Agnotology, Gender, and Engineering: An Emergent Typology

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Abstract

This article explores agnotology and ways of not knowing in the context of gender in engineering. It presents an empirically-emergent, three-part typology of ways of not knowing about gender based on interviews with engineering professors, and contributes to the growing body of scholarship on agnotology. Just as knowledge is inseparable from issues of power, so too are areas of non-knowledge, and it is important to understand how, and to what ends, non-knowing is produced. This analysis of the social construction of ignorance around gender in engineering contributes new insights to feminist STS scholarship, as well as agnotology research.

Keywords

agnotology, engineering, epistemologies of ignorance, gender

Introduction

For all that we have learned about the social construction of knowledge, we are just beginning to scratch the surface of understanding ignorance as a social phenomenon. The last decade has seen a growing interest in conceptualizing and theorizing ignorance. In addition to a growing list of articles and special journal issues (Doerr 2009; Rappert and Bauchspies 2014;
Tuana and Sullivan 2006), three edited volumes on the topic have been published since 2007 (Gross and McGoey 2015; Proctor and Schiebinger 2008; Sullivan and Tuana 2007). As a lens, ignorance has been used to generate new insights into a wide range of topics, including agricultural research (Elliott 2013), bee research (Kleinman and Suryanarayanan 2013), bureaucracy (Messac 2016), the history and philosophy of psychology (Teo 2013), sociology of absence (Croissant 2014; McGoey 2012), and education (Bedfor and Cook 2013; Legates, Soon and Briggs 2013).

Epistemologies of ignorance and agnotology are two terms that have been coined to advance theorizing about ignorance (Mills 1997; Proctor 2008a; Tuana 2004). Agnotology is defined most simply as “the study of ignorance making” (Proctor 2008b: vii). Proctor explains that in coining a new term his aim was to designate an area of study concerned with the “historicity and artifactuality of non-knowing and the non-known – and the potential fruitfulness of studying such things (2008a: 27). Central to the body of work on ignorance is the recognition that ignorance cannot be understood as merely an absence of knowledge (Gross and McGoey 2015; Proctor and Schiebinger 2008; Tuana 2004). Rather, ignorance is produced, it is socially constructed, it serves certain ends, and it is interrelated with knowledge in complex ways (Gross and McGoey 2015; Mills 2007; Proctor and Schiebinger 2009; Tuana 2004).

While ignorance is not necessarily related to oppression and power, it often is (Doerr 2009; Mills 2007; Sullivan and Tuana 2007; Tuana 2004). Gender is one of the ways ignorance is related to power, politics, and oppression. For example, historical research of colonial knowledge transfer revealed gendered patterns in the production of ignorance about abortifacients (Schiebinger 2008). Sociological research has explored the relationship between ignorance of vulnerability and contemporary rape culture (Gilson 2015). In many fields, there is
the well-documented fact that women have simply been left out of research all together (Kourany 2015; Schiebinger 2001; Spender 1981; Stacey and Thorne 1985), which has resulted in ignorance about their lives and bodies. Nancy Tuana’s (2004, 2006) foundational work on epistemologies of ignorance called attention to ways in which ignorance of women’s bodies and sexuality influences medical and cultural knowledge. Of particular salience to this article is work by Suzanne Franzway and colleagues who applied categories from Tuana’s (2006) epistemologies of ignorance framework in a study about engineers (Franzway, Sharp, Mills and Gill 2009). Similarities and differences to their findings are elaborated in the Conclusion.

“What other kinds of work does ignorance do? How else is it created, via what other kinds of inattention, disinterest, calculation, resistance, tradition or distraction? And when does knowledge create ignorance?” Those are some of the questions Proctor asks us to consider as we add to the body of work on agnotology (2008a: 24). This article answers that call through exploration of such questions in the context of gender in engineering. It contributes to the growing body of findings on agnotology by examining ways of not knowing about women and gender in engineering. Building on the concepts of agnotology and epistemologies of ignorance, the article explores engineering professors’ ways of not knowing and presents and empirically-emergent typology. The typology is the first grounded theory effort to better understand ignorance of gender in engineering. As readers will see however, the interviewees’ ways of not knowing cannot be seen as simply problems. Rather, the ways of not knowing were produced alongside (or juxtaposed with) important knowledge about gender in engineering and attempts not to reproduce gender biases or stereotypes. Efforts to change knowledge of gender issues must therefore account for the complexities of how ignorance is produced in this context.

**Gender in engineering education**
While a thorough review of the research on gender in engineering is beyond the scope of this article, there is a large body of literature on the ways in which engineering/education cultures and practices are gendered (Faulkner 2009; Mills et al 2013; Riley 2008; SWE 2017; Oldenziel 1999). The research tends to fall into three categories: the social structure of society; the social structure of STEM education and profession; and the content and application of STEM knowledge (Lehr, Finger and Christine 2014). Within engineering education more specifically, seven facets of engineering curriculum and pedagogy have been identified as gendered: 1) assumptions about students’ experiences, values, and backgrounds, 2) aims and objectives of engineering programs, 3) forms of assessment, 4) course content, 5) teaching and learning methods, 6) teaching practices, and 7) the learning environment (Mills, Ayre and Gill 2010). More specific examples of issues that have been identified as problematic for women engineering students include, spotlighting, unsupportive professors, teamwork, topics of problems and projects, and masculine communication expectations (Foor, Walden and Trytten 2007; Beddoes and Panther 2017, 2018; McLoughlin 2005; Tonso 2007; Wolfe and Powell 2009). A related study about computer science education concluded that: “Women and other students who do not fit the prevailing norm are disproportionately affected by problems like poor teaching, hostile peers, or unapproachable faculty. Perhaps the most important place to start is the classroom experience” (Margolis and Fisher 2003: 140). More recently, institutional policies have come under scrutiny for being gendered (Beddoes 2018). It must also be noted that gender is intersectional, meaning that not all women (or all men) experience engineering in the same way; race, ethnicity, sexual orientation, and socioeconomic status, among many other factors, shape how different women (and different men) encounter and navigate the field (Beddoes and Borrego 2011). Collectively, these studies demonstrate that the structure and content of
engineering education are gendered and contribute to women’s continued underrepresentation. In other words, there is a lot that professors could know about gender in engineering/education. Underlying each of the ways of not knowing identified in this analysis, is a non-knowing about the body of research on gender in engineering/education.

Methods

Thirty-nine engineering professors from three different institutions in different parts of the United States participated in interviews for this study. The institutions represented geographic and institutional-type diversity, including research-intensive and undergraduate-focused institutions. Eighteen interviewees identified as women and twenty-one interviewees identified as men. The interviewees were Assistant, Associate, and Full professors, and were drawn from the full range of engineering disciplines at each of the three institutions. Several interviewees also held administrative positions. Seven participants self-identified as Asian or Asian/white, two identified as Black, two identified as Indian, and the rest identified as White. Participants were originally from ten different countries.

A combination of maximum variation sampling and purposeful random sampling (Patton 1990) was utilized to recruit participants. Public, departmental websites were used to randomly generate names. Within the parameters of random sampling, purposeful steps were taken to recruit participants from all engineering disciplines and career levels, as well as an equal number of men and women. A personalized email was sent to each potential participant explaining the study and offering a $20 gift certificate to Amazon.com for participating. Potential participants were asked to reply by phone or email if they were interested in scheduling an interview. The response rates at the three institutions were 28%, 40% and 17%.
The semi-structured interviews (Singleton and Straits 2010) were conducted in 2014 and 2015 and averaged one hour in length. They were audio-recorded and then transcribed. They were conducted in-person, except for two that were conducted via Skype. The interview protocol covered a wide range of topics related to gender in engineering/education and women’s underrepresentation in engineering/education. Topics included general beliefs about underrepresentation, students’ experiences, values, and backgrounds, course content, teaching and assessment practices, learning environments, and policy. The overarching aim of the study was to better understand what and how engineering faculty members think about gender in engineering, women’s underrepresentation in engineering, and how they make decisions around gender in their classes.3

“I don’t know” was an oft-repeated phrase throughout the interviews. For this article, a grounded theory (Charmaz 2006) approach was taken to analyze the data related to instances in which something was not known, and instances in which the significance of gender was denied. This was not limited to instances when a participant said specifically “I don’t know.” A grounded theory approach was taken to identify and explore patterns that emerged from the data, instead of applying categories from a pre-existing typology, of which there are many (Smithson 2015). After the three types presented below were established, I reviewed other taxonomies and typologies to determine if it made sense to discuss my categories in terms already delineated by someone else. However, none of the exiting taxonomies/typologies I reviewed would have adequately explained my findings.

In this article, participants are identified with an alphanumerical code. Codes starting with “M” were men. Codes starting with “F” were women. Each number then identifies a specific participant. In recognition of the diversity of participants, they have been assigned numbers

rather than pseudonyms, which, although a common practice in social science research, can carry cultural associations. The quotations from participants have been edited for readability and anonymity and to remove false starts and crutches of speech. Text in square brackets was added by the author. The italicized portions of quotations highlight the most relevant text. I turn now to presenting the three-part empirically-emergent typology.

An emergent typology of ways of not knowing

There were three primary ways in which the interviewees explained their not knowing something about gender in engineering or women in engineering: 1) *I cannot know because of the small numbers of women in engineering*; 2) *I cannot know because I am not a woman*; and 3) *I do not know because gender is not salient*. The complexities of each way of not knowing are discussed in turn. While there is some merit in some of these ways of not knowing, they are simultaneously problematic in various ways.

1. Not knowing because of the small numbers of women in engineering

One of the most common ways of not knowing was the explanation that there are simply too few women in engineering to make any claims about them or their experiences. Prevailing assumptions from quantitative research and statistics undergirded explanations that interviewees could not know the answer to a question because the numbers of women in engineering are too small. When relating a story, they would often emphasize that it was just “anecdotal” or not “real data.” In the following example, M6 had been asked if he had observed any communication differences between men and women students. He responded:

*I don’t think my sample size is big enough to actually make a statement on that.* I mean I see a lot of communication differences between different students, and again this class has a lot of verbal communication, a lot of recitation. But when I’ve got a room of 36
and only two of them are women, it’s very hard for me to attribute a difference as being it’s because the girls are all like this versus just we’ve got shy kids who I can’t hear at the back of the room. We’ve got kids who have a severe stutter or speech impediments. We’ve got first generation college student Latinos who have never faced anything like this before in their life. So we’ve got all these different experiences that play into their public speaking and their assertiveness and how they handle themselves and yeah, with those small numbers I don’t think I could put a gender bias to it.

Also seen in this explanation is the tendency to deny the salience of gender by ascribing observations to other factors, which is discussed in type 3 below.

M5 also answered that question by saying, “My feelings on all of these things, really it’s so hard to judge because it’s such a small number…It’s hard to make any generalizations on it because the numbers are so small.” In a similar question about whether there might be differences in how men and women students are “heard” in a classroom or on teams, M20 said:

I think I read studies about those types of things. From my experience – and this is where it's kind of hard to say because it's kind of statistics of small numbers – so surely more male students ask questions, but I wouldn't be able to tell you whether that proportion of questions asked by male students followed the breakdown, the proportion, the male-female breakdown in the class.

Similarly, F7 hesitated to make claims because there are “so few women” in her classes:

[Women] want to have discussions…as opposed to kind of just like being efficient with their time and making decisions and just kind of being like sterile in their conversations.

So I think I do see some of those, but there’s so few women in my classes it’s hard to say if I can really generalize that or not.
M13 repeatedly stressed that the story he was sharing was “anecdotal” and that the situation is different for different people:

This is just one anecdote out of multiple years, but I had a student who was both in my sophomore class and was also an advisee, who was an outstanding student. I think she graduated with a 3.8 or something high – outstanding student. Stereotypical zero self-confidence; very quiet, always questioned herself, whereas [with] less capable male students I'm sort of used to [them] coming in with bold, strong "I know what to do here," and this student was exactly the opposite, even though she was more capable. So again, this is kind of one anecdote, but you see lots of people in different situations, and of course… you look out at the class and it's predominately male – overwhelmingly male.

He went on to explain that he tends not to think of women students in terms of women as group, but rather as individuals, stating that, “I almost don't think about the underrepresented students as a percentage. You think about them as individual people because the numbers are so small.”

Another place in which this discourse appeared was in response to the question of what differences there might be in the experiences of men and women engineering students at that institution. F3 couched her response with the caveat that “small number statistics” make this a hard question to answer:

We have around 15 percent female in our department. Obviously that goes up and down, but a small number statistics, we lose one and it drops us a lot in percentage. So in a given class there will maybe be two or three women in a group of 30 to 40 guys. And this is generically – the differences that I see, the girls are usually a little bit quieter, they don’t speak up quite as much. But they are more apt to come to office hours…The boys tend to not come to office hours quite as much. And that’s hard to say because there are
so many more of them that only two of those boys need to not fit that mold and it throws
the numbers completely off.

What these responses demonstrate is the idea that as engineering professors they have only had
opportunities to observe a small number of female students and that therefore they should not be
making claims about “women in engineering.” In other words, any real knowledge would need to
be made based on a much larger “n”. Yet, that epistemology becomes problematic when it is
conflated with the belief that the only way they could know about “women in engineering” is
based on the students in their classes, or based on a statistically significant sample size.

Considering that engineers are trained to value quantitative methods and statistics, it is
perhaps not surprising that this was a common way of not knowing. Moreover, what we see in
these responses likely reflects traditional hierarchies of research methods, in which qualitative
research is seen as anecdotal and not rigorous. In particular, this way of not knowing echos
patterns seen in the research landscape on women in engineering. Several researchers have
critiqued the way in which the dominance of quantitative methods has limited our knowledge
about different types of minority groups in engineering and intersectional studies of gender in
particular (Pawley 2013; Pawley and Hoegh 2011; Slaton and Pawley 2015). Slaton and Pawley
have identified a “prevailing stigma of research on under-represented groups that is conducted on
small subject populations” (2015: 3). Thus, it appears that norms that have long governed STEM
education research can also be seen in individual engineer professors’ ways of not knowing
about gender in engineering.

Related to this small numbers discourse was a hesitation about stereotyping. Very often,
even when providing an answer, interviewees expressed a belief that they should not be making
claims about “women in engineering” because to do so would be to engage in stereotyping of
women and making problematic generalizations. In this way of not knowing, interviewees would sometimes give a response but then say they were uncomfortable with such stereotyping.

2. Not knowing because I am not a woman

For some male participants, discussions went beyond saying they did not know something to contending that because they were men they could not ever understand the experiences of women in engineering. For instance, one of the questions asked participants to think about how a woman might experience engineering education, and how a man might experience it, and what differences might exist in their experiences. M13 explained that he did not want to speak about what women’s experiences in engineering education might be because he did not have that “perspective”:

So that one is hard for me to answer. One thing I've learned from a number of years being involved in discussions on diversity issues is that, it's relatively easy to say, "Okay, if I'm in a significantly underrepresented group, feelings of isolation are easy to experience." The other thing I've learned is that I can't possibly really – in a deep way, at least – understand that perspective, not having shared it. I mean being a white male it's fairly rare that I feel that I'm an underrepresented part of a group. I've been in situations where I'm the only white male – yeah, that does happen, but it's relatively rare, and honestly, you tend to laugh about it when it happens. If you're one of 5 or 6 female students in a class of 100, or if you're the only black student in the group, or something, I can recognize that as an issue, but I'm reluctant to pontificate about what that person's experience is like. I just don't have the perspective.

Likewise, M16 stated, “I don't know. It's hard for me to put myself in a woman's place.” This way of not knowing also appeared in response to a question about gendered communication differences
and if such differences might have an impact on assessment in engineering courses. M7 said he could not answer because he had never “walked in a woman’s shoes”:

I have to be really honest. I’m just having trouble not really having ever walked in a woman’s shoes, especially as an engineering student or an engineering professional. I just am not very aware of what those biases look like and how they appear, and how it makes people feel. I’m thinking to my colleagues that I have a dialogue with and they report being treated differently by administrators…So I think those things are real for them. Just in my experience I’m just not able to really perceive those or process them.

On the one hand, these responses are insightful and demonstrate an important awareness that men may not be able to truly understand what it is like to be a women in a male-dominated environment, or more generally, that members of majority groups may not be able to truly understand what it feels like to be a member of a minority group. On the other hand, it is problematic that this way of not knowing is being used to justify lack of awareness about a large body of literature on the problems women experience in engineering.² Certainly, one can have knowledge about an issue without having personally experienced it. Additionally, it conflates “gender” with women and serves to hide the dominance of men and masculinity in engineering. Thus, in this way of not knowing, participants’ recognition of their social position is also an erasure of women’s social positions and experiences.

3. Not knowing because gender is not salient

The third way of not knowing that emerged from the interviews was explaining that problems experienced by students and/or differences among engineering students were not really about gender. Rather, they were about individual learning styles, personalities, or simply being
any kind of minority. For example, when asked if the learning environment, atmosphere, or culture in engineering classrooms and labs could be considered gendered, F3 said:

I’m not sure it’s gendered, because I actually don’t know the numbers on that. But I think we definitely have a learning type problem. And whether that ends up being gendered, I’m not a hundred percent sure. But we definitely teach towards one type of learner and one type of student. And it really takes an awareness that there’s more than one type of learner in the first place to teach differently… But again, I would have to say it’s more of a learning style than if I realize it’s gendered or not.

Similarly, M14 invoked both learning styles and personality, saying, “I think understanding that the students in the classroom are going to have diverse personalities and diverse preferences and diverse styles of learning, and I think just trying to come up with ways that are a little bit more – that are less rigid, I think.”

This “individual personality” explanation was common. M14 elaborated on how differences observed between men and women students may simply be explained by introversion and extroversion of individuals:

And so it is a possibility [that men have more of sense of agency to control things]. I don’t know, right? But then like I said earlier, it doesn’t have to be just with gender, right? It might just be the personality of students. Students that are more introverted perhaps might feel like they’re less in control and they’re just doing stuff, as opposed to not asking what’s around for them, right, what opportunities exist. The most extraverted students might seek out those opportunities. I don’t know.
When asked about differences in the backgrounds of men and women engineering students, F3 attributed differences to “personality type”, and stressed that every student has a different background:

Yeah, I would assume there probably [are differences]. I don’t have any hard evidence of that. I don’t have any even hearsay evidence of that. Each student, to be honest, has a really different background, even in the type of students that we end up having [here] where our diversity isn’t great across the board, and let alone just with women. But I would imagine every single one of them has a very different background and a very different experience growing up. And so some of their experiences in the classroom that they’re outwardly showing to me may be from that background. It may be their personality type, but maybe they had a teacher that made fun of them when they asked a question. I don’t know.

The same participant also invoked “personality” when responding to a question about if she had observed gendered dynamics on teams:

I do hear it once in a while, but I’m not sure it’s necessarily men versus female as it is just someone with a strong personality that’s harder to work with than others. Maybe I should pay more attention to that. It’s probably something I should work on as far as making sure that it’s not a male/female thing. But I don’t know of anything.

Also when asked about gendered interactions among students, M2 attributed problems to personality:

…I think I see more, like, there’s just personality differences. Sometimes someone will just take it over because they want to have control. And sometimes someone’s just really organized and they’ll take it over, and they’ll delegate. And you know, I’ve seen that and
I don’t know that I could attribute that to female or male. I think sometimes those personality traits get aligned with a gender. And I would say more maybe stereotypical, but that the male would be more – just want to have control over it. And you know, a female maybe more likely to organize and delegate… But I certainly don’t think it’s a universal rule. But those are things that I see happen in groups… But no, I don’t – I feel like it’s more you see these group-type dynamics, and if you have a strong personality in a certain way, that those will sometimes tend to dictate how the group behaves. And I think certainly…some of those interactions can be off-putting, depending on what your personality type, or your way of interacting with others is like.

The same participant explained communication differences in terms of personality. He has observed the tendency for men to be more “aggressive” but hesitates to make that claim and concludes that, “personality traits outweigh gender differences”:

I think I was going to say males are more … aggressive, you know, in terms of they’ll come up right after class. You know, they’ll be right … right next to you. You know? It’s like you can’t ignore that they’re right there and going to ask you a question. Or they’re going to follow you along. You know? And I feel like that happens less with females. But then I think my perception is, it’s more, again, kind of personality styles. Where I’ve had some very outspoken female students. Very shy male students. And so I feel like personality traits outweigh gender differences in most cases when it comes to how they interact, you know? Kind of eyes down-cast. Kind of sheepishly coming in.

In the same way, F1 downplayed gender differences in favor of personality stating: “Male students can be equally quiet in a group and I think that has to do more with a more dominating personality type of thing.” When asked why it matters that women are underrepresented in

engineering, M20 explained that it is actually not gender diversity that matters, but diversity of all kinds, including personality. Other times, when I would ask about women or gender, participants would respond by discussing issues with international students instead, or, as seen in the quotation from M6 above, to the fact that “We’ve got kids who have a severe stutter or speech impediments. We’ve got first generation college student Latinos who have never faced anything like this before in their life. So we’ve got all these different experiences that play into their public speaking and their assertiveness and how they handle themselves…”

While it is certainly true that personality and learning preferences may play a part in anyone’s educational experiences in any field, such responses to questions about gender serve to obscure the salience of gender in engineering and engineering education. Moreover, to equate being a woman in engineering to being any kind of minority in any setting is to deny the “sexual politics” of engineering. Sexual politics is most simply defined as “gendered power relations,” and is a useful concept for:

…recognizing the everyday denial of gender that takes place within the complex gender relationships of power as domination, resistance, alliances, and pleasures that are central to all social institutions, including engineering organizations. When the relevance of gender as a cause or explanation for the absence of women from the central concerns of work and cultural change is denied, it is not just a matter of ignorance or carelessness. Rather, it is a clear sign that a non-egalitarian sexual politics that advantages men is in play. (Franzway et al. 2009: 92)

It reflects and perpetuates the myth that engineering is value-free and objective (Erickson 2012; Mills et al. 2014; Jorgenson 2002; Mills and Gill 2009; Rhoton 2011; Riley 2008) by interpreting what can be seen as gendered patterns in terms of individual, and less politically-charged,
differences. I am not suggesting that this is a necessarily an active or conscious strategy to avoid invoking gender. Indeed, my guess is that it genuinely is how participants interpret their observations. As with all of these ways of not knowing, however, I can only report what they said in the interviews. Furthermore, while the attention given to some facets of students’ identities, such as ethnicity and disability, in one case, could be an important step toward intersectional understandings of gender, that would require that they been seen as interacting with gender, not negating it.

**Situating findings in relation to prior typologies**

Some of these ways of not knowing could be conceptualized in terms of Nancy Tuana’s (2006) taxonomy of “epistemologies of ignorance,” which was concerned with ways in which ignorance of women’s bodies and sexuality has been socially constructed. The first way of not knowing in Tuana’s taxonomy is “Knowing that we do not know, but not caring to know” because a topic is “not linked to present interests.” Here Tuana is referring to what scientists choose to study, and not study, recognizing that subjects deemed worthy of investigation are determined by social interests. Drawing on feminist Science and Technology Studies scholarship, such as that of Helen Longino, this way of not knowing asks us to critically interrogate why some research topics merit money and time, while others do not.

“We do not even know that we do not know” because “current interests/knowledge block such knowledge” is the second way of not knowing in Tuana’s taxonomy. This way of not knowing refers to subjects that are obscured by dominant interests and beliefs, such that most people are unaware there is even something to know about. Drawing on feminist standpoint epistemology, this way of not knowing also calls attention to the social construction of knowledge. “They do not want us to know” wherein “the ignorance of certain groups is
systematically cultivated” is the third way of not knowing in Tuana’s taxonomy. Here, she refers to instances in which knowledge is actively and purposefully withheld from certain people as a means of social control. “Cognitive authority” is constructed as belonging to experts, while other groups’ ignorance is systematically maintained. Then, there is “willful ignorance” in which “they do not know and they do not want to know.” Here, she refers largely to race and draws upon the work of Marilyn Frye and Charles Mills, among others. Referencing denial around involuntary sterilization of women of color, for instance, she explains that, “willful ignorance is a systematic process of self-deception, a willful embrace of ignorance that infects those who are in positions of privilege, an active ignoring of the oppression of others and one’s role in that exploitation” (Tuana 2006: 11).

“Ignorance produced by the construction of epistemically disadvantaged identities” is the fifth way of not knowing. This category encompasses instances in which ignorance is sustained through granting of “cognitive authority” to some people but not to others. It points to questions about who gets to be a knower and who does not. Lastly, Tuana articulates “loving Ignorance” by “accepting what we cannot know,” which she sees as the opposite of willful ignorance. This way of not knowing is not linked to injustice or inequality. Rather, it involves recognizing and accepting that not all experiences can be shared and understood, and that there are limits to what we can know about others’ experiences.

Suzanne Franzway and colleagues (2009) subsequently applied Nancy Tuana’s epistemologies of ignorance categories to their study of engineers in Australia. “Knowing that we do not know, and not caring to know” was evident in the way engineers explained the lack of change despite efforts to increase women’s representation in engineering. “Do not even know that we do not know” was evident in explanations that assumed gendered family roles as given.
“Willful ignorance” was evident in participants’ determination to maintain that sexual politics do not play a role in engineering. “Ignorance produced by the construction of epistemically disadvantaged identities” was evident in responses indicating that women in engineering still lack – and must prove differently – credibility and legitimacy as engineers. “They do not want us to know” and “loving ignorance” were not discussed in their analysis.

Using one lens, then, some of my data can also be seen through Tuana’s categories. For example, while stereotyping or universalizing was avoided, the “small numbers” way of not knowing simultaneously allowed professors to not acknowledge prevalent gendered patterns in the literature. In some ways, this could be seen as similar to Tuana’s “epistemically disadvantaged identities” in that women are made unknown by virtue of their small numbers not being deemed valid enough to constitute knowledge. Or, it could be seen as a case of “Knowing that we do not know, and not caring to know” because of a “present interest” in maintaining a standard for evidence in engineering, as well as their own self-conceptions or identities as good engineers who adhere to research method norms and do not draw conclusions on any other basis.

The second way of not knowing – because I am not a woman – partly encompasses Tuana’s notion of “loving ignorance” and engages a type of standpoint epistemology. However, it takes those concepts too far by conflating personal experience or embodied knowledge with the ability to know anything about another groups’ experiences. As noted, one can of course have knowledge about something without having personally experienced it. Lastly, the third way of not knowing obscures masculine biases in engineering while perpetuating the myth that engineering is gender-free and objective (Erickson 2012; Mills et al. 2014; Jorgenson 2002; Mills and Gill 2009; Rhoton 2011; Riley 2008). Ultimately, this way of not knowing is similar to the upshot of Mills et al.’s (2014) study in that it amounts to a denial of gendered power relations
in engineering. This way of not knowing aligns most closely with Tuana’s “willful ignorance.”

However, mobilizing only pre-existing categories would not illuminate how actors themselves understand or discuss their knowledge-ignorance. Identifying the empirically-emergent ways of not knowing through grounded theory analysis builds on prior findings in new ways. Specifically, it provides insight into how professors themselves discursively construct their own non-knowing, which may be an important first step in change initiatives. For instance, one new finding to emerge was what I have labeled “a logic of quantification” shaping engineers’ ways of not knowing about women in engineering. As noted, a similar phenomenon has been identified in the methods of STEM education research and critiqued by Amy Slaton and Alice Pawley (2015). They observe that methodological beliefs about rigorous research influence the types of research conducted – namely large “n” research that does not address intersectionality. In brief, they concluded that there is a “prevailing stigma” against STEM diversity research on small populations:

Whatever its source or however explicit (or not) its ideological origins, disregard of the “small n” population as non-meaningful reproduces a marginalization of students. It also casts particular human experiences as aberrant by virtue of statistical rarity. But most profoundly, researchers’ definition of small or large “ns” reiterates the value or necessity for established categories (say, racial demarcations, or binaries of ability and disability), while we instead believe that critical reflection on categories is necessary for any address of power and privilege. (p. 2)

The “ontological choreography” (Michael 2015) that methods perform has, in this context, erased small “n” groups.
While research and faculty members’ perceptions of their students are two different issues, my findings demonstrate that a logic of quantification similar to what has been documented in the research landscape holds sway in the context of how professors think about what can be known about gender in engineering. In this case, the logic obscures what is known about common gendered patterns and experiences in engineering. On one hand, it is positive that participants know they should not assume any two women in their classes are the same. Yet, that logic becomes problematic when it is conflated with the idea that the only way they could know about “women in engineering” is based on the students in their classes. While any individual student would be anecdotal, and the tendency is to want to avoid generalizing, those individual students may fit into gendered patterns that could be known and recognized. In other words, while stereotyping was avoided, the “small numbers” explanation simultaneously allowed them to not acknowledge prevalent gendered patterns in engineering.

Another newly identified way of not knowing included ascribing differences in experiences to personality or learning style, thus relegating the salience of gender to other concerns, including international students or personality differences. Examining actors’ own discourses adds nuance and insight into why and how the myth of gender-neutrality persists in this context: differences are able to be attributed to individual students’ characteristics and personalities rather than gender. Yet another newly identified way of not knowing was when men participants said that they could not know something because they are not women. As with the other types, while there is some important knowledge here, it simultaneously has the effect of perpetuating non-knowing about ways in which engineering is gendered.

**Conclusion**
By identifying and categorizing the ways in which engineering professors explained their not knowing about women and gender in engineering/education, this article contributes new insights into the persistent issue of gender diversity in engineering. Three primary types of not knowing were observed in the interviews: 1) *I cannot know because of the small numbers of women in engineering*; 2) *I cannot know because I am not a woman*; and 3) *I do not know because gender is not salient*. These exact ways of not knowing have not been identified in previous typologies or analyses and add to existing typologies. As noted, each way of not knowing also evidences non-knowing about the available literature on this topic.

Delineating explanations for not knowing in this context contributes to the growing list of contexts in which an agnotology lens has provided insights about the functioning of ignorance. Change efforts in engineering education will likely need to account for these ways of non-knowing. This study also points to the need for further grounded theory research on agnotology, gender, and STEM in other contexts and with other populations. Before concluding, it should be noted that some participants *did* know quite a lot about gender in engineering. 6 This article is not meant to imply that no one knew anything about gender or women in engineering. Rather, given how often not-knowing was present in the interviews, this article aimed to shed light on the different ways that not knowing was explained or justified when it was present. Taking Proctor’s cue to interrogate “the conscious, unconscious, and structural production of ignorance, its diverse causes and conformations, whether brought about by neglect, forgetfulness, myopia, extinction, secrecy, or suppression” (2008a: 3), this work has taken up the task of identifying new ways that not knowing about gender in engineering is discursively produced and maintained.

Notes

1. *Agnotology* was coined by Iain Boal in 1992 at the request of Robert Proctor (Proctor 2008a). *Epistemology of ignorance* was coined by Charles Mills (1997) to discuss white supremacy and white privilege. In 2004, Nancy Tuana (2004) popularized the plural *epistemologies of ignorance* to discuss multiple ways of not knowing about gender. These terms should not be confused with the older metaphysics term *agnoiology*, which is concerned with things that can never be known.

2. Nationality, race and ethnicity were asked for on an open-ended demographic form given at the end of the interviews. The form was optional, but all participants chose to complete it.

3. As noted, intersectionality is an important, but under-explored, concept in research on gender in engineering (Beddoes and Borrego 2011). With these interviews, I wanted to see what participants would say when asked about gender without imposing my understandings of gender and gendered on them. I did not specifically ask any questions about intersectionality, and it did not feature in participants’ responses.

4. One might argue that it is not an engineering professor’s job to know about such literature; however, that is not a discourse the participants themselves ever engaged.

5. The discourse of rigorous research was also recently discussed in Beddoes (2014).

6. Other findings are discussed elsewhere (Beddoes 2018; Beddoes and Panther 2017 and 2018).

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