Investigation of students' experiences of gendered cultures in engineering workplaces

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Women remain severely under-represented in engineering in Australia as in all western countries. This limits the pool of talent, standpoints and approaches within the profession. Furthermore, this under-representation equates to restriction of the benefits of being an engineer mainly to men. Gendered workplace experiences have been found to contribute to women leaving the profession. In this study we explore *students'* experiences of gendered cultures in engineering workplaces, using interviews with a purposive sample of 13 students (4 male) recruited following a previous survey. Although the overall experience of workplace learning is positive for many students, male and female engineering students reported experiences consistent with masculine cultures. Educators and employers must proactively lead improvements to the culture in engineering workplaces, prepare students for gendered workplaces and support students to reflect during and after workplace experiences. The experiences presented here could be adapted to enhance inclusivity training.

Keywords: gender; engineering education; workplace learning

1 Introduction

Women are under-represented among engineering students (Kaspura 2012a), and more so among professional engineers in Australia, New Zealand, Canada, the UK, the USA, and Western Europe. In Australia, only 12% of professional engineers in the workforce were female at the last census (Kaspura 2012b, 1) although in 2011 14% of engineering graduates were female (Australian Government Office of the Chief Scientist 2016, 136). This is a loss to society because engineers shape peoples' lives, and without gender diversity in engineering teams, both the quality of the teams (Ihsen and Buschmeyer 2007) and opportunities for women in the profession are limited.

Although more successful than men as students (King 2008), women leave the profession at higher rates than their male counterparts (Kaspura 2014). An identified

factor is workplace culture (Gill et al. 2008; Singh et al. 2014), where interactions in engineering workplaces marginalize female engineers' professional identities (Hatmaker 2013).

Programs to increase the participation of women in engineering have been numerous (Fox, Sonnert, and Nikiforova 2011). These initially focused on increasing awareness among school students and supporting female engineering students, and later combined initiatives with improvements to the curriculum, based on recommendations of studies on gender inclusivity of engineering curricula (Godfrey and King 2011; Godfrey 2003; Mills, Ayre, and Gill 2010). Recommendations have included emphasizing applications of engineering science, or teaching engineering in context, and problem and project based learning (Mills, Ayre, and Gill 2010; Kolmos et al. 2013).

Gill et al. (2008) recommend that inclusive curricula should develop understanding of engineering workplace culture. However the recommendation has not received attention, which is concerning because engineering students experience workplace culture even before they graduate. In Australia, at least 12 weeks of relevant workplace experience is compulsory at most of the universities offering formative engineering degree programs (Male and King 2014).

Only a handful of studies have investigated the gender inclusivity of engineering students' workplace experiences (Fifolt and Abbott 2008; Powell, Bagilhole, and Dainty 2009; Male and MacNish 2015; Seron et al. 2016). In the USA, Fifolt and Abbott (2008) surveyed 91 students (74 male) and interviewed 9 students (4 male) from a single university, about mentoring in their cooperative education programs. They found that female students faced challenges in the workplace that were additional to those

experienced by male students. The challenges included lack of role-models, unconscious bias among supervisors, and isolation.

In the UK, Powell, Bagilhole, and Dainty (2009), interviewed 26 female engineering students about their responses to the masculine cultures during industry placements. They identified students' responses, including: 'acting like one of the boys', 'accepting gender discrimination' and 'achieving a reputation', seeing 'advantages over disadvantages', and adopting an 'anti-woman approach' (pp. 418–21). These responses are similar to those identified by Hatmaker (2013) through interviews with 52 female engineers, rather than students, in the USA. Approaches adopted by her participants in response to marginalizing interactions included rationalising the interaction (similar to accepting and seeing advantages over disadvantages) and/or proving themselves and/or protecting their reputations to be visible as engineers rather than women (similar to achieving a reputation). However, Hatmaker also found that participants blocked marginalizing interactions. For example, they refused to accept gendered expectations.

In a recent study in the USA, Seron et al. (2016) tracked 40 engineering students at four colleges from orientation to the end of fourth year using diary entries recorded twice-monthly, and interviewed 100 students. They summarize the female students' experiences on internships as including '[having] fewer opportunities to practice, [being] assigned supporting roles, co-workers [assuming] lack of experience, also [experiencing] some confirmation of expertise' (p188). In contrast they summarize male students' experiences on internships as including 'continuation of collaborative experience, confidence from previous experience that they bring, [and] not alien but familiar' (p188). They conclude that internships are among experiences that often lead

female students to begin to doubt that they will fit into a professional engineering culture.

In Australia, Male and MacNish (2015) interviewed six students (including two male) and identified experiences consistent with a masculine culture.   A larger study of the gender inclusivity of engineering students' workplace experiences in Australia was due.

In the current study, we investigated gender inclusivity of the workplace experiences of engineering students at three Australian universities (Male 2015). In the first phase of the study, students completed a survey about their workplace experiences ($N = 160$, 25% female). In the survey, 86 (53.8%) of the participants reported increased motivation to become an engineer as a consequence of workplace learning. However, male and female students experienced isolation, and doubt of their credibility by co-workers; and female students experienced gendered marginalization. Female students were more likely than the male students to experience imposed gendered expectations, comments that drew attention to their gender, and requests based on their gender – all interactions identified by Hatmaker (2013) as marginalizing the professional identities of female engineers. Deeper understanding of these experiences was needed in order to prepare students for such experiences and in the longer term generate change in engineering workplace cultures. This paper is on the second phase of the project, in which we interviewed 13 students (4 male).

1.1 Theoretical framework

The study is based on an understanding of engineering practice as masculine gendered, meaning that cultures in many engineering workplaces marginalize women and stereotypically feminine traits and practices, while granting privilege to men and stereotypically masculine traits and practices.

Many workplaces are gendered in the sense that men and masculine traits and practices are privileged over women and feminine traits and practices, with gendered hierarchies supported within organizations (Acker 1990). However, engineering is unusual in its extremely low representation of women at all levels not only in management. Female engineers frequently find themselves to be the only female engineer in a workplace. No-one in the workplace expects the woman to be an engineer and women frequently find that they have not been accommodated. For example personal protective equipment that fits women is often unavailable.

Visible features of engineering support the privileged position of stereotypically masculine traits and practices. Technological knowledge and skills, which are often considered masculine, are important in engineering. Although physical strength is irrelevant for professional engineering, engineers are associated with remote and/or dirty environments in which the workforce is mainly male. Many engineers work with tradespeople, technicians and labourers - people in stereotypically masculine paid work rather than the stereotypically feminine unpaid domestic domain. This is in contrast with professions such as dentistry, law, medicine, and teaching which involve interactions with families and children. In summary, there are many factors that can contribute to engineering cultures in which men and masculine traits and practices are privileged over women and female traits and practices (Faulkner 2007, 2009a).

There is much literature consistent with masculine gendered cultures in engineering workplaces (Male 2014; Faulkner 2006; Fletcher 1999; Gill et al. 2008). Faulkner (2006), in the UK, describes engineers' disappointment at discovering that their work is more about people and less about nuts and bolts than they had hoped and expected. Fletcher (1999), in the USA, found that engineers in a design firm did not recognise the value of relational practice despite her observation that it was critical to

the success of engineering projects. Gill (2008), in Australia, collected female engineers' reports of interactions that marginalized their professional status. Women reported that they had to prove themselves every time they joined a new team. In summary, findings consistent with gendered cultures in engineering have been made in studies in engineering workplaces in Western Europe, the USA and Australia.

We sought to describe examples of manifestations of gendered cultures as experienced by students in engineering workplaces, and how students responded to these. Hatmaker's (2013) identification of types of personal interaction known to marginalize the professional identity of female engineers in engineering workplaces presented possible examples of manifestations of gendered cultures. As already noted, in the survey that formed the first phase of the current study, female students were more likely than male students to report experiencing the following types of interactions identified by Hatmaker: imposed gendered expectations, comments that drew attention to their gender, and requests based on their gender.

1.2 Research questions

The second phase of the study was designed to describe students' experiences of gendered engineering workplace cultures. Goals were to inform recommendations to improve the inclusivity of engineering students' workplace experiences immediately, and in the long term improve gender inclusivity of engineering workplace culture. This phase of the study addressed the following questions.

(1) What are examples of students' experiences of gendered engineering workplace cultures during their work placements?

(2) How do students respond to them?

2 Method

Interviews were conducted in 2014, with undergraduate engineering students at three Australian universities. Two universities were members of the Australian Technology Network and the other was a member of the Group of Eight research-intensive universities. At one university 12 weeks of engineering-related employment were compulsory, complemented by four weeks of other employment or exposure to engineering practice. At the second university, 12 weeks of engineering-related employment were compulsory, and at the third local students were required to undertake two compulsory semester-long internships.

2.1 Participants

In the survey in the earlier phase of the project, participants were asked to indicate whether they would agree to be invited to participate in an interview. Of the 160 survey participants, 55 indicated agreement to be invited and 25 of these were then invited by email. These participants were selected for maximum variation (Creswell 2007), based on their survey responses, to include students from each university, both sexes, and a range of experience, both motivating and demotivating and including and not including negative experiences. Although the scope of the paper was gendered workplace culture, it was important to include, in the interview sample, students who had not indicated experiencing this in the survey in order to discover any experiences that could be explained as gendered culture although the students had not perceived or declared this.

We interviewed ten students who accepted the invitation. Three students who were not identified through the survey but had reported critical incidents to their university during their placements were invited to participate and accepted.

Students who had left engineering following a workplace experience and enrolled in a different program at the same university were also invited to participate. Five such students were identified and none replied. This is consistent with the experience of Meyer and Marx (2014) who also found that students who had recently withdrawn from engineering did not wish to participate in their study. Meyer and Marx supposed that this was because the experience was too recent and raw.

For the ten students recruited following the survey, demographic characteristics and features of their most influential workplace learning placements were known from the survey. The other three students completed an abbreviated version of the survey questionnaire at the start of their interviews.

The participants are identified by interview number and sex. Although the study is about gendered cultures, the term 'sex' is used here because the students were asked to indicate whether they were 'male' or 'female' and it reasonable to assume that they referred to their sex rather than how they did gender in the sense of acting in manners that are stereotypically considered to be masculine or feminine. Students expected to complete their degrees in 2014, 2015, or 2016. Their ages at their last birthdays ranged from 20 to 31 years ($M = 23.7$; $SD = 3.1$). Additional details about participants and their nominated most influential placements, which they discussed in the interviews, are presented in Tables 1 and 2.

[Table 1 near here.]

[Table 2 near here.]

2.2 Interviews

Consistent with the human research ethics approval, interviews were conducted by a research team member employed at the student's university but not involved in teaching the student that semester. All interviews were face-to-face except one online because

the student was on international exchange. Interviews lasted 45 minutes and were recorded and transcribed. Students received $20 vouchers to compensate for their time. The protocol was agreed by the research team and the transcripts of the first two interviews by the lead were shared with the interviewers at the other universities before their first interviews. At one of the universities there were two interviewers and both attended the first interview at this university.

Interview questions are listed below. Questions were adapted for those who had not participated in the initial survey.

(1) In the survey you referred to your most significant workplace learning placement. In this interview you will be asked about this placement but you are welcome to refer to examples from other engineering placements that you have had. The placement you referred to in the survey was an [internship, vacation work, part-time work…] after [2nd, 3rd year…]. Please describe the work you were doing.

[Questions 2 to 6 apply only if the student had indicated any relevant experiences in the survey responses.]

(2) In the survey you noted that you had [been set up for humiliation, had your commitment to becoming an engineer questioned, had your recruitment to the organization questioned… refer to the survey response]. Please describe an example of the interaction when this occurred.

(3) How did you feel at the time?

(4) How did you respond at the time?

(5) What was the consequence of this response?

(6) How do you feel about the incident now?

[Questions 2 to 6 were repeated as time permitted.]

(7) Did the workplace learning experience influence you to find a particular engineering role appealing as a future role for you? If so what and why?

(8) Did the workplace learning experience influence you to find a particular engineering role unappealing as a future role for you? If so what and why?

(9) Did the workplace learning experience influence your confidence that you could become an engineer? If so how and why?

(10) Did the workplace learning experience influence you to consider changing your enrolment?

Data collected included audio recordings and handwritten notes made by interviewers during the interviews.

2.3 Analysis

Only data consistent with a gendered workplace culture and therefore within the scope were analysed for this study. Understanding features of gender inclusive workplaces is also important in order to improve inclusivity. However, these will be presented separately. All student reports consistent with marginalization of women or stereotypically feminine practices or traits, or privilege of stereotypically masculine practices or traits, were identified. These represented reports consistent with a gendered culture.

The reports consistent with a gendered workplace culture were analysed thematically and compared with previous studies. The first level of identification of themes was deductive. Interactions consistent with Hatmaker's (2013) four types of interaction that marginalize the professional status of female engineers were coded under Hatmaker's interactions. Hatmaker's (2013, p. 387) interactions are 'amplifying gender', 'imposing gendered expectations', 'tuning out' and 'doubting technical

abilities'. Only two were present. Their names were adapted to better fit the data, and other themes emerging from the data were created. Additionally the workplace features, other than interactions, that were consistent with gendered cultures, were analysed thematically using an inductive approach.

Students' responses to the interactions and other workplace features consistent with gendered cultures were also analysed at first deductively and then inductively. The deductive stage was based on themes that were adapted from the student and engineer responses to masculine cultures that were identified by Powell, Bagilhole & Dainty (2009) and Hatmaker (2013) and listed in the Introduction. Four of their seven themes were present in the data. Again, additional themes were generated inductively.

Themes identified in the data are presented in Table 3.

[Table 3 near here]

3. Findings and Discussion

Many of the students described experiences that were motivating and increased their confidence and they described working with friendly supportive people. However, only findings relevant to the research questions are presented below.

3.1 Interactions consistent with gendered workplace cultures

Experiences of interactions consistent with gendered workplaces included

- interactions that demeaned women or drew attention to their gender;
- requests based on gender;
- imposed gendered expectations; and
- marginalization of stereotypically feminine interests.

These are described below with examples from the participants.

3.1.1 Interactions that demeaned women or drew attention to their gender

Interactions that draw attention to gender were identified by Hatmaker (2013) as marginalizing the professional identities of female engineers. In this study, participants of both sexes expressed discomfort with comments that drew attention to gender or demeaned women. 8M was miffed by the attention drawn to female students due to their gender:

> When I went offshore… I went out with another guy, but… there had been two or three girls that had gone out… And the most common conversation… was… 'Where's the girls?' Or they would mention that these girls came out before and that was the focus, was the gender of the people that had been out there beforehand…
> No-one ever talked about the guys that went offshore or what they did. It was only that there was females offshore that went as vacation students. (8M)

Additionally 8M noted discussions demeaning women: 'Some team members… spent quite a bit of time talking about prostitutes that they were interacting with in Singapore'

5F noted incidents with contractors on site who drew attention to her gender: 'I do have to say that especially working with the contractors, when I did first walk into the room they were like "No swearing there's a lady here."' This resembled a comment that Male & MacNish (2015) described in which men had complained to female students on a rig that they could not tell jokes now that the female students had joined them. While framed as if caring for the women, this practice has many other possible explanations that marginalize women. The comments could reinforce gendered norms and isolate the women consistent with experiences of female students' studied by Seron et al. (2016), and position the women as threats to men's previously assumed rights in the workplace and to their ability to be masculine as explained by Faulkner (2009b).

13F did not like 'the swearing thing'.

When someone swears they'll always- even if they're around the corner they'll come around and go 'sorry for the swearing'. It's always the swearing thing. I just don't like that I'm singled out and then other people think that I've had a problem with it because they've apologised to me. (13F)

Female engineering students are familiar with comments about low numbers of women. This arises from the reality that engineering faculties and even more so the workplaces have very few women. 4F and 6F described examples. 4F's description follows.

When I first got there of course, there was, 'Oh, you're a female engineer. You don't see many of them', and 'When I went to uni there was this many, and how many..?' ... And then there was... something along the same lines of, 'There were no girls when I was doing it.' (4F)

Ill-fitting safety wear is another way attention was drawn to gender for students in this study. In addition to being unsafe, this led to women becoming subjects of mirth. 12F identified examples.

One time… I had to wear a tighter [high visibility] vest than I usually had to, and so it kind of put out my shape a bit more, and while we were out there I was, he called me 'Mumma Jugs'…
I was provided safety gear but… I was given these black [steel-capped boots], because they were just trying to get rid of them, and they were two sizes too big, because they didn't want to order any new stuff in. And they would order new stuff in for other people all the time, but no not for me. (12F)

3.1.2 Requests based on gender

Requests based on gender are demeaning but also limit students' opportunities to gain the experience they need for career progression. 2F undertook stereotypical feminine work during her placement. No work had been allocated to her and she was asked to find her own.

I ended up talking to a guy... He said 'Can you type out this stuff for me?' I was
essentially a secretary for the whole time. Another time I was putting labels on file
dividers…

I ended up mostly working with not the receptionist but the personal assistants of
the engineers instead of the engineers. (2F)

2F's experience is consistent with the students in the study by Seron et al. (2016) being

given supporting roles and limited opportunities.

3.1.3 Imposing gendered expectations

Hatmaker (p387) identified 'imposing gendered expectations' as a type of

interaction that marginalized the professional status of female engineers.

5F, an environmental engineering student working at an oil refinery, reported

that operators on site refused to call her an engineer: 'Some of them called me

'environmental scientist' and not an environmental engineer but that's a joke.' It is

likely this expression was due to gendered expectations, because women are more

common among scientists than engineers (Australian Government Office of the Chief

Scientist 2016). Choosing not to acknowledge someone's qualification or profession

correctly is likely to diminish their professional status.

12F reported a supervisor imposing gendered expectations:

One of my supervisors… believed women should not be engineers… He was one
of the people directly responsible for me…

I ended up having to get other people to take me out on site and explain me things.
But… site meetings as well, overall I'd be expected to attend, my supervisor told
me 'Don't come. You're not needed here'… I eventually didn't listen to him and
went to all of them like I was expected, because people would ask me 'How come
you weren't there?' …

There was a male undergraduate, and he did very well, He got taken out on site all
the time and he was treated much differently to how I was treated…

[The supervisor] said that I would be much better off being an administration lady
instead of being an engineer. (12F)

13F was given accounting work on spreadsheets:

> [My boss] made me do everything spread sheet related and I got really upset about
> it because when one of the guys would say 'come on site with me' they would ask
> my boss and he would say 'no she's busy in the office'; and to me, my priority is
> my work and not doing spread sheets in the office. (13F)

11F was inspired by her placement. She chose a workplace where she would gain practical experience. She described most men in the workplace being helpful and supportive. However, it was difficult at first:

> In general it was very difficult because at first being the first female who was
> working in that environment and… all the men were very chivalrous… I'd go to
> pick up something heavy and they'd be I'll get that for you or I'd go to use the
> grinder or use a power tool and they'd say I'll do that for you and always really
> keen to do it for me because I was a girl so I wouldn't be able to – not that I
> wouldn't be able to do it by myself but they were very keen to help me. (11F)

3.1.4 Marginalization of stereotypically feminine interests

Below 8M, a male student, describes the criticism he received for taking flexible hours to accommodate his voluntary humanitarian engineering work and reconciliation work. He notices the contrast between lack of tolerance for these voluntary activities and the admiration from his colleagues for a student who took flexible hours to accommodate sport.

> Because I…do volunteer experience and things like that there was a couple of
> times where I called into teleconferences… that ended up being during work hours
> or just after work hours… and I'd make up the hours, more than enough… but then
> that was perceived that my priorities were still in the wrong place…

> It got a bit disappointing, because one time a student … took a whole day off and
> maybe even a couple of days to go and do the sporting competition and people talk

about how great that is that he… does a sporting competition at national level. (8M)

8M did not consider that the above contrast in the workplace tolerance of volunteering and sport could be related to gender. However, elite sport is a stereotypically masculine activity and 8M's voluntary work had caring, feminine connotations. A likely explanation for 8M's experience is that in the gendered workplace culture engineers prioritised the stereotypically masculine activity of elite sport over the stereotypically feminine activity of voluntary work.

With the above explanation, this example is consistent with a gendered culture affecting a male student who had stereotypically non-traditional interests. Faulkner (2009b) warned of the necessity to break down the dual gender norms in engineering. 8M's actions sat outside the dual norms.

Connell (2013) describes multiple masculinities, that is practices and traits associated with men. Within his theoretical framework the multiple masculinities have relative status. Elite sport is an example of a 'hegemony', that is, the most honoured and desired masculinity (p 10-11). Although another hegemony might be present in an engineering workplace, men demonstrating practices and traits that are consistent with masculinities that are not hegemonic will be systematically marginalized.

3.2 Students' responses to gendered cultures

Students' responses to their experiences of the culture included:

- blocking;

- leaving the workplace;

- tolerating and adapting;

- justifying interactions they experienced;

- denying the gendered culture; and

- reporting.

3.2.1 Blocking

Hatmaker identified 'blocking' and 'rationalisation' as responses by professional female engineers to interactions that marginalized their professional identity:

> When the engineers experienced encounters that imposed gendered expectations or amplified their gender identity, they responded in two ways: by blocking an interaction to bring their professional identity back to the foreground of the interaction and through rationalisation of the situation (Hatmaker 2013, 389).

4F and 6F described their visibility as women due to the low numbers of women in engineering. 6F reacted by blocking. Her response, below, reveals acute awareness of the well-recognised paradox of visibility as a women and invisibility as an engineer (Faulkner 2009b).

> The boss was so used to saying, 'Come on guys, let's do this' and then he'd be like, 'Oh, and girls'. I wouldn't have worried if he didn't bother making that adjustment. Actually, that comment comes out at uni sometimes too. We'll just be talking and someone is like, 'Oh but you're a girl' and I'll say, 'No, no I'm not a girl. I'm an engineer.' (6F)

11F effectively blocked imposed gendered expectations when men stepped in to relieve her of physical tasks:

> I had to kind of step away and say 'I can do it'. I had to be very firm and say 'I can do it. I'll ask for help when I need help' and that was a couple of months in the making…

Then I was considered one of the boys, when I left. I'd go for Friday afternoon drinks with the boys. I'd eat lunch with the guys. I wasn't one of the girls. There was only one girl but I was one of the boys. (11F)

3.2.2 Leaving

In response to being given secretarial work, 2F left her placement after only six of the planned twelve weeks. She did not raise the issue of gender when discussing the experience in her interview.

I was just really bored and because I was earning less than my current job, which is in retail, I just ended up quitting and going back to my job in retail. I'd earn two thirds more. (2F)

3.2.3 Tolerating and adapting

4F responded differently from 6F to their visibility as women: 'I was fine with it. It's something I'm used to by now, I do tend to get that a bit, "What do you do?" "Engineering" "Really?" '(4F)'.

Students described tolerating workplace cultures and taking responsibility for adapting to fit in. 2F reported her site experience on a refinery as positive overall:

At the start I felt a bit uncomfortable… but then after a while I got used to it and I… felt comfortable speaking to them... They were lovely people… By the end of it I felt like I was family, felt comfortable and they really helped me to fit in… even though there were some things that they said that I felt… you can't really say that in a workplace. If you go to a mine site or something there's probably men that say the same thing. (2F)

Above, 2F was initially uncomfortable with the rough language on site but tolerated it and enjoyed her experience. She described having learned a skill she understood to be required for engineering practice, namely to adapt to cultures and expect rough

language on engineering sites. Additionally, 2F tolerated discussions of no interest to her:

> When… they were talking about footy and because I am not a football watcher… if they're on that topic, I do feel a little bit - I guess I should start watching football. (2F)

In the bar with members of the drilling engineering team after work, 8M was not comfortable with conversation about prostitutes:

> It's not something that I'm comfortable with, but as a vacation student, you don't really have much power at all and when you are in situations that you don't agree with, there's the three options, you can either try to change the culture, you can put up with it or you can leave. And it wasn't really an option to leave, because that would have big consequences and I have to pay the rent and all that sort of stuff. And I felt like if I wanted to change that, that not only wouldn't be a successful outcome, but it would mean that you are absolutely never going to be perceived as a potential fit with that group. (8M)

Above, despite finding the gendered culture uncomfortable, 8M described tolerating it for financial reasons and because he assumed that tolerating the culture was necessary in order to fit in.

3.2.4 Justifying

Discussing the experience of having his voluntary work criticised while another student's sport was praised, 8M, explained,

> I can understand where they're coming from, because a lot of organizations don't necessarily acknowledge the diversity and then adapt to it… I can see why for them it's easier to just have expectations for students and expect people to align to that, instead of trying to adapt to each individual person. And particularly it was a very diverse team that I was a part of, where my supervisor wasn't from Australia, so… there might be an aspect where he doesn't acknowledge the importance of

engaging in reconciliation programs and things like that. So, he might not see it as an important task that I'm doing anyway. (8M)

5F had been called a scientist rather than an engineer. Yet, she rationalised and accepted this, reporting, 'For me, I'd prefer to be an environmental engineer but it was okay. That was just his character and I could deal with him perfectly fine.'

The above justification of gendered culture is consistent with female engineers' justification of workplace interactions that marginalized their professional status in Hatmaker's (2013) study. Hatmaker explained that this rationalisation allowed the women to 'cope and move on' (p390). The experiences reported by 8M are consistent with the professional status of a male student being marginalized by a masculine culture, and the male student's response is consistent with that of many female students.

3.2.5 Denying a gendered culture

Importantly, consistent with female students studied by Seron (2016) and Powell, Bagilhole and Dainty (2009), some students did not recognise cultures as gendered or potentially harmful to their futures, even when we did. 2F had been given secretarial work and yet, when asked at the end of her interview whether gender had been an issue, she responded:

> I don't think so because you hear all the time that women get paid less and things like that but I've never ever found that, … I've never felt like I was excluded because of it or they're going, 'Oh, she's a woman, she can't do that.' (2F)

Similarly, 9F indicated she had an overall positive experience. She was the only female of four interns. The male interns all went to site a few days before her 'to give her more time to settle in'. This did not bother her. Additionally, her safety clothes did not fit:

> They never had my size. They didn't because I'm particularly short and small. It was very, very large. …hi-vis vest. I was wearing a large one... That was actually very funny that people around office actually see me wearing that… I mean even myself found it funny. It wasn't because of gender, but because I'm small I think. (9F)

We cannot know whether the students did not recognize gendered culture or chose to deny it. Indeed, there can be inconsistencies between people's attitudes and actions. Powell, Dainty, and Bagilhole (2012) interviewed female engineering and technology students at a university in the UK and revealed disparity between the gender norms and beliefs about equity of access to their chosen profession implied in their interview responses. However, denial of the gendered culture is consistent with other studies (Faulkner 2009b). Jolly (1996) noted that the most common strategy for first year female engineering students at an Australian university was to outwardly condone the masculine culture. It is dangerous to rock the boat if you would like to remain welcome on board.

3.2.6 Reporting

Reporting incidents is one of the few responses that can generate change that helps others in the future. 13F reported a lack of female toilets and was pleased that female toilets were then quickly created.

The outcome of reporting was not always satisfactory. 13F reported being 'slapped on the arse twice' to her supervisor but she was not sure what the outcome was, and she reported to the human resources department an incident in which she was shouted at in front of clients. A bystander reported an incident that was experienced by 12F. However 12 F was not satisfied with the outcome.

> There was another person - he was one of the tradesmen - he had reason to come into the site office occasionally…. I was bending over the printer to get the paper

in, and he said 'oh wouldn't you like to rape her'… He was spoken to and that was all, he was just spoken to about it and was still around the office. But I was told about that later, I didn't know at the time. (12F)

3.3 Other workplace features consistent with gendered workplace cultures

Here we report features, other than specific interactions, that could be described as consistent with a gendered workplace culture.

3.3.1 Perceived poor fit between work and life

Accommodating family responsibilities was important to male and female students as was found by Male and MacNish (2015). 2F explained,

> I can't work full time at the moment because I do also care for my [family member] …. There's no flexibility in engineering until you get quite high up obviously… If I had kids I couldn't work… We can't have kids if we're both working so one of us would have to give up a job and it would be the person who earns the least so probably be me. He's been working six years already in engineering…
> I don't see why it's so important to be at work when most of the stuff's on the computer I can do as much at home as I can in the workplace… I don't see why it's so hard to get people working from home or part time. (2F)

By the time of the interview, 2F had graduated but was not working as an engineer and could not see a future for herself working as an engineer because she saw only full-time engineering positions, which did not accommodate her current or planned caring responsibilities. The search for a placement confirmed for her that engineering positions were exclusively full-time.

3M explained that he would rather work in maintenance than construction because he expected the fly-in-fly-out roster would be better.

> I think it's more to do with the lifestyle… The maintenance guys… were doing maybe two and ones [i.e. two weeks on and one week off rosters], one and ones,…

where all the construction guys, the engineers, they were doing three and ones, and the labourers were up there even doing four in ones, so a combination of that and talking to guys on site, you know, a lot of them were from the [other] coast [of Australia]. They'd spend a day travelling each way and work for three weeks. They were getting… maybe five days a month to see their families - you know - actually have a life… I would rather earn less and have a life. (3M)

3.3.2 Rough culture on site

Rough cultures on sites were implied to be inevitable by female and male students in this study, including 7M, 5F, 8M, and 2F. The cultures on the sites experienced by these students are likely to have been gendered. Indeed Ely and Meyerson (2008) labelled the culture on an oil rig as masculine and improved efficiency and safety by changing the gendered culture. 7M commented of working with tradespeople, 'their language might be a bit foul sometimes but that's really typical of the tradie environment though. Really typical' (7M).

Below, 5F reported much swearing on site, and she rationalised it.

It's not totally acceptable but it seems normal on the site…. I did speak to my manager about that: 'You just have to adapt to different situations', and I think that's really important as an engineer so [I] definitely learned something about that. I totally enjoyed it… One time I had to ring [the contractors] up on the phone and I was put on hold…. and I could hear… every second word was… the 'f' word, swearing... After a time they also started using a lot of like swear words… when I was there also but that's kind of — Australians do kind of speak like that in general. (5F)

Below, 8M recognised a difference between the culture on site and the culture in the office in the city:

I felt that there was this clash of cultures, where you have the organization's corporate culture, the other divisions which is all quite good and [I] never really

saw anything that seemed inappropriate when interacting with other divisions within the organization….

When I got told I was going offshore, other team members would talk about how people offshore are rough and that you have to expect a lot of swearing and things like that. I think there was this expectation that that's the culture of that part of the industry and so people didn't take offence. It was probably more the opposite, like it was if people said things, like they would be laughed at. (8M).

2F reported that manners were not as good on site as in the design office and there were fewer women on site, leading to the advice below.

I did went to a site where there is unisex toilet and the engineer actually asked me, if you want, I will stand outside and just to make sure no one will go in… And she said, 'In the future, even though you become an engineer, no matter which site you go, if it's a unisex, you have to always ask anyone just to let them know that you are inside'. (2F)

3.3.3 Difficulty asking for support

In performing genders, and assuming a masculine culture in engineering, female and male students delayed their responses to experiences they should not need to tolerate. Above, students accepted language that they found disconcerting because they assumed it was usual and they wanted to fit in – a perception probably partly based on their assumptions that engineering workplaces are gendered. This also affected students when they needed to ask for help, which was often the case, and when they were bullied. 10F reported being in a small organization, with no human resources department. She and the male engineering student in the organization were frequently bullied. There was no-one they could speak to in the organization. They were reluctant to seek help because they feared that the experience might be typical of engineering and they should toughen up. 10F reported that this expectation was felt more keenly by the male student, consistent with him meeting gendered expectations as described by Faulkner (2009).

> There were times I talked to [another student]… I would say… is this what happens in engineering? Because you hear everyone's tough and everyone's really manly about everything…. There were times where I really considered... what I was doing, and if it was for me… If I can't handle this sort of toughness, what am I going to do in my second internship and what am I going to do once I graduate? (10F)

Eventually 10F sought and gained help from her university which blacklisted the employer so that students would not work there in the future. The action taken by 10F protected future students. It could also be described as a slow form of blocking as identified by Hatmaker (2013).

Connell's (2013) theory of masculinities explains and demonstrates the importance of students' experiences such as described above. Within the framework, people develop individual practices and traits based on interactions, and they participate in the construction of masculinities together with others. The students were developing their understanding of the masculinities and femininities based on their expectations and through their interactions with others, and developing their own practices and traits partly based on these interactions. The students perceived a tough hegemonic masculinity, despite feeling bullied by people showing this trait. The students were also participating in constructing masculinities and culture with others in the workplace, by initially tolerating the behaviour.

3.3.4 Lack of respect from tradespeople or technicians

The need to earn respect from tradespeople or technicians featured in both female and male students' interviews. This is described here because it also arose as an issue for the female students in the study by Male and MacNish (2015) and because establishing credibility or building a reputation has been identified in other studies as a persistent burden for female engineers (Gill et al. 2008). In the current study 1F described the

challenge and also satisfaction of earning respect with a leading hand.

> I had to contact the builder by myself and I had to talk to them… The second day I find they're missing one component that they had to install and I had to talk to the leading hand. At first, he thought that he had installed it, but I showed him the drawing and showed that is that thing and that is that, and the middle one, it's not there. When he looked at the drawing, he actually, yeah, he understands and then he really trusted me from then on. (1F)

1M also reported having to prove himself. He had always wanted to be an engineer. He studied at TAFE (the public technical colleges in Australia) before entering university and had worked part-time in trade environments for two employers including a business in his extended family. It is reasonable to expect that a student from this background would manage to fit into a trade environment relatively easily. However, even this student spoke about the challenge. He was baffled by managers persistently failing to acknowledge him. At other times he fitted in by discussing hobbies with the tradespeople, including a computer game in which he had no interest, asking questions, and helping with physical tasks such as cleaning up. He then learned from them.

> You just start talking about like their hobbies… And then because you're a student I guess they have an idea: they think that you think that you know everything. But I have the opposite view. I think I know nothing but I wanna' learn things. So it was good, like I always used to ask questions. (1M)

In the study by Male and MacNish (2015), male students spoke of learning from workers, and female students spoke of the need to first earn respect as 9F and 1M describe above. The current study complements the previous work and raises the possibility that earning respect from tradespeople and technicians may be a challenge for students of both sexes.

4 Recommendations

Engineering educators and employers must work together to improve the gender inclusivity of engineering workplaces to avoid losing competent engineering graduates of both sexes, and thereby optimise the quality of engineering teams, to society's benefit.

This study found threats to the professional status of female and male engineering students due to gendered cultures in workplaces. However, in several cases female and male students did not recognise features of their experiences as being due to gendered cultures even when such an explanation was apparent to us. Additionally, some students did not perceive threats to their professional status. This lack of awareness coupled with the vulnerability and limited influence of students, lead us to make recommendations for employers, engineering educators, and finally for students.

4.1 Employers

(1) Examples of illegal practices were identified. Employers must develop cultures in which illegal actions are reported to authorities, and ensure that staff are aware of public support for victims of sexual harassment and discrimination.

(2) Policies must be upheld from within the engineering team and therefore all members of engineering teams should be trained in inclusivity. Many of the non-inclusive incidents described by students in this study occurred in large organizations with policies on equity and diversity. The values of members of engineering teams were felt by members of the team. It should not be necessary for junior staff to block gendered culture; others should also take responsibility.

(3) Complaints processes for staff must be promoted and clear so that people know how to use them and feel confident to use them.

(4) Flexible and part-time work should be offered proactively, even when promoting graduate employment to allow staff to accommodate responsibilities other than work. Lifestyle is important to students.

4.2 Educators

(1) Engineering educators must learn to recognise, monitor, and mitigate gendered workplace culture in engineering faculties.   We suggest engineering academics attend workshops or become involved in diversity programs at universities such as the Athena Swan initiative (https://www.sciencegenderequity.org.au/athena-swan-principles) to sensitise themselves to gendered workplace cultures. Educators can take simple steps in their classes such as ensuring that student groups include at least two female students where possible and stipulating that group members take turns using equipment in laboratories so that roles are not gender-segregated.

(2) Engineering educators should support employers to be inclusive. This could be undertaken by raising the issue at industry advisory meetings when the faculty seeks feedback and input on teaching and research programs, addressing industry association meetings, holding workshops with industry participants in which interactions are role played (Male 2015). Additionally, employers who implement initiatives to improve the workplace cultures can be recognised by universities, through engagement with university leadership teams, teaching and public events at the university.

(3) Engineering academics must support students to recognise gendered culture so that students do not take it personally, do not normalise inappropriate cultures, and do not feel the need to meet gender norms. Engineering educators should work with other staff in their universities to ensure students are taught about

their legal rights and responsibilities, and available support for victims of sexual assault. Workshops based on scenarios adapted from those identified in this study have been designed and tested (Male 2015; Willey, Gardner, and Figueroa 2015).

(4) Universities should have accessible points of contact and processes to support students while they are on placements and to reflect on their experiences during and after their placements. For example at the University of Technology Sydney students undertake a preparation subject before their internship and a review subject after their internship. During their internship they keep in contact with at least two other students to share workplace learning experiences and have access to an academic co-ordinator for reference.

(5) Universities should have processes to monitor the incidence of sexual harassment and discrimination experienced by their students. De-identified data should be used to proactively avoid future incidents.

4.3 Students

Students should reflect on their experiences with others and seek advice when needed. Most of the responses to gendered cultures by students in this study were coping strategies. Some students blocked interactions effectively and others successfully reported incidents and sought assistance. In some cases this generated change, and no student regretted this action but they did regret delaying their action.

In the long term, students should learn about gendered culture, learn to recognise it, and become leaders, generating cultural change in the engineering profession.

5 Limitations

The analysis presented in the paper focuses on gender. Other frameworks would present

alternative explanations for the experiences described by the students. While it is important to consider other explanations, because cultures can be difficult to reveal it is critical to focus on gender to ensure that gender effects are not missed. Analyses through other lenses are outside the scope of this manuscript.

Intersectionality between gender and race, religion, sexual orientation and disability are important because effects are likely to interact. Future research should investigate intersectionality and placements in various countries.

The features of placements that motivated students are important when making recommendations for inclusive engineering education. This analysis will be reported separately.

This study is based on students' recollections of workplace experiences. The sample was comprised of students from only three Australian universities. Perspectives were collected from students and no other members of the teams they worked with. These limitations are mitigated by other studies. Findings are consistent with the studies of engineering students' experiences in placements in the UK and USA identified above. They are consistent with observations by Tonso (2007) who, rather than relying on student reports, participated in engineering teams, including teams that worked on projects with employers in industry. Findings are also consistent with the reports by engineers in Australian workplaces (Ayre, Mills, and Gill 2013).

6 Conclusion

Engineering students experience gendered workplace cultures. Employers and educators who seek to improve participation and success of women in the engineering profession must address this problem by improving engineering workplace cultures and preparing students for the unfortunate reality of gendered workplace cultures. To fulfil these

responsibilities, employers and educators require understanding of how engineering students experience and respond to gendered cultures in engineering workplaces.

The study describes interactions and other workplace features that male and female engineering students experienced in the workplace and that are consistent with gendered cultures. Female engineers had attention drawn to their gender, received requests based on their gender, and met gendered expectations. Students also experienced marginalization of stereotypically feminine interests, and perceived incompatibility between work and life, and a rougher culture on site than in offices.

In light of previous studies about how students respond to gendered interactions (Powell, Bagilhole, and Dainty 2009) the responses reported here are consistent, with the addition of blocking which Hatmaker (2013) had found to be demonstrated by professional engineers. In addition to female students, *male* students were affected by the gendered culture. Their responses were often similar to those of female students and were also influenced by expectations that they should be strong and tolerate stereotypically masculine cultures if they find them uncomfortable.

The identified students' experiences of gendered workplace cultures and their responses can be used for training students and engineers. Such training should accompany any efforts to recruit female students to engineering. Recognition of the experiences of engineering students in gendered workplaces is an overdue element in programs to improve gender equity in engineering.

The views in this achievement statement do not necessarily reflect the views of the Australian Government Office for Learning and Teaching.

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Table 1. Participant demographics

ID	Engineering discipline	Enrolment	County in which participant completed high school	Years of degree completed at time of placement
1M	mechanical/ mechatronic	domestic	Australia	2
2F	mechanical/ mechatronic	domestic	Australia	3
3M	civil/structural	domestic	Australia	3
4F	civil/structural	domestic	Australia	5
5F	civil and environmental	domestic	Australia	2
6F	chemical	domestic	Australia	3
7M	mechanical/ mechatronic	international	Singapore	5
8M	civil/structural	domestic	Australia	5
9F	civil/structural	international	China	1
10F	civil and environmental	domestic	Australia	1
11F	mechanical/ mechatronic	domestic	Australia	2
12F	civil/structural	domestic	Australia	1
13F	electrical/ electronic/ computer/ICT	domestic	Australia	3

Notes

1. Identifier codes are comprised of the interview number and the student's sex.
2. All students were undergraduate engineering students. Their degrees are not specified to avoid identification.
3. Universities are not specified to avoid identification.

Table 2. Details about participants' most influential placements

ID	Placement	Country where placement was undertaken	Interactions with professional engineers during placement	Number of female professional engineers in the workplace (meaning the same building or site as the student was based)
1M	part-time work	Australia	0	1
2F	vacation employment	Australia	1 -5	0
3M	vacation employment	Australia	>15	0
4F	vacation employment	Australia	>15	1
5F	vacation employment	Australia	>15	2
6F	vacation employment	Australia	>15	0
7M	internship	Singapore	>15	2
8M	vacation employment	Australia	>15	>=3
9F	internship	Australia	>15	1
10F	internship	Australia	>15	2
11F	internship	Australia	>15	0
12F	internship	Australia	>15	1
13F	internship	Australia	>15	0

Notes

1. Identifier codes are comprised of the interview number and the student's sex.

2. Vacation employment is normally 12 weeks taken during the summer vacation.

3. An internship is usually 6 months.

Table 3. Themes identified in the data

Theme	Definition and example
Interactions consistent with gendered workplace cultures	
Demeaning women or drawing attention to their gender[1]	Making comments that draw attention to women and/or demean women (e.g., making a scene of changing behaviour because ladies are present, or bragging about using prostitutes)
Making requests based on gender	Making requests of women based on stereotypical assumptions about women (e.g., asking female engineers to do secretarial work)
Imposing gendered expectations[1]	Imposing expectations based on stereotypical roles or characteristics of women (e.g., keeping female engineers from going to site)
Marginalizing stereotypically feminine interests	Privileging stereotypically masculine interests over stereotypically feminine interests (e.g., praising and allowing time for a colleague to play sport but showing no interest in a colleague's volunteering)
Students' responses to gendered cultures	
Blocking[1]	Countering gendered interactions and reclaiming status as an engineer (e.g., by disagreeing with a gendered comment and reminding others of her position as an engineer)
Leaving	Leaving to avoid the culture (e.g., by resigning)
Tolerating and adapting[2]	Accepting the culture and adapting to fit in (e.g., by deciding that the benefits of the job are more important than being concerned by coarse language, and watching football to fit in with the conversation)
Justifying[1]	Making excuses for gendered interactions (e.g., by arguing that it is difficult for an employer to accommodate differences between individuals)
Denying a gendered culture	Denying that incidents are related to gender (e.g., attributing ill-fitting safety clothes to body size and shape rather than lack of accommodation for women)
Reporting	Reporting harassment or discrimination to people who could be expected to provide support or initiate change (e.g., reporting sexual harassment to the human resources department)
Other workplace features consistent with gendered workplace cultures	
Poor fit between work and life	Incompatibility between expectations about workplace practice and living a role that differs from a traditional male role (e.g., assuming that work should be completed full-time and without flexibility and this being incompatible with caring responsibilities)
Rough culture on site	A rougher culture on site than in offices (e.g., swearing and sexist jokes)

Difficulty asking for support	Difficulty seeking help due to an expectation that engineering environments and engineers are macho (e.g. not reporting bullying)
Lack of respect from tradespeople or technicians	Lack of support and/or respect from tradespeople or technicians for engineers (e.g., being ignored in the team)

Notes

1. Adapted from interactions or responses identified by Hatmaker (2013).

2. Adapted from responses identified by Powell, Bagilhole, and Dainty (2009).