

# MIND-SETS FOR STUDENT SUCCESS

A wider range of institutions must join in changing engineering culture.

Engineering education research, much of it funded by the National Science Foundation (NSF), has shown that while passive knowledge acquisition can be effective for a fraction of learners, active learning enhances outcomes for a broader spectrum of students not only in the classroom but also in life. Furthermore, there is growing recognition that engineering education needs to produce graduates who can not only leverage their technical skills but also have an appreciation of nuanced societal contexts. There is also convincing evidence that the attitudes, behavior, and motivations—that is, the *mind-sets*—of engineering graduates are critically important to career and personal success.

Unfortunately, higher education, and engineering education in particular, have yet to be persuaded that change is needed to address these expectations. A 2013 Gallup Poll conducted on behalf of the Lumina Foundation determined that 96 percent of chief academic officers believe their institutions are “very/somewhat effective at preparing students for the world of work,” but just 11 percent of business leaders “strongly agree that graduating students have the skills and competencies that their businesses need.”

Last spring, with NSF sponsorship<sup>1</sup>, we brought together a group of thought leaders from 16 institutions (a dean/chair and a faculty leader from each) to identify the core reasons for the current state of engineering education and to offer suggestions for ways to change the culture of education to promote success-oriented mind-sets. The workshop, entitled Catalyzing a Research Agenda for Enhancing Engineering Education Through Institutional Collaborations, was opened by NSF Program Director Elliot Douglas, who emphasized that more engineering education research was not needed as much as wider

implementation of best practices and engagement of more and different institutions.

One aspect of our group effort, which included a significant pre-workshop data exchange, quickly became evident: Progress in developing students’ mind-sets depends heavily on an institution’s resources. We developed 10 “axes of variation,” such as undergraduate engineering enrollment, engineering undergraduates per teaching faculty, and endowment per undergraduate student. Engineering undergraduate enrollments at participating institutions varied from over

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11,000 to less than 350. The ratio of students to teaching faculty ranged from six to over 45. Endowment per undergraduate student ranged from less than \$100 to over \$3 million—a range of four orders of magnitude!

The workshop sought to develop a framework for ways in which diverse institutions can improve engineering education in addressing questions such as these: How to scale, adapt, and transfer best practices? What are the roles of differing types of institutions? How can engineering education research at all institutions be enhanced?

After two intense days of brainstorming and synthesis, we reached a number of consensus findings. We need to redefine the foundational base of engineering education and expand the spectrum of students who are

attracted to engineering. We must avoid the commoditization of engineering talent and ensure that engineers define problems not by the niches in which they fit but through the wide range of systems that they touch. We specifically recommended that NSF support not only *research* in education but also *development* and *implementation*, while seeking to address the challenge of how best to support education research and development at schools with limited institutional resources.

We are all contributors to an ecosystem (academics, nonacademics, and professional societies) that is having limited success creating the culture, climate, and educational outcomes desired of engineering graduates. As Virginia Tech cultural anthropologist Gary Downey pointed out to conference organizers, the problem goes beyond content, data, or rational arguments narrowly construed to the failure to consider ways that existing infrastructures of engineering formation and work have emerged and pose powerful cultural challenges. Changes in culture can begin with

changes in mind-sets, including through personal experiential transformation. One way to start is for both faculty and students to reflect on the *knowledge, identities, and commitments* they value or feel expected to value. We educators need to lead such reflection not only because employers and students themselves will demand it but also as part of our pedagogical responsibilities in the 21st century.

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