
AC 2011-2916: GENDER SCHEMAS, PRIVILEGE, MICRO-MESSAGING, AND ENGINEERING EDUCATION: PRACTICAL LESSONS FROM THEORY

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Gender Schemas, Privilege, Micro-messaging, and Engineering Education: Practical Lessons from Theory

Introduction

Despite concerted efforts to dismantle formal barriers to entry and retention, clear differences persist between the experiences of women in undergraduate engineering programs and their male counterparts.¹⁻⁵ Many existing explanations of women's under-representation in engineering and physical sciences are based on differences in intrinsic values, psychological needs, preparation, work-related values, family obligations, and lack of "critical mass."^{3,6-14} Without ruling out the possible significance of these factors, this paper explores an alternative factor, one over which the engineering profession itself might have greater control: the culture of our classrooms. In particular, we introduce several frameworks from the psychology and gender studies literature that shed light on how classroom climate plays a role in student experience and, in turn, in the recruitment and retention issues with which we, as educators, are all familiar.

Our premise is that the impact of engineering's cultural norms and associated discourses about women may be better understood (and addressed) if we move some of our attention away from the individual differences between men and women and, instead, spotlight the issue of engineering "as a *socially constructed* profession" of masculinity.⁸ For example, in their investigation of engineering education, Seymour and Hewitt (1997) ascribe common reasons for women's attrition to "the practices and attitudes which define and sustain the structure and culture of S.M.E. [Science, Mathematics, and Engineering] majors." Specifically, experiences of these majors' "weed-out" culture disproportionately affect women students, "leading to discouragement, and loss of confidence in their ability to do mathematics and science."¹⁵

A more recent study following *successful* engineering students from their matriculation to their graduation demonstrated a consistent gap in self-confidence: women had lower self-confidence in their mathematics and science skills, as well as in their open-ended problem-solving skills, than their male classmates.⁴ That is, even among those successfully completing engineering programs, women are less confident than men. Given the disproportionate drop-out rates and the known correlation between self-confidence and completion, these figures should be especially alarming.¹⁶ Of particular importance is the self-confidence drop that occurs for women during the first-year in engineering programs. Women who complete their engineering programs do show slight gains in overall self-confidence during their later years as undergraduates. However, women enter these programs with less self-confidence than their male counterparts and, following the general first-year decrease in self-confidence, female students statistically do not regain even these lower levels of self-confidence with which they entered their engineering programs.¹⁶ Other studies demonstrate women's decreasing feelings of inclusion and confidence in success as a function of the time they spent in engineering programs.^{5,16,17} How students feel about themselves, what they understand engineering success to look like, and how they formulate their identities as engineers *matters* in students' success, and there is reason to believe that engineering classrooms make women feel like they do not belong.

What are the roots of these differences? Few, if any, formal barriers to entry for women in engineering programs exist. On average, women receive grades in engineering school that are as high as or higher than their male counterparts.¹⁵ Overt sexism is frowned upon at most institutions (at least in North America). Structurally, the experiences of men and women in engineering schools are the same. But women are the recipients of subtle messages of non-belonging, and we argue that this creates a ‘chilly climate,’ a phrase popularized by Hall and Sandler in their landmark 1982 report.¹⁸ In particular, as social persuasion is a key contributor to self-efficacy, these messages of non-belonging – whether inadvertent or deliberate – undermine overall expectation and motivation to succeed. Similarly, they undermine the development of an engineering identity among female engineering students (for example, when others are surprised to learn that the women are in engineering).¹⁹ Both of these effects are likely to be significant factors in the under-representation and under-retention of women. In particular, the gap in self-efficacy is known to exist at matriculation, which suggests that any efforts to address it should start in the first year.⁴ The first year, where students transition to college and, in many cases, to engineering programs, is also where students learn what it means to be an engineer and acquire cultural norms concerning what it will take to succeed.

The purpose of this paper is to provide engineering educators with several theoretical frameworks – lenses by which to perceive and understand this ‘chilly climate’ – and to begin a discourse about how these frameworks may be used to construct a more positive environment for all engineering students.²¹ We do so by presenting the concepts of *privilege* and *gender schemas* and using them to frame the concept of *micro-messaging*.

Making the invisible visible: the concept of privilege

Privilege refers to unearned advantages that accrue to us that we are able to take for granted. There are privileges of being right-handed, literate, living above the poverty line, living in the United States (where, e.g., basic sanitary conditions are for the most part widely available), and more. Most privileges are contextually specific: being tall is a privilege with respect to reaching high cabinets and projecting success in business contexts but not with respect to flying in economy class on most commercial airlines.²⁰ Privilege is often invisible to those who have it, while simultaneously apparent to those who lack that particular kind of privilege.

The extent to which privilege is visible depends on the position of the beholder. In other words, “It is a privilege of the privileged not to see their privilege.”²¹ People in dominant groups, at best, perceive inequalities as happening somewhere else; at worst, and more commonly, dominant groups do not see inequalities at all. For example, when entering a building, many people who are able-bodied do not pay particular attention to whether someone with a physical disability could easily navigate the entrance, while for someone in a wheelchair, this would be an issue of critical importance. For dominant groups, the world works smoothly. However, because there are many attributes that convey privilege, a dominant group in one situation may lack privilege in another. The experience of *social privilege* means that one is able to assume that one’s appearance, culture, beliefs, etc. are normal and acceptable; one can take these things for granted. It also means that members of a dominant group accrue invisible benefits associated with that membership, while those not part of the dominant group are typically aware of not quite fitting in.

Born in the work of Coleman on social class group privilege (1960) and further propelled by Peggy McIntosh's manuscript on "white privilege" (1988), the general concept of social privilege gave rise to a new discourse on male privilege, a topic of particular interest in a discussion of the male-dominated engineering environment.^{7,22,23} Male privilege is particularly difficult to unpack because it has to do with gender identity: what it means to identify as – and to be seen as – masculine.²¹ Male privilege in the workplace can be seen in the frequent assumption that a doctor or a manager is a man, and in the continuing trend that male job applicants are more likely to be hired than women applicants with comparable credentials.²¹ A similar female privilege exists with respect to professions seen as nurturing or supportive: nursing, childcare, even teaching (especially at the primary level), and secretarial/administrative support roles. In the next section, we explore the roots of these gender privileges in gender schemas and probe the consequences of schema violation for female engineering students.

Interestingly, revealing privilege creates cognitive dissonance that dominant groups – those with privilege – usually resolve by considering un-privileged groups as deficient in some way. Able-bodied-ness, right-handedness, and prime-of-life age range are all positions whose privilege has, at some point in history, come at the expense of seeing outsiders as deficient. This shifts the problem squarely onto the shoulders of the un-privileged, making it *not a problem about which the privileged need to be concerned*. We sometimes see a similar discomfort when male privilege in engineering is raised.^{21,24,25} Calling attention to male privilege threatens to make visible gender inequalities that are otherwise hidden and comfortably tucked away. As long as it remains invisible, the under-representation of women in engineering becomes the problem of women. To understand why, we turn to the concept of gender schemas and the consequences of their violation.

Gender schemas and implicit associations

Related to the idea of privilege is the concept of gender schemas, so-called by researcher Virginia Valian.²⁶ Briefly, schemas are hypotheses, largely non-conscious, that are used to frame and interpret social behavior in a wide range of roles or settings. Schemas help us to make sense of our world and to know what we can expect. For example, students have schemas for professors: what professors are expected to look like and how they are expected to behave. They are analogous to Schank's 'scripts' for everyday activities.²⁷ When over-applied, schemas can lead to overt biases, prejudices, and discrimination; but in their more usual form they are simply part of a process of categorization that we do to make sense of the world.

It is a mistake to believe that we can do away with schemas entirely. If every detail of every situation needs to be considered before any conclusions can be drawn, cognition becomes hopeless.^{26, 28} We rely on generalizations as a way to make sense of the world. Problems arise when we are unaware of these generalizations, refuse to question or reconsider them, or apply them in the face of competing evidence. As we shall see, engineering culture has a particular propensity to believe that schemas can or should be eliminated entirely, leading to special problems when they are in use but denied.

As a society, we have a set of schemas related to gender. Male and female privilege in the professional space, discussed above, arise from gender schemas that men are technical, task-focused, career-oriented while women are nurturing, emotional, and communication-oriented. These schemas influence our interpretation of the behavior of others. For example, we may assume that women who learn another language are doing so for their own personal growth, whereas men intend to use it to advance their careers. Or men who go golfing are networking, while women who socialize with colleagues are having a “girls’ night out.” Or, to draw an example from an academic setting: a student is struggling with a problem set in calculus. If it is a male student, one may conclude that the material is difficult. If it is a female student, a conclusion may be that she isn’t very good at math, or even that women are not good at math. In all these examples, the same experience or behavior is interpreted differently through the lens of gender schemas. Gender schemas, like other schemas, do not stem from malicious intent; this is rarely a case of overt sexism (‘women-do-not-belong-in-engineering’). Gender schemas are a consequence of our use of mental models to make sense of the world.

We are not necessarily conscious of the gender schemas that we hold. One way to reveal these unconscious biases is through the use of implicit association tests,²⁹ which measure the differential association of concepts. A cross-cultural study using an implicit association test around gender and science suggests that approximately 70% of the respondents associate science with males more than with females.³⁰

Another way of identifying schemas comes from the linguistic custom of explicitly calling out – or verbally *marking* – individuals who violate them: *white* rapper, *wheelchair* athlete, *male* nurse. This is a simple example of the dissonance caused when schemas are violated. Being *unmarked* is a form of privilege. You do not need to think about your role or identity: you are simply a rapper, an athlete, a nurse. Being marked means constantly being reminded that you are *both* a rapper *and* white, *both* an athlete *and* confined to a wheelchair, *both* a nurse *and* male, that your identity is at odds with itself. Privilege is accorded to those who fit the schema; additional effort is required from those who do not fit, who lack privilege, who are continually conscious of their dual roles, just as a left-handed person is continually reminded of the ways in which ours is a right-handed world.

In this context, it is clear that engineering, a field historically created and populated by men, has been constructed as a masculine profession; women in the field are marked as *female* engineers. Even when rendered as a positive – “it is so nice to see a successful female engineer” – this marked-ness places a burden on the individual beyond that carried by an unmarked counterpart. *He* can simply be an engineer; *she* is rarely accorded this privilege. Instead, she carries responsibility for female-ness in addition to engineering. In many cases, she is seen as a representative of her entire gender. To date, women remain marked in engineering; the unmarked engineer is *not* female, rendering women the *out-* or an *invisible group* in this profession. While men are socialized to belong (and to feel that they belong) in engineering, women are perceived to not fit in or to not be capable of being engineers. This dissonance between schemas for women and for engineers – this conflict regarding their identities, interests, motivations, and abilities – can create a perception that they are unfit for the profession. Most perniciously, this cognitive friction can undermine their *own* sense of identity as engineers, especially in the first-year when engineering identity begins to bud.

Schemas reinforce privilege and cause dissonance when violated. While some responses to violated schemas may be overt (such as verbally expressed surprise on learning that a female student is majoring in engineering), many others are more subtle, expressed through *micro-messaging*. This is the topic of the next section.

Subtly enforcing privilege and schemas: the role of micro-messaging

Overtly negative behaviors, whether gender-related or not, are readily perceived and responded to. However, subtle and seemingly insignificant behaviors that reveal implicit biases and gender schemas are more challenging to recognize. Moreover, even once these behaviors are recognized and made visible, they are a challenge to address and change. It is the responsibility of faculty and academic mentors to recognize their own unconscious biases and to minimize or mitigate the effects of inappropriate behaviors of others in the classroom environment. The latter task becomes particularly difficult in the cases of micro-messaging, a term that refers to subtle behaviors that signal intentions and attitudes. Although small, micro-messaging behaviors may have enormous effect in conveying either negative or positive meaning.

Micro-messaging can be seen in such historical practices as basing classroom examples on the rules of American football, traditionally familiar to US male students and less so to US female students or to international students of any gender. This practice reinforces that classroom as a place where only US male students belong. Thankfully, such culturally specific examples have become less common as awareness of these matters has increased. However, the rates at which male and female students are called upon to participate in class, the kinds of questions asked of each, and even the demographics of classroom and team composition provide micro-messages reinforcing students' sense of belonging or alienation.³¹

Micro-messages often include our reactions to schema violations: When we are uncomfortable, we turn away, diminish, or exclude. When we wrestle with paradoxical roles, we highlight their marked-ness – “*African-American President*” or “successful in spite of her handicap” – thereby reinforcing their inherent conflict. We reaffirm that which makes us comfortable, that which fits our norms. We subtly undermine that which we sense does not belong.

Further, like privilege, the differential build-up of positive and negative micro-messages can lead to micro-inequities. The term “micro-inequities” was coined in 1973 by Mary Rowe (2008) to describe “apparently small events, ... often ephemeral and hard-to-prove, ... which are covert, often unintentional, frequently unrecognized by the perpetrator, which occur wherever people are perceived to be different.”³² These subtle, often nonverbal, micro-messages are as significant as overt behaviors in conveying privilege and schemas. As such, micro-inequities lead to exclusionism, discouragement, and devaluing. Examples of micro-inequities include lack of collegiality or mentoring/support, exclusion from informal networks, and isolation.³³

Micro-affirmations, by contrast, are “apparently small acts, which are often ephemeral and hard-to-see, events that are public and private, often unconscious but very effective, which occur wherever people wish to help others to succeed.”³² These can be as simple as effective mentoring practices. positive micro-messages that act as catalysts for positive change in individuals and

organizations. These can be especially effective in the early years of engineering education, where student identity and self-confidence are being shaped.

Engineering educators: what you can do

Gendered exclusivity and male privilege are dominant in the field of engineering.^{6,23} Theoretical frameworks of privilege and gender schemas allow us to frame conversations about positive change towards a more gender-equitable environment in engineering education. For an engineering educator, practical steps towards such an environment include awareness of the issues at hand, idea sharing, and behavioral change. By first engaging in critical self-analysis and aligning one's intent with positive micro-messaging, engineering educators may begin their journey towards creating positive classroom environments for women and other marginalized groups. By effectively using micro-affirmations, clearly delineating parameters of acceptable behavior (e.g., rendering micro-inequities visible), and making a conscious effort to view the educational environment through the eyes of non-privileged groups, engineering faculty and mentors will make a great impact for all students, especially women. The power and effect of changing one's language and subtle behaviors cannot be emphasized enough.

A further step would be to move beyond individual reflection and behavioral changes to begin discussing issues of privilege, gender schemas, and micro-messaging with engineering colleagues and students. Discussions with colleagues are an important mode of education and building awareness of the existence and pervasiveness of privilege, schemas and micro-messaging within a department or institution; this awareness is critical to build momentum to create change. Students, too, benefit from and can contribute to this conversation. As an example, the authors have co-created an extracurricular offering, entitled "Gender and Engineering," to discuss these issues with interested students and faculty. Providing female students with a framework to understand their experience has the capacity to transform their individually internalized messages of personal inadequacy or not belonging into a larger contextualized experience that they can name. For male students, it often opens their eyes to the experience of their women colleagues and motivates them to become allies and to bear witness to others' experiences. Among our colleagues, it has created a supportive and vigilant environment in which we can work to shape experiences to the benefit of all community members.

Engineering educators need to focus especially on the early experiences of our students. Specifically, our efforts need to be centered on first-year experiences in order to intervene in the negative micro-messaging female engineering students receive and to maximally facilitate their development as engineers. The following action items should be taken up by the engineering education community, individually and collectively:

1. Know your biases. You cannot eliminate all biases. By being aware of them and articulating them explicitly, you can guard against their inappropriate application. You can explicitly do things to minimize their impact.²⁶
2. Watch for privilege. Make it visible even when you cannot change it. The invisibility of privilege allows those who have it to remain oblivious to the circumstances of those who lack it. By making privilege visible, you begin to subtly shift its impact.

3. Monitor micro-messaging. Monitor it for yourself and ask a colleague or collaborator to do it with you. Sit silently in a class and observe behavior; videotape yourself and tally your responses; learn what messages you are subtly sending.
4. Share your observations. Talk to colleagues and students. Make these frameworks a part of the vocabulary of your department or school. Open discussion of these issues, letting those with privilege begin to see it and those who lack it attribute the dissonance to culture and not simply internalize it.

One of the most pernicious practices in engineering education is to state that, as a discipline, engineering is gender- (or race- or color- or...) blind, that it is a genuine meritocracy. By denying the existence of schemas and the privileges they encode, this approach makes it nearly impossible to improve the classroom climate and culture. Only in the face of overwhelming evidence is it possible to challenge the resulting inequities.³⁴ Moreover, the burden of producing this evidence is placed squarely on those most harmed by these practices. If engineering wants to improve the recruitment and retention of female students, it is necessary to recognize that female students will often face challenges – to their sense of self, to their confidence, to their identity as engineers – that differ from most of their male colleagues. By recognizing this fact, engineering education can help shape a first-year experience that reinforces positive identity formation and bolsters self-confidence for all of its students.

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