

Is Engineering For Me? Do Girls Have Enough Information to Decide?

Janis E. Swan¹ and Bronwen Cowie².

¹ School of Engineering, ² Wilf Malcolm Institute of Educational Research,
University of Waikato, Hamilton, New Zealand 3240
Corresponding Author Email: Janis.swan@waikato.ac.nz

STRUCTURED ABSTRACT

CONFERENCE SUBTHEME

3. Beyond the classroom – tailoring engineering and STEM education to meet the needs of all stakeholders. (External Industry requirement)

CONTEXT

Increasing the diversity in engineering starts with increasing the proportion of the specific cohort choosing to study engineering. The proportion of women doing engineering is low. Common barriers to increasing the proportion of woman in engineering include not studying the appropriate subjects to meet entry requirements, misconceptions about engineers, and lack of information on possible careers after graduation. Various strategies have been developed to overcome barriers but the proportion of woman studying engineering has not increased significantly over the past fifty years.

PURPOSE

To survey female high school students attending structured engineering information events and identify how much prior knowledge they had about engineering as a career and where they had obtained this knowledge.

APPROACH

The University ran a “Engineering and Science Week’ to publicise the degree science programmes offered. Participants could attend up to four different half-day sessions, each containing practical sessions on different aspects of the seven professional engineering programmes or the four broad science areas offered by the Faculty. Female attendees were asked to complete a short survey on their interest in engineering as a career and where they had obtained information about engineering. All responses were anonymous. The study was approved by the University of Waikato Human Ethics committee.

RESULTS

One third of the students attending the sessions were female and one-third of them (i.e. 10% of the cohort) attended engineering sessions. About half of the females rated their interest in pursuing engineering as high to very high. This cohort considered engineering fitted with their ability in maths and the sciences. Information on engineering came mainly from family members and family friends, followed by teachers. Low interest in engineering careers was attributed to perceived gender stereotypes and sexism. Only one-third of the respondents gave suggestions for increasing female participation in engineering, which included better marketing, having interesting gender-tailored activities such as engineering camps and workshops. The survey will be repeated in future years to increase the data.

CONCLUSIONS

Although many female students attending an engineering week considered engineering may be an interesting career option, gender stereotypes and sexism were major hurdles to increasing participation.

KEYWORDS

Engineering, gender, recruitment, career options

Introduction

It is widely recognised that we need to increase the diversity of engineering students if we are to grow the capability and capacity of the engineering profession to provide the creative and innovative engineering solutions that are needed by society today (Corbett & Hill, 2015; Hill, Corbett, & St. Rose, 2010). Recent data, however, shows that although the proportion of women in engineering programmes is slowly increasing, the majority of engineering students in western countries are male (ASEE, 2016; ASEE, 2017; Hango, 2013; IPENZ 2015; NSERCC, 2017; ONWiE, 2017; WES, 2018). As with other international governments and bodies, there has been a growing call within the New Zealand education system to increase the number of students (particularly women) to study in the STEM fields. In 2018, Engineering New Zealand (formerly IPENZ), along with the New Zealand Institute of Architects and ACENZ, launched an initiative to attract 20 percent more women into engineering and architecture roles by 2021 (Freeman-Green, 2018).

People have researched how outreach programmes help increase interest in STEM. Recent reports include those by Vennix, Brok and Taconis (2017) on perceptions of STEM-based outreach learning activities in secondary education, Sadler, Eilam, Bigger and Barry (2018) on the types and impacts of STEM outreach programmes delivered by some Australian universities, and using humanitarian engineering to engage young girls (Goodyer and Soysa 2017). There is evidence that engaging undergraduate STEM students in delivering outreach programmes benefits them and the outreach event participants (Ferrara, Talbot, Mason, Wee, Rorrer, 2018; Fitzallen & Brown, 2017; Jacobson, & Gallagher, 2018). Prosis, Romatoski, Stonedahl and Shi (2018) report that outreach events can influence girls to pursue STEM, who find hands-on activities interesting, appealing, and meaningful (Geist & King, 2008; Halpern, 2004; Mitchell, 1993). Even short-term outreach programmes have a lasting effect on a girl's career directions (Callahan, Llewellyn, Strieha & Delaney, 2017).

The University of Waikato runs sessions to introduce students to the various science and engineering programmes it offers. Women participants at these sessions are asked to complete a survey to identify factors that have influenced them to consider an engineering career and informed their early tertiary enrolment decisions. The aim is to identify potential reasons for the under-representation of women in engineering.

Method

The Faculty of Science and Engineering at the University of Waikato runs Open Days each year to allow the public to experience STEM topics during a half-day of hands-on activities. Each session covers two related STEM areas. Eight different half-day sessions are available and each session is repeated twice. Participants can attend as many sessions as they are interested in and can schedule during their time on campus. Schools in the region are informed of the Open Days and often arrange for groups of their senior (Years 12 and 13) students to attend. The wider public can also attend as individuals.

Data was gathered at the University of Waikato Engineering and Science Open Days held in July 2017. Female secondary students were invited to voluntarily fill in a survey of eight open or closed questions aimed to provide a glimpse into their reasons and level of interest in pursuing an engineering qualification. The survey aimed to identify what motivated them and the challenges they foresaw in working and studying in a traditionally male-dominated field. Respondents were given approximately 10 minutes to fill in the survey.

Results

Of the 526 students from schools across the region who attended the Open Days, one-third (158) were female students. Of the female students, 47 completed the survey (a 23% participation rate). One-third of the female students and 60% of the male students attended the engineering sessions. This translates into a female 'participation' rate in engineering activities of 20%, which is the same as the current proportion of women undergraduates in the engineering school. Of the 47 survey participants, 42% were in Y13 and (58%) in Y12, while 60% attended co-educational and 40% attended single-sex schools.

As expected from a survey of people attending an engineering 'promotion' activity, a significant majority (79%) of survey respondents were indeed interested in pursuing an engineering career, with 26% confirming a high-level interest (i.e. 6-8 on the 8-point Likert scale (Fig. 1) and only 21% of respondents signalling varying degrees of disinterest (1-4 on the 8-point scale).



Figure 1. Current interest in pursuing engineering as a career (8-point scale where 1 = very low and 8 = very high).

A more detailed analysis identified that the Year 13 cohort were more certain of a career in engineering as 60% of this cohort had indicated a strong interest compared with only 45% of the Year 12 cohort. A higher proportion of the students from single-sex schools (nearly 60% of those surveyed) were strongly interested in engineering as a career than those from co-ed school (45%). This strong interest in engineering as a career had developed in Y12 students from single-sex schools, where 50% were already strongly interested in engineering as a career compared with 40% from the same year cohort attending co-ed schools.

Over half (55%) of the participants had sought or received career advice about engineering. People with whom students could be expected to have comparatively close relationships featured - father, mother, sibling, family friend, peers (Fig. 2). Teachers were also important but interaction with school career advisers was limited, with less than 10% of the participants having had any form of engagement about engineering from a careers adviser. There also was low level of engagement with external engineering organisations and/or the tertiary sector. These findings suggest there is opportunity for the secondary sector to improve student access to quality careers advice, and that this is an area where the tertiary sector can assist.

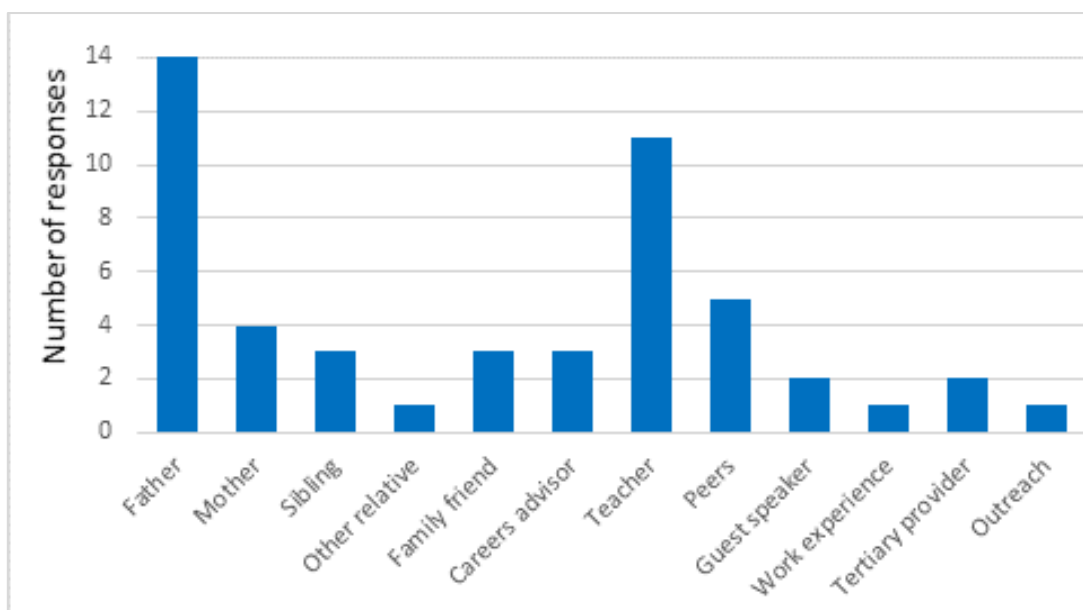


Figure 2. Sources of advice on an engineering career.

Engineering education research has emphasised the positive connection between early exposure to and engineering experiences along with quality careers advice work in raising awareness and improving tertiary student enrolment rates (Powell, Dainty, & Bagilhole, 2012). This is particularly important for women and minority groups. Over half of the participants in our survey indicated they had engaged in some form of advice about engineering careers before attending the Open Days but we did not explore the quality of this advice.

There were a wide range of reasons the participants thought engineering would be an interesting career (Fig. 3). The participants enjoyed or cited their academic match to particular subject(s) at school (41%) e.g. “my ability in maths and physics”; engineering-related activities are design orientated and enable students to build and create things (17%); and there is an opportunity to problem-solve and do interesting and varied work (11%). Abel-Palmieri (2014) reports that integrating problem-solving approaches helps increase engagement, thereby increasing the likelihood of women seeking these types of careers. Some participants commented they were encouraged by their parents, “My parents said I would be good at it” or had some type of family connection with an engineering background (7%). Others credited their teacher with encouraging them to study engineering (6%). Factors such as salaries, employability or recruitment activities were acknowledged to a lesser extent. One striking observation was that respondents did not include the role engineering plays in helping society as one of their reasons; this aspect is commonly referenced in the literature (Garibay, 2015).

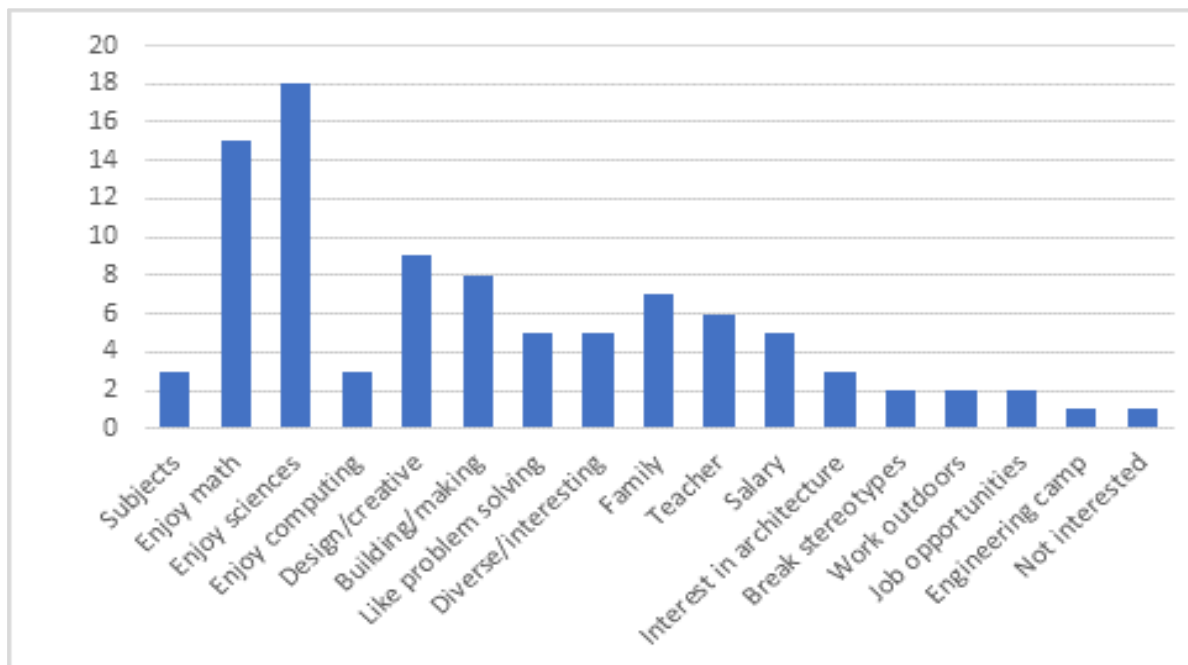


Figure 3. Reasons for engineering being an interesting career.

Survey participants were asked to list up to three alternative career choices they were interested in besides engineering (Fig. 4). A small number of participants referenced careers such as computing, law or the military (Fig. 4) but most of the responses were in three major areas: another field of engineering (22%), careers associated with health/medicine (21%) and creative areas such as design, architecture and the arts (19%). This creative aspect correlates with the ranking of key influencers in selecting engineering as a career (Fig. 3).

Respondents gave many reasons on why women may find engineering unattractive (Fig. 5) but the well-documented problem cited by many respondents (26%) was prejudicial stereotypes based on societal norms around gender roles and sexism. The following comment illustrates this sentiment, “Men don’t believe women can do this stuff and therefore put them down or talk to them as if they are stupid”. Participants also described engineering as being a “male dominated” job (14%), along with comments describing engineering as being, “very physical” (8%), and “considered as ‘dirty’ because if you’r[e] in the technical trade you’r[e] fixing/making things” (10%). Although 11% also felt insufficient information, poor marketing and advocacy were contributing factors, others (6%) maintained there were no issues and that women are just as capable as men are (6%). One participant inferred the negative connotations had spurred her decision to enter engineering, “[W]omen tend to not have the

confidence to 'stick it to the man', I think otherwise". Lack of confidence can discourage women and the need to attend university or have good mathematical abilities was considered a deterrent.

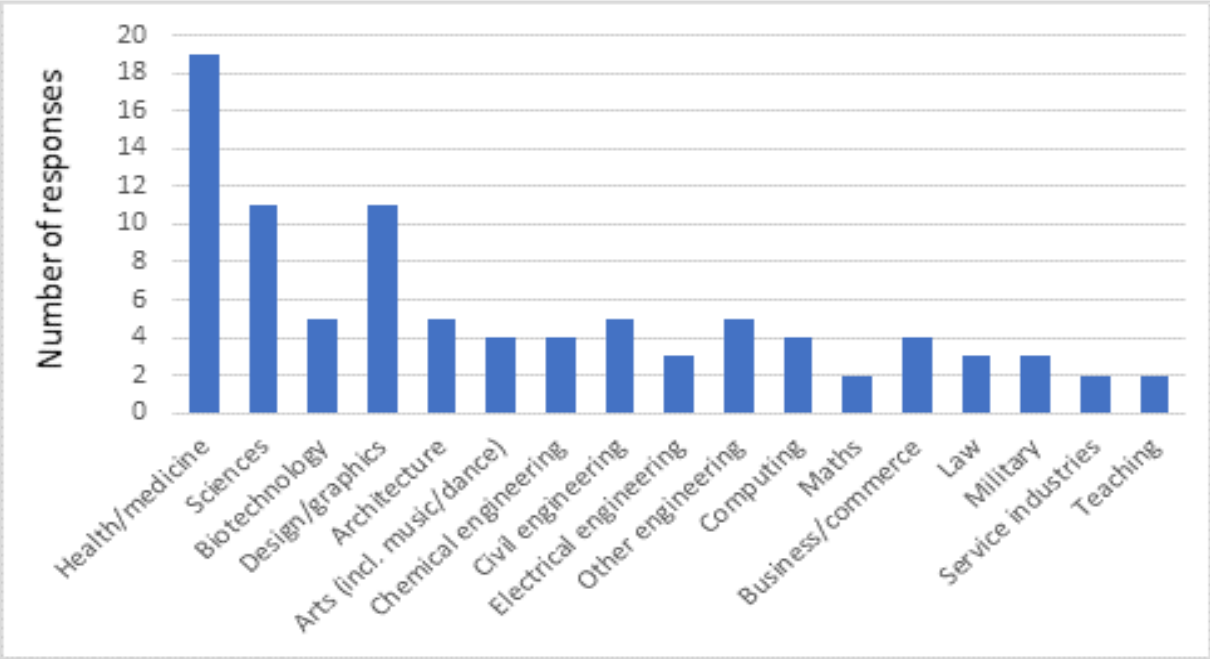


Figure 4. Other careers respondents may consider.

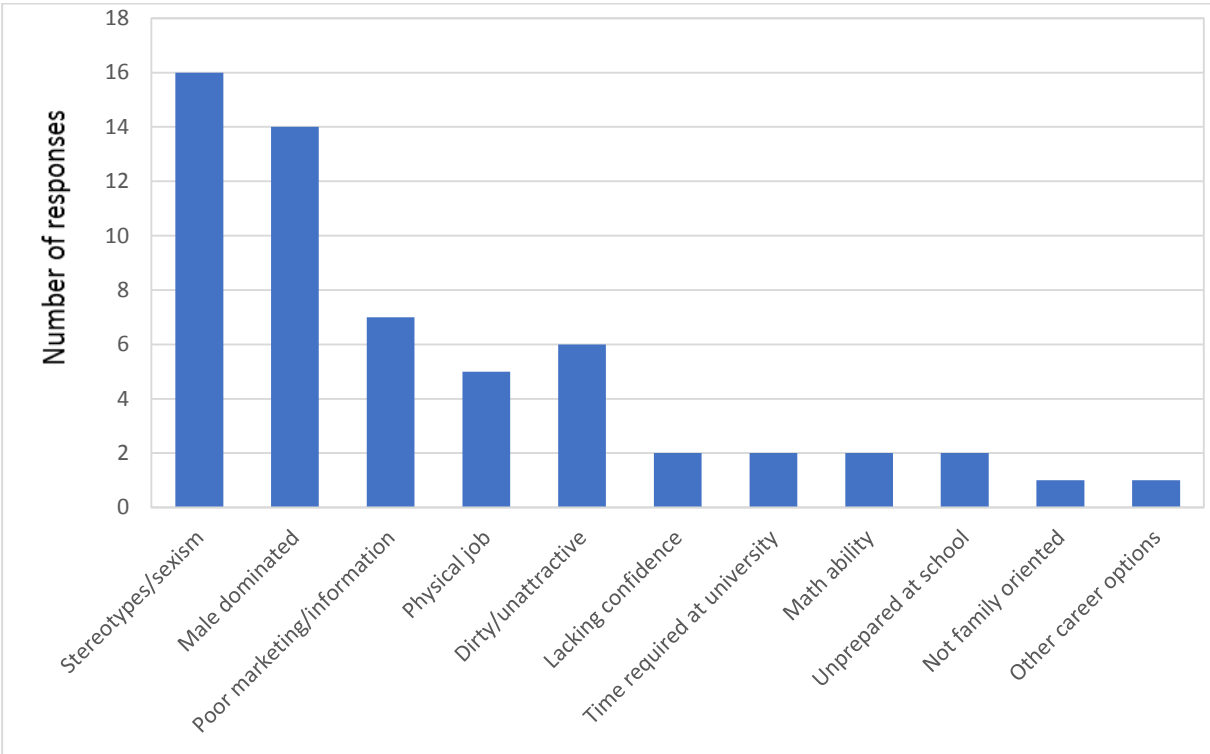


Figure 5. Reasons engineering is not an attractive career for women.

To elicit information on how to counteract engineering being viewed as unattractive, the final survey question sought ideas to improve engagement and recruitment of women students into engineering. Interestingly, while there is a growing wealth of literature attempting to address these issues and dispel gender stereotypes, this survey question had the largest number of nil responses (21%) from the 47 respondents (Fig. 6) so the results are limited. The respondents suggested the following ideas to understand the nature of engineering and reduce any significant barriers to engineering pathways:

investing in gender tailored activities (20%) such as engineering workshops and camps; improving communication and marketing (19%); and introducing engineering-type courses into the school curriculum (13%). They also advocated for hands-on learning and relevancy through real world learning e.g. “give more opportunities to experience [engineering]”. Taken together, these results confirm a desire/need for early exposure towards pre-engineering concepts, skills and experiences, which corroborates previous research (Denyszyn, 2013; Suescun-Florez, Iskander, Kapila, & Cain, 2013). Other interventions included student-centric activities such as mentoring by women university students and scholarships.

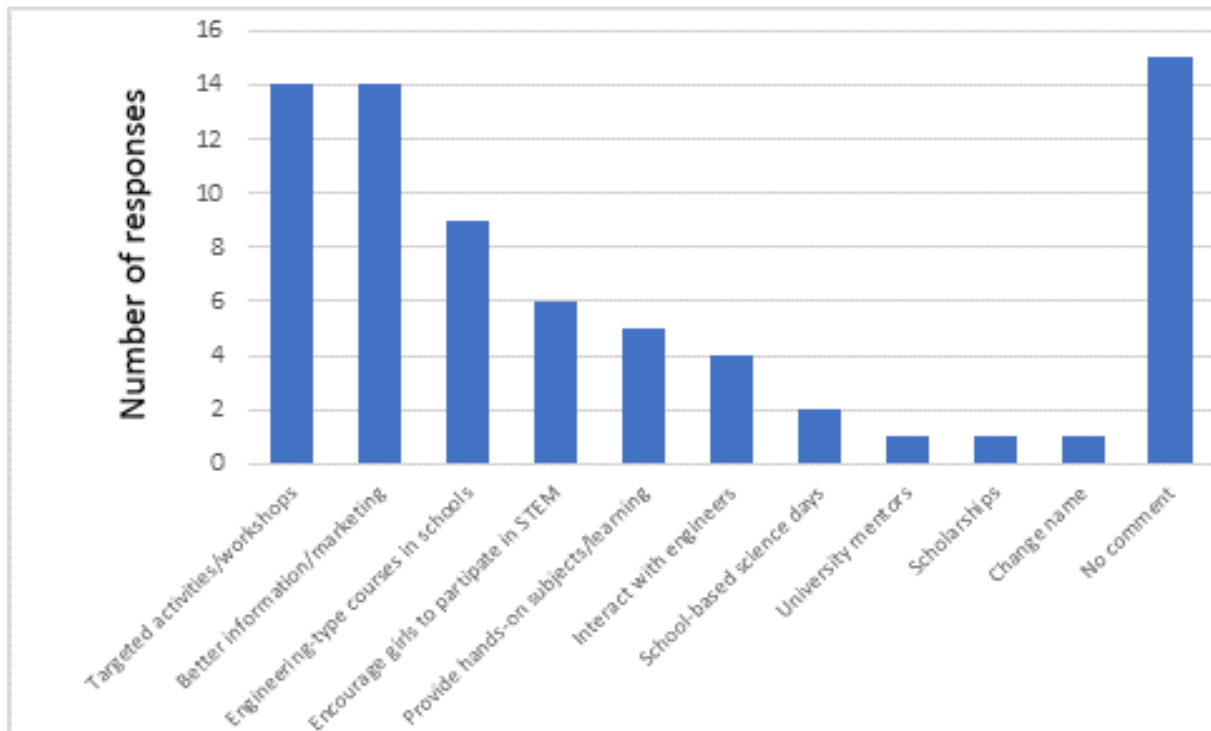


Figure 6. Activities to encourage girls to consider an engineering career.

Conclusions

The Open Day data identified that the female students’ perceptions and career decisions are a complex and dynamic. The research also revealed the various factors influenced their career choices. These include different socialisers, academic knowledge, skills and ability, perceived career rewards, and taking on challenges. It also supports evidence that career decision-making is a gendered process, and as a result, different strategies may be required to promote engineering as a career path for women. In particular, the respondents recognised the need for targeted and high quality information and experiences that connected to their creative and/or analytical problem-solving talents.

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