

Choosing Engineering and Its Influence On Classroom Dynamics

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Why women are NOT choosing engineering as a career option is obviously an extremely difficult question to answer, as it appears that the major factors may vary with time, location and even cohort. This paper is presented to add to the body of knowledge in this area to try to understand more clearly what the reasons for their choices are and to compare them with the male student perspective.

The results presented in this paper are a section of a much larger study conducted into the dynamics between genders in an engineering classroom at an Australian University. In this section of the study the focus was to investigate the degree of exposure to engineering and what form that exposure took prior to enrolment. It also investigates students' prior knowledge and reasons why they choose engineering. The study used gender as a major criterion so that comparisons could also be made between men and women. This paper goes on to look at what affect the different reasons for choosing engineering will have in the engineering classroom.

1.0 Introduction

Social conditioning and established gender paradigms have been recognized in the literature [Beder, 1998, Roberts, 1996] and in the broader study [Burrowes, 2001] as being influential to an individual's ways of acting and thinking. Therefore it is not surprising that external factors, including students past experiences and previous exposure to engineering, are not only influential in the reasons for choosing engineering as a career but also influences their experiences within the classroom.

The general culture and ambience confronting first year students is one that is likely to be seen as 'difficult' by most women for its impersonality and the apparent need to be 'one of the boys'. Jolly [1996] cites research by Smeaton which shows that Year 12 girls who have the qualifications to enter engineering expect to find that entering the profession would require a loss of femininity and a willingness to think and act like their male compatriots, which most of them find unappealing.

Smeaton also found that workload and the reputation for the difficulty of the program was an issue for potential students. Also, the perception that engineering is a 'thing' orientated profession, not 'people' orientated has kept particularly women from choosing it as a career.

2.0 The Study

The study on why students choose to do engineering is a section of a much larger study performed to investigate the gender dynamics in an engineering classroom [Burrowes, 2001]. The study used gender as a major criterion but also used discipline area and age. The results therefore are presented predominately in gender categories. The reasons for their career choose and students prior experiences and knowledge were studied to provide an understanding of the state of mind and perspective that students had before entering an engineering classroom which is an important part of the foundation to understanding how they reacted once within the classroom.

An ethnographic research methodology was used to obtain an understanding of the behaviours and socio-cultural activities and patterns of a group of engineering students, from their perspective, in a 'typical' engineering classroom setting and to find out the influences on them both past and present. Ethnographic research is designed to present a dynamic picture of the student group and their interactions and provide an alternative, more humanistic research paradigm to the traditional empirical scientific method.

The process of ethnographic research is essentially to collect descriptive data as the basis for interpretation and analysis of the research questions. Data for this research study was obtained primarily through fieldwork, which involved both observations of the engineering classroom setting and interviews of participants within that setting. Surveys were also used and have provided some quantitative measures to increase the reliability of the results. Thus, three data collection techniques were used: observation, focus groups and surveys to produce the empirical findings.

The classroom used in this study was a second semester first year course taken by students in the Mechanical, Environment, Surveying and Civil discipline areas. There were 136 students who participated in each of the two surveys conducted at the beginning and end of the semester, 122 male students and 14 female students or 10.3%, which reflect the female average participation in engineering classrooms at the University. Three groups of 6 students participated in the focus groups sessions that were held twice during the semester. There were 12 male students and 6 female students in these focus group sessions. The researcher was also a second tutor in one of the large tutorial groups and so was able to make observations during class sessions as well as in assignment work.

3.0 Data Collection Results

The first survey asked students what exposure they had had prior to enrolling in engineering. A selection of ten alternatives were given plus an option to add others. The question did not ask explicitly whether this exposure was necessarily influential in making a career decision however,

this connection was determined by the students who attended the focus group sessions. Therefore, the results are interpreted as influential in choosing an engineering career.

The data found that with this cohort of students the major category of influence for women was ‘visiting engineering sites’ where 6 out of 14 or 43% of women indicated that this was the major exposure to engineering prior to enrolling. This was confirmed in the focus group sessions where the female students felt that visiting engineering sites and (often) accidentally finding out about engineering was a major influence for women choosing engineering careers. The next most important categories for female students were family connections and using computers as tools, with 29% of female students in each category indicating these areas as influential in their prior exposure to engineering. Families were specifically seen as helpful in supporting the gathering of information about engineering programs and careers and less related to actually being influential to career choice. Figure 1a illustrates the responses for all female students compared to Figure 1b which shows the male student responses.

For male students the stereotypical ‘tinkering with mechanical equipment’ remained by far the most influential factor with this cohort of students with 68% (83 out of 122) indicating this was the exposure they had had to engineering prior to enrolment. Three of the female students (out of 14) also selected this category. The female students in the focus group said that they were either keen on Lego as a child or came from a farm where it was expected that they help out in the ‘machinery’ shed. As may have been expected, the breakdown by discipline showed that 75% of the mechanical engineering students selected this category with only 55% of the civil engineering students and 50% of environmental and surveying students selecting this ‘tinkering’ category.

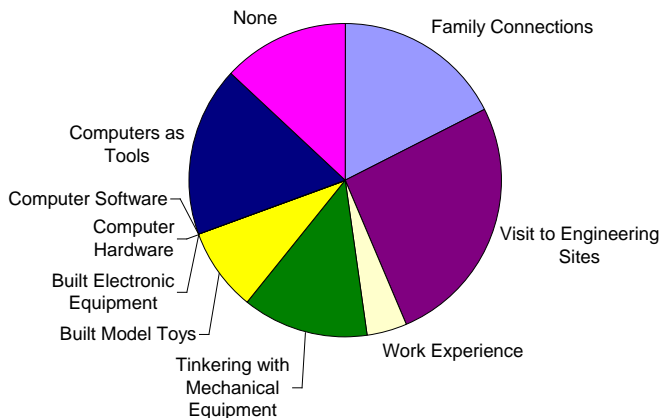


Figure 1a Engineering Exposure Prior to Enrolment for Female Students

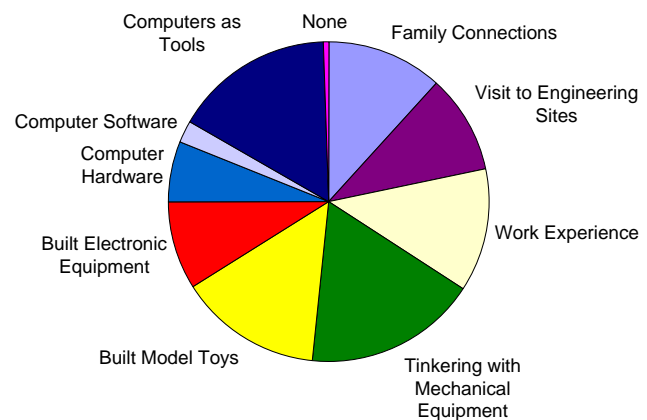


Figure 1b Engineering Exposure Prior to Enrolment for Male Students

The next two significant factors for male students were 62% recognising ‘computers as tools’ and 56% indicated ‘building model toys’ as areas of exposure to engineering prior to enrolment. A male student in the focus group session expressed surprise that students would connect the use of ‘computers as a tool for engineering work’ as exposure to engineering prior to enrolment. It *“surprised me, that so many of the students indicated that was sort of a factor in their choosing engineering”* [Male Student, Focus Group 2]. There was a notable debate in the focus group sessions regarding the connection of computers and engineering. There appeared to be quite a distinction among those female students who saw computers as associated tools of engineering and those who did not. It would seem that this distinction is also valid in the male cohort. The majority of students, however, as indicated in the survey, did not see any connection.

Interestingly, three male and three female students indicated that they had no previous exposure to engineering. My understanding from one of these female students was that it was a love of mathematics and science that led her to engineering despite not having any exposure to it. This was confirmed on numerous occasions during the research from students who related their choice of engineering to the enjoyment of mathematics and science at school. A male student in the focus group session commented from his experience:

“if they (students) have done a high level of math’s and a lot of science (at school), they automatically then look at the choices of science degrees or even engineering degrees. I suppose the engineering degree option I can understand for males I suppose, not trying to turn this into a sexist situation but I suppose historically I guess boys would go into that field if they have the educational prerequisites to follow that goal”.

Thus an interest in science and or mathematics at school was an important ingredient for both genders, however, due to the image of engineering as a male domain it was often seen only as a career option for men. For female students the love of mathematics and science needs to be combined with either the support and encouragement of a teacher or from some obvious but often-accidental exposure to engineering.

Also given, as a high priority by all students was the prospect of a good job that was well paid and had interesting career opportunities. It was clearer in the comments from the female students that social issues and the impact of technology on the environment was much more important to them than for their male counterparts, which is supported by the literature in this area.

The categories which the female students did not select at all also had a low selection rate by male students as influential areas. These areas included ‘computer software’, ‘computer hardware’ and ‘electronic equipment’. It became apparent during the focus groups that there was a lack of understanding of these terms, which also meant that interest in these categories remained low. This could be due to the fact that there were no Electrical/Computer Engineering students involved with this study group. In fact, one male mechanical student commented *“when I started here I didn’t think there would be computer work in it”*. A female student went on to say:

“I’m surprised that 62% of males, of these young guys connected engineering with computers because it means to me really heavy industry or mining and the computers have come in very late from my point of view and I still believe that”.

4.0 Study Results

4.1 Social Stereotypes and Image of Engineering

It has been recognised [Beder, 1998; Brown, 1996] that the image of engineering continues to be presented as a career for males and only attracts women who are still willing and comfortable to challenge or accept this ‘norm’. All the women interviewed in the focus group sessions indicated that they were aware of the non-traditional nature of engineering, some from an early age, and were none-the-less prepared and determined to become engineers despite this fact. As other research has also suggested [Stonyer, 1999; Lewis, 1995] there was clearly a feeling among the female students in this study that they would be able to ‘handle’ this non-traditional area, as after all they had already spent a number of years in a similar environment at school having chosen non-traditional courses for this career path. This attitude of being able to ‘handle’ it was clearly expressed by these women about their classroom experiences also. They were able to overcome their fears and seek academic help more readily than their male peers however they were much less inclined to seek out other support as a member of a minority group, as they did not see the necessity. This highlights a significant issue which needs to be addressed in engineering education as there were times when female students expressed frustration with the attitudes of men which are accept as the norm. The result of this is that women have to deal with an additional dimension in their learning environment that effectively questions their presence in engineering classrooms and their ability to fit in.

4.2 Choosing Engineering

It was established from the discussion in the focus groups that female students did find choosing engineering a more stressful decision than for male students. This is despite the fact that they did not generally feel as though they had gone through any extra hurdles to choose engineering as a career and that they felt able to ‘handle’ this non-traditional area. Male students’ discussion in the focus groups did not show the same level of anxiety when choosing engineering. In fact, male students did not seem to feel that they went through an arduous process to choose engineering as a career despite the fact that in the broader sense they had similar interests in mathematics and science and had participated in some form of ‘tinkering’ during childhood. As one male student explained *“boys would go into that field if they have the educational prerequisites”* as if it were the normal thing to do. These choices and the resulting motivations have an important impact on individuals within the classroom and the approach that students take with the workload that they are required to handle.

4.3 Exposure To Engineering

A greater proportion of female students to male students had sought after or accidentally come across some exposure to engineering prior to enrolling. This included site visits, work experience or through family/friend connections to engineering. There were, however, four female students

who indicated in the survey that they had no exposure to engineering prior to enrolling and had simply made the choice based on their love of mathematics and science at school despite their awareness of engineering's non-traditional nature. It was interesting that a large number of women students in the focus group sessions recognised their love of playing with Lego and/or time spent in the farm shed, or their confidence in using computers but this only surfaced after a similar admission by a fellow female student. These interests and skills were clearly not the obvious connection to engineering that the male students professed. These female students still had a strong love of mathematics and science as their main reason for choosing engineering. On the other hand, many male students still choose engineering based on their love of 'tinkering'.

4.4 Mathematics Influence

Many of the male students admitted that mathematics and science was not their most enjoyable or strongest subjects but had taken these subjects for career purposes. This was shown to be the case in a broader study recently completed by the Australian Government "*Factors Influencing the Educational Performance of Males and Females in School and their Initial Destinations after Leaving School*" [DETYA, 2000].

The first year of engineering programs in particular and later years also have a strong mathematics and science foundation, often being extensions of mathematics and science subjects at school. This appears to give female students an advantage as a majority of them have been very conscious of the high academic requirements of mathematics and science in engineering. This has been illustrated on a more general basis at the University of Newcastle with up to 70% of female students graduating with honours over a 5 year period in the late 1990s and early 2000s.

4.5 Family Connection

Family connections and in particular fathers and brothers or uncles has long been seen anecdotally as a strong influence, especially on women, in making choices about engineering as a career but this was not reflected in this study. Other literature [Smeaton, 1996; Lewis, 1995] in this area has suggested that many women in engineering have in fact gone against the advice of family and friends. These influences, both positive and negative, might be true on a broader social level however in this study it was not found to be true at an individual level. To some extent this was due to a high proportion of mature age women in the focus group sessions who indicated that their decision to study engineering was based on broader experiences beyond the school yard and family spheres.

4.6 Role Models

In fact, it was the female students who suggested it was critical that they had a mentor or role model who was supportive of their decision to do engineering. Role models are extremely important for inspiration as they provide someone to look up to as well as someone that can mentor you in the new environment to provide ongoing encouragement. For these women the lack of role models in the engineering classrooms was clearly evident from the observer's viewpoint but was not identified by the female students. As they do not accept the need for non-

academic support they clearly do not recognise the importance of female role models. It was interesting that in general female students did find it hard to describe themselves as engineers or see themselves in an engineering position. There was not one student (female or male) who knew of a women engineer (except the few academics at the University) when asked in the focus groups.

4.7 Prior Knowledge

Despite choosing engineering so effortlessly many male students did admit that they did not have a good understanding of what engineers did either but clearly appeared far more comfortable with their ability to be an engineer. The results showed that two-thirds of male students referred to 'tinkering' and hands on practical experience, which was described as playing with computers, building model toys or working on mechanical equipment found in the garage and farm shed, as important to their career choice. This supports the literature [Roberts, 1996] that suggested that having these skills and interests is continually being reinforced as beneficial to doing engineering despite them not necessarily being related to what engineers actually do or study. Roberts [1996, p8] in the National Position Paper for Women in Engineering commented that "for many women, engineering still presents a masculine culture associated with hands on skills, cars and sport". This was reiterated in the Review by the Institution of Engineers Australia [1996] where it was recognized that despite these interests having little connection with 'real engineering tasks' they were represented within engineering curricula. Mare et al [1996, pg85] states that "it appears as though the more usual informal background of the male students is relied on in a formal way within the curriculum". This frustrated the female students who commented that they were "expected to mysteriously know the language and parts of mechanical apparatus".

The positive exposure to engineering which female students obtained prior to enrolling, however, was necessary to give them confidence when using equipment or in keeping up with the jargon. The Mare [1996] study showed there was a hesitation and lack of confidence in female students towards laboratory equipment. Results of this study have shown female students definitely admitting that they were more hesitant about approaching courses and computer assignments than their male peers however they clearly believed in themselves and in fact would end up feeling more confident by the end of the semester in both areas. Thus female students awareness of the difficulty of engineering programs appears to be a determinate of the more positive application to their study.

5.0 Conclusion

There has been two major aspect of this paper that present students perspectives of why they choose engineering and how their prior knowledge and experiences have affected their place in the classroom. Some of these facts highlight aspects of engineering education which need to be addressed.

In choosing engineering it was clear that women had to go through a far more rigorous process socially and mentally than their male peers. This does not appear possible to change until society perceptions of engineering changes. There were however two major issues that strongly influence the chooses to do engineering. These are the emphasis on Mathematics and Science

that engineering continues to promote (possibly against what practically is required) and the narrowness of definition of what engineering is understood to be by these students. The discussion on the connection of computers and engineering highlighted the lack of personal connection to engineering objects and the built environment that is so much apart of our society today. I have previously questioned the need to turn around our promotion of engineering to reflect on how we are all 'consumers' of engineering [Burrowes, 1998]. This approach might also go some length in moving women from finding out about engineering accidentally to them proactively seeking it out.

In the classroom the emphasis on masculine interest areas means that women (and some men) can be disadvantaged academically because of the assumption of prior technical experience and language interpretation and that without role models and a change of culture, women are still struggling to find their place in engineering.

6.0 References

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7.0 Acknowledgements

This paper is presenting a portion of the study conducted which formed part of my Master of Philosophy Thesis. I would like to thank my supervisors, Prof Catherine Smith & Prof. Adrian Page again for their support in that process.

8.0 Biographical

GUNILLA BURROWES has managed a Women in Engineering Project followed by a Diversity in Engineering Project at The University of Newcastle, Australia for 6 years from 1997 to 2002.

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