

Engineering qualifications at the OU – what motivates women to study?

Keywords: engineering, women, mature, motivation, undergraduate

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Report submission date: 21/09/2019

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Executive Summary

A project was carried out aimed at gaining a better understanding of the motivations and career aspirations of mature women studying engineering qualifications at the OU and to find out more about how their study experience differs from that of their male counterparts.

Key findings:

- The majority of OU engineering students are working, with men more likely to be working full time and significantly more likely (58% men vs 19% women) to be already working in an engineering role; although high, the proportion of men currently working in engineering is lower than has traditionally been the case and suggests a change in the demographic of these students.
- Significantly more women than men (44% women vs 17% men) have never worked in engineering but want to enter the profession. As a consequence, men were significantly more likely to be studying to progress their current career, while women are more likely to be interested in changing career direction or entering the engineering profession. Women were also more motivated by studying something useful.
- Many female engineering students are well qualified: 46% of the female students already had another degree, compared to just 16% of the men. Female students tend to be aiming higher in both terms of qualification aim and professional registration intention.
- When choosing their qualification, female students were more likely than men to have used the OU website or prospectus, or to have spoken to an OU adviser. Men were more likely than women to have seen advertisements and were more likely to have had advice from others, including friends or family, work colleagues, employers and engineering institutions.
- The male students were more likely to have been encouraged to do engineering by others. Several female students reported a lack of information about engineering as a career option both at school and afterwards, but they were more likely than the men to report a family connection with engineering and found networking opportunities very helpful.
- The most common source of funding was a student loan, but a high proportion of students were paying the fees themselves and significantly more men than women received funding from their employer.
- Students were happy with the subject content of the OU engineering qualifications, its level and its delivery. The Open University, and especially their tutors, were identified as being consistently supportive and flexible and the importance of support from family was also recognised.
- Interests in sustainability and environmental engineering featured highly for both sets of students and are reasonably well catered for in the OU engineering curriculum. However, civil engineering, which emerged top of the list for women but was a much lower priority for men, is not currently offered as a specialism.
- Whilst most students reported positive attitudes towards their study of engineering, there were instances of negativity from managers and work colleagues towards women. All of the interviewees with experience of working in engineering had seen, or been subject to, sexist attitudes and behaviour. Male students interviewed were aware of the gender imbalance in most workplaces and of the sexism faced by their female colleagues.
- Although a higher proportion of women strongly agreed that they were confident to succeed on their qualification compared to the men (48% women, 35% men) the overall confidence levels (strongly agree + agree) are higher for men (84% women, 94% men), possibly related to the educational background of the women. A similar but less pronounced effect was seen for confidence in mathematics. Men were more likely to believe they have a similar level of previous knowledge to others on the qualification' (22% of women strongly agree or agree,

compared to 47% men), but assumed prior knowledge in OU module materials was not considered a major issue.

- Women were far more likely to be aware of being in a minority (64% strongly agree, or agree), mainly due to their gender, but a smaller number of men (18% overall) were also aware of being in a minority for reasons that included being good at maths, being a distance learner, not working in an engineering context, being non-British and being older.
- The biggest challenge to studying for most students was the demands of their work schedule. The demands of home life and health issues were also mentioned. The most common requests for improving their OU study experience were for more flexibility in study patterns and more tutorials.

The project has led to a more detailed understanding of the backgrounds and prior educational experiences of female engineering students and the challenges they face, not only in their study but in their work and home lives. We have also gained an understanding of male students' work experience, which is significantly different from that previously assumed. The knowledge gained from this project will inform future curriculum developments and current presentation practices.

Aims and scope of the project

There have been many initiatives in the UK over the past 30 years aimed at increasing the number of girls entering higher education to study engineering, such as those reported by WISE (1). However, a 2018 report by Engineering UK (2) stated that while women make up 47% of the overall workforce, they account for only 12% of those working in engineering, suggesting that past initiatives have not been successful. Similarly initiatives exist encouraging women qualified in engineering to return to the profession after a career break (3), but take-up is low, contributing to what is often referred to as the 'leaky pipeline'. The Open University (OU) is an open access, distance-learning institution which offers full and part-time degree level study in engineering, potentially providing an alternative route into the profession for mature women who are new to the discipline.

The main aim of our research was to understand the motivations of mature women studying engineering qualifications at the OU. Women make up approximately 12% of engineering undergraduates at the OU, which is low compared to the sector average of 16% (Engineering UK). By developing an understanding of the motivations and career aspirations of these students we hope to increase the number of mature women studying and entering the engineering profession. We also aimed to discover what attracted them to engineering to assist marketing to reach untapped pools of students.

The project also yielded valuable information about the study experience of OU engineering students and how that differs between men and women.

Activities

The overall approach of the project was to gain a better understanding of the demographic, motivation and career aspirations of our current female engineering students and how they differ from the male students, in order to inform future developments in marketing, curriculum development and student support.

The original planned activities were:

- Phase 1 – literature review of existing strategies and interventions from UK HEIs encouraging women into engineering.

- Phase 2 - focus groups (~6) and individual in-depth interviews (~10) with current women students.
- Phase 3 – online survey (informed by focus group activity) for all active female engineering students, together with a representative sample of male engineering students to allow comparison.

An Associate Lecturer was commissioned to carry out an initial literature review, but this produced little of direct relevance to the context of the project, confirming the lack of published material relating specifically to mature female engineering students. However, we continued to scan the literature for relevant material as the project progressed. It was decided to reverse phase 2 and phase 3, due to the difficulty of identifying volunteers for focus groups and interviews. Carrying out the online survey first provided an opportunity to seek volunteers for follow up activities; this was effective in identifying interviewees, but the wide geographical distribution of the volunteers made focus groups impractical.

Two student surveys were carried out. The first, in November 2017, was a small pilot survey sent to 65 women registered for an engineering qualification and studying their first module (T192 Engineering: origins, methods, context, 30 CATS credits). The same survey was sent to 125 male students to allow comparisons to be made. Responses were received from 18 women and 10 men. Based on the results from the pilot survey some small changes were made and a second survey (the main survey) was sent to all other actively studying female engineering students and a slightly larger number of randomly selected male engineering students. Responses were received from 58 (out of 311) women and 51 (out of 489) men. For analysis the results from the two surveys have been combined, except in the few cases where a change to the survey prevented this. A copy of the questions asked is included as Appendix 1. Institutional data including student age, geographical location, socio-economic status, previous educational qualification and disability enabled us to compare the overall profile of our sample with that of all OU engineering students. No significant differences were found, confirming that, with the exception of gender, our sample is broadly representative of the overall OU engineering student population.

From the surveys, 23 students volunteered to participate in follow-up activities and 17 (12 female and 5 male) were subsequently interviewed. The interviews were carried out by Moira Dunworth, an Associate Lecturer with considerable experience of conducting and analysing interviews. The interviews were based on a semi-structured research instrument, see Appendix B. All interviews were recorded and transcribed. The data were entered into an NVivo project using a coding framework that evolved from the initial research instrument and analysed within NVivo.

Findings

Data analysis from the questionnaire revealed some similarities between the responses from men and women, but also several significant differences. Statistical significance, where included, was evaluated using a two-tailed chi square test.

The main findings are grouped into categories below, each combining relevant quantitative results from the questionnaires and more qualitative insights from the interviews. The small sample size and gender imbalance of the interview sample should be borne in mind when interpreting these results. A selection of quotes from the interviews are included as Appendix C.

Student profile

The student age profile was similar for both genders as shown in Figure 1, though slightly skewed towards older age groups for the male students.

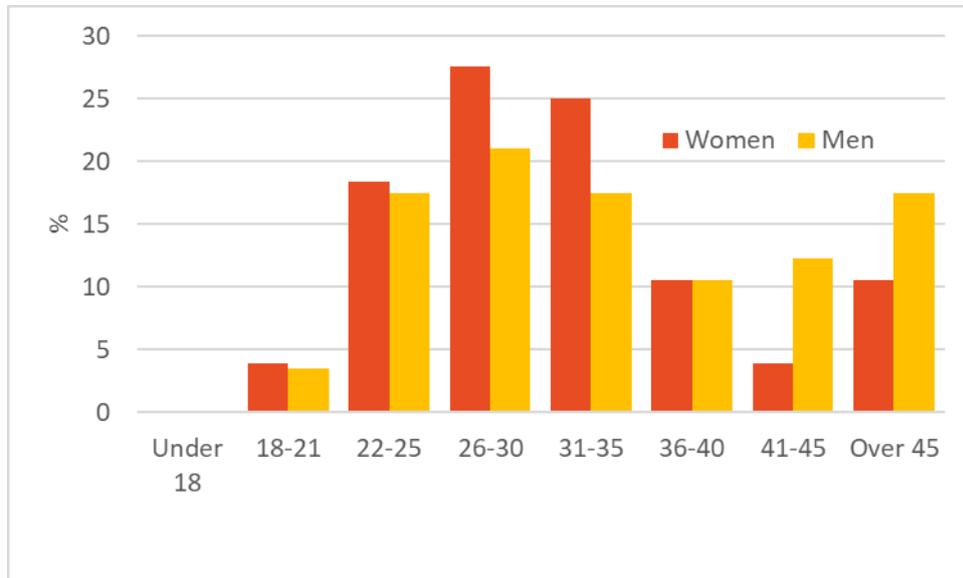


Figure 1 Response by gender to 'What age were you when you started studying for an OU engineering qualification?'

When asked 'What is your gender identity?', one female student (from 76) and one male student (from 57) identified with the opposite gender; no respondents chose the 'other' option.

Table 1 shows that the majority of the students are working, although men are more likely to be working full time than women. The increased level of caring responsibilities amongst women is interesting but not quite statistically significant based on this sample.

Table 1 Responses by gender to the question 'What is your current working situation?'

	Women %	Men %
Working full time	71	84
Working part time	10	4
Seeking employment	4	7
Not currently able to work for health reasons	3	4
Not currently able to work due to caring responsibilities	7	0
Retired	0	0
Other	3	2

However, there are marked differences in working situation: more than half the men are already working in engineering, while women are more likely to be wanting to work in engineering in the future. Both these results (shaded in the table) are extremely statistically significant. Although high, the proportion of men currently working in an engineering role is lower than has traditionally been the case and represents a change in the demographic of our students. The main 'other' responses were from people working alongside engineers, but not in STEM.

Table 2 Responses by gender to the question ‘What (if any) has been your experience of working in the engineering sector?’

	Women %	Men %
Currently working in an engineering role	19	58
Currently working in a non-engineering role but in STEM sector	23	12
Have worked in engineering but left and now wanting to return	4	5
Have never worked in engineering but want to enter	44	17
Have never worked in engineering and have no intention of doing so	4	0
Apprenticeship	1	3
Other	4	5

The answers to the question ‘Did you already have another degree before you started this degree’ showed a surprising difference between genders: 46% of the female students already had another degree, compared to just 16% of the men. This result is extremely statistically significant with a two-tailed P value of less than 0.0001. Previous qualifications covered a wide range of subject areas, both in Arts and Social Science (e.g. Classical Studies, Music, Economics) and STEM subjects (e.g. Analytical Chemistry, Human Nutrition, Zoology).

Choosing engineering

The way that students first found out about OU engineering qualifications showed some gender variation, as shown in Figure 2. Female students were more likely than men to have used the OU website or prospectus, or to have spoken to an OU adviser. Men were more likely than women to have seen advertisements and were more likely to have had advice from others, including friends or family, work colleagues, employers and engineering institutions (CIBSE was named). The main ‘other’ source of information stated was a google search.

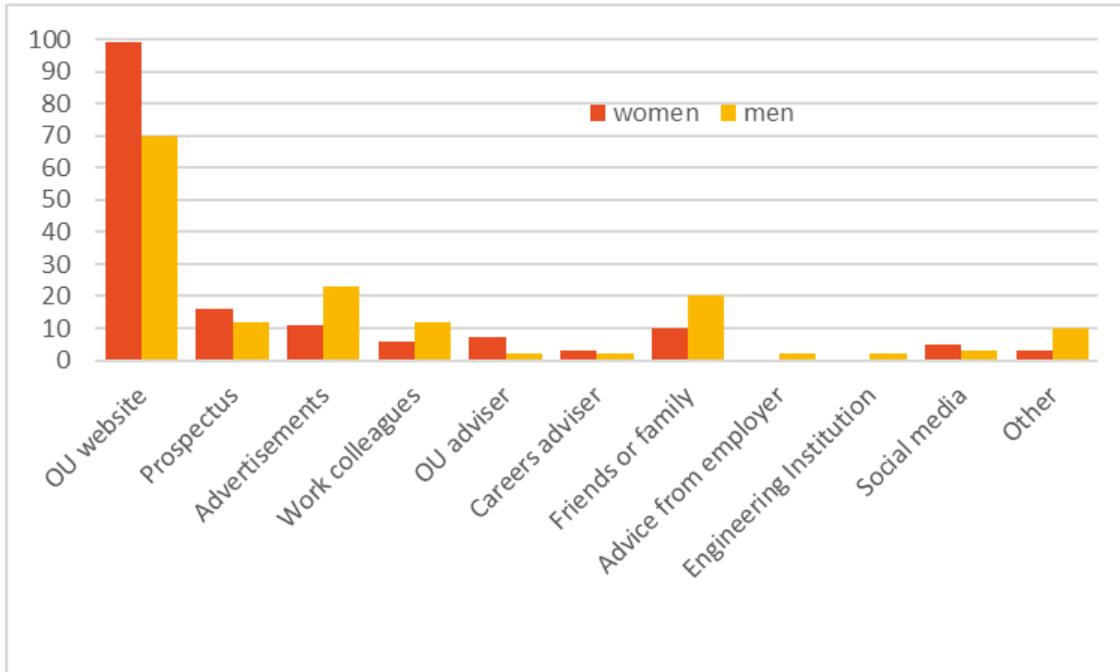


Figure 2 Response by gender to ‘How did you first find out about OU engineering qualifications?’

Students were asked about sources of encouragement. The results shown in Figure 3 suggests that men were more likely to have been encouraged to do engineering in every category, but the differences are not statistically significant. The main ‘other’ cited were work colleagues or personal interest; the most unusual response, from a male student, was ‘airport visa checker’!

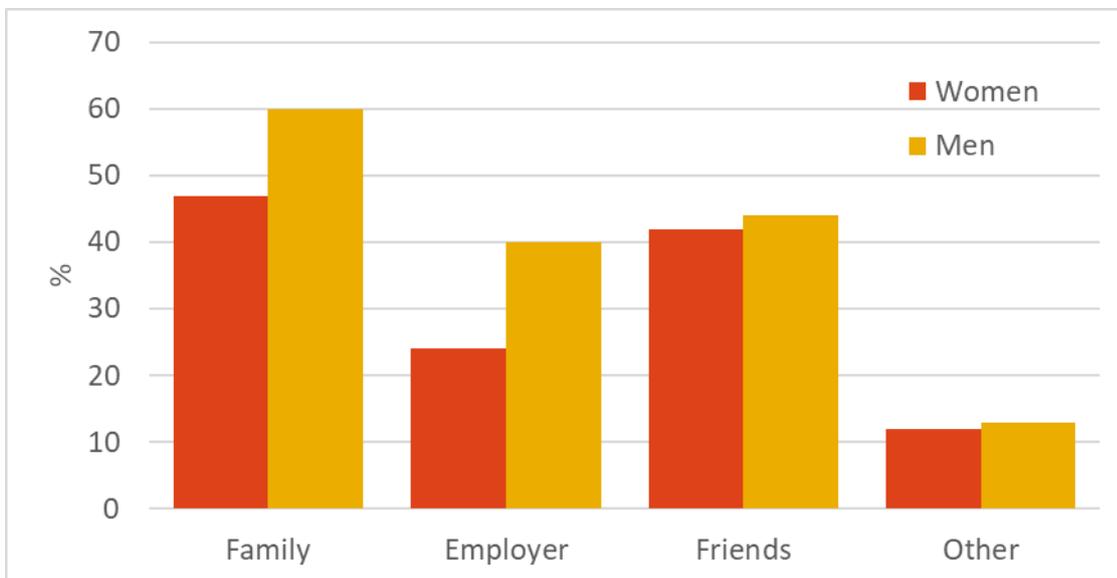


Figure 3 Response by gender to ‘Were you encouraged to study engineering by any of the following people?’ (main survey only)

The women who were interviewed were more likely to have had a previous connection with engineering than the men: 80% (four) of male students reported no family, friend or work connection with engineering before embarking on their degree, compared to only 17% (two) of

female students. Three female students had family members who worked, or had worked, in an engineering setting but no male students reported a family connection.

In the interviews, several of the female students reported a lack of information about engineering as a career option both at school and afterwards. They described barriers at school level, where they were not encouraged to take up engineering and were sometimes actually hindered in their efforts to move into that area of work/study. Many students are studying engineering as a second degree because they were not encouraged to choose this the first time around.

Women students, in particular, felt uninformed as to what options existed in terms of study and, especially, in terms of career options. Several mentioned finding WES (Women’s Engineering Society) events useful because they meet other women there who shared information on what options there are. To have had other women to speak to when choosing their degree would have been appreciated by many of the respondents.

Motivation and aspirations

‘Motivation’ is used in this study to refer to an active desire to achieve something and ‘aspiration’ to describe long-term hopes.

The questionnaire explored motivation by asking students to choose their ‘main reason for choosing to study engineering’; the results are shown in figure 4. The most significant differences were that men were far more likely to be studying to progress their current career ($P = 0.005$, very significant), while women are more likely to be interested in changing their career direction or entering the engineering profession. Women were also more motivated by studying something useful ($P = 0.0359$, significant). ‘Other’ responses mainly cited career flexibility.

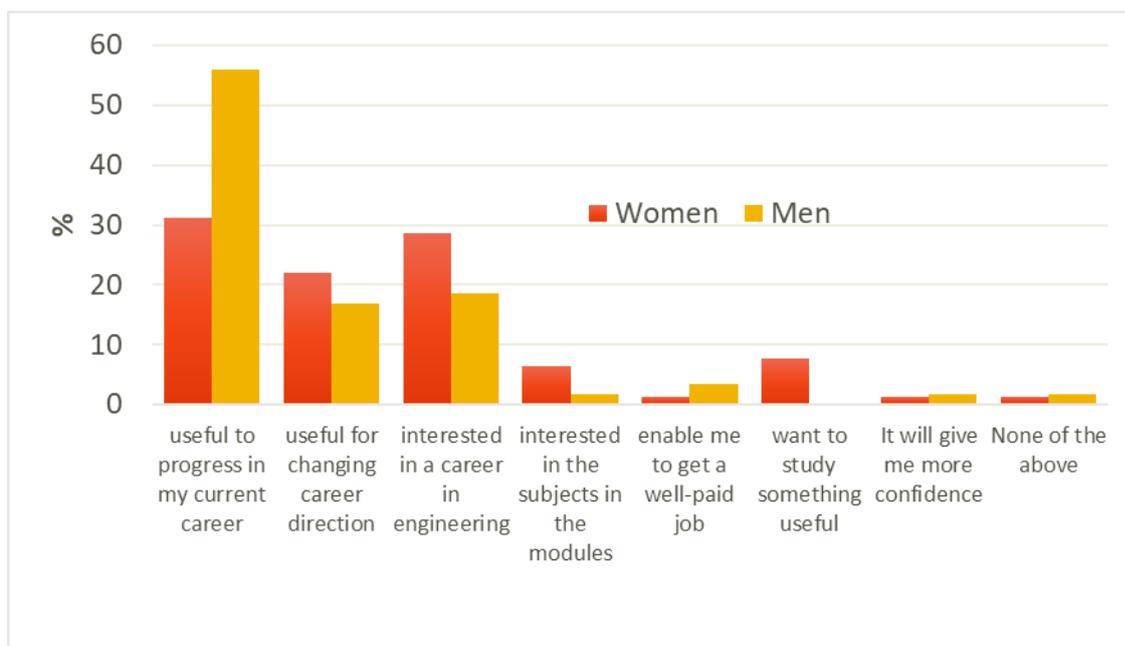
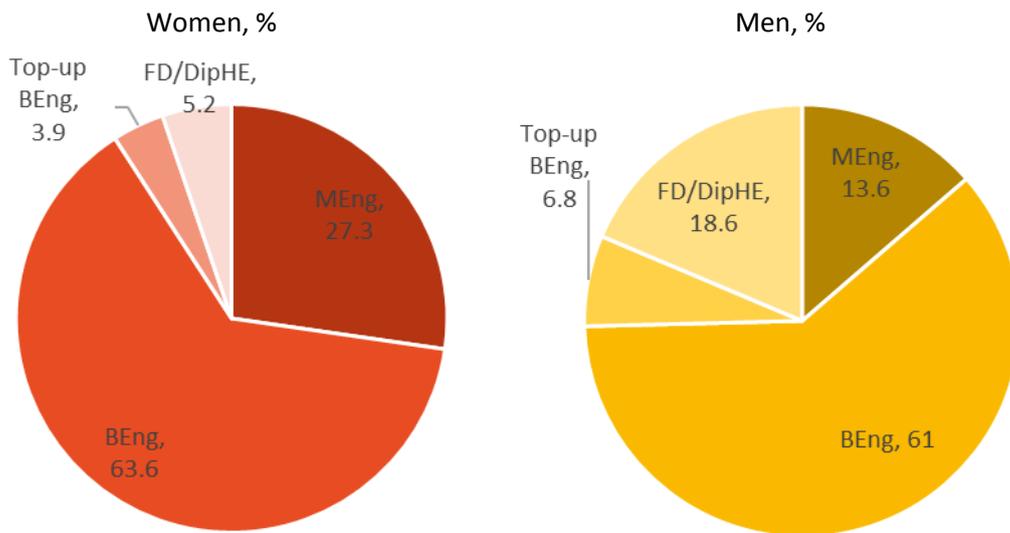


Figure 4 Response by gender to ‘What was your main reason for choosing to study engineering?’

Overall 51% of students surveyed were studying at level 1, 27% at level 2, 19% at level 3, 3% at level 4: the profile was similar for women and men. The differences in qualification and professional

registrations aim shown in Figure 5 suggest that the female students tend to be aiming higher, with a higher proportion than men aiming for an MEng qualification, and professional registration as a Chartered Engineer. Although only the differences in Foundation degree/Diploma of HE registrations are statistically significant based on the questionnaire data, the same trend in qualification aim is seen in overall qualification registration data. The FD/DipHE requires students to be working in engineering, so the lower number of women on these qualifications is perhaps not surprising in the light of Table 1.

a) Qualification aim



b) Professional registration aim

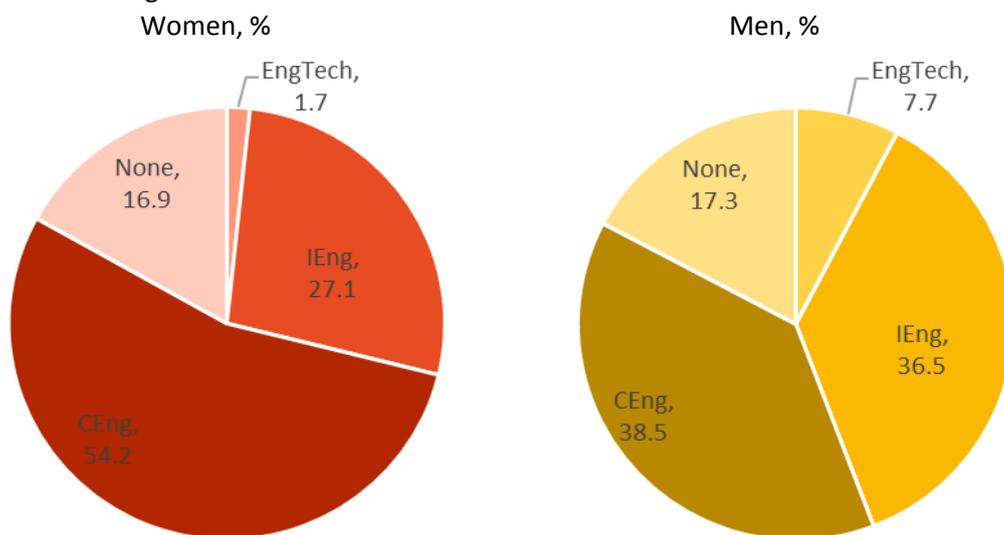


Figure 5 Response by gender to a) ‘Which OU qualification are you currently registered on?’ and b) ‘As a result of your studies which of the following are you considering working towards?’

The more limited data from the interviews largely confirmed these findings and provided further insights. Almost all of the students had chosen to study for an engineering degree in order to enhance their career prospects and this went alongside a personal interest in the area for almost all of them. A personal interest was cited by more women than men.

For many students their aspirations have developed into motivation, with female students in particular reporting increased motivation to complete their degree with each year of study. The majority of students (14/17) identified career change or career ambition as a motivating factor in their choice of engineering as a degree subject. Career ambition and personal interest coincided for many students - they did not see those drivers as mutually exclusive. However, proportionately more females than males identified personal interest as a motivating factor in choosing to study engineering (7:1). For women that personal interest was their love of 'puzzles' and 'how things work'. More female students also cited personal experience of engineering as a motivating factor than their male counterparts (4:2) but these numbers are small and there were twice as many female students in the sample than male. For women, personal experience came from being around partners, family or friends who were involved in engineering-type activities. For men, personal interest and experience tended to come from their work settings. When asked if their original study aim had changed, almost all students reported that their aspirations and levels of interest were even higher now and they were more determined than ever to complete their degrees and move into the engineering job of their dreams.

Interests

The questionnaire presented students with a list of nine current engineering challenges, influenced by those identified in the NAE Grand Challenges for Engineering report (4) and asked, 'Which of these current engineering challenges are of particular interest to you?' with a yes/no option for each. Several topics were popular for both genders: environmental sustainability (88% women, 62% men), energy efficiency (85% women, 94% men), engineering for the developing world (68% women, 60% men) and civil engineering projects (56% women, 56% men). The biggest differences were for automotive engineering, which was more popular for men (32% women, 60% men), and chemical engineering, which was more popular for women than for men (41% women, 29% men). Less popular choices for both genders were medical engineering (37%, 37%) engineering for the food industry (25% women, 13% men) and cybersecurity (19% women, 19% men).

Respondents were also asked to choose the one area that most interested them, with an option to add additional topics. The results are presented in the form of in Figure 6 in the form of 'wordles' (5) where the size of each word represents the number of times it occurred.

a)

b)

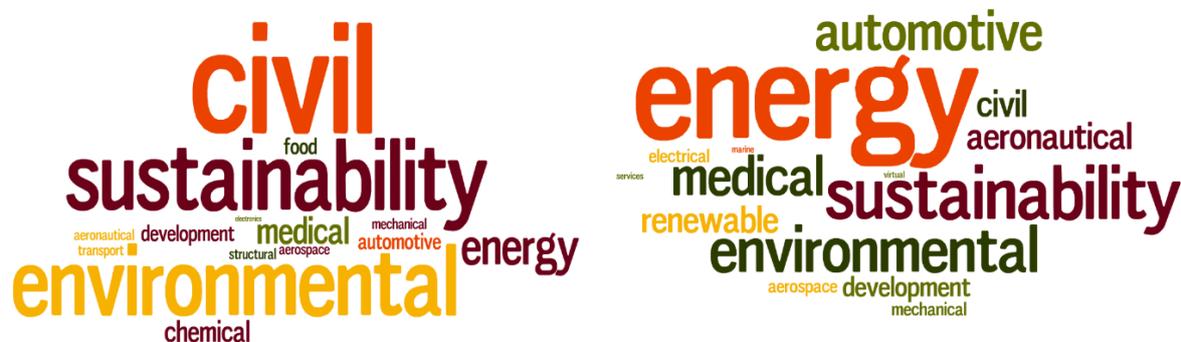


Figure 6 Engineering topics of particular interest to a) women and b) men.

Figure 6 reveals some common interests but also highlights some different priorities between the two groups. Sustainability and environmental engineering feature highly for both sets of students and, along with energy, are reasonably well catered for in the OU engineering curriculum. However, civil

engineering, which emerged top of the list for women but was a much lower priority for men, is not currently offered as a specialism.

The students who were interviewed were very happy with the subject content of the OU engineering qualifications, its level and its delivery. Two students, both female, reported that the degree study was more intense that they had expected with a further five, one male and four female, reporting it to be more discursive, broader and more thought-provoking than expected. Civil and/or structural engineering was mentioned by some female students as an option that they would like to see within the OU degree.

Sources of support

The questionnaire asked about financial support. The most common source of funding was a student loan, but a high proportion of students were paying the fees themselves, as shown in Figure 7. Significantly more men than women received funding from their employer, which is consistent with the higher proportion of men currently working in engineering (Table 2). ‘Other’ responses cited specific funding sources, most commonly ELCAS (an MOD scheme to promote lifelong learning amongst members of the armed forces).

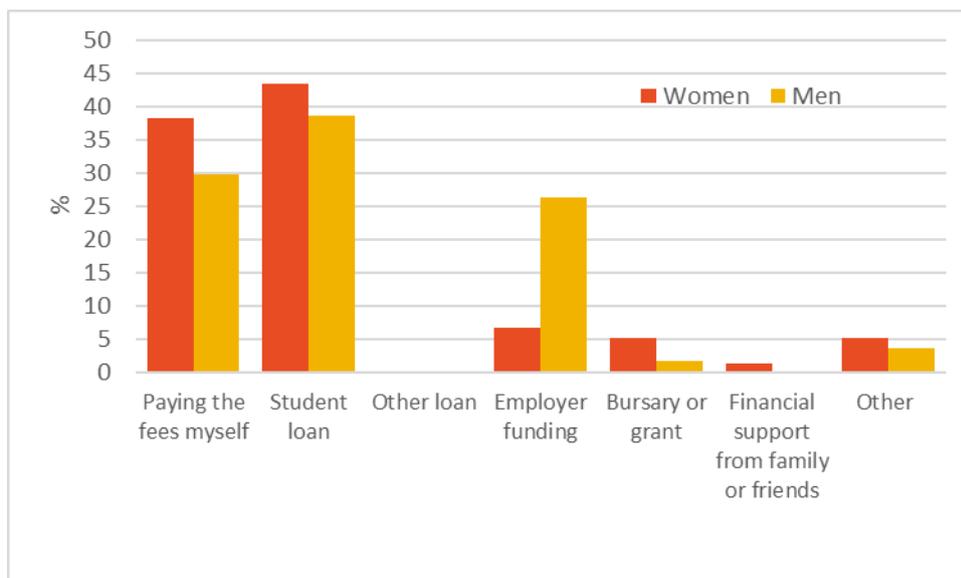


Figure 7 Response by gender to ‘How are you paying for your studies?’

In the interviews, the change in regulations whereby funding was available for students to study engineering if they already had a degree was mentioned by several respondents as a key enabler of their change of direction.

The interviews also explored sources of non-financial support. Students were asked what non-financial support they get and from whom: the results are presented in Figure 8.

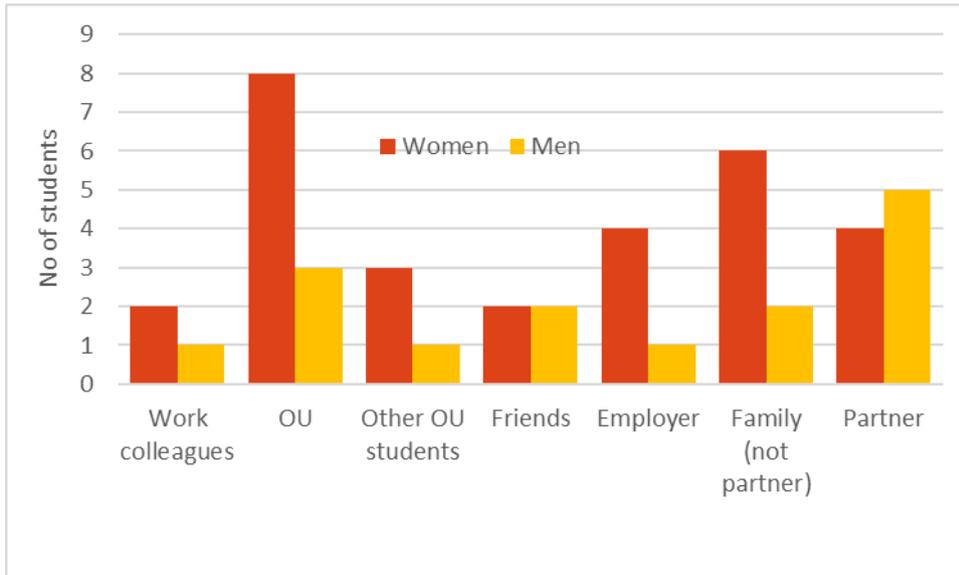
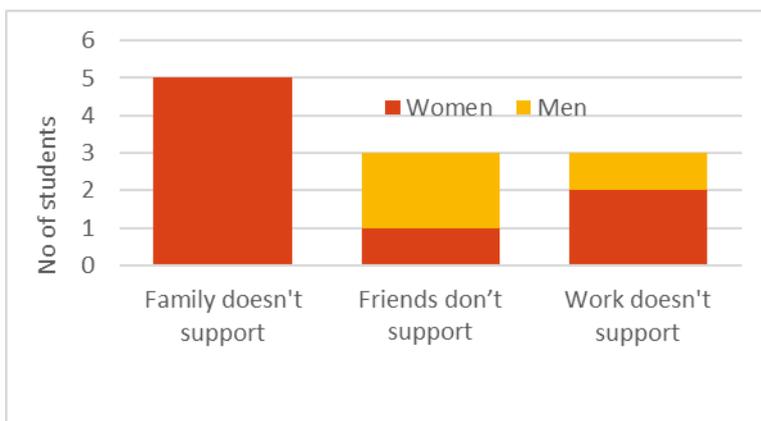


Figure 8 Sources of support cited in interviews by gender of student

The Open University, and especially their tutors, were identified as being consistently supportive and flexible – eleven students made sixteen references to this source of support. While several students spoke about their ability to work on their own without support, the majority reported that the support of their partners and families made a big difference to them and, for many, they would not be able to continue their OU studies without this support. Men reported more support from partners than women did. Women students appreciated moral and practical support from their mothers, in particular.

While most students appreciated the support of others, some students worked to an expectation that their study was their own responsibility and they did not seek support from other people. Mentions of a particular lack of support were also recorded, as shown in Figure 9.



These numbers are too small to be considered significant, but the marked gender difference in terms of lack of support from family, with only women students reporting a lack of family support, is interesting. When viewed alongside Figure 8, it is clear that there are different experiences in this respect.

Figure 9 Areas of lack of support mentioned in interviews, by gender

Attitudes of others

Fifteen of the seventeen students interviewed, female and male, reported positive attitudes towards their study of engineering from employers/colleagues in the workplace (seven), family (six) and friends (two). Negative attitudes were mainly identified as coming from work colleagues or managers. Two female students identified neutrality as the main attitude of people to their studying engineering. Three other female students reported negative attitudes, and these were all from their

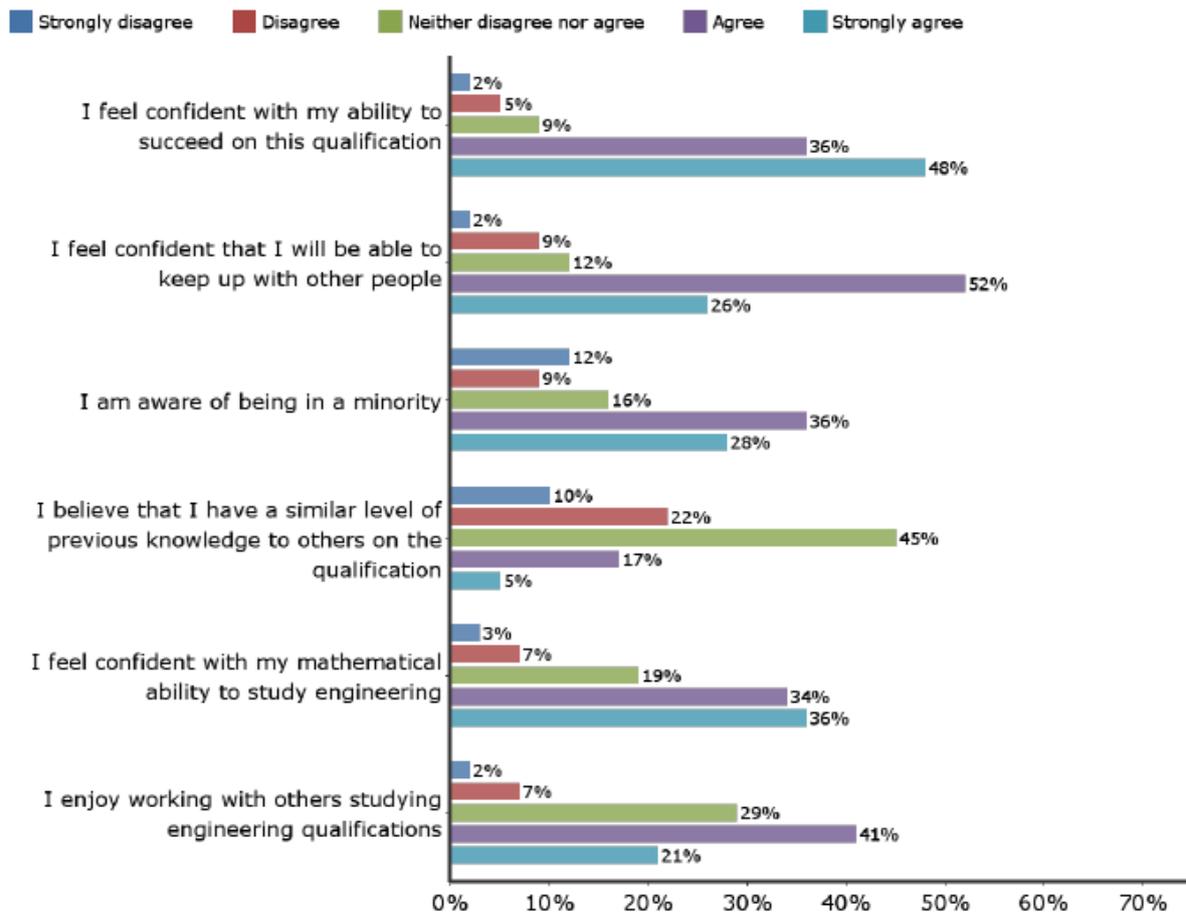
school days and/or from work colleagues. Negativity from managers and work colleagues was sometimes identified as 'disinterest', but two students reported being 'mocked' by their male line managers for their choice of degree subject. No male student reported any dubious reaction to their choice of subject, unlike four of the female students who reported people being incredulous that they thought they could achieve an engineering degree. No-one was incredulous about any of the male students' ambitions.

Those students who work, or had worked, in an engineering environment were asked if they have seen or experienced discriminatory behaviour in the workplace. Of the nine students who responded with experience, two were male and seven were female. All nine of these students reported sexist attitudes and behaviour; some of this was routine but some extreme examples were recorded. The male students were aware of the gender imbalance in most workplaces and of the sexism faced by their female colleagues. One female student also reported an incident of ageism and a male student gave an example of discriminatory behaviour involving attitudes to transgender colleagues. The female students who reported these issues considered them as a spur to be 'better than the men' and to show colleagues that women can be good engineers too. Women students are also aware of the problems they face, or will face, in the workplace when they have children. Examples of behaviour reported by students are included in Appendix C.

Attitudes to study

Students were asked a range of questions concerning how they felt about their studies. The results, shown in Figure 10, reveal some interesting differences in confidence levels: although a higher proportion of the women strongly agreed that they were confident to succeed on their qualification compared to the men (48% women, 35% men) the overall confidence levels (strongly agree + agree) are higher for men (84% women, 94% men). A similar but less pronounced effect was seen for confidence in mathematics. This may be related to the educational background of the women; it would be interesting to know whether there is a correlation between the very confident women and those who already have a degree in a different subject.

FEMALE RESPONDENTS



MALE RESPONDENTS

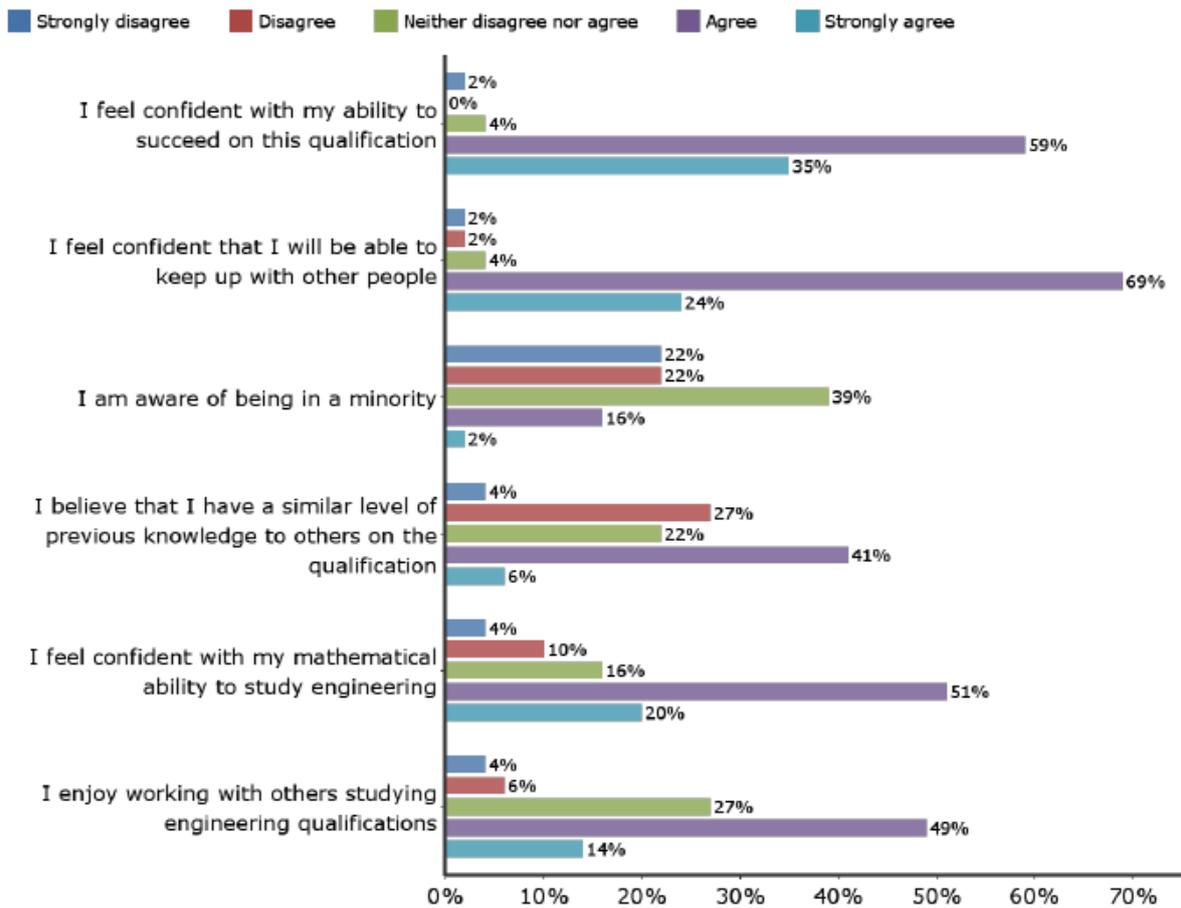


Figure 10 Response by gender to ‘How do you feel about studying for your engineering qualification?’ (main survey only)

Figure 10 also shows that women were far more likely to be aware of being in a minority (64% strongly agree, or agree), despite the fact that they are studying largely independently and rarely have opportunities to meet fellow students face to face. A smaller number of men (18% overall) were also aware of being in a minority, so this is an area that warrants more detailed investigation. There is also a marked difference in the response to ‘I believe I have a similar level of previous knowledge to others on the qualification’ (22% of women strongly agree or agree, compared to 47% men), which is likely to be linked to the fact that more men are currently working in engineering. There were a range of free text comments, both positive and negative, that elaborated on these themes.

Similar areas of questioning were included in the interviews. When asked about what they felt most and least confident about in relation to their studies, maths featured in eleven of the twelve responses, with roughly half the students feeling unconfident. The findings are apparently contradictory because the areas discussed included both challenges and confidence. Although numerically more women than men (3:2) cited maths as an area of greatest confidence, proportionately more men (40%:25%) felt confident with it. Equal numbers (3:3) of men and women cited maths as an area of least confidence but the proportions (60%:25%) suggest that men are more confident. However, proportionately more male students find maths a challenge (60%:17%). This contradiction might be explained by a variance in how they feel about maths and how they view their own level of ability in that area.

All other areas cited as being 'least confident' were mentioned by just one student each and these were 'mechanical stuff' (female), 'putting myself forward' (female), terminology (female), the final project (female), the exam (female), the residential school and having to work with other people there (male) and, finally, the 'professional development stuff' (male). Several students mentioned more than one area in which they felt 'most confident'. Six students, four women and two men, noted that they were confident in themselves as independent learners with good self-management and study skills. Two students, one male and one female, felt confident about engineering theory and one female student felt most confident about 'the technical stuff'.

When asked if they felt that they were in a minority amongst engineering students, most respondents paused to think before answering. Six of the women students (50%) reported that they were in a minority by virtue of being female in a male-dominated degree. A further three female students felt in a minority for being female, coupled either with being a single parent, having no engineering experience or being non-British. So, nine of the twelve female students felt that they were in a minority and all cited gender as a basis for that feeling. Three others did not feel that they were in a minority. There was no obvious age-related pattern to these responses. Four of the five male students felt that they were in a minority among Engineering students for the following reasons: being good at maths, being a distance learner and not working in an engineering context, being non-British and being older. The student who felt older than other students was 45. Most (11/17) of the students interviewed were in Stage 1 of their degree studies; those who did not feel in a minority were all in Stage 1.

Assumed prior knowledge did not appear to be a major issue for the students who were interviewed. All of the students found the module materials interesting, relevant and pitched at the right level. Where they already knew some of the content, they appreciated that other students might not know it and they all enjoyed the refresher of existing knowledge and were relieved that it was not all completely new information. When asked whether modules made assumptions that they knew what they did not and vice versa, all the students interviewed were relaxed about that. However, some students, male and female, found an expectation that they knew something which they did not. This experience seems to be more marked in tutorials than in the module materials. One female student graphically reported a tutorial where the other students, who were all male, sat silently while the tutor assumed knowledge of material that had not yet been covered in the module. This was the exception, however, and generally the students seem to be very flexible about the level of knowledge assumed and they work around that effectively.

Challenges faced

Fourteen of the seventeen students interviewed identified challenges to being an Open University student that they had experienced since starting their studies. These fell into three key areas, as shown in Figure 11.

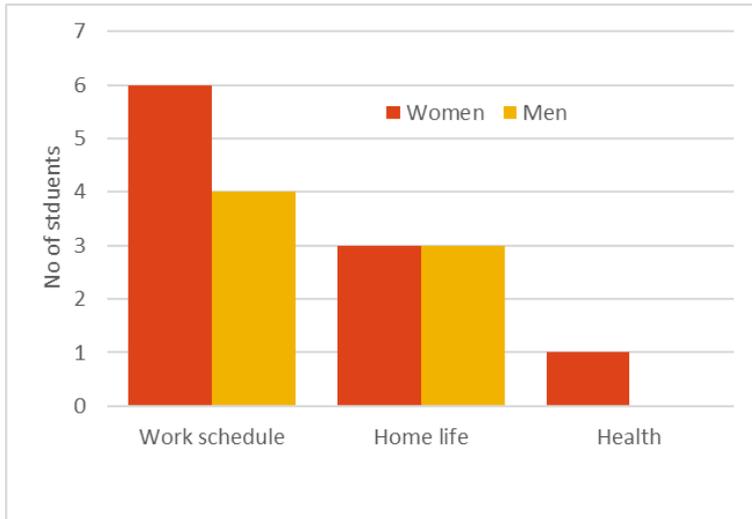


Figure 11 Challenges to OU study identified in interviews

The biggest challenge for the most students was that of the demands of their work schedule. Two male students worked away from home, with others working shifts and unpredictable hours. For those who worked long shifts and, particularly, those who worked away from home, the amount of module material which they were expected to access online presented a problem for them. Two female students identified health issues as their biggest challenge. Six students, equal numbers of men and women, cited the demands of their home life as a challenge in their studies. Women with children are very aware of the barriers they will face when they graduate and start to work in an engineering setting.

General

The questionnaire finished with two open questions. The first invited students to comment on their decision to study with the OU. Key themes that emerged are summarised in Table 3; they have not been split by gender as there were no significant differences. The final question asked for any other comments and asked about future plans. This produced a wide range of individual responses, most of which picked up on the themes of the study already discussed. Results have not been included here.

Table 3 Key themes covered by responses to the question ‘Reflecting on your decision to study with the OU what, if anything, would you like to be different?’

Theme	No of comments	Summary
Degree structures	11	Mostly wanting more flexibility over timing and rate of study. Included 6 comments from students wanting to study full time.
More/better tutorials	10	Requests for more face to face tutorials, also more venues, more recorded tutorials
Study time	8	Comments on the difficulty of finding enough time to study.
Online vs print	8	7 prefer some/more/all content in print, 1 would prefer all online.
Subject focus of curriculum	7	Requests for civil and structural, biomedical, aerospace, electrical/electronic, robotics, mechatronics engineering, more options.
Cost	5	Felt to be expensive. Overlapping modules increases OUSBA payments.
Practical work	5	Requests for more hands-on / work related activities. Praise for residential schools.
Work experience	3	Requests for help getting work experience, or mentoring.
Maths	5	TMA's not exams for maths, more practice.
No change needed	11	Positive comments on OU experience.

- **Do you have you any particular successes to report?**

The proportion of female students on T192 (the entry level module for engineering qualifications) has increased from 13% in October 2016 to 20% in October 2019. Although we cannot attribute all the increase to outputs from this project, we have been able to put support in place for female students, informed by the project.

- **Has your project generated any unanticipated outcomes or unexpected opportunities and how have you taken account of these?**

Some of the results from the surveys and interviews were unexpected, for example the responses of male students suggest that fewer of them work in an engineering role than we originally assumed. We have fed this outcome to the qualification team as this will inform curriculum development.

Many of the female students were well qualified at degree or higher degree level in non-STEM subjects and are changing career. We are working with Careers and Employability to help those students gain some industrial experience before they graduate.

Students identified as being in a minority other than by gender – we need to investigate what effect age and ethnicity have on study success.

Civil engineering identified as a discipline of interest by female students.

- **Have you informed key stakeholders (e.g. ALs, module teams, students on affected modules, OUSA, etc) about your project and its findings?**

We have disseminated key findings at external and internal conferences, such as AdvanceHE STEM conference, SEFI conference, Engineering Education Research Network symposium and eSTeEM conferences.

The findings have been shared with BoS Exec and production module teams

Some results shared with students at Women in Engineering conference

Impact

a) Student experience

- In what ways has your project impacted on student learning?

The significant findings from the project will inform future curriculum developments – case studies need to reflect the spectrum of prior experience of all students, not only those who already work in engineering roles.

- How is your project contributing to increasing student success (i.e. retention, employability, etc.)?

Extra support has been put in place for female students, eg annual conference to celebrate International Women in Engineering Day, networking through a dedicated Women in Engineering forum, currently working with employers to find potential mentoring opportunities for final year students, working with Careers and Employability to encourage student placements, Women's Engineering Society student group established.

- Have there been or will there be any benefits to students not directly involved in your project?

The School has gained a Royal Academy of Engineering Visiting Professor for 'Transforming Engineering Cultures' (Carol Morris is Co-I). The outcomes of the project are informing the work of the Visiting Professor on inclusion. This will be of benefit to all future engineering students.

b) Teaching

- How have you affected the practice of both yourself and others within the OU?

We have raised awareness of issues affecting female students amongst engineering colleagues, particularly those on production modules.

- What has been the impact of your project outside the OU?

OU engineering students have become more involved with external organisations and projects – WES student group and student on the Board, a team entering the IMechE Unmanned (sic) Aerial Systems challenge, with at least 30% of the team members being female.

c) Strategic change and learning design

- What impact has your work had on your Unit's or the University's policies and practices?

A copy of the report will be sent to Marketing to inform their campaigns and prospectus copy. Project outcomes reinforce BoS' wish to keep print and online to maintain flexibility of study.

List of deliverables

Poster at IET/EPC 'New Models of Engineering Education' conference, London, 2017 (6)
eSTeEM conference; winner, best poster, 2018

Refereed paper at 2018 SEFI conference, Copenhagen (7)

Presentation at 2018 Engineering Education Research Network Symposium, Portsmouth
Presentation at 2019 AdvanceHE conference, Birmingham (8)
Poster at 2019 Retention and Progression Fair

Figures and tables

- Figure 1** Response by gender to ‘What age were you when you started studying for an OU engineering qualification?’
- Figure 2** Response by gender to ‘How did you first find out about OU engineering qualifications?’
- Figure 3** Response by gender to ‘Were you encouraged to study engineering by any of the following people?’ (main survey only)
- Figure 4** Response by gender to ‘What was your main reason for choosing to study engineering?’
- Figure 5** Response by gender to a) ‘Which OU qualification are you currently registered on?’ and b) ‘As a result of your studies which of the following are you considering working towards?’
- Figure 6** Engineering topics of particular interest to a) women and b) men.
- Figure 7** Response by gender to ‘How are you paying for your studies?’
- Figure 8** Sources of support cited in interviews by gender of student
- Figure 9** Areas of lack of support mentioned in interviews, by gender
- Figure 10** Response by gender to ‘How do you feel about studying for your engineering qualification?’ (main survey only)
- Figure 11** Challenges to OU study identified in interviews

Table 1 Responses by gender to the question ‘What is your current working situation’

Table 2 Responses by gender to the question ‘What (if any) has been your experience of working in the engineering sector?’

Table 3 Key themes covered by responses to the question ‘Reflecting on your decision to study with the OU what, if anything, would you like to be different?’

References

List any key literature and existing/previous research that you referred to.

1. Women into Science and Engineering (WISE) “Not for people like me?” Under-represented groups in science, technology and engineering, 2014
2. EngineeringUK, Engineering UK 2018: The state of engineering, Feb. 2018
3. Herman, C., Returning to STEM: gendered factors affecting employability for mature women students, *Journal of Education and Work*, 28(6) pp. 571–591, 2015
4. National Academy of Engineering, NAE Grand Challenges for Engineering, 2017. Accessed at: <http://www.engineeringchallenges.org/challenges.aspx>
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6. Morris, C and Organ, SJ; ‘Women in Engineering at the Open University – motivations and aspirations’, IET/EPC conference, London, 2017

7. Morris, C and Organ, SJ; 'Changing direction: understanding and promoting mature female entry to undergraduate engineering programmes', Proceedings of European Society for Engineering Education (SEFI) annual conference, pp1081-1088 Copenhagen, 2018. ISBN 1-902435-61-3
8. Organ, SJ, Morris, C and Goodyear, A; 'No more leaky pipelines: Is it time for a new metaphor for women in engineering?' AdvanceHE Conference, Birmingham, 2019

Statement of ethical review

Correspondence with HREC concluded that no ethical review was required, providing all student data was deleted at the end of the project.

The project was approved and supported by the university Student Research Project Panel.

Appendices

Appendix A – Survey Questions

Appendix B – Interview Questions

Appendix C – selection of quotes from interviews

Appendix D – Confidential Commentary

Acknowledgements

The authors are grateful to the input of Associate Lecturer, Moira Dunworth and to colleagues from Marketing who helped with the structure of the survey to students. They also acknowledge the help and support of the SSRC and survey team. We are grateful to eSTeEM for their financial support of this project and for the help and encouragement we received from the team. Last, but not least, we would like to thank all the engineering students who gave up their time to complete the survey and take part in interviews.

Appendix A – Survey Questions

Motivations for studying an Engineering qualification

Thank you for agreeing to answer some questions for us. This survey is aimed at current students registered for an OU engineering qualification. The survey should take no more than 5 – 10 minutes to complete.

We would like to know more about what motivates you to study engineering and what you hope to gain from an engineering qualification. We will use the results of this work to improve the information, advice and guidance we provide to current and future students who wish to study engineering with the OU.

All your responses to the survey will be treated in the strictest confidence in accordance with the Data Protection Act 1998. Please be assured your answers will not be linked to your studies in any way, and used only to provide statistical information and analysis about groups of students.

Initial choice

1. How did you first find out about OU engineering qualifications? (Select all those that are relevant)

- OU website
- Prospectus
- Advertisements (e.g. OU posters, TV ads)
- Work colleagues
- Spoke to an OU advisor
- Spoke to a careers advisor
- Friends or family
- Advice from employer
- Professional engineering institutions (please specify)
- Social media e.g. Facebook
- Other (please specify)

Insert free text box

Choice of subject

2. What was your main reason for choosing to study engineering? (Please pick one)

It will be useful for me to progress in my current career

It will be useful for me for changing career direction

I am interested in a career in engineering

I am interested in the subjects offered in the modules

It will enable me to get a well-paid job

I want to study something useful

It will give me more confidence

Please let us know if you have other reasons for choosing this degree:

Insert free text box

3. Where you encouraged to study engineering by any of the following people?

Family	Yes/No
Employer	Yes/No
Friends	Yes/No

Other:

Insert free text box

4. Which OU engineering qualification are you currently registered on?(drop down list)

Q65 – Bachelor of Engineering (Hons)
M04 – Master of Engineering
Q78 – Bachelor of Engineering (Hons) – Top up
W11 – Diploma of Higher Education in Engineering
X11 – Foundation degree in Engineering
Z65 – Bachelor of Engineering (Hons)

5. What stage of your studies are you at? (drop down list)

Level 1, eg T1xx
Level 2, eg T2xx
Level 3, eg T3xx or T4xx
Postgraduate, eg T8xx

6. As a result of your studies which of the following are you considering or working towards (choose one)

- Engineering Technician (EngTech)
- Incorporated Engineer (IEng)
- Chartered Engineer (CEng)
- None of the above

7. Which of these current engineering challenges are of particular interest to you? (Choose any that apply)

Environmental sustainability	Yes/No
Energy efficiency	Yes/No
Engineering for the developing world	Yes/No
Cybersecurity	Yes/No
Automotive engineering	Yes/No
Medical engineering	Yes/No
Civil engineering projects (e.g new roads or rail networks)	Yes/No
Engineering for the food industry	Yes/No
Chemical Engineering	Yes/No

Other:

Insert free text box

8. And which one of the above is of most interest to you – choose one

Insert free text box

9. What (if any) has been your experience of working in the engineering sector? (please select one)

- Currently working in an engineering role
- Currently working in a non-engineering role but in Science, Technology, Engineering or Mathematics (STEM) sector
- Have worked in engineering but left and now wanting to return
- Have never worked in engineering but want to enter
- Have never worked in engineering and have no intention of doing so
- Apprenticeship
- Other (please specify)

Insert free text box

About you

10. How do you feel about studying for your engineering qualification?

Please rate each item on a scale from 1 to 5, where:

1 = Strongly disagree	2 = Disagree	3 = Neither disagree nor agree	4 = Agree	5 = Strongly agree
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- | | |
|--|-----------|
| I feel confident with my ability to succeed on this qualification | 1 2 3 4 5 |
| I feel confident that I will be able to keep up with other people | 1 2 3 4 5 |
| I am aware of being in a minority | 1 2 3 4 5 |
| I believe that I have a similar level of previous knowledge to others on the qualification | 1 2 3 4 5 |
| I feel confident with my mathematical ability to study engineering | 1 2 3 4 5 |
| I enjoy working with others studying engineering qualifications | 1 2 3 4 5 |

Please let us know if you have any other comments on how you feel about taking this degree:

Insert free text box

11. How are you paying for your studies?

- Paying the fees myself
- Student loan
- Other loan
- Employer sponsorship/funding
- Bursary or grant
- Financial support from family or friends
- Other (please specify)

Insert free text box

12. What age were you when you started studying for an OU engineering qualification?

- Under 18
- 18-21
- 22-25
- 26-30
- 31-35
- 36-40
- 41- 45
- Over 45

13. What is your gender identity? (Pick one)

Female

Male

Other

Background and career

14. Did you already have another degree before you started this degree?

If yes - what subject was this in?

Insert free text box

15. What is your current working situation? (Please select one)

- Working full time
- Working part time
- Seeking employment
- Not currently able to work for health reasons
- Not currently able to work due to caring responsibilities
- Retired
- Other (please specify)

Insert free text box

16. Reflecting on your decision to study with the OU, what, if anything, would you like to be different?

Insert free text box

That is the end of the survey. Many thanks for your feedback, it is very valuable to us. Please use the box below to tell us anything else you would like to share about your decision to study engineering with the OU and your plans for when you finish studying.

Insert free text box

We would like to follow up this survey with some focus groups or telephone conversations to investigate these issues in more depth. If you would be interested in taking part in these discussions please leave your email address below.

Insert free text box for email

All data collected as part of this research will be treated anonymously whether you choose to leave your email or not.

Thank you for your time.

Appendix B – Interview Questions

Background

1. Which OU modules have you studied so far?

Choosing engineering

2. What led you to choose to study engineering? (*Try to tease out whether this is their first degree – we know many of the women are already qualified to degree level*)
3. (*If not first choice*) Why didn't you choose to study engineering originally?
4. Do you have any personal experience of engineering e.g. family members or friends who are engineers?
5. Did you start your degree with any particular aim in mind? Has this changed as your studies have progressed?

Subject content

6. Is your study so far what you expected from an engineering degree? (*If not, why not?*)
7. Have you found the range of subjects covered by the OU engineering modules interesting?
8. Is the subject content relevant for you – does it support your career aspirations?
9. Have you found that the study materials make assumptions about prior knowledge or experience that you don't have? (examples?)
10. Have you found that the study materials assume you don't know things that actually you do know? (examples?)

Support

11. What support (*personal, not financial*) - if any - are you getting for your studies from family/friends/OU?
12. Are there aspects of your life which make studying difficult? (*we really want to know if they are overcoming any barriers to study*)
13. Is there any support – that you are not currently getting – which would make studying easier?

Feelings about study

14. Do you feel that you are in a minority amongst engineering students? (*If yes, what makes you feel this?*)
15. Do you feel that being in a minority affects your study? (*only if they answer 'yes' to above*)
16. What aspects of your study do you feel most confident about?
17. What aspects of your study do you feel least confident about?

Attitudes of others

18. Have you come across any positive or negative attitudes towards you studying engineering? If so, who from and how has it affected you?
19. If you already work in an engineering environment, have you seen or experienced examples of sexist (or other discriminatory) behaviour?
20. Is there anything else you would like to tell us?

Appendix C – selection of quotes from interviews

Gender of student is indicated by (F) or (M) after the quote

Challenges identified by students

When I was trying to get work experience at school and things like that, I approached lots of garages and generally the response I got from most of them was, 'what do you mean? - in the office?' and then my response was 'no'. I got a lot of 'we're not insured' and things like that, so when I approached the school about it because I was trying to arrange it, they kind of went 'oh well, we will just have to give you one now' and [they] gave me one in an office. So I got quite a negative response to my interest in mechanics and things like that and I don't know, I guess I really didn't know what to do with it so I just went off and did other things and kind of assumed that was an avenue that was closed to me. (F)

I'm a rotating shift operator so I work a different shift in every block, so that makes studying with The Open University very challenging. That and the fact that some of the stuff is only online, [...] I appreciate it is electronic content but if it could have been put onto a key drive or something I would be able to study it everywhere, whereas I am limited to where I can use an internet. (F)

... you know women in engineering obviously there is a high proportion of mothers and, as a mother myself, I know that I'm going to find getting into the industry tough. Because I can only work part time, so until my children are older and I can see that as being, going to be a hell of a barrier to push past, for an employer to see past that, I think. (F)

Motivations

My original aspiration was to have a Masters in Engineering, I want to do that and be a chartered engineer as well now. (F)

I feel more encouraged to actually get a job in engineering (F)

It's opened my options (F)

I have spent most of my adult life being a frustrated Engineer, I'm very good at fixing things, understand things other people don't about equipment and machinery. (F)

Attitudes/Support

My Grandmother is, 'but you've got a husband, what are you doing?' (F)

I just carry on, I have got my own mind set. That's how I stay focused but I suppose you're supposed to have people supporting you, but I don't have anyone supporting me. (F)

Discriminatory behaviour at work

You're expected a lot to do note-taking, minute-taking and it takes a long time for men to take your opinion on board, so [...] if you said an opinion they would never listen to you but would come back with the same opinion from themselves and you're like 'oh wow this is wonderful. ... They expect you to do the menial things when you go to meetings and in the office. (F)

I always found before that jobs I did well would not be recognised as much and men doing less or same got promotions but perhaps I need to be more assertive as a female to do so. But there are

men less assertive placed higher for much less than the nine years I've been working for companies. (F)

They would always go to my male colleague without talking to me. (F)

There's an assumption I am there socially rather than working, even with tools in my hand that can be the case. (F)

I did witness one of the training supervisors - well, he was the mechanical lecturer I suppose - turn round to one of the girls and say engineering is no place for a woman. (M)

There were no concessions and hours were so long that I sent my child off early at 7 and returned at 8 to afford to work. When I return after this break I assume I will be on a lower wage or position than I was before even though I spent the whole time studying. I will have to sacrifice a lot in my career to raise children even with a partner. There were no people there who understood enough about being a sole parent as it was mainly male-dominated much of which were (all that I knew) not single parents. (F)

One of our squadron changed gender. I have got no problem with that, but everyone else did and there were comments about it. One example would be that every morning we have a meeting - at the end of the meeting the person chairing it said "oh and such a such has got a girlfriend now" I thought well that's not to do with anything, there's no need to comment. So unfortunately it does happen. (M)

Subject content

There was loads of technical stuff but I think I was expecting it to be more exclusively technical material but there was a significant emphasis on professional skills and how to prepare you to apply for accreditation when you are finished. (M)

but in terms of like the more wordy questions and the theory behind some of the stuff, it potentially is not what I expected. Maybe I expected it to be more focused on maths and that side of things, but actually there is quite a lot of the theory side and using loads of case studies and stuff like that which I quite enjoy actually, it makes it better for me not being from a maths background. (F)

It made me feel a little more confident because I was like, 'oh yeah that makes sense I know what that is, that rings a bell'. (F)

Yes, but that's been helpful because it was a long time ago that I did those A Levels, so actually it's been nice to revise. (F)

Maybe sometimes with the maths but I don't know if it's just me, because I haven't used it for so long I forgotten some of the things. But then again it is Open University and it's self study, a lot of self studying so it's just up to myself to look for more sources like I used You Tube videos a lot to help me out. (F)

We are now at the manufacturing stage so I know quite a lot about the moulding and rolling and forming so but I completely understand there are people that maybe never ever been in that environment and that they don't understand so I understand the need to explain it more in detail. (F)

I should imagine there will be people who haven't studied this kind of thing before. I think they would struggle but then actually when you're studying at university level you should expect to look outside of the course materials to find the extra resources to help you. (F)

It is Open University and it's self study, a lot of self-studying so it's just up to myself to look for more sources, like I used YouTube videos a lot to help me out. (F)