Gender Equity and Engineering:  
A Review of Education Policy 
And Research Since 1964

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Abstract

The civil rights and women’s movements have created profound and lasting changes in the education and employment opportunities of many United States citizens. Yet despite these changes, equality for marginalized groups has yet to be fully realized. In this paper, we will examine how the passage of civil rights legislation has defined the direction and scope of subsequent education policy and research in terms of gender equity. In 1964, Congress passed the Civil Rights Act, which, among other things, prohibited racial discrimination in education. As a part of this Act, Congress also commissioned a national study to determine the extent of racial inequality in terms of access to educational opportunity. With the passage of Title IX, in 1972, discrimination on the basis of sex in educational institutions and programs was also prohibited, but, unlike the 1964 Civil Rights Act, no research to examine sex discrimination was included in the legislation. In the early 1980’s, national concern about the growing shortage of scientists and engineers gave rise to policy initiatives designed to increase the numbers of women in science and engineering. Yet women’s presence in engineering education programs remains low. A review of the research literature suggests that this persistent under representation is not simply the result of poor academic preparation or gender-specific patterns of socialization, but is also embedded in the habits of mind that have shaped education research and public policy since 1964.

I. Introduction

This paper reviews education policy and research efforts to enhance gender equity in engineering education. Efforts to increase the numbers of women in engineering have resulted in a range of education and co-curricular programs designed to encourage women to major in engineering and to seek employment in the field of engineering. The results of many of these programs have been presented to the scholarly community in the form of refereed journal articles and papers presented at professional meetings. Yet despite these initiatives and the knowledge they have contributed to our collective understanding of the problem, women’s representation in engineering remains quite low. In reviewing both education policy and the research literature,
We seek to answer the following questions: What is gender equity? Can gender equity in engineering be enhanced by programmatic initiatives? Or are gender inequities too strongly embedded in early gender-role socialization to be affected by educational interventions? Does the research on women in engineering education programs provide evidence that changing curricular content, pedagogical practices, and co-curricular experiences leads to an increase in gender equity in engineering? In this paper, we will examine the course of education policy and research set in motion by the passage of the Civil Rights Act in 1964, Title IX in 1972, and the Women’s Equity in Education Act in 1974. We will continue with a brief overview of the subsequent research on program initiatives supported by federal and foundational funding. We will conclude with suggestions for future research initiatives designed to enhance gender equity and thus increase the representation of women in engineering.

II. Civil Rights, Equality of Educational Opportunity, and Equity

1964 marks the point in American history at which the federal government addressed the problem of overt racial discrimination. What many may not realize is that Congress never set out, in the days leading up to the passage of the Civil Rights Act, to address the problem of sex discrimination. In fact, the word sex appears only once in the original version, in Title VII, which prohibits discrimination on the basis of sex in hiring and employment practices, but not in education. According to Kessler-Harris, the addition of the word “sex” to Title VII was considered by many to be something of a joke. It happened something like this: Congressman Howard Smith (R-VA), Chairman of the House Rules Committee, responded to a request from the National Women’s Party (NWP) to add “sex” as a protected category in civil rights legislation pending before Congress. While these requests by the NWP were routine, they had a long history of being either ignored or ridiculed by legislators from both parties. In this case, however, Smith announced that he was taking the request “seriously.” Historians speculate that Smith thought including sex as a protected category might help defeat the entire Civil Rights Act. Smith must have misjudged the resolve of Congresswoman Martha Griffiths (R-MI), who rose to speak not only in favor of passage of the Civil Rights Act, but of the inclusion of sex as a protected category. Her reasoning was that if the Act did not include sex as a protected category, then the only people who would not be protected under the proposed legislation would be white women. Black women, she argued, would be included by virtue of their race. This odd argument served to persuade several southern Democrats to vote in favor of the entire Civil Rights Act, including the addition of sex as a protected category in Title VII, in order to defend the rights of white women.¹

But while the Civil Rights Act protected women’s rights in terms of employment, there was no protection against sex discrimination in terms of education. Thus, women had the right to be hired into any jobs for which they were qualified, but they did not have the right to pursue an education that would prepare them to be employed in any field of their choosing. The fundamental split between employment rights and educational opportunities still plays out today, as we will address below. One important, yet often overlooked, aspect of the Civil Rights Act is Section 402, which directed that Congress would commission a study to determine the “lack of availability of equal educational opportunities for individuals by reason of race, color, religion or
Congress recognized that disparate conditions in schools needed to be addressed. However, Congress did not choose to document the extent of discrimination on the basis of sex in public education. In this simple act of omission, Congress turned a blind eye to the possibility that girls might also suffer from a lack of access to equal educational opportunities.

When the outcomes of the study were reported to Congress some two years later, the results were troubling. Essentially, the report, Equality of Educational Opportunity (EEO), concluded that student achievement is determined more by educationally immutable factors such as socio-economic status and family background than it is determined by curriculum, teacher characteristics and qualifications, pedagogy, class size, or resource allocation. Findings of a study released by the International Association for the Evaluation of Educational Achievement (IEA) seemed to corroborate the findings of the EEO report. The release of the findings from these two studies marked a turning point in the relationship between research and policy. No longer convinced that education research could provide the knowledge needed to craft national policies to enhance student achievement, subsequent efforts were directed toward equalizing the demographic composition of public schools, particularly by ethnicity and socio-economic class.

In many ways, education researchers and policy makers were conceptually limited by the EEO and IEA reports. They began to focus on demographics and descriptive statistics rather than on curricular or pedagogical interventions to improve academic achievement. Thus, in the years following the initial civil rights legislation, demographic representation became one of the primary foci of education research. Yet in spite of growing awareness and a healthy public discourse on women’s rights, the education of women and girls was given relatively little attention and virtually no funding.

III. The Educational Amendments Act of 1972 and Title IX

A review of the educational research on women and engineering education in those early years is illustrative of this point. For example, a search of the ERIC database contains citations for only five journal articles addressing women or gender and engineering between 1966 and 1972. While none of these articles qualifies as a “scientific” publication according to guidelines recently published by the National Research Council, they do provide important demographic information on the persistent lack of equal representation in engineering. They do so by focusing on the number of women enrolled in engineering education programs, the number of women actually practicing engineering, the salaries and workload responsibilities of engineers by gender, and the anticipated growth of employment opportunities in various engineering fields. None of these articles addresses issues of gender equity in engineering education.

In 1972, in response to increasing public pressure from the women’s movement, Congress included Title IX in the Educational Amendments Act. Title IX prohibits discrimination on the basis of sex in educational programs and activities, including recruitment, admissions, financial aid, housing, course offerings, employment and athletics. The law provides for the cutoff of federal funds if educational institutions do not comply. However, Title IX was enforced by self-
report, with each institution assessing its own degree of compliance with the law’s requirements for equality of opportunity.

For the purpose of our argument, we make a distinction between the terms “equality” and “equity.” Equality means equal access to resources and services. Equality can be measured in fairly precise ways. It requires good record keeping and systematic counting of categorical data. On the other hand, equity refers to providing the special support needed by marginalized groups to realize their full rights as citizens and to reach their full potential in terms of education and employment. It is much more difficult to assess; it cannot be simply counted. Equity suggests special consideration and treatment to achieve a goal. 

Unlike the Civil Rights Act, there were no provisions within Title IX to examine equality of educational opportunity on the basis of sex. A search of the ERIC database for journal articles published between 1972 and 1978 reveals a very modest increase in publications. However, these publications continued to reflect an emphasis on compliance with non-discriminatory practices, that is, an emphasis on equality. While this information is still very useful in terms of documenting the slow pace of progress in eliminating discrimination, it provides little information for programmatic interventions to enhance women’s success in engineering.

IV. The Women’s Equity in Education Act and Beyond

Passage of the Women’s Equity in Education Act (WEEA) in 1974 marks an important milestone in education policy and research. For the first time there appeared to be a significant source of funding for the implementation of alternative educational environments that would achieve gender equity. Those who had been working in isolation, without benefit of federal financial support, took WEEA as the beginning of a new era in educational opportunities for girls. In 1978, Congress directed the National Science Foundation to prepare biennial reports on women and minorities in the sciences and engineering. These reports are essentially records of progress and, indirectly, indicators of compliance with previous legislation. Through NSF, Congress also directed funds toward encouraging educators and employers to “maximize the potential contribution and advancement of women in scientific, professional, and technical careers.” WEEA was legislated under the Special Projects Act, which initially was to be funded at $200 million a year. However, due to political maneuvering in Congress, WEEA was funded for only $6.3 million its first year. Those funds were used primarily to provide modest support and technical assistance for the design and implementation of programs to reduce sex discrimination in educational settings. Full-blown support of gender equity research was withdrawn.

Gender equity research was dealt another severe blow by the Reagan administration in 1982. Political appointees to the U.S. Department of Education believed that women working outside the home posed a serious threat to family values. One of the first acts of these conservative policy makers was to remove the Director of the WEEA Program and slash its budget to $500 thousand, less than 8% of its first-year funding. This attack on WEEA funding continued in the Bush and Clinton administrations. By 1996, WEEA was zero funded.
Gender equity would have lost all of its policy and research support if not for two additional reports that appeared in the early 1980’s. First, the Reagan administration produced the report, *A Nation at Risk* (1983). Another conservative initiative, the report was intended to provide support for Congress to implement a school voucher program. Instead, the report painted a bleak picture of the failure of public education “to prepare a competitive workforce for a global economy.” As a result, Congress moved to implement education and labor initiatives that strongly encouraged women and girls to pursue education and vocational training in the sciences and mathematics. Education policies designed to support family values gave way to policies designed to enhance global economic superiority.

Second, and at roughly the same time, the National Collegiate Athletic Association (NCAA) released a report of the level of compliance with Title IX in collegiate athletics. This report documented gross disparities between funding levels of male and female athletics in public, post-secondary education. For the first time, female athletes were seen as revenue-generators.

In a striking way, *A Nation at Risk* and the NCAA Report were similar. Each considered the material implications of restricting women from public work, and each report, for different reasons, concluded that women’s continued confinement to traditional roles would be economically and educationally untenable. We can conclude this from examining the language used to shape the argument for the need to increase women’s representation in science and engineering. The most often-cited reasons were (and continue to be) global economic competitiveness, not equity for women.

V. Education Policy and Research

How does the body of knowledge on women in engineering reflect the public policy decisions made by Congress following the Civil Rights Act of 1964? As discussed above, there is no record in the ERIC database of any education research on the development, implementation, or evaluation of alternative educational environments for women until 1978. 10 journal articles are cited in ERIC from that year. In 1979, the number of articles increased to 42. As the modest WEEA funds were disseminated and the outcomes of the research came in, one can observe a dramatic increase in the quantity and scope of research articles on women in engineering. The majority of these papers focused on the outcomes of specific demonstration projects. The quality of the research varies from well-designed program implementation and outcomes evaluation to more anecdotal or descriptive work. The main theme was still one of adapting women to engineering rather than changing engineering culture to be more inclusive of women. Why was this the case? In part, it was the result of deeply embedded habits of mind that shape our research directions as well as our policy decisions. These habits of mind have led us to examine the ways in which women are different from men, the academic and personal skills women need to be successful in engineering, and the ways that women can be trained to adapt to traditional engineering culture.
One important stream of research has examined the relationship between various academic and personal factors and women’s persistence in or attrition out of engineering programs. These factors include high school GPA, SAT scores, interests in mathematics and science, course-taking patterns, grades in college-level course work, learning styles, self-efficacy, self-confidence, personality type, and specific cognitive factors such as spatial visualization and mental rotation ability. Examples of this research include Besterfield-Sacre, Atman and Shuman, Felder et al, Gallaher and Pearson, Moller-Wong and Eide. These studies have made major contributions to our understanding of why women choose to become engineers, what sorts of academic preparation women need to be most successful, what kinds of learning environments are related to women’s educational success and persistence, and how to identify students most at risk of leaving engineering programs.

In the absence of a national agenda supporting research on gender equity, however, there has been very little investigation across institutions. Thus, little is known about the extent to which particular institutional environments mediate individual factors. There are a handful of exceptions, and their findings are not conclusive. Huang, Tadese, and Walter report that most of the gender differences in science and engineering can be accounted for by individual differences including family background and academic preparation. However, Takahira, Goodings, and Jones report that while the within-gender variables most likely to predict persistence are GPAs and SAT-M scores, between-gender variance in persistence is mediated by the selectivity of the institution. Jacobs also addresses institutional selectivity in a study of gender stratification. His findings reveal that women have and continue to receive degrees from less-prestigious institutions. The differences are accounted for by the under-representation of women in engineering programs and the over-representation of women enrolled in part-time programs, which are clustered in less-prestigious institutions. He suggests that this stratification may be the result of efforts to re-segregate women into lower status institutions while protecting the enrollment of males in high-status, private institutions.

Clark refers to this function of re-segregation as a “cooling out” process. Rather than providing more highly trained engineering students to pursue graduate work, lower status institutions assume the role of a sorting mechanism by redirecting some students into lower-status jobs and away from advanced training in high-status careers. One line of inquiry that is used to justify women’s self-selection into lower status jobs is research on early gender-role socialization. In this line of research, women are often described as choosing to leave engineering because it conflicts with the traditional gender roles that they have assumed from early childhood family and educational experiences.

Gender socialization research looks at the attributes that women and men bring with them to education and the workplace. There is a growing body of literature that reports on the role of the family and the schools in shaping children’s perceptions of work as “male” or “female” and of the various traits considered essential for success in each type of occupation. “Male” occupations require “mechanical and mathematical skills” along with a high degree of “emotional individuation” and “toughness.” Girls are socialized to be more nurturing, emotionally expressive, and sensitive. As a result, female students are believed to enter college
with less academic self-confidence and lower expectations for success than do male students. Thus, women are at a disadvantage in “male” careers, like engineering, because of their early gender-role socialization. Much of the research on women in engineering has been grounded in gender socialization theory, particularly the work originating in the fields of psychology and counseling. This theoretical framework determines how questions are framed, the methods of data collection used, and interpretations of the results of the studies. One of the implicit conclusions that can be drawn from this line of research is that gender socialization will continue to limit the number of women who choose engineering.

These conclusions are oddly parallel to those drawn by Coleman (1966) about racial disparities in student achievement. One of Coleman’s findings was the “80/20” rule. That is, 80% of the variance in student achievement was due to immutable factors beyond the control of the schools. These factors included family characteristics and socio-economic status. Thus, schools could only be accountable for 20% of the variance in student achievement. A similar conclusion can be drawn if one adopts the gender socialization model in the analysis of women’s low participation in engineering programs of study. Family characteristics and socially acceptable gender-role identification are beyond the control of the post-secondary educational system. They are immutable.

McIlwee and Robinson25 have argued that in order to understand the lack of gender equity in engineering, one must also consider structural theories of both conflict and cultural reproduction. While they acknowledge that gender roles imbue men and women with differing characteristics and methods of acting, they do not determine academic or professional success. Instead, they are mediated by the organization structures of the educational institution and the workplace. Moreover, these structures vary according to the status that engineering holds relative to other specialties within the institution, the level of formal bureaucracy, and the degree to which women’s presence has been established as an acceptable component of institutional culture.

V. Conclusions

In light of the persistence of significant gender disparities in engineering despite the many projects, programs, and publications designed to ameliorate the problem, what lies ahead? To date, most of the research has focused on gender-role differences in education and the workplace. There is the need for an understanding of the kinds of institutional and bureaucratic configurations that most enhance women’s persistence in engineering education as well as their success in the workplace. Such an investigation could begin with a comprehensive evaluation of those women in engineering programs already in place. This meta-evaluation should include implementation, outcomes, and impact evaluations of these programs as a class, and should be disseminated widely in the scientific and scholarly community through a wide range of journal articles. The evaluation and educational research journals have thus far published very little in the way of gender equity in engineering education. To date, findings have been disseminated primarily through papers presented at ASEE and/or published in JEE. But there is no published review of the literature documenting the outcomes of these programs available to the education policy and research communities at large. This paper provides a very modest beginning by
discussing the extent to which policy and research have supported progress in the quest for gender equity since the passage of the Civil Rights Act in 1964.

6 Educational Resources Information Center. U.S. Department of Education.
10 The first of these reports was published in 1982. The next report will be available in September of 2002.
13 Sadker, & Sadker. (1994).

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