



UNIVERSITY
OF
OKLAHOMA

RECOMMENDATIONS FOR BUILDING DIVERSITY IN ENGINEERING EDUCATION

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The Research Institute for STEM Education (RISE) brings together a multi-disciplinary research team whose mission is to study the complex array of factors contributing to diverse students' successful academic experiences in science, technology, engineering, and mathematics majors (STEM). Utilizing a combination of discourse and artifact analysis, RISE develops recommendations to educators and academic policy makers based on those factors. RISE also strives to promote a more equitable and diverse cultural climate within engineering education.

The most succinct summary of RISE research findings to date would be to emphasize the importance of a positive academic culture on the recruitment and retention of engineering students. But what is meant by a positive culture? A positive culture recognizes that there are multiple pathways to the goal of graduating with an engineering degree, requiring different amounts of time and types of energy. A positive culture does not promote nor endorse preconceptions about students, but recognizes that all students come to education with a unique set of characteristics and experiences. Furthermore, the positive culture is inclusive and offers appropriate supportive opportunities for students with each of those characteristics and attributes. Finally, a positive culture engages in open communication ensuring that all students are informed of the formal and informal rules governing their engineering education and receive equitable treatment and opportunities under those rules.

First this publication will acknowledge the diverse members who have served on our research team. Next, we present specific recommendations derived from analyses to date of the barriers, challenges, strategies, and resources described by the 518 students, faculty, alumni, and staff that have provided over 610 interviews for our research. This list of recommendations includes cross-referencing to the papers that disseminated these findings to the engineering education community and comprise the remainder of this publication.

Positive Press

Eckel, E., "Individual Diversity in Engineering," in *World of Engineering – blog for the WMU Science and Engineering Library*, <http://parkview.wordpress.com/2007/04/>

National Award

D.A. Trytten, A. Wong Lowe, and S.E. Walden won the William Elgin Wickenden award from ASEE for the best paper of the volume year 2012 in the *Journal of Engineering Education* for their paper entitled "'Asians are good at math. What an awful stereotype.' The Model Minority Stereotype's Impact on Asian and Asian American Engineering Students. "

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Who has contributed to RISE?

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Recommendations

The following recommendations can be loosely categorized into nine domains. These domains, however, overlap with one another and certain recommendations may fall under multiple domains. The domains are:

- **Communication:** information dissemination
- **College Culture:** the shared values, assumptions, beliefs, attitudes or ideologies that frame college level policies and procedures and also influence how individual college community members interact with one another
- **Department Culture:** same as college culture, except at the department level
- **Classroom Culture:** same as college culture, except at the classroom level
- **Faculty-Student Interactions:** through classroom practice, office hours, individual advising and mentoring, directing project teams, or organizational advising
- **Student-Peer Interactions:** within classrooms, class project teams, student organizations, tutoring/mentoring or recruiting
- **Academic Pathway:** routes to an undergraduate engineering degree
- **Individual Action:** personal drive, motivation, and behaviors supporting success
- **Research Methodology:** theory and methods informing the research and the building of a multi-disciplinary team

Domains	Recommendations
College culture Student-peer interactions	Administrators must be wary of intent – impact conflict in the design of programs to serve students. Intent-impact conflict refers to unforeseen and negative consequences of well-meaning programs or policies. [1-11]
Faculty-student interactions Communication, College culture	Educate faculty, staff, and students for cultural competency, awareness of stereotypes and unconscious biases. Cultural competence requires that one value the contributions, knowledge and worth of members of different groups. Cultural competence derives from an awareness and understanding of different cultures and allows respectful communication between members of different social and cultural groups including race, ethnicity, gender, religion, sexuality, ability, language, or socioeconomic statuses. [3-9, 12-20]
College culture	Institutional programs must support all minority student populations. Minority should not be defined strictly based on racial/ethnic difference, nor on underrepresentation. [3, 4, 10, 17, 21, 22]
College culture, Communication, Student-peer interactions	The institution must develop advising and mentoring programs that recognize the differences existing within racial/ethnic groups, social classes, and gender identifications. [3, 6, 7, 9, 22]

Domains	Recommendations
College culture, Communication, Academic pathway,	Institutional programs must assist students in acquiring the appropriate social and cultural capital needed for success within the dominant culture of the academy. Cultural capital is the distinctive cultural knowledge (e.g. how to apply for financial aid, what is meant by office hours) that equips one to succeed in a particular environment, e.g. higher education. Social capital refers to the people and resources one has available to support an endeavor, e.g. parents who have been to college. [3, 4, 17, 22-24]
College culture	Recognize that discrimination occurs even in the absence of reported discrimination. Certain cultures disapprove of complaining, challenging authority or even acknowledging discrimination; furthermore, students can be highly reluctant to report a professor because of fear of retaliation. [3, 6, 8, 9, 20]
College culture, Student-peer interactions	Racial/ethnic-based student organizations must be structured in ways that honor the differences within the group and can serve the needs of all of the racial/ethnic group members. [6, 9, 10, 20]
College culture	General education requirements for U.S. institutions need to include a multi-cultural perspective on race issues in the U.S. [20]
College culture	Recognize that students who are members of a minority group may lack understanding of diversity, inclusion, stereotypes (even of their own group), and how minority group membership interacts with U.S. culture. [20]
College Culture	Moderating institutional promotion of student experiential competition team images and competition performance might open opportunities for students who have financial or personal constraints that preclude extraordinary time commitment. [11]
College culture Faculty-student interactions	Faculty and staff advisors must take an active role in oversight of student organization leadership and activities and develop understanding of the cultural issues and tensions inherent in the organizations. [6, 9, 19]
College Culture Student-Peer Interactions	Provide leadership and management instruction, mentorship, and guidance for students leading organizations and for all members of student experiential learning competition teams. Leadership and management skills are not innate. 'Sink or swim' is wasteful of resources and contributes to exclusion. [11, 19]

<i>Domains</i>	<i>Recommendations</i>
Communication	Dissemination of institutional information and informal knowledge and advice must reach all students without prejudice. Examples of informal knowledge and advice would include: value of student organization membership or strategies for succeeding in notorious courses or with difficult professors. [3, 22]
Communication	The academic and professional benefits of co-operative and internship placements must be promoted to all students without prejudice. [3, 22]
Communication	Administrators must be aware that budget priorities, staffing, and physical space location and allocation contain powerful messages to students about priorities and inclusion. [10]
Academic pathway, Communication	If a student begins calculus sequence at a community college and has marginal performance, the student must be encouraged to complete the calculus sequence at the community college. Based on RISE data, transferring partial sequences of calculus courses with minimally acceptable grades imposed difficulty in the subsequent calculus courses taken at the receiving institution. Whereas, either transferring a partial sequence with better grades or transferring the entire sequence, even with minimally acceptable grades, did not result in subsequent difficulties. [4]
Communication	Student advocates need to be aware that peer-advising messages can be either beneficial or detrimental, for example - regarding concurrent transfer. Concurrent transfer courses are courses taken at a community or regional college during an active semester or between two semesters of enrollment at a senior institution, usually during summers. [4, 14]
Communication	Actively and clearly promote the fields of engineering by informing students of both the degree requirements and the career options afforded from the different engineering degrees. [2, 5, 23, 24]
Department culture, Academic pathway	Departments must facilitate multiple entry points into the curriculum as few students new to engineering have the background knowledge or resources to know unequivocally where they best fit among the engineering disciplines. Multiple entry points allow students who may have never been exposed to engineering to choose engineering or to change engineering disciplines after matriculation without significantly extending their time to graduation. [5, 24]

<i>Domains</i>	<i>Recommendations</i>
Department culture, Academic pathway	Recognize that students who have difficulties in one engineering discipline can thrive in another. [5, 24]
Department culture, Communication	Departments endeavoring to attract and retain diverse students must promote a professional image that is multi-faceted, clearly defined, and relevant to students' lives. [5, 7, 23-27]
Department culture, Academic pathway	Authentic representation of degree programs as challenging, but achievable, may enhance recruiting and retention of future and existing students. Engineering students are not necessarily looking for easy ways out. They often recognize that many valuable things do not come easily. [28]
Communication, Faculty-student interactions, Student-peer interactions	Departments need to employ personable, caring faculty as well as satisfied, influential student ambassadors to effectively promote the department and recruit prospective students. [5, 23-26]
Department culture, Faculty-student interactions	Foster a collegial and inclusive department culture of faculty who demonstrate a genuine interest in students' academic futures and provide encouragement. [2, 3, 5, 23-26, 29]
Faculty-Student Interactions	Encourage students to adopt mastery oriented goals instead of performance oriented goals. [30]
Faculty-student interactions, Classroom culture, Communication	Faculty need to recognize the value of and incorporate appropriate challenges for students in their classes. Students seek and desire challenges and appreciate faculty who provide attainable challenges. Pedagogically this goal may be accomplished using constructivist techniques. [28]
Department culture, Faculty-student interactions	Faculty must be available by appointment for students with conflicts during office hours. Students should not have to choose between earning income for tuition and food and seeking academic help. [3, 5, 23, 24, 29]
Classroom culture, Faculty-student interactions	Faculty must be cognizant of inadvertently supporting an insider vs. outsider dynamic and the presence of cliques in their classrooms. [3, 13, 14, 17]
Classroom culture, Student-peer interactions	Recognize and correct inappropriate intra-group interactions in class group-work. [8, 13, 14, 17, 20]

Domains	Recommendations
College culture, Faculty-student interactions	Engineering student advisors need to be aware of and often mediate students' perceptions of required, outside-of-major courses (e.g. calculus and physics) and faculty that can undermine student confidence and their commitment to an engineering degree. For example, the grading schema used in some physics classes can destroy students' self-efficacy. [1-3]
Individual Action	Recognize that families have a strong influence on academic success for many students, including members of minority groups. [20, 31]
Research methodology	Faculty reward structures must recognize the value and complexities of qualitative methodologies and of interdisciplinary approaches for engineering education research. [3, 7, 15, 16, 18]
Research methodology	Academic administrators must support and recognize the value of the work of engineering education researchers. [3, 15, 16, 18]

Recommendations from students to students

Academic pathway	Assure appropriate academic preparation before college and explore and test possible disciplines during your first year of college. [32]
Faculty-student interactions, Student-peer interactions	Surround yourself with supportive peers, involve yourself with student organizations and seek assistance from faculty and academic programs. [32]
Individual action, Department culture, College culture	Accept responsibility for your own education and career, including learning appropriate time management and study skills. [32]
Individual action, Department culture, College culture	Anticipate and build coping strategies for self-doubts that can arise from an academic environment more-demanding than most high schools. [32]

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