



## Revolutionizing Engineering Diversity

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Beena Sukumaran has been on the faculty at Rowan University since 1998 and is currently President's Fellow and Professor of Civil and Environmental Engineering. She was Department Head of Civil and Environmental Engineering previously. Under her leadership, the Civil and Environmental Engineering Program saw considerable growth in student and faculty numbers. Her area of expertise is in microgeomechanics and has published over 100 peer reviewed conference and journal papers including several papers on engineering education and the unique undergraduate curriculum at Rowan University, especially the Engineering Clinics. She has been involved in various outreach activities to recruit more women and minorities into engineering and is Program Chair Elect of the Women in Engineering Division of ASEE. She is the recipient of the 2011 New Jersey Section of ASCE Educator of the Year award as well as the 2013 Distinguished Engineering Award from the New Jersey Alliance for Action.

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Dr. Stephanie Farrell is Professor and Founding Chair of Experiential Engineering Education at Rowan University (USA) and was 2014-15 Fulbright Scholar in Engineering Education at Dublin Institute of Technology (Ireland). From 1998-2016, Stephanie was a faculty member in Chemical Engineering at Rowan. Dr. Farrell has contributed to engineering education through her work in experiential learning, focusing on areas of pharmaceutical, biomedical and food engineering. She has been honored by the American Society of Engineering Education with several teaching awards such as the 2004 National Outstanding Teaching Medal and the 2005 Quinn Award for experiential learning.

### Dr. Kauser Jahan, Rowan University

Kauser Jahan, is a Professor of Civil and Environmental Engineering at Rowan University. She received her B.S.C.E. from the Bangladesh University of Engineering and Technology, an MSCE from the University of Arkansas, Fayetteville and a Ph.D. from the University of Minnesota, Minneapolis. Her passion as an educator and mentor has been recognized by many professional organizations over the years. She is the recipient of the Gloucester County Women of Achievement Award, Lindback Foundation Teaching Award, the NJ ASCE Educator of the Year award, the Gary J. Hunter Excellence in Mentoring Award, the ASEE Environmental Engineering Division Meritorious Service Award, the ASEE Women in Engineering Division Sharon A. Keillor Award and the WEPAN Women in Engineering Initiative Award. She has been instrumental in establishing the Attracting Women into Engineering, the Engineers on Wheels and Engineering Clinics for Teachers programs at Rowan University. She has served as the Institutional Representative and Advisory Board Chair for the Women's Professional Network at Rowan University for six years and currently is an advisory board member of the New Jersey Chapter of the American Council on Education (ACE) Office of Women in Higher Education (OWHE). She received a Fulbright award in 2015.

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# Revolutionizing Engineering Diversity

## Abstract

The Civil and Environmental Engineering (CEE) Department at Rowan University is currently participating in the National Science Foundation's Revolutionizing Engineering and computer science Departments (RED). RED is a program that seeks to improve the undergraduate engineering curriculum to graduate engineering and computer science students that are more inclusive and suited for the 21st century workforce. The CEE Department's contribution to the RED program is called Revolutionizing Engineering Diversity (RevED). The RevED team is embarking on its second year, building on the momentum established in the prior year. Under guidance from RevED, the CEE Department faculty have taken part in workshops that have established a shared set of values and language around diversity and inclusion. The CEE Department is currently engaged in implementing inclusive curriculum in several courses offered freshman through senior year. This poster intends to showcase the developments made in several CEE courses that have developed student projects or assignments that enable students to have a more global and diverse experience, which in turn creates a more inclusive environment. The RevED team will show how these inclusive assignments were created to attain alignment with departmental goals and how they were used to assess student learning. The poster will also showcase how the CEE student body has changed between both years since the initiation of the RevED team's efforts. Our engagement with partners within the university have helped us identify more targeted ways to recruit and support students. Over the first two years, RevED surveyed students regarding the climate of diversity within the CEE Department. The poster will show changes from student responses from the baseline survey to now. The intent of the comparison is to show how the RevED team's visibility has impacted the way in which the CEE Department approaches diversity. The poster will also illustrate how the RevED team has made changes since the first year and what future plans are being made.

## Introduction

The College of Engineering at Rowan University was established in 1992 through a multimillion dollar gift by an engineering entrepreneur [1]. The engineering college is divided into the following departments: Civil and Environmental, Electrical and Computer, Chemical, Mechanical, Biomedical Engineering and the Engineering Entrepreneurship Program. Through the National Science Foundation's Revolutionizing Engineering and computer science Departments (RED) grant, the Civil and Environmental Engineering (CEE) Department is attempting to change its ability to recruit, retain, and graduate more underrepresented minorities (URMs) and underserved groups over the course of five years. The RED initiative in the CEE Department is known as Revolutionizing Engineering Diversity (RevED). The RevED research group comprises of multiple faculty and staff members within the CEE Department, the Sociology and Anthropology Department, and the Experiential Engineering Education (ExEED) Department. Within the five years of the RED grant, the RevED research group looks to take a multipronged approach to achieving their goal by using a mixed-methods research-action plan based on critical theory of education. In critical education theory, policies and practices in

education are seen as methods that maintain present levels of privilege and power in education. Critical education theory views education as a means to create social transformation in students. This transformation is the key to developing equity [2]. The RevED research group seeks to develop the following: curricular changes that promote inclusivity and diversity, establish a mentoring program that is open for all students, change requirements for acceptance into the department,

Over the course of RED grant, the CEE Department is serving as a test bed for the College of Engineering with regards to promoting and developing a more inclusive climate for students. During the first year of the study, the RevED research group was driven by the fact that visible elements of diversity such as gender, race, and ethnicity were below the national average. Prior to the start of the RevED research group's efforts, the amount of women enrolled in the CEE Department was at 19.5% of the population, which is close to the national average of 20% reported by the National Academy of Engineering [3]. URM students in the CEE Department was 9.5% of the student population. That population of URM students can be broken down further into racial and ethnic groups. Within the CEE Department, African Americans, Asian Americans and Hispanic Americans accounted for 2.3%, 3.2% and 4.1% of the student population. When considered with the national averages of 2.6%, 10.9% and 3.5% as reported by the National Academy of Engineering, it is apparent that there is room for improvement within the CEE Department [3]. Non-visible elements of diversity such as socioeconomic status, ability, sexual orientation, and gender expression were not being considered in previous department records. The non-visible elements of diversity have typically been unconsidered and overlooked by educational policy [4]. Since certain groups are non-visible, it is difficult to see how much of the student population belongs to a given group. Having small populations of underserved groups makes analysis of those groups difficult. For instance, transfer students are an underserved group but they make up a small percentage of the CEE student population so it is difficult to make a statistical case for improving their recruitment and retention. The RevED research group however is taking an approach to inclusivity and diversity that takes visible and non-visible elements into account.

### First Year Summary

In the first year of the project, the RevED research group sought out information regarding the climate of diversity and inclusion for the entire College of Engineering. A climate survey based on work by Ferdman and Jost concerning the expression of diversity in curriculum, policy, and practice in institutions was conducted for students and faculty through an online survey [5,6]. Among the results of the climate survey, women, non-Christians, and people with some form of disability expressed concerns over how inclusive practices were being applied to the university. This allowed the RevED research group to develop a baseline for the entire project, see how certain groups react to a campus wide climate, and justify their claim that a more inclusive approach to education was needed. To help pave the way to develop more inclusive practices, the CEE faculty attended a workshop run by overseers to the RED project. Through the workshop, the faculty developed an understanding of what diversity means and established different ways to

practice inclusivity in their courses. This enabled the RevED research group to talk with faculty members about how to develop a more inclusive classroom [7].

In order to develop better student recruitment, admissions data was also investigated during the first year. The RevED research group compared SAT scores with District Factor Groups for in-state school districts and found that the institution was not recruiting many students from the highest or lowest socioeconomic school districts. It was seen that while the institution had established a certain level of SAT score for students to be accepted, some students with scores below the prescribed level. After multiple engagements with the Office of Admissions, the RevED research group revealed their findings and asked that the CEE Department be given a chance to select students in a more holistic manner. This would enable the CEE Department Head the ability to look beyond a student's SAT score and take into account their GPA and transcript to admit a student. To help provide support for the CEE students, a mentoring program was developed to incorporate a hierarchical approach to mentoring where underclassmen would be mentored by upperclassmen while the upperclassmen would be mentored by alumni. A mentoring program is important to the project since mentoring does help with student retention [8]. This mentoring program would start for the second year of the project. The RevED research group has also been concerned with disseminating our work and findings to the greater engineering community. Within the first year, RevED researchers have given workshops and participated in panel discussions concerning with the development of a more inclusive engineering climate. The momentum of the first year kept the research group focused on new developments [7].

## Second Year Initiatives

In the second year, the RevED research group has conducted a new online survey for CEE students. The intention was to see any significant difference between the baseline campus climate to the climate of the department. This would also be paired with the initiation of focus groups where the RevED research group would interview groups of students regarding how they view diversity within the institution and how it impacts them. There will be multiple focus groups, which are composed of different URM student groups, which will be used to ensure that as many underrepresented and underserved groups get an opportunity to share their views. The analysis of the focus group data will take place during the summer and will be used to establish targeted approaches to address issues the students are facing. After the faculty workshop in the first year, the RevED research group was able to make suggestions regarding the development of inclusive practices in class. The RevED research group used multiple course syllabi and meetings with faculty to address what inclusive practices can be added. To that end, the inclusion of global examples was sought as a means to incorporate more inclusive materials in courses. Riley identifies that using non-western examples is an inclusive practice and global competency is an important facet of engineering that the Accreditation Board for Engineering and Technology included it in its evaluation criteria [9,10]. This would enable faculty to explore technical issues that are grounded in practical contexts. One of the main curricular features of the College of Engineering is the inclusion of the Engineering Clinic. These clinics are offered at every semester for every year and the RevED research group seized the opportunity to develop a

clinic where students offered ideas on inclusive practices based on their own experiences in courses. This is also considered by Riley to be an inclusive practice and it enabled students to connect with faculty to provide a grounded means to develop new course material [9]. From these interactions the RevED research group was able to pilot projects, assignments, and lectures across multiple technical courses within the CEE Department.

The second year also established the first cohort of students admitted through a more holistic admittance procedure. These students' progress are being monitored to see how to best serve their needs. The RevED research group is reaching out to other campus institutions to focus on what courses are serving as gatekeepers to more advanced courses and how to intercept students with issues. The mentoring program began in the Fall semester where upperclassmen who agreed to participate were paired with an alumni mentor and an underclassmen mentee. Students have noted a positive presence by alumni mentors. A formal event will be held in the Spring semester to help establish more connections between the alumni and the students. The RevED research group will also host more seminars within the College of Engineering featuring faculty and practitioners that cover the intersections of engineering and society. Students have come to panel discussions from alumni who explain how diversity and inclusion has impacted their professional development. The students saw the panel discussions as a positive addition to their experience in the CEE Department since it allowed them to gain more exposure to professional practice. The RevED research group also increased efforts to disseminate knowledge and findings. More papers were submitted to conferences largely due to the efforts RevED researchers gave in helping CEE faculty develop papers based on their experiences with implementing global examples. Also the RevED research group launched a dynamic website where individuals interested in diversity and inclusion in engineering can see all of the present examples of efforts being undertaken. As more momentum builds, the RevED research group will continue to push new developments in curriculum and admission.

## Conclusions

The efforts presented in the paper are a summary of the strategies being used to achieve the study's objectives. Having an established understanding of how students view the climate of diversity and inclusion in the College of Engineering has been instrumental in implementing more targeted approaches to make changes. Seeing that students have responded positively to global examples and guest speakers enables the RevED research group to develop more experiences for future years. Building off the use of global examples in CEE courses, the RevED research group will continue to develop more global examples but also encourage the use of historic and practical examples. Another development for future consideration is reaching outside of the CEE Department to other departments in the College of Engineering and other colleges to help develop interdisciplinary skills within students. Such skills are needed in an ever changing professional landscape and ABET considers multidisciplinary experiences to be essential to developing effect engineers [10]. Increased familiarity among the CEE faculty has led to positive partnerships in curricular change. Seeking new partnerships with other campus institutions will also fortify the CEE Department efforts in admissions and help provide further support for struggling students. These efforts help build the CEE Department as a place where

positive change is happening and coupled with the research group's efforts to disseminate knowledge, will lead the transformation of the College of Engineering.

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