

Creating a Climate That Fosters Institutional Change

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Abstract

The Center for the Advancement of Scholarship on Engineering Education (CASEE) of the National Academy of Engineering (NAE) will examine how engineering associations can successfully integrate principles of gender equity into their existing programs. The American Society of Mechanical Engineers (ASME), the Institute of Electrical and Electronics Engineers, Inc. (IEEE), and Project Lead The Way (PLTW) are part of CASEE's Engineering Equity Extension Service (EEES) project that is a comprehensive research-based effort to enhance gender equity in engineering education programs. The goal of EEES is to increase the number of women who graduate from baccalaureate engineering programs. The panel, which includes members of ASME, IEEE, and PLTW, will share their experiences working within their organizations to incorporate gender research into a variety of programs provided for their members. They will discuss why gender equity is important to their organization and provide details on how they have transformed some of their programs using gender research. Examples of programs that will be discussed include the review of outreach programs developed by associations for their members to visit local schools; the inclusion of gender sensitivity into teacher training; and how to engage senior leaders of associations in their efforts.

Introduction

The purpose of the Gender Equity Extension Service Project is to increase the enrollment, retention, and graduation of women as baccalaureate-level engineers. The Center for the Advancement of Scholarship on Engineering Education (CASEE) of the National Academy of Engineering (NAE) is leading NAE's effort on this project. In 2005 19% of the bachelor's degrees awarded in the United States were awarded to women.ⁱ NAE, the Institute of Electrical and Electronics Engineers, Inc. (IEEE), the American Society of Mechanical Engineers (ASME), and Project Lead the Way (PLTW) are working together to provide training to their members. Each collaborating organization has chosen a targeted population for training. ASME is focusing on mechanical engineering faculty and what they can do to retain students in their programs. IEEE is working with volunteer members and concentrating on their outreach activities to pre-college students and how they can better engage all students in their projects. PLTW is working with their master teachers and equipping them to help PLTW teachers encourage diverse students to consider pre-college engineer courses.

The training for each organization focuses on how more female students can be encouraged and retained in their programs. The integrative approach to training should work well, not only for female students, but for all students. This training is designed to engage many traditional players in the engineering community and to work within existing structures to increase gender equity in a variety of current programs. The training methods and results will be disseminated by a variety of Web-based tools. The Gender Equity Extension Service is unusual in that it brings expertise in both gender studies and research on science and engineering education to bear on the academic preparation of students from middle school to the sophomore year of college. The project will also assess the impact of in-class social environments and instructional styles on the attrition of female students as well as the importance of the out-of-class environment for recruiting and retaining young women in engineering programs.

Needs Assessment Surveys

In 2006, CASEE conducted a Needs Assessment Survey of members of the three collaborating organizations in order to identify the professional development topics of most interest to the members of each organization. This would allow the organizations to use the data in structuring the activities on gender equity for their members. Survey respondents rated the importance of several issues in the field of engineering today, including items related to the importance of increasing K-12 students' exposure to and interest in engineering, effective techniques for teaching engineering to different types of learners (including women and other groups who do not typically pursue engineering), and creating the engineering workforce of tomorrow.

Preliminary results indicate several common themes were found across organizations as well as differences in responses based on race, gender, and sector of employment (e.g., academia or industry) of respondent. These survey results have been used to inform programming decisions made by each organization and have implications for embedding gender equity into existing engineering programs.

The Needs Assessment Survey was developed by the Goodman Research Group. Eighty percent of the respondents were male. Approximately half of the IEEE respondents were employed in industry. The PLTW respondents were mostly teachers, and the vast majority of the ASME respondents were faculty. Twenty two percent were untenured faculty, 57% tenured faculty, and 18% were department heads or chairs. Initial results indicate the following:

- Women respondents in two of the three organizations (PLTW and IEEE) rated the need for more women in engineering and the need for more racial/ethnic diversity in engineering as more important issues compared to the men who responded. When asked to pick the most important issues from the list, all organizations focused on reaching and retaining pre-college students. Creating tomorrow's workforce was also seen as an important issue.
- PLTW members rated increasing pre-college interest in and exposure to engineering as the most important issues facing the field today, followed by increasing the number of American engineering students and creating the workforce of tomorrow.
- IEEE members rated creating the engineering workforce as the highest, followed by pre-college interest in and exposure to engineering.

- ASME members rated increasing pre-college interest and retention of undergraduate engineering students as the most important issues.
- If we look at these data overall by gender, the need for more women in engineering is among the top three issues with women who completed the survey.
- A feedback mechanism was provided in the survey. Approximately one in five respondents provided comments. For all of the organizations the most common or second most common response focused on the fact that the respondent felt that the organization should not focus on increasing the diversity in engineering.

American Society of Mechanical Engineers (ASME)

ASME has decided to focus on the retention of undergraduate mechanical engineering students and how mechanical engineering faculty can be engaged in encouraging and retaining more female undergraduate students in their departments. One of the first activities organized by ASME was to incorporate gender equity research into the Essential Teaching Seminars that are given by ASME for engineering faculty. Current efforts have utilized several on-going ASME activities including the Department Leadership Workshop in the spring of 2007 and the Department Heads Forum in the fall of 2007. Topics addressed at these and other ASME meetings include the following:

- Creating an effective teaching climate in the classroom;
- Creating a supportive/effective climate in your department and how to get your colleagues to support this effort;
- Effective hands-on pedagogy; and
- Enhancing diversity through curriculum reform

These activities are being developed to improve faculty awareness of gender equity issues and to give faculty practical tools and resources that will positively impact the retention of female students.

Institute of Electrical and Electronics Engineers, Inc. (IEEE)

IEEE has focused on a strategy of K-12 outreach. In order to have the broadest possible impact on its current activities, IEEE has concentrated its efforts on the production of outreach materials that will be used by its members in outreach activities to the pre-university community. IEEE has developed an on-line train-the-trainer module that will provide information to IEEE members on how to make presentations to students at various grade levels. The module will include “gender-friendly” outreach strategies and training to sensitize the member to addressing diverse student bodies. Assessment of this effort will include determination of the impact of the IEEE-developed K-12 outreach modules on visited adult leaders of K-12 students via surveys on their attitudes about gender equity both before and after their exposure to the IEEE modules. In addition, attempts will be made to measure the evolutions in the attitudes of K-12 students toward engineering and engineering careers over time by identifying selected sites where visitations have occurred repeatedly.

Project Lead The Way (PLTW)

Project Lead The Way (PLTW) is a not-for-profit organization that promotes pre-engineering courses for middle and high school students. PLTW forms partnerships with public schools, higher education institutions and the private sector to increase the quantity and quality of engineers and engineering technologists graduating from the U.S. educational system. PLTW curriculum was first introduced to 12 New York State high schools in 1997. Currently PLTW courses are offered in over 2,000 schools in 50 states and the District of Columbia. The table below provides the profile of the PLTW Survey Respondents.

Demographic Profile of PLTW Survey Respondents

% Respondents		
Gender	Male	82%
	Female	18%
Race/Ethnicity	African American	4%
	American Indian	< 1%
	Asian	2%
	Hispanic	3%
	Native Hawaiian/Pacific Islander	< 1%
	White	88%
Current Position	Teacher	89%
	Counselor	< 1%
	Professor	9%
	Other	5%
Number of Years Teaching	Less than 5 years	32%
	6-15 years	28%
	16-25 years	22%
	26-35 years	14%
	36-45 years	2%

N = 1,067 for each category with the exception of Number of Years Teaching (N = 1,045)

Those who responded “Other” to the question about Current Position included mostly administrators.

PLTW has developed a high school program for engineering that is a four year sequence of courses which, when combined with traditional mathematics and science courses in high school, introduces students to the scope, rigor, and discipline of engineering prior to entering college. As you can see from the two tables below there were two topics, “The need for more women in engineering” and “The need for more racial/ethnic diversity in engineering” that were rated significantly different by women respondents than male respondents and five topics by members of underrepresented groups shown in the second table below.

Mean Ratings of Issues in the Field Today, by Gender

	Males (N = 877)	Females (N = 190)
Increasing the number of American engineering students	4.58	4.57
Creating the engineering workforce of tomorrow	4.53	4.52
The need to improve engineering education	4.67	4.37
Increasing K-12 students' interest in engineering	4.45	4.48
Retention of undergraduate engineering students	4.25	4.31
Exposure of K-12 students to engineering	4.48	4.45**
The need for more women in engineering	4.42	4.40**
The need for more racial/ethnic diversity in engineering	3.79	4.22

**p < .01

Mean Ratings of Issues in the Field Today, by Racial/Ethnic Representation in the Field of Engineering

	Underrepresented Groups (N = 80)	Non-Underrepresented Groups (N = 987)
Increasing the number of American engineering students	4.59	4.58
Creating the engineering workforce of tomorrow	4.65	4.52
The need to improve engineering education	4.67	4.37*
Increasing K-12 students' interest in engineering	4.60	4.45*
Retention of undergraduate engineering students	4.39	4.25
Exposure of K-12 students to engineering	4.61	4.46*
The need for more women in engineering	4.60	4.41**
The need for more racial/ethnic diversity in engineering	4.47	3.82**

*p < .05; **p < .01

Using the Need Assessment Surveys, Project Lead The Way has joined forces with the National Alliance for Partnership in Equity for its EEES work and has focused its efforts on the following activities:

- Review of current PLTW curriculum using research on gender inclusion;
- Training of high school guidance counselors and of PLTW master teachers on the importance of gender equity principles and their application to their work; and
- Development of EEES activities at the Summer Training Institutes for PLTW teachers and staff.

The Need for High Quality Professional Development

A potentially large part of the EEES challenge requires that teaching NOT be viewed as a set of quick tricks and simple fixes. It must embody a comprehensive set of modules that synthesize what one knows about course content with what one knows about how to teach the content.

According to our experts involved in this project, change teaching requires that educators take a close look at what they want students to know and then develop strategies for low-risk assessments to student understanding. In this way, they can attend to new ways to engage their students in understanding the course content. Moreover, educators must think in terms of things that must be done to be effective rather thinking in terms of things that should be avoided.

Persistence to work through developing expertise in some or all of these realms is necessary: content knowledge, pedagogical content knowledge, knowledge about students, using evaluative information about students to guide classroom practice, working with administration, and finally sustaining their changes by becoming a change-agent.

Pedagogical content knowledge is a large domain of methodologies endorsed by certified teachers. They use these to teach scientific concepts and practices in the most appropriate way. Most engineering educators don't spend time thinking about different approaches to teaching explicitly, but often simply do what they've always done. However students vary, so teaching engineering educators to value those differences and take them into account in their teaching styles is important.

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