, and policies support the development of students' contextual competence.

The case studies identified a broad array of approaches institutions taken to promote their students' awareness of context when designing solutions to engineering problems.

ACKNOWLEDGMENT

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REFERENCES

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- [3] Lattuca, L. R., Terenzini, P. T., & Volkwein, J. F. *Engineering change: A study of the impact of EC2000, Final report*. Baltimore, MD: ABET, Inc, 2006.

FACILITATOR INFORMATION

Lisa R. Lattuca, Associate Professor and Senior Research Associate, Center for the Study of Higher Education, The Pennsylvania State University, Lattuca@psu.edu

Dr. Lattuca's research interests focus on the intersections of curriculum, teaching, student learning, and faculty work in postsecondary settings.

Carolyn Plumb, Director of Educational Innovation and Strategic Projects, College of Engineering, Montana State University, cplumb@coe.montana.edu

Dr. Plumb has been involved in engineering education for 20 years. At MSU, she works on various curriculum and instruction projects including instructional development for faculty and graduate students. She is also the college's assessment and evaluation expert.

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Dr. Terenzini has spent 35 years studying the effects of college on student learning and development. He has done extensive research on learning among undergraduate engineering students.

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Dr. Trautvetter studies faculty development and productivity issues, including those that enhance teaching and research, motivation, and new and junior faculty development. She also studies gender issues in the STEM disciplines.

The approaches were both curricular and co-curricular, although these six campuses appeared to place heavier emphasis on students' out-of-class activities (e.g., internships, student clubs, international experiences, entrepreneurial opportunities, and faculty-linked research opportunities) than on their curricular experiences. First-year design and capstone design courses were the most likely curricular venues for developing students' contextual competence. Whether using curricular or co-curricular activities, however, not all six of these institutions had adopted each of these approaches. Similarly, it is not clear that the co-curricular approaches were intentional (as opposed to just making available opportunities to develop contextual competence). Similarly, the extent to which any given approach reaches large numbers of students remains unclear. We found little evidence of assessment of the scope of these activities or of the extent to which they are effective in promoting students' awareness of context in designing engineering solutions.

CONCLUSIONS

Curricular approaches and co-curricular opportunities varied considerably across the six sites. On campuses where attention to contextual competence was most apparent, institutions appeared to take a "design-across-the-curriculum-and-co-curriculum" approach that provided students with multiple venues for developing their contextual awareness and skills. These included first-year design and capstone design courses, entrepreneurial opportunities, internships, and project-based approaches to teaching and design courses. The site visits and interviews suggest that these efforts may be more effective when design project/task courses or project-based instructional approaches are broad in scope and focus on a "real-world" project derived from an industry or other client, rather than when they are narrowly focused technical projects that do not require or invite students to consider "engineering in context."

SESSION FORMAT

Patrick Terenzini, will introduce the P360 study and methods. Drs. Lisa Lattuca, Carolyn Plumb, and Lois Trautvetter will then summarize and discuss the findings from the individual institutions listed above. Dr. Lattuca will close the session, summarizing common themes and topics for further study. A discussion with audience members of emerging findings and analytical strategies will be encouraged. The session will be of interest to faculty and administrators interested in incorporating and integrating contextual competence into their curriculum and co-curriculum.

Panelists request a projector for this session.