

THE 4CS--COMMUNITY, CONFIDENCE, COMMITMENT, AND CLIMATE: WHAT MAKES ENGINEERING A GIRL'S BEST FRIEND?

Christine M. Cunningham¹, Meredith Thompson, Katherine C. Bittinger, Cathy P. Lachapelle, Irene F. Goodman

Abstract— *The Women's Experiences in College Engineering Project (WECE), a national study of women's persistence in undergraduate engineering degree programs, reports on the 4Cs crucial to women's decisions to remain in or leave the engineering major: climate, commitment, confidence, and community. The following is a summary of preliminary findings related to these factors.*

Index Terms—*academic persistence, college, engineering, evaluation, longitudinal study, support programs, women*

The Women's Experiences in College Engineering Project (WECE) is the first controlled, cross-institutional study designed to identify which aspects of their educational experiences are critical to young women's retention and success in engineering and, most importantly, *why these aspects lead to success*. This computer-adaptive, web-based evaluation project uses a scientific sampling strategy—we are collecting data from 27 institutions with Women in Engineering (WIE) programs and 26 schools without a formal WIE program. The 53 participating colleges and universities were chosen to represent a range of institutional size, region, engineering emphasis, Carnegie classification, and funding source.

At each institution, three rounds of surveys (spring 1999, 2000, and 2001) are being conducted of all women majoring or intending to major in engineering. Each year, about 21,000 women are invited to participate in the survey. During the first year of the project (1998-99), 7000 women (33%) responded to the on-line survey; this increased to over 9000 women (41%) the second year. Sixty-six percent of the women who were eligible to complete the survey during the second round of data collection chose to participate for a second year. The three sections of the survey focus on student perceptions of engineering, participation in engineering support programs, and background and demographic information.

To situate the student data in its larger institutional context, the WECE study also surveyed engineering faculty members and deans at the 53 participating institutions, interviewed WIE directors and support staff, and conducted site visits to a subsample of 11 schools.

We have been particularly interested in factors that differ significantly between "stayers" (those students who indicate that they are still majoring or considering a major in engineering) and "leavers" (those students who once were

considering majoring or did major in engineering, but are no longer). Our analysis has investigated the differences between these populations in two ways: (a) we can compare responses for a single year (i.e., 1999) between stayers and leavers, and (b) we can compare responses across years of the study. For students for whom we have multiple years of data, we can compare the Year 1 responses (the first year they completed the survey) of those who decided to leave engineering the subsequent year (Year 2) with those who remained in engineering. (During Year 1 of our study, all students were majoring in engineering).

Our session reports on four factors that affect women's persistence in an engineering major: climate, commitment, confidence, and community. This summary provides a brief overview of some of the preliminary findings; a complete paper with quantitative data will be available upon request.

The climate of engineering courses and departments has been identified as a factor that affects women's persistence in an engineering major. The WECE survey assesses variables pertaining to climate. We have constructed a 30-point composite "course atmosphere" scale of variables reflecting course factors that encourage or discourage pursuit of engineering as a major. These include the time that engineering courses require, the pace of engineering courses, the competitive nature of engineering courses, students' grades, and whether or not students feel overwhelmed by their engineering coursework. An examination of the Year 1 responses of students by their stayer/leaver status in Year 2 indicates that there is a significant difference in the way that both freshmen and sophomores who persist in engineering and those who leave perceive their courses (T test, $p < .01$).

Likewise, there are significant differences in the way that the stayers and leavers perceived the atmosphere of their department. An 18-point composite "department atmosphere" scale of variables reflects department factors that encourage or discourage pursuit of engineering as a major. The department factors include teaching, class size, and department atmosphere. Again, the Year 1 responses of students by their stayer/leaver status in Year 2 indicates that there is a significant difference in the way that both freshmen and sophomores who persist in engineering and those who leave perceive their department (T test, $p < .01$).

Another related measure is students' comfort in their engineering courses vs. their non-engineering courses. The percentage of leavers and stayers who agree or disagree that

¹ Goodman Research Group, Inc., 30 JFK St. Floor 3, Cambridge MA 02138, wece1@grginc.com

they are more comfortable in non-engineering classes varies greatly. About 62% of leavers agree that they are more comfortable in non-engineering courses, 19% neither agree nor disagree with this statement, and 19% disagree. On the other hand, only 25% of stayers agree that they are more comfortable in their non-engineering courses than in engineering courses, 22% neither agree nor disagree, and 53% disagree.

Our analyses have also indicated that students' commitment to majoring in engineering is also related to whether they continue or leave. We constructed a 24-point composite scale of variables related to commitment in engineering. These included questions related to their level of interest in engineering, level of happiness, and commitment to engineering as a major. The Year 1 responses of students by their stayer/leaver status in Year 2 indicates that there is a significant difference in the way that both freshmen and sophomores who persist in engineering and those who leave report their level of commitment to engineering as a major (T test, $p < .01$).

Women's self-confidence is another variable that, other researchers have linked with persistence in engineering. Our research findings also support this relationship. Our survey asks women how their self-confidence in their math, science, engineering, overall academic abilities has changed since they entered college. The construction of a self-confidence scale (a composite of these fields) permits an overall measure of women's change in self-confidence. Analysis of Year 1 responses of students by their stayer/leaver status in Year 2 indicates that there is a very significant difference in levels of self-confidence for freshmen and sophomores who persist in engineering and those who leave (T test, $p < .001$). Additionally, a comparison of individual's levels of self-confidence between Year 1 and Year 2 indicates that there is a significant difference in the changes that occur from Year 1 to 2. Leavers' self-confidence drops and stayers increases at levels that are significantly different between these populations both from freshman to sophomore year (T-test $p < .001$) and between sophomore and junior year ($p < .05$).

Finally, our focus groups with over 100 female undergraduate engineering students during our site visits to 11 schools evinced that one extremely important factor cited by these women is a sense of community. The lack of such an engineering community is often cited as a disheartening factor that prompts women to look for such a network in a non-engineering major. Women need to feel they "belong" in the field of engineering and are welcomed in the department. The networks they engage in vary greatly—some are formed through formal programs sponsored by the engineering school, others are generated through study groups or residential living areas, others still are fostered by close interactions with faculty members.

Thus, we have found that the 4Cs are crucial in women's decisions to remain in or leave the engineering major. When our longitudinal study is completed, we will

have followed these women over three years and will have the ability to construct complex statistical models that further investigate the interactions between climate, confidence, commitment, and community.

The WECE project is supported by a grant from the NSF (REC 9725521) and from the Sloan Foundation (96-10-16).

Christine M. Cunningham, Ph.D., Senior Research Associate, currently serves as the co-PI and Project Director of the NSF- and Sloan-funded Women's Experiences in College Engineering grant, joining GRG in 1998. Her research interests focus on making science and engineering more accessible to students who have been traditionally marginalized; she is particularly interested in the ways that science and engineering, the teaching of these disciplines, and institutional structures can change so that they include, and benefit from, a more diverse population. A strong interest in gender issues in science and aspects of science education that discourage women and minorities has grounded her work. Dr. Cunningham received her B.A./M.A. in Biology from Yale University and her Ph.D. in Science Education, Curriculum and Instruction from Cornell University.

Irene F. Goodman, Ed.D. is the founder and president of Goodman Research Group, Inc. (GRG), of Cambridge, MA., a research firm specializing in evaluating programs, materials, and services for clients around the country in the education, not-for-profit, corporate, and government sectors. GRG's expertise extends to all areas of evaluation research, including feasibility studies and needs assessments, formative research, process evaluation, and outcome evaluation, as well as related services such as workshops and consultation. Dr. Goodman has over 25 years experience in research, teaching, and consulting. Prior to founding the company in 1989, she had an extensive research consulting practice and served as a senior research associate at other research institutes in the Boston area.

Cathy Lachapelle, B.S., Research Associate, is the Project Manager for WECE, on staff at GRG since the spring of 1998. She is responsible for the day-to-day operations of the WECE project, overseeing the collection and maintenance of data for the study, as well as designing databases and survey instruments, and analyzing statistical and qualitative data. Ms. Lachapelle is a Ph.D. candidate in Educational Psychology at Stanford University, where, as a graduate student, she conducted research on student learning and curriculum in science and mathematics classrooms. She received a Bachelor's degree in Brain and Cognitive Science from M.I.T., after which she worked as an aide and student teacher in an alternative school in Cambridge, MA.

Meredith Thompson, B.A., Senior Research Assistant, is primarily attached to the WECE project, on which she

helped to recruit schools to participate in the project, established a pilot testing program for the surveys, and maintains contact with over 150 administrators and staff at the 53 participating institutions. Ms. Thompson has developed expertise in managing and manipulating large databases from her involvement in managing the WECE participant database of over 22,000 students. She has also taken an active role in learning new computer programs, and teaching other GRG staff members about those programs through presentations. Ms. Thompson served as the project coordinator for an alumni survey of a community service organization, for which she organized the tracking and interviewing of over 100 hard-to-reach respondents. Ms. Thompson graduated from Cornell University in 1996 with a B.A. in Chemistry and a concentration in Education

Kate Bittinger, B.A., Senior Research Assistant, works full-time on the WECE project, where her responsibilities have included managing WECE literature and writing literature reviews, coding interviews and focus groups from site visits, developing and distributing the non-respondent survey, scheduling and coordinating site visits, and organizing and managing follow-up surveys of women engineering graduates. Ms. Bittinger has also served as the research assistant for other GRG projects, including WGBH's Arthur's Library Adventure, the Mathematical Association of America's Historical Modules project, and the Jewish Women's Archive's Women of Valor. Ms. Bittinger graduated from Barnard College in May 1999 with a B.A. in History.