

Exploring Gender and Self-Confidence in Engineering Students: A Multi-Method Approach

Abstract:

Despite generally higher academic achievement, female students display lower academic self-confidence than males. Of particular interest to engineering educators is the difference in confidence in mathematical or scientific skills. Gender differences among engineering students have been explored by the Persistence in Engineering survey, a component of the Academic Pathways Study (APS), a multi-method longitudinal study which is part of the Center for the Advancement of Engineering Education. This survey was administered to engineering students seven times during their college years, thus tracing students' confidence in math and science skills over time. Men had higher self-confidence in math and science throughout the four years ($p < 0.05$ for gender by ANOVA), even when the dataset was limited to persisters (students who completed their engineering degree in this time). Similarly, the academic self-confidence of males in their ability to solve open-ended problems was higher than that of females. Student interviews, administered during the last semester of their senior year, provide additional evidence about confidence in engineering students, with marked differences in the responses of male and female students. This multi-method approach, utilizing the rich dataset of the Academic Pathways Study, enables us to consider approaches to understanding the 'confidence gap' in engineering students.

Introduction:

Despite years of research and intervention, women continue to be underrepresented in engineering.¹ Women earned less than one-fifth of the bachelor's degrees in engineering and engineering technologies granted in the U.S. in 2004.² One reason for the gender gap which has been explored by researchers is a gap in self-confidence, which refers to the strength of belief in one's abilities. Previous research indicates that self-confidence plays an important role in women's and men's academic experiences in STEM fields.³⁻⁵ Self-confidence in math and science has been found to be positively associated with the likelihood of entry into science and engineering majors, and with persisting in science and engineering majors later in college.⁶⁻¹⁰ At the same time, there is evidence that women exhibit lower confidence in their skills and knowledge than men in areas, like math and science, which are cornerstones of engineering. Differences indicating higher confidence levels among men relative to women have been found for physics and engineering background knowledge, problem-solving, and overall engineering abilities,¹¹ preparation and ability to perform in specific engineering courses (e.g. chemical engineering),¹² as well as engineering-related technical and mechanical abilities.¹³

Research has also demonstrated that there is no performance or preparation lag to account for women's lower self-confidence. For example, Felder *et al.* found that women's performance in first-year college courses does not account for their lower self-confidence and grades in later courses compared to men.¹² In addition, a survey of engineering faculty found that "both male and female faculty members perceive that the "academic preparation" and "study habits" of female engineering undergraduates are as good as, if not better than, those of their male peers."¹⁴

Because the outcome of preparatory and programmatic interventions has been largely positive for URM students while remaining, in the aggregate, neutral for women, we seek to extend this inquiry into self-confidence to a different group of students. While much prior research has focused on tying differences in confidence to different trajectories of academic study, such as selecting a major or switching out of STEM majors, we wanted to investigate the interaction among self-confidence, gender, and majority or URM status for those who “stuck with it,” persisting as engineering majors throughout their academic career.

Given the persistent gender gap between men and women in engineering and other STEM fields, we are exploring the character of this difference using data from the Academic Pathways Study (APS), part of the NSF-funded Center for the Advancement of Engineering Education (CAEE). The APS is a multi-university, longitudinal study that focuses on students’ experiences as they move into, through, and out of engineering education.¹⁵ Using a variety of methods, including ethnography, surveys, interviews, design tasks, and analyses of academic transcripts, APS researchers have been systematically examining how engineering students navigate their education, and how engineering skills and identity develop during their undergraduate careers.

In this paper, we take a mixed-methods approach to inquiry. There are several models of mixed-methods research; the one used here has been termed a “concurrent triangulation” design, where the integration of the results from the various methods occurs during the interpretation phase,¹⁶ enabling researchers to address a broad range of research questions directed toward discerning complex phenomena like student learning and development.¹⁷ The advantage to this approach for our purposes is that it combines the power of quantitative methods to identify a phenomenon that occurs across a larger sample of students with the power of qualitative methods to provide a robust description of the phenomenon.

Quantitative differences in academic confidence, by gender:

Survey data were used in order to investigate population-level differences by gender. Data were derived from the Persistence in Engineering Study (PIE), a component of the Academic Pathways Study. This survey was administered longitudinally to a cohort of 40 students at each of the four CAEE institutions (n=160 in total). All of the first-year students who entered the study were either admitted to an engineering program or were intending to major in engineering, and the resulting sample discussed here consists of those same students who entered the study in their first year and persisted in engineering until graduation. It should also be noted that the student participants in the APS were what we consider “traditional” students: those who enter college as very young adults and attend full-time until the completion of their degrees. Full details of the development, administration, and preliminary results of the survey can be found elsewhere.^{18, 19} For the purposes of this paper, we will be focusing on three constructs that measure different aspects of academic self-confidence. Each construct comprises two or more items (questions).

I. Confidence in math and science skills:

- a) math ability*
- b) science ability*

II. Confidence in open-ended problem-solving skills:

- a) Creative thinking is one of my strengths.*
- b) I am skilled in solving problems that can have multiple solutions.*
- c) Critical thinking skills.*

III. Professional and interpersonal confidence:

- a) Self-confidence (social)*
- b) Leadership ability*
- c) Public speaking ability*
- d) Communications skills*
- e) Business ability*
- f) Ability to perform in teams*

For items IIa and IIb, respondents were asked, “Please indicate how much you disagree or agree with each of the statements” with the options ‘disagree strongly,’ ‘disagree,’ ‘agree,’ ‘agree strongly.’ For the remaining items, the prompt read, “Rate yourself on each of the following traits as compared to your classmates. We want the most accurate estimate of how you see yourself.” The options for these items were ‘lowest 10%,’ ‘below average,’ ‘average,’ ‘above average,’ and ‘highest 10%.’ The Cronbach’s alpha score was calculated for each set of items to confirm intra-construct reliability; all values were higher than 0.6.²⁰ Student scores for each construct and timepoint were normalized to a scale of 0 to 1 (each item was equally weighted).

The respondents were limited to those who completed their engineering degree in four years (persisters), which included 45 females and 62 males, for a total of 107 persisters. A repeated-measures analysis of variance, using gender and administration (time) as the factors, was then performed with the data. The ANOVA provides information on overall differences between men and women’s responses, effect of administration, and any interaction effect. If the overall ANOVA was statistically significant for either gender or time, it was followed by *post hoc* t-tests to observe differences in gender at each timepoint, or an ANOVA followed by LSD tests to determine differences between administrations for a given gender. Note that, while the repeated-measure ANOVA is an extremely powerful statistical technique, it can only be used for complete sets of data: each respondent must have answered all the items on each survey. Some of the persisters did not answer all items belonging to one construct, but answered all the items for another. As a result, the exact number of participant varies slightly with each construct.

Graphs of the responses to these three constructs are given below. The mean values are presented, with error bars depicting the standard error of the mean. Note that along the x-axis, ‘time,’ is an approximation. Due to the exigencies of administering surveys at different sites, the timing of administration varies slightly by institution.

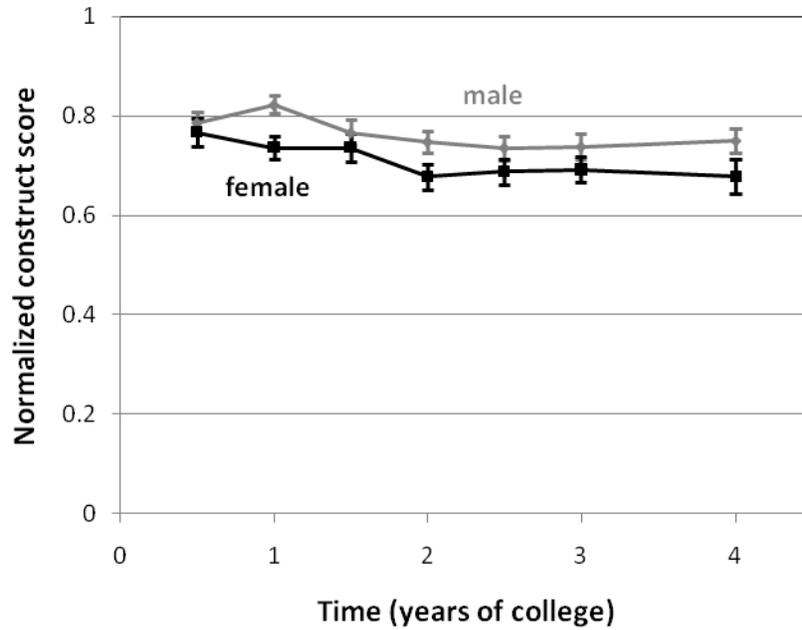


Figure 1: Confidence in math and science skills

Over the course of the four years, male engineering students displayed a higher confidence in their math and science skills than their female counterparts ($p < 0.034$ using overall ANOVA). *Post hoc* testing revealed that the means differed significantly at the 1- and 2-year marks. There was no statistical evidence to suggest that confidence in math and science ability changed with time for either men or women over time.

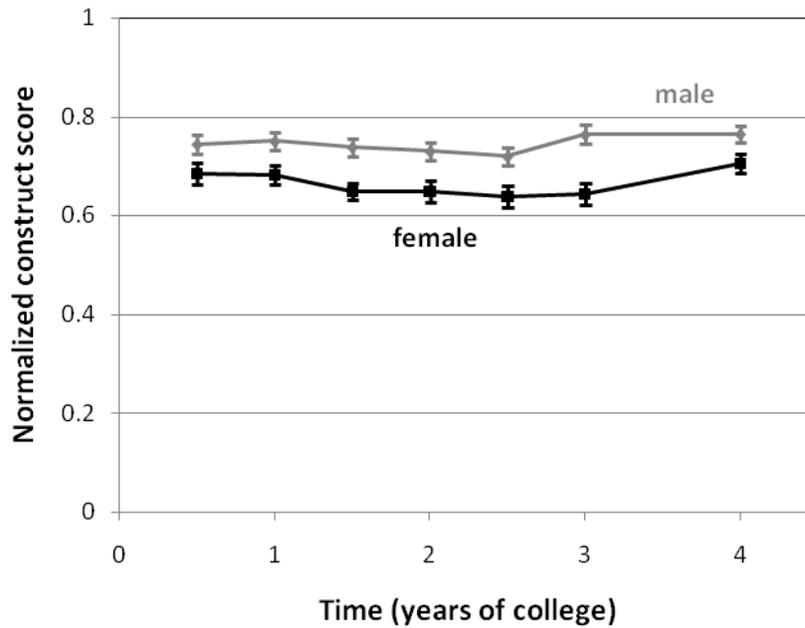


Figure 2: Confidence in open-ended problem solving skills

Paralleling the findings for confidence in math and science skills, male engineering students are more confident in their open-ended problem solving skills than female engineering students over the course of their education, and the means differed at all time points ($p < 0.0005$ for overall ANOVA; $p < 0.05$ at 0.5, 1 and 4 years; $p < 0.005$ at all other time points). Again, there is no evidence that the confidence changes with time for either gender.

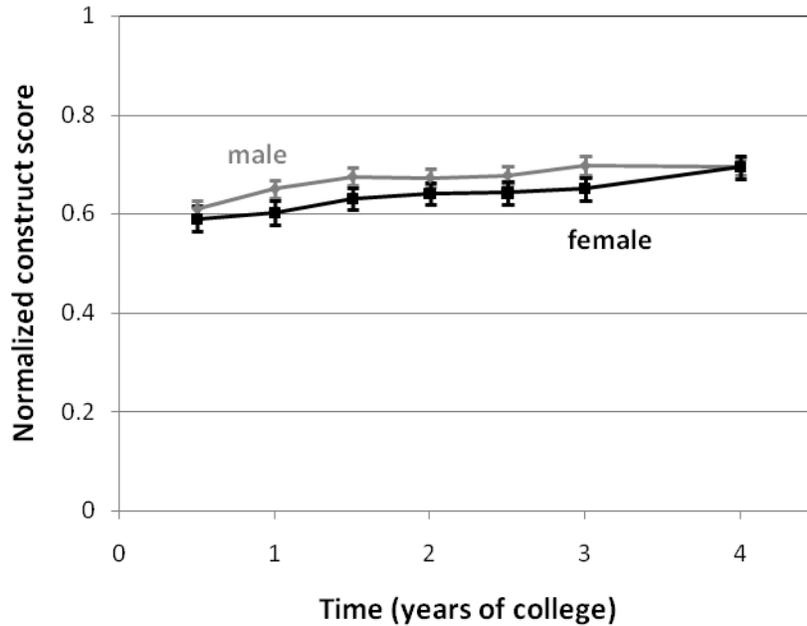


Figure 3: Professional and interpersonal confidence

Finally, no statistically significant differences were found between male and female respondents when they were asked about their interpersonal and professional skills. As with the other self-confidence constructs, the means for each gender remained statistically constant over time.

A few caveats are in order while reviewing these data. For a qualitative survey of this nature, the number of respondents was relatively small. However, the PIE survey was used as the basis for a similar, national survey, the APPLES2 survey,²⁰ which was administered to over 4000 engineering students in a stratified sample of institutions,²¹ and the findings for the larger sample are similar [unpublished data]. In addition, we might expect that our findings underestimate any gender gap, as this is a fairly homogeneous and academically successful group: the respondents self-selected to be in a multi-year study of engineering students (demonstrating a commitment to their course of study), and only students who completed their four-year engineering degrees were included in this analysis. These students are not likely to be representative of the engineering student population at large, and they are certainly not representative of college students in general. As successful engineering students, they could be expected to have higher-than-average self-confidence in their math, science, and open-ended problem solving skills.

Nevertheless, even in this successful and relatively homogeneous group, clear differences emerged between male and female self-confidence in the two areas that we normally consider

central to engineering. On the basis of the much smaller p-values, it seems like this ‘confidence gap’ is more profound for open-ended problem solving than for math and science skills ($p < 0.0005$ vs $p < 0.05$). This may be attributable to the kinds of instructional feedback students receive for these respective skillsets. Math and science feedback typically takes the form of objective grades on individual work such as problem sets and exams, while open-ended problem solving skills may be employed in larger, design-oriented projects, often carried out in teams, where feedback may not be given to individuals and may also include a larger subjective component. The relative uncertainty inherent in such an assessment of open-ended problem solving skills may have a multiplicative effect when differences in confidence exist.

These findings complement those found in previous research, and also demonstrate that not only are women less confident than men, the confidence gap persists from the beginning to the end of their engineering education. We recall that these seniors are high-performing, traditional students who have spent the last four years engaged in an intense educational experience that had more influence on their transition to adulthood than perhaps any other factor in their lives. It seems clear that the college experience has done nothing to close the confidence gap, and perhaps contributed to its persistence. We now turn to students’ own reflections on their engineering education for an explanation.

Results from student interviews:

In their senior year, 15 of the APS students participated in an in-depth, semi-structured qualitative interview. Some questions in the interview were designed to elicit students’ reflections on their experiences as engineering undergraduates. Others were designed to elicit students’ conceptions of engineering and themselves as engineers now embarking on their professional careers. In this section, we complement the findings from the PIE survey with a rich picture of students’ self-confidence as new engineers entering the world of work. We consider students’ answers to three sets of questions. The first questions considered here ask students to reflect on how gender may have played a role in their undergraduate education. The second set of question asks students to identify the skills that are most important for engineers to have, and discuss the extent to which they believe they have those skills. The third set of questions began by asking the students to describe themselves as newly minted engineers:

If I were a recruiter for a job you want, what would you really want me to know about you before we complete this interview?

We analyzed students’ responses to these questions using a constant comparative analysis.^{22, 23} With this method, the analyst inductively examines the transcripts of the interviews, coding statements or ideas (sometimes referred to as “thought units”) into categories, comparing one thought unit to previously coded units, and allowing categories to emerge from the data that seem to explain a particular social phenomenon. As the process of comparing and coding continues, theoretical properties of the categories may emerge; for example, in the present study we are interested in the specific kinds of expressions men and women use to describe or explain their level of self-confidence with respect to engineering. An important quality of this systematic method of grounded theory-building is that all thought units related to a category are coded, especially those that seem to contain new theoretical properties, even properties that stand in

contrast to previously coded thought units. Thus, the theory of self-confidence and gender that emerges from the data here is multi-faceted, rather than unified.

The difference in self-confidence that we observed on the survey was also identified by several of the seniors during the qualitative interviews. Simply prompting them to describe the role gender may have played in their educational experience led several to discuss confidence and gender in a number of ways. In the following sections, we will describe how, according to our respondents, the relative numbers of men and women may have contributed to the confidence gap,

Self-confidence in context: Almost everyone mentioned the relatively low proportion of women in engineering, especially if they were in a sub-discipline like Mechanical Engineering where women's participation is especially low. In some cases, the skewed distribution between the sexes was perceived to be related to confidence. Samantha was majoring in Bioengineering, a discipline with a high percentage of women, so she had little experience being in the obvious minority in her classes. She recalled one class she took in a male-dominated engineering sub-discipline, where she felt intimidated being one of a very few women in class. As a result, she reflected that in contrast to her participation in other courses, "I guess I didn't talk very much in that class." John also observed that "as the minority, maybe women feel a little bit more intimidated or maybe, you know, have something to prove in a more male-dominated field." Jesse, on the other hand, reflected that if the shoe were on the other foot, "if it was a hundred girls in the department and five guys...I don't know if you really have the sense that you need to prove yourself...but you definitely know that you're more unique, I guess...it would be different." Other students remarked that a skewed distribution would make a difference in women's and men's experiences, even if they were not able to express what that difference would be.

Ethan expressed surprise at how few women choose to pursue engineering degrees. He could count the number of women pursuing his major, Mechanical Engineering, on one hand. Ethan reflected that he was "raised believing that, you know, anyone could do anything, and, um, that people who suggested that girls weren't good in math and science were bigots." He thought the reason women were scarce in engineering was simply a lack of self-confidence.

I think any girl is just as capable as any guy doing engineering, but I've never seen one try. Even the girls that were in my department, they just seemed like they didn't think they should be there, like they would ask more questions than they needed to, doubt themselves when they shouldn't. And I thought if they just had some confidence, sat down and did it, that—I mean I'm sure they could all do it, you know, just as well.

Elizabeth, a Computer Engineering major, had a great deal of experience with classes where there were relatively few women. Elizabeth explained that men tended to talk more than women in class because they were more confident in themselves and cared less about others' perceptions of them.

[S]ometimes [guys] don't care how people are going to react, you know, like I think girls tend to care more about the emotions of other people, you know...what they're going to think of us and so on. And so if I'm—usually guys are like, 'I

don't care, I'll just ask a question, and even if that is like, you know, a really bad question, if — even if people think it's a stupid question, they don't care, you know, they just ask the question. I do that sometimes. Sometimes I—like if I think too much, I cannot ask the question, but if I stop thinking and say that I don't care, I can be like a guy, too.

Ethan concluded that with respect to any confidence gap “at this point it's more up to the girls.” With “more scholarships available, extra help, student societies, things like that,” girls' continued lack of confidence is “basically their fault.” However, Elizabeth explained it was also a matter of how much confidence others have in you:

Let's say there are three people in the group and...then let's say I'm the girl and there's another guy trying to like explain the same thing to another person, that person turns to listen to the guy more than the girl. Like that happened to me a lot, you know — I feel like we both know the same level of concept, but then they turn to listen to the guy more than the girl.

Elizabeth speculated that maybe people tended to have more “confidence in the guy's knowledge level than me maybe, I don't know.” Matthew supported this view, suggesting “there's kind of a sub — like beneath-the-surface idea that people might have maybe not consciously, but subconsciously, that girls aren't as good as guys at engineering, um, and of course it's crazy.” Although he felt that this view was incorrect, he said that he had to make an effort to beware of such a bias. He explained,

It's kind of something that you just get the idea that this is the case without thinking about it. And then it kind of creeps into your conscious thought about things, and you're like wait a minute, that's crazy. And you have to actively say, no, that's not right. Girls are as good as guys at engineering.

Even though Matthew insisted that a biased view of women in engineering was irrational, he made the same observation that several other men and women made during the interviews, that women had unfair advantages over men in engineering so maybe they really weren't as good.

I always kind of wonder like, hmm, when girls get something, you go I wonder if it's like because they're a girl or because they deserved it. So, yeah, I don't know, it's kind of a reverse discrimination thing that you wonder about.

Matthew was not the only one to wonder whether women's accomplishments were real. Kara received the Outstanding Female Award in her department from the Society of Women Engineers, “but if you look at numbers, it was, you know, one out of — there's probably only 20 girls in my class...”

Men and women both volunteered “confidence” as being an issue related to gender. Some thought sheer numbers might be intimidating to anyone. Others thought women's lower self-confidence resulted from a prevailing attitude that women simply aren't as good in engineering as men. At the same time, Ethan observed that all the structures were in place for women to succeed—scholarships, mentoring, special consideration for jobs and internships, and so forth—so the responsibility lay within women to allow their confidence to catch up to reality. But Matthew and other respondents who perceived women have special advantages over men in engineering, speculated that maybe the women they knew actually weren't as good or deserving

of rewards as their male peers. These narratives, for the most part, address the structure and culture of these students' engineering education program and how that may relate to gender differences in self-confidence. We turn now to students' conceptions of engineering and their identities as engineers. As we shall see, women and men express their understanding of engineering in slightly different yet meaningful ways, and speak differently of themselves as engineers, also.

Self-confidence and identity: Students were asked to discuss the most important skills they thought an engineer should have. As might be expected, and has been noted in other APS studies,^{24,25} almost everyone said math and science knowledge was important for an engineer to have. Students also frequently discussed cited communication, creativity, effective problem solving, and teamwork as important skills for engineers. Both men and women conceptualized engineering as the application of math and science to real-world problems, and both men and women expressed an appreciation for this quality of engineering, as Amanda summed up, "It's because it applies to life that it's more fun." Brandon agreed with this sentiment, "Yeah, that's probably the best thing about it, that you can actually apply it to real-world situations and solve problems that will help people." Interview participants were each unique in how they expressed their conceptualizations of engineering, but at the same time, there was no discernible overall gender difference in their fundamental beliefs about the most important skills to engineers. This finding is the same as that noted elsewhere.²⁶

However, when asked which of the important engineering skills they had, men and women differed in their answers. Eight of the 10 men quickly replied, "All of them," while only two of the five women did. This difference in how women and men described their abilities was elaborated upon in their answer to the hypothetical job interview question that came toward the end of the interview. "If I were a recruiter for a job you want, what would you really want me to know about you before we complete this interview?" Four of the 5 women included a statement very similar to Emily's, "I'm a hard worker. And a fast learner." Only two of the 10 men made similar statements. Furthermore, the men were more likely to speak confidently of their specific experiences as evidence that they had a certain skill or quality they wanted to communicate to a recruiter. Nicholas was not daunted by his lack of work experience. As he explained,

For someone with a bachelor's degree, I've taken actually kind of a lot of classes and two different specialties, and so I think I've had a pretty wide experience, wide range of experience already, even if I haven't had any engineering jobs. So I would focus on that.

At the time of the interview, Ethan had already taken a job. He said,

It seems like with engineering jobs they're mostly just interested in what you've done in the past, past projects and how they relate to what they're doing now. In fact, I think one of the ways I was able to get the job I have now is because I talked a lot about my interest in fuels and energy systems and they're building a big biodiesel plant right now. So that's, I think, what they're looking for most, is past experience.

Indeed, two of the men in this study appeared unconcerned about being offered a job, but rather wanted to communicate their experiences and interests to the recruiter to ensure that they were

offered a job they would like. Justin hoped “to be placed in a position that reflected what I previously had been comfortable with.” He explained further,

I would want you to know that I'm interested in more systems topics in computers, which is design of scalable systems, you can't run a website off just one computer. You might have hundreds that are doing it. So I would want you to know that I'm more interested in those types of things than writing interface-type software. I would also want you to know that I like to be on bigger projects that might be a little bit more open-ended rather than little, incremental features that are tedious maybe.

It was not as if the women hadn't had relevant experiences. At other points during the interview all the students discussed their coursework, design projects they'd worked on, engineering internships and jobs, and research projects. If anything, the women may have described more relevant research and internship experiences than the men. In response to this question, however, all but one of the women did not choose to convey their relevant experience. After four years of engineering education, men emerged with a sense that their experience, both in class and out, made them valuable to potential employers, while women largely ignored their experiences. In sum, women presented themselves as ready to work hard and learn, and eventually become valuable to a potential employer, while men presented themselves as capable of adding value from the beginning. Embarking on an engineering career, women saw themselves as full of potential, while men saw themselves as already equipped.

Discussion of findings:

From the quantitative data one might conclude that, while the gap in confidence for male and female students is statistically significant, the confidence for both genders is high and the numerical magnitude of the gap is small. It is true that engineering majors of both genders do have high levels of self-confidence in mathematics (which has been well-studied) relative to other majors.²⁶ However, the observed gap between the genders does appear to be meaningful; from the interviews, it's apparent that marked differences exist between male and female engineering majors, as demonstrated by both spontaneous verbalizations about confidence and in the different responses to questions by men and women. Together, the qualitative and quantitative data suggest that there is a clear differential in academic self-confidence between male and female engineering students, even when the study group is restricted to those who could be considered successful, having completed their engineering degree in four years.

What is the origin of this ‘confidence gap’? One reason why women have lower confidence may be simply because they have different experiences with faculty than their male counterparts. While engineering students generally have high confidence in math compared to other majors,²⁶ female students (not disaggregated by major) report a weakening of self-confidence with increasing interaction with faculty.²⁷ For men, but not for women, self-confidence in mathematics is increased for students who work with faculty on research and who feel academically supported by faculty.²⁶ Note that these data are not engineering-specific. Nevertheless, they point to a disturbing pattern: increased interaction with faculty does not increase women's self-confidence in mathematics. This may be a result of faculty unconsciously reinforcing gender schemas that mathematics is a male domain; the subtle but cumulative effects

of this have been considered for students at the non-college level.²⁷ As Matthew remarked above, such a bias against women was not lost on students.

These same gender schemas, which suggest to individuals that math and science are a male domain, may lead men to overestimate their ability and women to underestimate their ability. This is borne out by a number of studies on self-confidence in mathematics.⁴ The perception of mathematics as a male domain may discourage the expression of female self-confidence.²⁸ In this model, the lower self-confidence of women (or, alternatively, the inflated self-confidence of men) reflect the gender norms of math, science and engineering.

A related reason for the lower self-confidence in math and science and in open-ended problem solving skills may be due to the phenomenon of 'identity denial.' As the minority gender in engineering, the engineering identity of women is repeatedly questioned. For example, when female engineering students reveal their majors to strangers, they are much more likely than men to report surprise on the part of the other person ($p < 0.001$).²⁹ The repeated experience of having one's identity as an engineer doubted may have a corrosive effect on self-confidence in the areas that are considered central to engineering (math, science, and open-ended problem solving skills), but not necessarily on those skills that are less closely-associated with engineering (professional and interpersonal skills). Also, simply being the only woman or one of a few in an engineering program may reinforce the sense that a woman does not belong there. At the same time, the effects of identity denial may cause women to have higher standards for themselves, as they are likely to feel that they need to prove themselves as engineers, both to observers and to themselves. Other effects of identity denial are examined more deeply by Garrison *et al.*, who find women reluctant to ask questions in class for fear they will look stupid, and they instead speak of "going underground" to gather the information they need from other women they can trust.³⁰

While identity threat results from women not resembling the 'prototypical' engineer, they also may be negatively affected by the low numbers of women in engineering in another way. Both male and female students may feel that women, by virtue of their status as a minority, have special privileges in engineering school and engineering careers: increased access to scholarships, research opportunities, internships and the like. Similarly, there is a widespread perception among students at the institution from which the present sample was drawn, that the admissions standards for women into engineering programs is lower than it is for men.³⁰ Both men and women respondents disparaged recognition of female accomplishments, wondering as Matthew and Kara did whether it really meant something. This judgment is likely to be applied regardless of the actual merit of the recipient. Paradoxically, therefore, support structures for female engineering students may contribute to undermining confidence in female engineering students by their peers, which will in turn sap the confidence of the women themselves.

It's unlikely that there is a single, specific reason for the existence of this 'confidence gap,' and the suggestions above do not exhaust the possibilities for why the gap might exist, although they do suggest possible routes for considering how to address these differences. And the evidence does suggest that this gap results in our women engineers being shortchanged. Data suggest that self-confidence in a particular academic area affects whether a person will attempt or persist in a task, and may be a key to career decisions.³¹ While the overall confidence of women in these

areas may be high, they may be disadvantaged compared to their male peers when it comes to pursuing opportunities such as graduate school and engineering positions. Having lower self-confidence means that women may be more likely to decide that they aren't 'good enough,' and therefore disproportionately decline challenging opportunities. More perniciously, however, this consistent gap may also affect their experiences while in engineering school. For example, in team-based projects, this lower confidence means that women may be less likely to volunteer for the more 'technical' tasks, and this would certainly be consistent with the speculation that women are more likely to take on 'administrative' tasks (note-taking, planning, and the like).³² If women have less self-confidence and therefore are less likely to assert themselves to their male colleagues to focus on the technical aspects of a group project, this 'confidence gap' may turn into a genuine 'experience gap' over the course of four years of education. Fortunately, we did not see an experience gap in our respondents. All were high-performing engineering students and most had a myriad of substantive experiences outside the classroom (e.g. internships, summer jobs, research projects, design competitions, service organizations, and so on) that would contribute to their value to even the most discerning employer. Yet, the perceptions of both women and men remained: that women were somehow less equipped for engineering work than their male counterparts.

Research has repeatedly shown that there is a confidence gap that exists along gender lines. Our study shows that this gap persists throughout the college years even among high-performing students, that cultural and organizational factors contribute to the gap, and that this self-confidence is integral to the identity development of students and how they present themselves to others. While engineering programs and the profession would like to draw more high-performing women into engineering and retain them, it is evident that gender schemas exist that result in lowered expectations and valuation of women in engineering. Our findings that women and men tend to value their educational and related work and research experiences differently suggest that there is a point of intervention. There are several pedagogical mechanisms to help students to reflect on their experiences and tie them intentionally to the skills and knowledge acquired through engagement in those educational activities, including professional portfolio development, critical reflection exercise, and small group interactive seminars. Creating space for such mechanisms may be one way to address the confidence gap.

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