

Gender differences in student attitudes toward engineering and academic careers *

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SUMMARY: *Past research has attributed many reasons for the under-representation of women in engineering and academic careers, which start from childhood and progress all the way to professional levels in adulthood. The focus of this research is on understanding barriers to further education experienced by female students in order to encourage them into postgraduate study and an academic career. A pilot study, an extensive survey of current students, both undergraduate and postgraduate, and focus group meetings were undertaken to identify the ways female students at present feel supported in pursuing a civil engineering degree and the forms of further support that could be provided. The surveys sought answers on how best to address the obstacles that discourage women from pursuing and completing graduate degrees.*

1 INTRODUCTION

Studies by physiologists and educationalists have focused their attention to biological differences to explain the disparity between men and women in science and engineering careers. However, initial studies that looked at brain size and different IQ levels of men and women to explain this proved futile as there was no average difference between male and female intelligence (Sadker & Sadker, 1994; Birke, 1992; Hyde, 1996). The only differences that have been found are in mathematic ability and spatial perception (Hyde, 1996). However Hyde (1996) observed that although the differences were statistically significant, this reason alone is insufficient to explain the degree of under-representation of women in engineering careers. Hence males' higher mathematics and spatial abilities could explain a 2:1 ratio of males to females in engineering, but it cannot explain the 20:1 ratio that is common place. It is dangerous to assume that biological differences are wholly to blame for the lack of females in engineering as it assumes that this is an unchangeable position.

The other predominant pre-tertiary explanations for the lack of females in engineering are a lack of preparation from a school level, and female attitudes and early experiences with mathematics and science. However studies have found that girls are more

qualified than their male counterparts (Stewart, 1998), even at a university level (Stenta et al, 1994), and yet opt out of science/engineering degrees. Further studies show that women that leave engineering or science majors once in university have better or equal grades with the men (Stenta et al, 1994) and women remaining in the course (Brainard & Carlin, 1998). Hence although it is worthwhile encouraging women to be technically well-prepared for engineering at a pre-degree level, these studies reveal that a lack of preparation at a pre-degree level does not explain why women self-select out of engineering when their scores are academically competitive.

Similarly, early attitudes of girls towards science have been blamed for the lack of females in engineering. A study conducted by Weinburgh (1995) did find that boys do have a more positive attitude towards science than girls; however, the effect size was fairly small. These attitudes may be explained by the gender bias in textbooks and television where few women are depicted as engineers (Baker & Leary, 1995). Blickenstaff (2005) suggested that efforts to improve girls' views of science could pay off in achievement and retention. Although prior views may effect whether or not girls enter into engineering, the leaking-out effect can be minimised for those who do continue such that their perceptions of science change due to way in which the university moulds their personal experience of tertiary science education.

Moreover, a study by Seymour (1995) found that the quality of the education in science classes has a substantial impact on students persistence in science

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majors. In the study pedagogy was a serious concern for over 90% of participants who chose to elect out of science and for almost three-quarters of those who stayed. In terms of the pattern of interaction with students research has found that girls generally receive less attention from teachers than boys do, regardless of age or subject-matter (Wilkinson & Marrett, 1985). The nature of attention also varies as boys are given feedback and questions on their ideas, while girls are given feedback on the quality of the presentation of their work (Sadker & Sadker, 1994; Spear, 1987; Eccles & Blumenfeld, 1985). Blickenstaff (2005) suggested that the way in which teachers teach science may re-enforce negative attitudes about science and make females feel undervalued in this line of work.

Brainard & Carlin's (1998) study found that women cited barriers blocking the route to the continuation and completion of their degrees. This was a phenomenon that became worse as the women progressed in their degree as they expressed feelings of isolation and intimidation as well as a drop in self-confidence. The major reasons for dropping out of their degrees were because of poor teaching or their own lack of interest in the subject.

The commonality of student experience suggests that there is a lack of female teachers in tertiary education. One explanation of gender inequity within academia has been attributed to the gendered nature of university institutions. For instance, the merits criteria upon which promotions are based can be challenged as reflecting the norms of male professional experience (Bailyn, 2003; Benschop & Brouns, 2003; Probert, 2005). Women are disadvantaged in the promotion and tenure process as there is a higher value placed on time-consuming research, as opposed to teaching and other activities. Further works suggest that faced by the dual responsibility of work and home women find it difficult to satisfy the extensive commitment required to meet expectations of a "successful" academic (Currie et al, 1998). These pressures are illustrated in a study by Probert (2005) where participants were questioned about what was needed most for completion of research, and women were more likely to refer to "more time", while male academics placed greater emphasis on the need for more money to facilitate their research.

Similar to other professions, taking a break in their career to pursue familial obligations can be severely detrimental to career progression (Coman et al, 2000). Apart from planned periods of leave, greater family burdens on an everyday basis also often force female academics to cut down on their hours. This comes particularly at the expense of time spent on research, which is a discretionary task; its demands being more flexible and less urgent than teaching or family obligations (Probert, 2005; Currie et al, 1998). Considerations of the balance between research and family are important considerations as the absence of positive female role models and mentors within the

academe has also been suggested as a factor impeding the progression of women (Sullivan, 1999).

Negative perceptions of female academics in senior positions may in some cases also serve as disincentives to pursue an academic career, as female students are discouraged by perceived lifestyle of senior female academics in their chosen field. However, positive role models and networking between female colleagues may provide a valuable support network, particularly in order to manage workplace cultures within male dominated fields (Ingram, 2006).

1.1 Female students in the School of Civil and Environmental Engineering at UNSW

Evidence of the need for a program to encourage female students to pursue graduate research degrees in engineering became obvious after considering findings of a pilot research program by the authors. The pilot survey reflected the "leaky pipeline" carrying students from a Bachelors degree to postgraduate (PG) studies and then an academic career (Bailyn, 2003). The Human Resources statistics at the University of New South Wales (UNSW) show that women leak out more than men do. Blickenstaff (2005) described the effect of this as "creating a sex-based filter that removes one sex from the stream and leaves the other to arrive at the end of the pipeline". Further, Cronin & Roger (1999) described the absence of women in maths and science disciplines such as engineering, as both "progressive" and "persistent". This means that the problem is more severe further into their engineering career and that, despite attempts to alleviate this situation, women are still under-represented in these fields.

Blickenstaff (2005), after conducting an extensive survey of research literature, relayed the following explanations for the proportional lack of women in science, technology, engineering and mathematics (STEM) careers:

1. biological differences between men and women
2. girls' lack of academic preparation for a science major/career
3. girls' poor attitude toward science and lack of positive experiences with science in childhood
4. the absence of female scientists/engineers as role models
5. science curricula are irrelevant to many girls
6. the pedagogy of science classes favours male students.
7. a "chilly climate" exists for girls/women in science classes
8. cultural pressure on girls/women to conform to traditional gender roles
9. an inherent masculine worldview in scientific epistemology.

The scope of this study is limited to points 4, 5, 6, 7, and to some extent 8 and 9. However, as these explanations do not stand alone, it is important to grasp how they may conjunctively lead to the "leaking out" of women from engineering careers.

In order to observe these effects at the UNSW, this study is designed to test the relationships between gender and perceptions of academics and engineers, and the barriers to further education. The research questions that guide this study are as follows:

- Why do females enter into a Bachelors engineering degree?
- What barriers do female engineering students face in their decision to pursue PG education?
- What are student perceptions of academia?
- What barriers do female engineers face in not entering into an academic career?
- What can be done to encourage more female PG students and more women in academia?

2 FINDINGS

The results reported in this paper are based on a combination of three data sets: School of Civil and Environmental Engineering at UNSW students' answers to a pilot questionnaire (sample size (N) = 16), a large scale questionnaire (N = 346), and focus group meetings (N = 14). In the large scale survey, males made up 76% of the sample, while females were 24%, which is representative of the male-female ratio in the School of Civil and Environmental Engineering at UNSW. Furthermore, the large scale survey included 17 participants from the School of Chemistry, which traditionally has a more significant representation of women in academia, industry and classrooms, and can serve as a helpful comparison to the Civil Engineering surveys.

2.1 Results of pilot survey

The pilot survey found that although females were more qualified than their male counterparts they self-selected out of the PG research programs at a higher rate due to a lack of networking, role models and retention programs. These deficiencies lead to under-representation of women, especially so in Civil Engineering, causing a shortage of qualified professionals and the exclusion of women from participating in academia, thereby explaining why there is only one female academic in the School.

Existence of the leaking pipeline is noticed by the students. One female student remarked that she does environmental engineering, which she estimates is close to 50% female, and as she completes her third year of undergraduate education she has only had one female lecturer who came from a civil background. She maintained that she would

consider an academic career in the future due to the fact that there is a "great lack of female teaching in engineering ... (and that) women teach and learn differently to men, and women students would benefit immensely from female teaching styles and their attitudes to students needs".

The literature shows that women who choose an engineering career have support for such choice from their immediate family and friends, and this is reflected in the pilot studies as most of the girls had relatives who were engineers. This suggests that role models and social support are then very important sources of encouragement for young women's career choice. And this same pattern was identified with this pilot study where the need for role models, networking and retention programs was emphasised. One student reflected upon the positive experiences she had with two female lecturers, but emphasised that there is a lack of knowledge about successful female engineers: "I have encountered a few women engineers and scientists who have led me to believe that women can excel in any profession they choose ... I personally have not learnt about the accomplishments of women engineers/scientists." Another student expressed a similar sentiment: "women accomplishments were rarely mentioned in course material". On the other hand, one student who had exposure to the WiCVEN (Women in Civil and Environmental Engineering) Programme noted very positive experiences and was able to remember the names of successful female engineers: "I had the opportunity to meet successful women in engineering and science (particularly in civil and environmental disciplines), and I can still remember what they had to say. This was invaluable as an opportunity to network, and also an opportunity to learn about different career paths and relevant issues for women in engineering".

Another recurring motif was that the main reason for opting out of an academic career was the desire to enter the "real" workforce or industry prior to embarking on an academic career: "I would like to do some other type of work beforehand", "I am keen to be a part of the workforce" and "I would not do a postgraduate degree until I had some industry experience". This suggests that the role of research as integral and essential in the enhancement of a society is not emphasised at an undergraduate level.

2.2 Results of large scale survey

The next step was a large scale survey of current students, both undergraduate and PG, which was carried out in order to identify the way in which female students currently feel supported in undertaking an engineering degree, and to identify forms of further support that could be provided. The survey questions addressed students' perceptions of engineering, academia and university life, and asked them to identify factors in their motivation or lack of

motivation to enter into PG studies and academic life. The sample consisted of 346 students of which 24% were female (N = 82) and 76% were male (N = 264). Table 1 reflects the degree and degree-stage spread of students.

2.2.1 Considering post-graduate careers

Table 2 reflects, in descending order, the most important factors in deciding to undertake PG studies. The average response column reflects the mean of student responses when asked to rank the importance of each factor from very important (1) through to not important (4).

There was no significant difference in the reasons listed by males and females. However, there was a significant relationship between background (either English-speaking and non-English-speaking background (NESB)) and choosing to undertake PG studies due to a scholarship (0.022, $P = 0.177$), sense of accomplishment (0.011, $P = 0.182$), and family support/encouragement (0.000, $P = 0.253$), although these were moderately weak associations. Background was an issue in whether scholarships and

a sense of accomplishment were factors in deciding to undertake PG studies, where background did not affect the relationship in females. However, these associations were weak even for males ($P = 0.190$ and $P = 0.225$, respectively).

Interestingly, there was a stronger association between background and family support for females (0.006, $P = 0.382$) than for males (0.08, $P = 0.218$).

The data suggests that females from a NESB find family support a more determinate factor in their decision than their English-speaking background (ESB) counterparts. 63% of NESB females stated that this was a very important or important factor, whereas only 32.1% of females from an ESB thought it was an important factor. Although interesting, this association is still relatively weak.

The students were also asked to comment on why they would choose UNSW to undertake their further education. Table 3 reflects in descending order the hierarchy of reasons for choosing UNSW.

There were no significant discrepancies stated by men and women under this test. However, when

Table 1: Distribution of large scale survey participants by degree type and stage.

Degree	Count	%	Degree Stage	Count	%
BE Chemical Eng	17	5%	1 st Year	129	37%
BE Environmental Eng	23	7%	2 nd Year	75	22%
BE Civil Eng	207	60%	3 rd Year	53	15%
BE Environmental Eng (Combined program)	7	2%	4 th Year	60	17%
BE Civil Eng (Combined Program)	40	12%	5 th Year	11	3%
Masters Programs	39	11%	6 th Year	3	1%
PhD	12	3%	Not specified	15	4%
Total	346	100%	Total	346	100%

Table 2: Reasons for undertaking post-graduate studies by importance.

Rank	Reason for undertaking PG studies	Average response
1	Further knowledge in my field of study	1.78
2	Further my education	1.83
3	Improve job skills	1.84
4	Increase worth in the job market	1.89
5	Opportunities for promotion	1.96
6	Personal growth and enrichment	1.98
7	Sense of accomplishment	2.06
8	Pay rise at work	2.11
9	Other	2.17
10	Increased confidence in myself	2.21
11	Family support/encouragement	2.47
12	Encouragement/support from an academic member of staff	2.57
13	Scholarship	2.72

Table 3: Reasons for choosing UNSW by importance.

Rank	Reason for choosing UNSW	Average response
1	Expertise in my area/field	1.80
2	International reputation of the school/university	1.84
3	High quality of research at UNSW	1.87
3	Good resources/research facilities	1.87
5	Helpful friendly staff	2.11
6	Other	2.17
7	Presence of positive academic role models in school	2.22
8	Support and encouraging environment	2.22
9	Relationship with academics	2.29
10	Sense of community between students and school staff	2.41
11	University's emphasis on multiculturalism and equity	2.62

Table 4: Importance of UNSW's emphasis on multiculturalism and equity by background and gender.

Gender		Background		Total
		English-speaking	NESB	
Male	Very important	10 10.3%	17 13.0%	27 11.8%
	Important	18 18.6%	55 42.0%	73 32.0%
	Of less importance	36 37.1%	44 33.6%	80 35.1%
	Not important	33 34.0%	15 11.5%	48 21.1%
Total		97 100%	131 100%	228 100%
Female	Very important	2 11.1%	7 15.9%	9 14.5%
	Important	1 5.6%	19 43.2%	20 32.3%
	Of less importance	9 50.0%	16 36.4%	25 40.3%
	Not important	6 33.3%	2 4.5%	8 12.9%
Total		18 100%	44 100%	62 100%

considering background as a factor both males and females, from a NESB, were more likely to consider the university's emphasis on multiculturalism and equity as an important or very important factor in considering whether or not to undertake PG studies at UNSW.

As can be seen in table 4, there is a significant association between background and importance placed on the university's multicultural and equity policy both for males (0.000, <0.05) and females

(0.002, <0.05). The strength of this association is stronger for females (0.437) than for males (0.306). This association is only moderate in strength however.

Another interesting finding was in the difference between males and females from different backgrounds and the importance they placed on friendly and helpful staff when considering whether to undertake PG studies at UNSW. In particular female NESB students placed significantly more importance

on this factor than any of their other counterparts. Where there was no significant association between the background of the student and choosing UNSW due to the friendly nature of staff for males (0.070, >0.05) there was a significant relationship existing for females (0.031, <0.05) although this association was moderately weak ($P = 0.352$).

There is no significant relationship between gender and likeliness to undertake PG studies (0.48, >0.05). Nor does the degree/program (0.873, >0.05) or years studied impact on likeliness to undertake PG studies. However, when considering background as a factor, there is a moderate yet significant correlation between gender and likeliness to undertake PG studies for females (0.03, <0.05) and males (0.04, <0.05). The relationship is stronger for females (0.447) than for males (0.256). Figure 1 reflects this relationship, where females from a NESB evinced a greater intention to undertake PG studies. Similarly, males from an ESB are less likely to undertake PG studies.

2.2.2 Considering an academic career

As the table 5 illustrates, the main considerations for pursuing an academic career were the desire to develop expertise, increase one's salary, and to attain personal growth and enrichment. Interestingly the desire to teach as an academic was rated as one of the lowest. This suggests either that students have not considered the prospect of teaching while an

academic or that they perceive it to be a negative factor in their decision to pursue an academic career.

This data did not reveal relationships between factors that would commonly be presumed to affect male and female decisions to enter into academia. For example, there was no relationship between gender and having positive role models (0.403), family support and encouragement (0.860), academic lifestyle (0.232), good working conditions (0.147) or desire to teach (0.656). The quantitative data suggests that these factors are equally important for males and females.

There was a significant relationship between gender and importance of desire to continue research in this area, although this is a weak relationship. (0.04, <0.05, $P = 0.171$). This disinterest may be evidence of the "leaking pipeline" effect was also reflected in Brainard & Carlin's (1998) study that "lack of interest" is one of the main reasons for science drop-out rates.

On average students were somewhat likely to unlikely to pursue academic careers ($m = 3.59$). There was no relationship between gender and likeliness to pursue academic studies (0.236, >0.05). However, there were significant, although weak, relationships between likeliness to pursue an academic career and:

- background (0.000, $P = 0.299$) – the relationship exists for males (0.000, $P = 0.304$), but not for

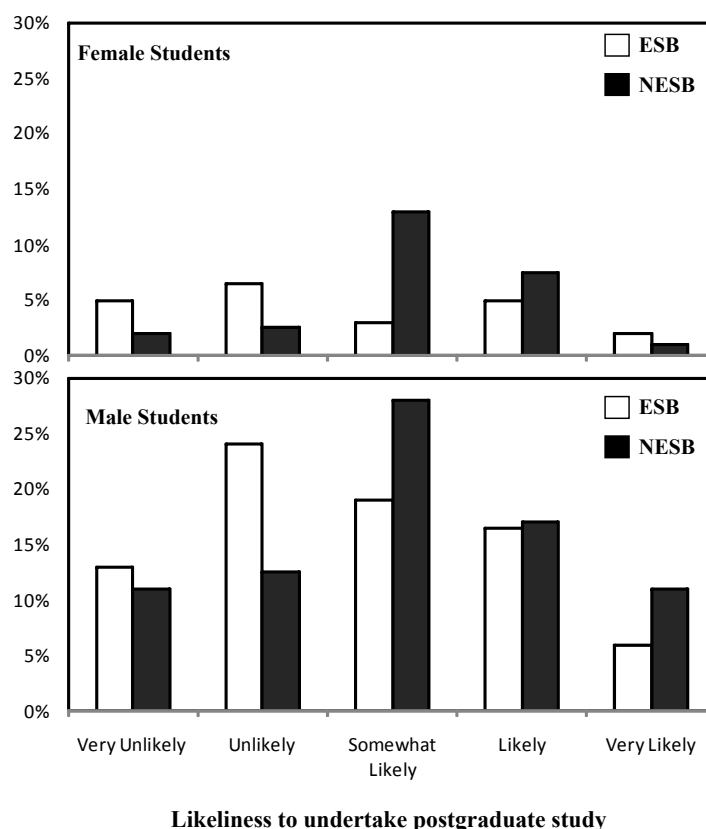


Figure 1: Gender and likeliness to undertake PG studies by background.

Table 5: Factors in considering an academic career by importance.

Rank	Factors in considering an academic career	Average response
1	Develop expertise	1.97
2	Salary	1.98
3	Personal growth and enrichment	2.01
4	Good working conditions	2.02
5	Industrial Experience	2.03
6	Opportunity for promotion	2.06
7	Sense of accomplishment	2.13
8	Research Interest	2.23
9	International reputation	2.33
10	Desire to continue research in this area	2.34
11	Status	2.37
12	Having influential or positive role models in the school	2.43
13	Family support and encouragement	2.44
14	Academic lifestyle	2.49
15	Location of workplace	2.52
16	Working with a community of scholars	2.57
17	Desire to teach	2.71
18	Other	4.42

females (0.066, >0.05). Males from an ESB are less likely to pursue an academic career.

- status (0.000, P = 0.282) – local students are less likely to pursue an academic career, this relationship is more pronounced for females (0.012, <0.05, P = 0.401) than for males (0.003, <0.05, P = 0.265).
- program/degree (0.001, P = 309) – this relationship exists for males (0.003, <0.05, P = 330) but not for females (0.450, >0.05).

2.2.3 Engineers and perceptions

Generally, most students agreed with positive perceptions about engineering. On a scale from 1 to 5, with 1 being strongly disagree and 5 being strongly agree, on average students highly agreed that "engineering makes a valuable contribution to society" (m = 4.44). Similarly most agreed that "engineering as a profession welcomes a diverse group of people" (m = 3.97) and that "engineers are exciting and innovative people" (m = 3.63). There were no significant differences in these responses from people that were from a different background, gender, school in engineering, level of progress through their course or status of enrolment.

The most negative perception of engineers were that they were workaholics, with the average response

somewhat agreeing with this statement. There was little support for engineering being considered a "blue collar" profession (m = 2.70) or that "engineers are boring and antisocial nerds" (m = 2.19). Similarly, students did not support the notion that the image of engineering dissuades recruitment and retention of students (m = 2.78).

Interestingly, there was a significant relationship between the status of the student (international or local) and the belief that engineering is a physically demanding profession (0.000, <0.05), although this relationship is moderately weak in strength (0.278). However, this relationship only applies for males (0.000, <0.05, P = 0.321). Similarly, a significant relationship exists between the background of a student and their belief that engineering is a physically demanding profession (0.000, <0.05). Students from a NESB were more likely to agree (32.3%) that engineering is physically demanding than their ESB counterparts (13.8%).

People from an ESB generally have a wider option of accepted career paths to choose from. Hence, as compared to different trades, for example, engineering may be a less physically demanding career path. However, as compared to law and medicine, which are the other traditional professions, engineering is a more physically demanding option. Hence, where students come from a NESB, and

have a smaller pool of accepted career options, this may explain why they have a greater perception of engineering as physically arduous. This is supported by the finding that males from an ESB are more likely to disagree with the notion that engineering is a "blue collar profession". 48% of ESB males either disagreed or strongly disagreed that engineering is a "blue collar profession", whereas only 29.5% of their NESB male counterparts disagreed with this statement. There was a significant relationship between the perception of engineering as a "blue collar" profession and background for males, but this relationship is of weak to moderate strength ($P = 0.210$).

There is moderate support for the notion that "engineering is an 'unfeminine' profession" ($m = 3.00$) and even less support for the notion that engineering is a physically demanding profession ($m = 2.81$), or that women have a hard time becoming an engineer ($m = 2.46$).

However, there is a significant relationship between gender and responses to the notion that "the image of engineering dissuades recruitment and retention of students" ($0.005, <0.05$). Although this is a weak relationship ($P = 0.207$), a notable comparison can be made between female and male responses agreeing with this statement. While only 22% of males students agreed with the statement, 35% of females either strongly agreed or agreed with the statement. This suggests that the image of engineering needs to

be considered carefully as there were no significant differences in male and female responses to the negative impressions of engineering, and yet females seem to suggest this image is detrimental to the retention of students. This may be a question more appropriately addressed in focus groups.

2.2.4 Academics and perceptions

Students largely perceive academics as good role models. There is an appreciation for the contribution that academia make to wider society, with a high percentage of students agreeing that they make a significant social contribution ($F = 87.7\%, M = 83.2\%$) and students agreed that academics were "bright, capable and conscientious" ($M = 52.7\%, F = 42.1\%$).

There was a weak yet significant relationship between the background of a student and their perception of whether academics are great role models ($0.007, <0.05, P = 0.201$). Where 58.8% students from an ESB agreed or strongly agreed with this statement, only 42% of students from a NESB did the same. However, when this relationship was further investigated, there was a moderately strong and significant relationship in the reverse for females ($0.011, <0.05, P = 0.372$). A significant relationship of less strength also exists for males ($0.017, <0.05, P = 0.211$). As can be seen in figure 2, male students from an ESB are more likely to value an academic as a great role model. However, it must be noted that this relationship although greater in numbers, due to the higher percentage of males

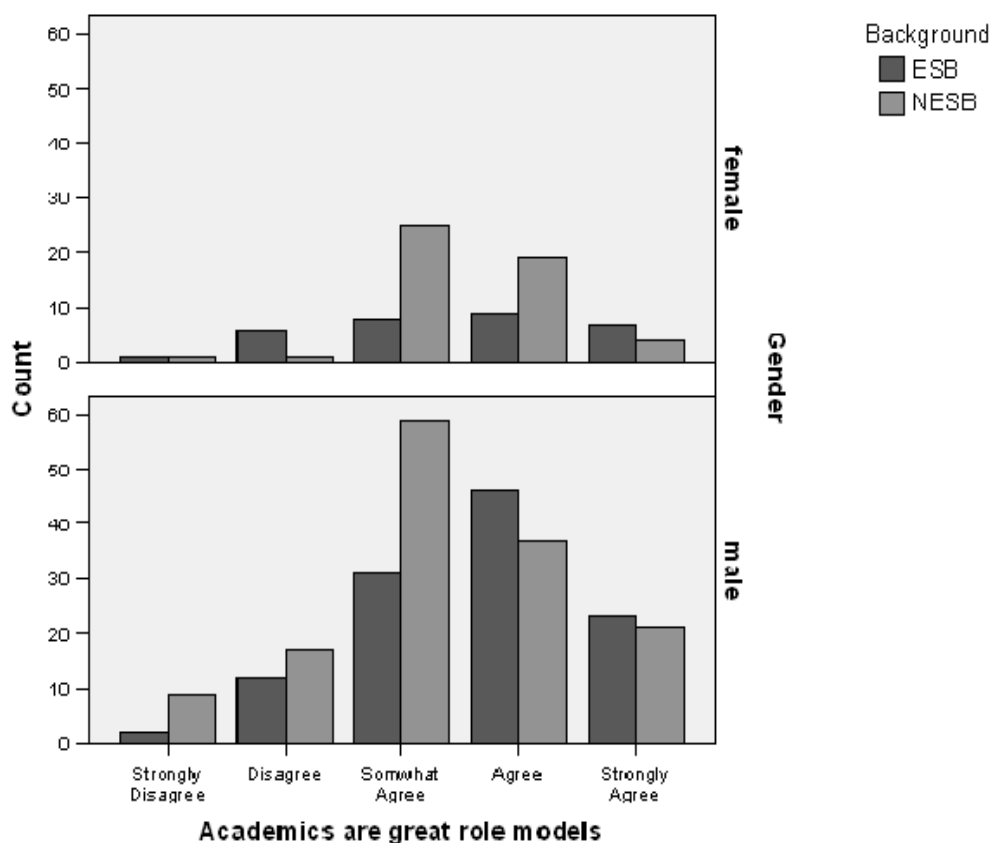


Figure 2: Male and female perceptions of academics as great role models.

in engineering, is not as strong as the relationship between NESB females and their greater appreciation of academics as great role models. This is best illustrated in figure 2.

Male students are more likely to have negative perceptions of academics, as 22% of males perceived academics to be "boring or antisocial nerds", while only 7.3% of female students conveyed a similar sentiment. The general consensus between male and female students is that academics are not aloof and unfriendly, with only 17.1% of males attesting that academics do hold these negative attributes, and an even smaller 11% of female students holding this negative perspective.

A higher percentage of female students believe that academics are principally teachers (F = 32.9%, M = 29.9%). Figure 3 reflects that there is a fairly even distribution of answers reflecting the importance of the image of academia and its effect on a student's decision to pursue an academic career.

Contrastingly, a significant majority of students suggested that having a staff member taking interest in them academically is very important. As figure 4 illustrates, the vast majority of students either somewhat agree, agree or strongly agree that their

interaction with staff members is of importance to them academically.

This finding is particularly important as a high percentage of students, and particularly female students, also agreed or strongly agreed that there is a need for more female academics in engineering (F = 54.8%, M = 45.8%). This suggests that not only is interaction with academic staff important to students, but the students themselves felt that there is a deficiency of female academics fulfilling this role.

Female students strongly endorsed the additional use of websites featuring successes of female graduates, engineers and academia (F = 54.9%) and more guest speakers (including more female engineers and academics) (F = 59.8%) as practical measures to increase the profile of women academics. Male students also endorsed the use of websites (M = 44%) and guest speakers (M = 51.2%) strongly, but to a lesser extent than their female counterparts.

The results of the survey show that there is slightly greater preference for guest lecturers rather than the website. This said, the disparity is not significant, and there is clearly support for both practical measures for increasing the prevalence of female academics.

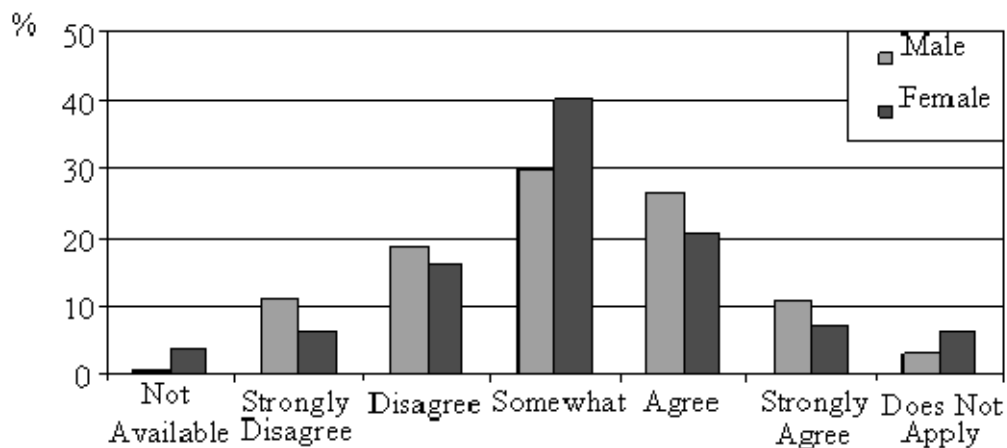


Figure 3: Students own assessment of whether their image of academia affects their decision to pursue an academic career.

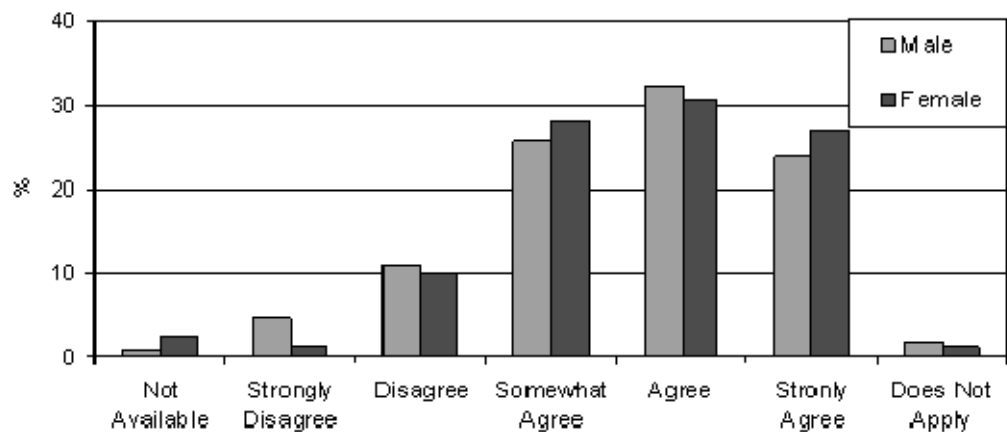


Figure 4: Students own assessment of whether a staff member taking interest in them academically is very important.

2.3 Results of focus group meetings

2.3.1 Female students

This focus group included eight female students who volunteered to take part and answer some questions related to this research.

When asked why they chose the UNSW to undertake their undergraduate degree, three predominate responses arose. The ranking of these reasons are summarised in table 6 and are not dissimilar in rank or substance from the reasons for entering PG studies in the survey.

Furthermore, there was no evidence that the lack of female academics in engineering was a dissuading factor in their decision to pursue this career path at UNSW. In fact most students claimed that they had no prior knowledge that this was the case, although some students did suspect that there would only be a few female academics and that the majority of the academics would be males. As reflected in the surveys, those students who responded claimed that it was not a problem for them to have the majority of the academics being male. However, they all agreed that female academics seem to "understand them better" and seem to "know where they are coming from", suggesting that females students receive support from the female academia. They also all agreed that having more female academics in the school should be encouraged as they feel more comfortable having them around. One respondent went so far as to claim that: "Women are better engineers – the way it is today is not like 15 years ago where men were better ... where there is such an emphasis on communication and big picture understanding, not the technical understanding ... [women are] more competent ... its easier to understand where women are coming from than men".

The female students were then asked about the factors influencing their choice of their field of study. Surprisingly, only one had a father of an engineering background. All the rest had different experiences. Most of them were good at Maths and Physics at school. Another tried different fields before realizing that engineering was what they wanted to study. Another had her parents totally discouraging her from pursuing an engineering degree which made her more willing to get into the field.

Initially all respondents suggested that females were treated fairly in the school. However, probing led to the discovery that they sometimes faced positive discrimination. When asked whether male and female students of the school get a fair treatment in terms of grades, they believed that they do. They believed that having more women in academia would bring about a "balance" to such issues. Further, the respondents claimed that sometimes they could get more attention than their male colleagues simple because they ask for it. "Yes – the boys don't ask for help as much ... almost all the girls are more comfortable going to ask questions" was one of the responses. This contradicts prior finding that girls generally receive less attention from teachers than boys regardless of the subject and age of the students (Wilkinson & Marrett, 1985; Sadker & Sadker, 1994). Interestingly, however, female willingness to inquire may not be met by the teachers with the same enthusiasm, as Eccles & Brumenfeld's (1985) study found that although girls asked more questions than boys, teachers gave less feedback to their responses.

When asked whether they felt "left out" or were treated unfairly by their male colleagues, the female respondents claimed that it was a cultural, more than a gender based, phenomenon. For example, they believed that boys like working together simply because they are used to doing so. They do not exclude women purposely. They reaffirmed this by saying that they did not face any problems working with a group of boys on a certain project. "They mostly listen to what we have to say ... they believe we are more clever than they are"; "they know we take care of responsibilities better so they rely on us more."

Unlike the responses in the male focus group, all female students suggested that they are considering undertaking PG studies. They all considered pursuing further studies, some considered doing a Master's Degree, while others considered going all the way and pursuing a PhD. However, for some this sentiment did not extend to the idea of working in academia. One respondent for example, preferred going out in the field and working before eventually pursuing a PhD and then perhaps an academic job. Many of the respondents in the pilot study also expressed similar practical reservations to pursuing an academic career, even though they all believed that they have the capacity to teach and to convey

Table 6: Reasons for undertaking undergraduate studies at UNSW

Number of responses	Reason
5	Popularity of degree with other students
2	University's good reputation
1	Scholarship

different ideas and explanations to the students in the future. When asked what their families and friends thought about their choice of studying engineering, some said that they were encouraged to do so, while others were faced with scepticism, and their families and friends had doubts about their future jobs as "Are you going to get a job?" was a frequent question they were faced with. The practical economic considerations are perpetuated by family and friends, and are present in the contemplations of both men and women who are deciding whether to pursue an academic career.

Those who were not interested in an academic career claimed that it was not "family friendly"; this specific respondent preferred settling down and having a family rather than entering the academic force. She claimed that being a teacher at school is a better option than a lecturer at university because it would be more flexible and less stressful. Those who supported pursuing an academic career knew that it was not only about teaching. They were very well aware of the amount of research they would have to undertake alongside teaching. They all supported the idea of having more female guest lecturers talking to them about their successes. They all suggested that more PG students should talk to them about their research areas. They all encouraged seminars be held for PG students' work and that these lectures be compulsory to attend. This, they believed, might give them a better idea of what PG studies are all about and maybe change their point of view about the matter.

2.3.2 Male students

This focus group took place after the female students' focus group. Six male students volunteered to take part and their answers to the different questions raised are discussed below.

When asked why they chose UNSW to undertake their undergraduate studies in engineering, one said that "it was the only university that accepted him because of his skills and experience in the field and not only on the basis of grades"; others said that it has the best reputation when it comes to the Engineering Department; others chose it because it was the closest university to home; another believed that having more international students was a good incentive for his choice because this allows for a variety of ideas when it comes to studying; others claimed that the university offers good scholarships and they did not really like what the other universities had to offer.

When asked whether they would like to have more female academics in the school, two agreed and based their answers on "wanting to have a diversity of lecturers and not just males"; some believed that having more academic women in the school would encourage more female students to undertake engineering as their field of study. One said that such

an issue "doesn't bother me, as long as I get lecturers that teach well, that's all I care about".

Unlike the female students, only two of the males considered pursuing PG studies. They believed that it would give them better job opportunities and would "keep the door open for pursuing an academic career in the future". Similar to female responses, they said they would prefer going out and "working in the field". Others were too sceptical of the grades they would get if they pursue PG studies. One of the students who was greatly interested in pursuing a PG degree gave credit to one of the courses he enrolled in where PG students came in to present their work. He also believed that his lecturer was a great role model and he saw how well this lecturer's PG students are progressing, this gave him the incentive to take further studies. When asked whether they would consider an academic career, most of them were negative about it. Some just wanted to "get out of here" and "into the field". Some agreed that the best lecturers are those who have field and practical experience.

They all agreed that those lecturers who do not have such experience are "boring and never change their syllabi". "They teach us things they taught four years ago, they are not so aware of practical advancements, and this is what we are looking for".

When asked whether they feel comfortable working with their female colleagues, they all agreed. They all believed that their female colleagues are more responsible and organised, and hence tend to work better than they do. Therefore, they had absolutely no problems working with them. They also had no problems with any female lecturers, they believed that "they are not lenient" as some might believe. When asked about their opinion to why there is such a low number of female students in the school, they said that it is because engineering is viewed as such a "male" career. They all agreed that this is changing and that more women have been joining the engineering force for the last decade or so. "Only time would fix this unbalance", one said.

When they were asked why they chose engineering as their main field of study, one said that "it runs in the family". Another said that "to get a decent job in engineering, you have to have a degree"; another said "because of new challenges available", while another said that "the area (environmental engineering) is new and is rapidly growing so that presents something new and challenging". Towards the end, however, they all complained about their workload. There was consensus between the students to the effect that the hours of work per credit point should be reduced: "We end up having bad grades because of the load we have". Some suggested that PG seminars be made compulsory so that they could get a better sense of what others are doing instead of having a huge load of work and getting low grades at the end.

3 CONCLUSIONS AND RECOMMENDATIONS

Producing a continuous supply of well-trained research students will be a great challenge for any engineering school over the next decade, even though a largely untapped talent pool is among the women who currently participate in our undergraduate degrees. This study reflects the reality that there are an immense number of factors that become important when considering whether to undertake PG studies and to further an academic career. Considering the multiplicity and combinations of reasons for entering PG studies, differentiating between male and female intentions becomes an increasingly complicated task, which has not been accomplished by this study. On the contrary, it was found that male and female students enter and retain BE degrees for the same reasons: attainment of expertise in their respective fields, to further their education and to improve job skills.

There were minor differences in preferences depending on gender when students' language background was also considered. 63% of NESB females stated that family support was an important factor in deciding to undertake PG studies, whereas only 32% of females from an ESB thought it was an important factor. The evidence also suggests that females from a NESB place greater importance on the university's equity and multiculturalism initiatives, and the friendly nature of staff in deciding to undertake PG studies at UNSW. Interestingly, females from a NESB evinced a stronger intention to undertake PG studies. Although these associations were weak they may require further investigation.

Studies conducted by Spear (1987) showed that science teachers consistently marked boys higher than girls for the same work, and in a later study found that teachers thought science preparation was more important for boys than for girls (Spear, 1987). As hypothesised by Blickenstaff (2005), our survey reveals that the notions of gender discrimination at school, such as that suggested by Spear (1987), are not visible at UNSW as both males and females believe they are treated fairly within the school. This to some extent suggests that the age old perception that engineering and sciences are a man's world have been widened.

This study also contradicts prior findings that girls generally receive less attention from teachers than boys regardless of the subject and age of the students (Sadker & Sadker, 1994; Wilkinson & Marrett, 1985). Discussion in the female focus group revealed that the girls felt that they interacted with teachers more due to their willingness to ask questions. However, it was noted in Eccles & Brumenfeld's (1985) study that, although girls asked more questions than boys, teachers gave less feedback to their responses.

Brainard & Carlin's (1998) longitudinal study revealed that there was a difference in attitude expressed by freshmen and seniors, with female students citing more barriers blocking the route to their degrees as the years progressed. However, these results were not reflected in this study as perceptions did not change significantly as students progressed along their degree.

Women who have become physicists report that one of the major obstacles in their path on the way to become an academic was the expectation that they would also be primary caregiver for their children (Ingram, 2006). The issue of family and work, the way in which academics deal with those competing pressures and student perceptions of those academics, requires further investigation as participants showed concern in the pilot study, but they were not fully explored in the survey or focus groups.

In summary:

- The main reasons for students entering into academic careers were to develop their expertise, increase their salary, and to attain personal growth and enrichment.
- This data did not reveal relationships between factors that would commonly be presumed to affect male and female decisions to enter into academia. For example, there was no relationship between gender and having positive role models or family support and encouragement, academic lifestyle, good working conditions or desire to teach. The quantitative data suggests that these factors are equally important for males and females.
- A high percentage of students, and particularly female students, also agreed or strongly agreed that there is a need for more female academics in engineering ($F = 54.8\%$, $M = 45.8\%$).
- The focus groups revealed that the main barrier blocking entry into an academic career seem to be the practical economic considerations ("Will you get a job?"), which are perpetuated by family and friends, and are present in the contemplations of both men and women who are deciding whether to pursue an academic career.
- Evidence from the study reveals that any measure that will attract more female graduates will also attract male graduates. More integration between Bachelor level studies and PG studies should be encouraged, such that BE students may experience the benefits of a PG degree and possibly an academic career. Examples include compulsory lectures or seminars where PG students present their work, guest lectures from prominent engineers, and a website featuring the successes of PG students, academia and female engineers.

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