Project: Investigating the motivations of female students choosing an open versus named qualification.

Final report

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Executive Summary

UK universities (including the OU) have continued to struggle to recruit women to certain subjects within STEM despite best efforts to address this gender imbalance. In 2017, the OU introduced a 'BSc (Hons) Combined STEM' degree (R28) alongside its single and joint honours degrees in STEM. The proportion of women registering on this combined degree is comparatively higher than expected; notably in those disciplines where the proportion of women is typically lowest (for example, engineering and computing key introductory modules).

The Combined STEM degree offers a wide choice within STEM modules with the option for students to study up to a third of their credits in non-STEM modules. Whilst recommended routes through the degree are offered, students are free to choose their own path. Here we present the results of a study that aimed to gain a better understanding of why the proportion of women is higher on the Combined STEM degree than other STEM-based qualifications.

A survey was carried out amongst students on both the Combined STEM (R28) and single honours degrees who had recently entered the university via the STEM Access route or Stage 1 key introductory STEM modules. The survey explored students' qualification intentions and how they made those choices. Semi-structured interviews followed with women enrolled on different qualifications, which allowed a deeper exploration of survey responses and motivations around qualification choice.

Following a thematic analysis of survey responses, the motivations identified included desire for choice, interest in the subject(s), career/employer motivation, lack of confidence, influence of others (family/friends/other students) and identity. Some of these themes were revisited by the interviewees who discussed valuing the ability to combine more than one subject, for personal interest or career reasons and the ability to change subject/ emphasis without changing qualification should they encounter difficulties or if their interests/career goals change. However, they also noted difficulty in articulating the concept of a 'Combined STEM' degree to others.

This study indicates that perceived 'choice' and 'flexibility' are particularly valued by women entering STEM subjects. Placing more emphasis on these aspects during qualification design and in descriptors may be important to encourage engagement of women in STEM subjects where they are traditionally underrepresented.

Aims and scope of your project

The aim of the Combined STEM (R28) qualification team was to better understand why students choose a STEM subject and specifically why a greater proportion of female students are choosing to register on R28 instead of a named STEM qualification, particularly in disciplines where the general female to male student ration is low (e.g. engineering).

Background

Since the creation of the Open University in 1969, students have been able to register on a BA/BSc (Hons) Open degree – which allows them to include modules from all Faculties in the university. This sits alongside a variety of single and joint degrees within STEM and across other Faculties which are also offered. In 2017 a 'BSc (Hons) Combined STEM' degree (R28) was introduced, alongside the Open degree and single and joint honours degrees in STEM. This Combined STEM degree offers a

wide choice within STEM modules with the option for students to study up to a half of their credits in non-STEM modules in both the first and second stages of the degree (equivalent to the first and second year of full-time study). Students on the Combined STEM degree can only study from STEM modules in the final stage (equivalent to the third year of full-time study) but modules can be chosen from across the STEM disciplines. Whilst recommended study routes through the degree are offered, students are free to choose their own path. Some students choose to study pathways similar to the pathways through our single honours degrees, but with minor variations, whereas other students choose to combine two STEM disciplines. Yet other students take the opportunity to include non-STEM study, for example to include language or business modules.

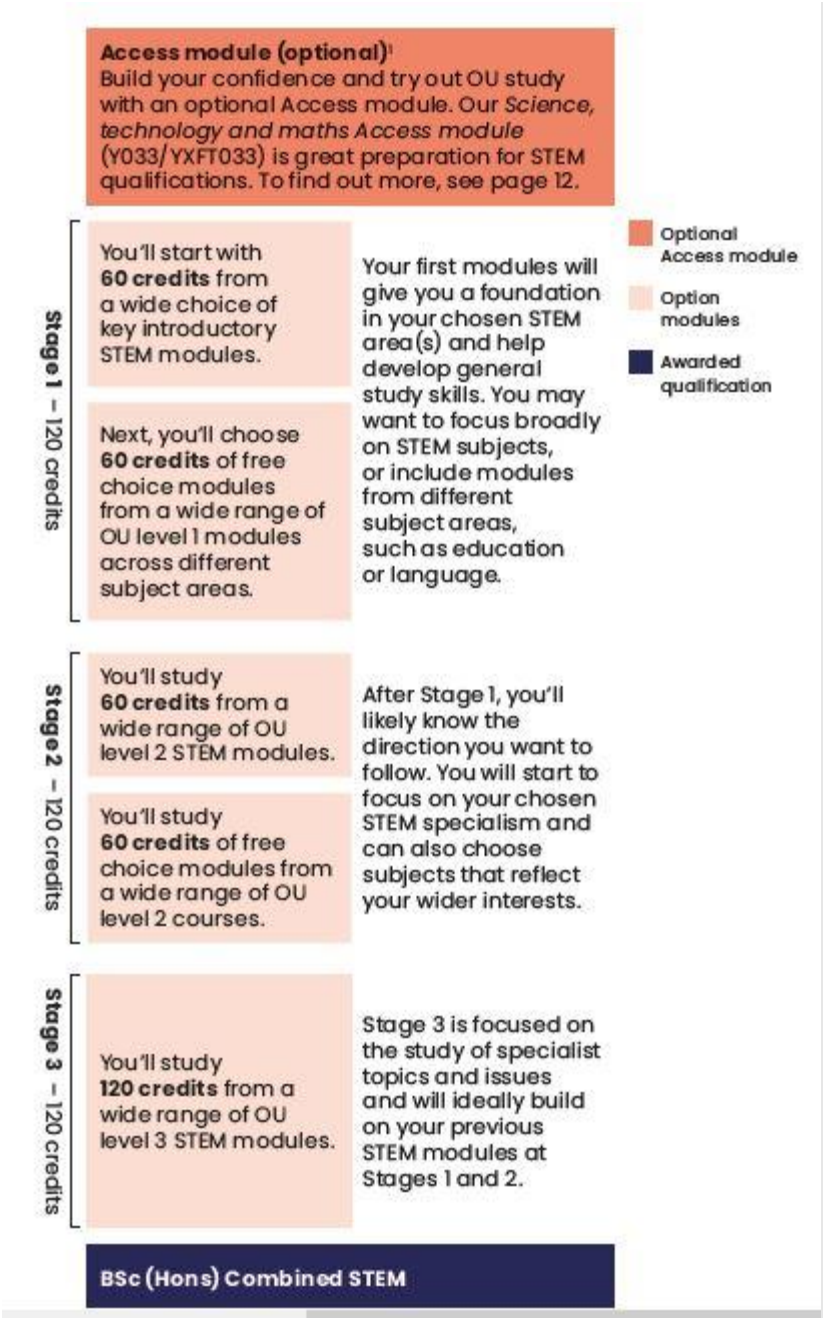

Figure 1 Combined STEM (R28) qualification structure from Open qualification prospectus

Somewhat unexpectedly the proportion of women registering on the Combined STEM degree was higher than in those STEM disciplines where the proportion of women is traditionally lowest for single honours degrees. For example, of the students starting the entry-level engineering module in 2019, 16% were women, whereas of the students starting that module as part of the Combined STEM degree 33% were women (Table 1). Likewise in computing modules, 27% of students starting the entry-level computing module in 2019 were women, whereas of students starting that module attached to the Combined STEM degree, 42% were women.

Table 1. Data for student intake October 2019

Module	% of students on module who were women	% of Combined STEM degree students on module who were women
Mathematics entry module 1 (MU123)	31.3%	42% (n=63)
Mathematics entry module 2 (MST124)	32.9%	50% (n=96)
Engineering entry module (T192)	16.4%	33% (n=64)
Computing entry module (TM111)	26.6%	42% (n=77)
Natural Sciences entry module (S111)	45.4%	46% (n=107)
Environment entry module (U116)	59.4%	67% (n=62)

Improvement in gender balance has been reported on joint/combined honours and interdisciplinary programmes at some institutions (e.g., Rossmann et al 2021, Brodley et al 2022), but is not something that had previously been noted on the Open degree. The reason for the increase in participation on joint and interdisciplinary degrees remains elusive in the literature. This study wanted to investigate why the gender balance was improved on the Combined STEM degree and whether there were lessons that could be learnt to help re-balance gender more widely in the STEM disciplines and STEM degrees.

Activities

Our initial investigations stemmed from data we had found through the OU's data systems (Power BI dashboards) and through the annual QME (Quality Monitoring and Enhancement) process. This data highlighted the differences in the proportion of female students registering on R28 compared with other STEM qualifications.

Literature review

Lack of gender balance in student recruitment in certain subjects within science, technology/computing, engineering and maths (STEM) has been a long-term problem in the UK. In 2019, one million women were reported to be working in STEM in the UK, making up "24% of the core-STEM workforce" (WISE, 2019). However, the numbers are not uniform across different sectors. While in engineering the number of women almost doubled from 5.8% in 2009 to 10.3% in 2019, in information technology there has only been a small increase from 15.7% in 2009 to 16.4% in 2019 (WISE, 2019) . These gender imbalances are still in evidence in UK universities. While in 2017/2018 overall 35% of students taking core STEM subjects were women, only 19% of students in computer sciences and 19% of students in engineering and technology were women (STEM Women, 2021).

A number of reasons for these gender imbalances in STEM have been proposed: experiences of isolation and harassment of female STEM students through their school and university careers (Hodgson et al, 2000); lack of real-world scenarios to demonstrate relevance and a highly competitive environment (Abu-Lail et al, 2012); lack of work/life balance, gender-bias /discrimination and high stress levels (Conrad et al, 2021). While early experiences and encouragement by family and friends can lead to an increased propensity to enroll in a STEM degree (Talley and Ortiz, 2017), women do not seem to see themselves in the image of the 'computer scientist' or 'engineer' and struggle with self-confidence and sense of belonging in spite of demonstrating equal academic and mathematical abilities to men (Shapiro and Sax, 2011). Moreover, in the case of mature STEM students seeking to return to employment after a career break, "gender role normativity, locality and mobility, and structural and institutional barriers" greatly influenced how mature, female STEM students fared in their attempt to re-enter the workforce (Herman 2015).

(See appendix C for extended literature review)

Surveys

Following SRPP approval, an online JISC survey was conducted with students on Key Introductory L1 STEM modules (T192, TM111, MU123, MST124, U116 and S111) and the STEM Access module (Y033), who were linked to R28 Combined STEM, the Open Degree and other named STEM qualifications.

The survey explored the range of qualifications students had initially considered as part of their registration with the OU and asked about the reasons for registering on or discounting certain qualifications. Students on R28 were asked about which subjects they planned to include in the first 120 credits of their degree. The survey also included demographic data, level of previous qualification (e.g., 'A' level etc) and current registered qualification. This allowed us to identify women students studying the Combined STEM degree and the Open degree, as well as those on specific subject-based qualifications.

Free text boxes were provided at various stages throughout the survey to allow for elaborations by students on their responses. We also used the free-text approach to ask follow-ups around closed questions.

The survey ran for the first time in September/ October 2020 across 1201 students on Combined STEM, Open degree and single honours degrees who had recently entered the university, with a response rate of 24%. A subsequent survey ran in March/ April 2021 with a pool of 297 new students and a 25% return rate. For the final survey, which ran in September-October 2021, students invited to the survey were restricted to women who had registered for the Combined STEM degree in order to increase our pool of respondents in that area. This gave a much smaller pool of 59 eligible students and a 20% return rate.

Interviews

The survey invited respondents to indicate if they would be willing to participate in a follow up interview, to explore their responses further. Over the three surveys, 112 expressions of interest were received to take part in the semi-structured interview process. Of these, 30 women were invited to take part and 9 agreed. As interviews were being used to drill down into why women chose or avoided the Combined STEM degree in preference to a single honours qualification, women across a range of STEM subjects were selected for interview.

The interview questions have been attached as Appendix B.

Thematic analysis
Following the literature review findings, it was decided to carry out a thematic analysis of the interview transcripts to identify the motivations of these women when choosing their degrees.

Using NVivo as an analysis tool allowed the importing of interview transcripts and responses to open questions from the surveys. Themes were identified and coded by one researcher and independently identified and coded by other researchers before being compared, discussed and a final set of codes identified. These were coded directly to the semi-structured interviews to identify motivations and drivers amongst these women.

Codes used in NVivo were:

- Affirmation of choice: Positive reasons for choosing their degree
- Career: Chose degree to enhance current career
- Employers: Choice influenced by employer and/or qualification paid for by employer
- Interest in subject: Chose degree because of interest in discipline content (e.g., enjoys computing)
- Confidence: Chose degree as unsure about what they wanted to study or whether they were capable or comments about their degree improving their confidence
- Disability: Choice influenced by additional requirements relating to disability
- Staff: OU staff/teachers influenced choice
- Other students/ friends/ family as advisors: Choice influenced by other students (either within or external to OU) or friends or family members
- Previous qualifications: Motivated by previous study or knowledge
- Time management: Choice influenced by time constraints
- Why the OU: Specific reasons for part-time distance at the OU
- Women in that career path: Choice influenced specifically by a woman in that role or career i.e., teacher, lecturer, family, friend or other professional
- Specific drivers: Identified another specific driver for choice

Once coding was completed it was possible to look at relationships between coded themes, open question responses and data gathered through the three surveys across the period of investigation.

Changes to the original project plan
The main impact on the project was a delay to the timings as the Covid pandemic hit shortly after we had received approval. This mainly impacted the project team's workload. The project continued but with delayed deliverables.

A few minor changes occurred. One of the initial project intentions was to include Access students to see if pre-university level study had an impact on choice of qualification. An early question was: "is there is a link between participating in the STEM Access module and the choice of a named versus Open qualification". Due to the delays in progressing through the Ethics approvals, there was a subsequent delay in sending out the survey. The resulting timing of the first survey reaching Access students close to module start meant that students had studied little of the Access module when they received the survey invitation.

The survey also included a question around students coming into the OU with credit transfer. However very few students responding to the survey had brought in credit transfer so this was not an area we explored further.

We had also intended to carry out interviews with SRSC staff including SST advisors, SRF team leaders and disabled student support teams to surface drivers to qualification choice that are mentioned in student support conversations. However, due to staff constraints during the pandemic this ended up being an e-mail conversation between the project team and SST colleagues.

Survey findings

In the survey, students were asked 'What attracted you to the qualification you are studying?' (Table 5). Commonly, responses from women studying the Combined STEM degree mirrored the responses of women respondents overall. 'Career' and 'Work opportunity' were both common drivers for all women and women choosing the Combined STEM degree.

Table 2. Percentage of students selecting responses to the survey question 'What attracted you to the qualification you are studying?'

	All respondents (%)	All women (%)	Women on the Combined STEM degree (%)
Interest in the subject(s)	89	86	80
Career	64	61	70
Being able to study while working	57	58	53
Improve self-confidence	42	41	43
Work opportunity	38	38	50
Choice within the qualification	**30**	**33**	**67**
Professional recognition	27	22	23
Financial considerations	19	16	23
Previous Educational experiences	18	16	13
Breadth of study	17	16	33
Family or peer influences	7	5	0
Encouragement of teachers	2	2	3
Other	6	6	10

The largest difference was in the number of women selecting 'Choice within the qualification' (33% of women versus 67% of women on the Combined STEM degree). Despite small numbers of women respondents on the Combined STEM degree (n=30), this large difference may indicate something significant about that cohort. It may suggest that there is a cohort of adult women learners (less likely to have HE qualifications) for whom choice is important. If so, it would follow that disciplines trying to attract more women into qualifications in STEM might want to consider expanding choice within their qualifications.

This is backed up by some of the open comments made by Combined STEM women students about why they chose that degree. Reasons included, "...the option to choose relevant and interesting modules is one of the first attractions I encountered" and "…this gave me more options". They also stated that single honours degrees "Limited module choices" and "Modules were too fixed". Similar comments were also made by men who chose the Combined STEM degree, who mentioned "More freedom with Combined STEM" and "I liked the fact that I could choose to do both engineering and mathematics within one degree". In contrast, reasons given for not choosing Combined STEM degree included 'I thought employers would prefer a more focussed degree" suggesting that external perceptions influenced choice above their personal preference.

Anecdotally, 'Ability to study while working' is thought to be a strong driver for students to choose to study at a distance with the Open University rather than attend a face-to-face UK university and indeed it emerged as a strong motivator in this survey and semi-structured interviews. Perhaps more surprising was the extent to which 'Improve self-confidence' was selected by all respondents.

One of the options that was less commonly selected by survey respondents was 'Influence of family or peers'. 'Encouragement of teachers' was also rarely selected, but the fact that few OU students are recent school leavers may explain the low number of students choosing that option, with career considerations and their own interest in the subject being stronger motivators.

Almost half of the students surveyed who were studying single honours degrees had been unaware of the Combined STEM degree when they registered and, only 10% of students on single honours degrees had considered it as an option.

Of the respondents studying the Combined STEM degree about 40% said that they planned to study only one STEM discipline with the majority planning to study more than one STEM discipline and less than 20% saying that they planned to include non-STEM modules (and of these only two were women). This may indicate that for most students the appeal of the Combined STEM degree is more about choice of modules within STEM rather than being able to include non-STEM modules. One woman offered a comment that revealed the need for choice sometimes relating to lack of confidence in their primary choice "I am still fairly sure I want to study just maths, but I don't want to close off my options". There was also some evidence of students misunderstanding the requirements of the single honours degrees, for example '... as for engineering, it required actual in-work experience, where a makerspace wouldn't be enough', which is not the case. These comments all suggest that the Combined STEM degree may offer opportunities that are lacking in the single honours degrees in terms of flexibility, choice and the space to try STEM subjects and disciplines without a full single discipline commitment.

Interview results

Women interviewed, from both the Combined STEM degree and the single honours degrees, gave more in depth information about the process of choosing their qualification than had been available from the survey. They discussed having made the choice of qualification carefully and of initially using resources on the internet before talking to people about it:

- "…I googled for a while … and then I was going through the OU website looking at all of different degrees, I had a notebook full of notes on different ones, spoke to people about which one to do..." (Combined STEM degree)
- "I spoke to someone over the university chat, I attended the Open Uni open days and watched the YouTube channel..." (Combined STEM degree)
- "…finding it online… have a look at what kind of information it includes… then I start to talk to people around me" (Engineering degree student)

Some spoke about the influence of others (university staff or family/peers) but more than one interviewee made it clear that they had chosen to make their own decision before they consulted family/friends, perhaps wanting to avoid any subtle (or unsubtle) pressure to choose/avoid a specific subject:

- "… these partial decisions I very much keep all to myself until I find all of the information … then go and talk to like my husband or a friend..." (Combined STEM student)

Some of the themes that were identified in the analysis of the survey results were revisited by the women who were interviewed. For example, they all talked about studying for interest in the subject:

- "…I'm doing it purely, purely for enjoyment. That's it really and I'll see where it leads after that I guess…" (Combined STEM student)
- "…it started to feel like something that I wanted to do for myself because it was incomplete in my life and my education…" (Mathematics degree student)

while others also mentioned careers:

- "I knew I wanted to do a degree at some point because I knew that would open doors for the career that I then wanted to progress to..." (Combined STEM student)
- "…and I want to increase my career prospects" (Engineering degree student)
- "…I am looking … to get a career where I am able to work part time around my disability" (Computing degree student)

Women studying the Combined STEM degree spoke about valuing its flexibility and the ability to combine subjects:

- "...I was in two minds on enrolling on a single honours maths degree … I thought it might just be a bit narrow and I do enjoy other areas of science..." (Combined STEM student)
- "I was torn between biology and history and then obviously I found the Combined [STEM}, so that was just better for me" (Combined STEM student)

This also included the flexibility of being able to avoid unappealing modules on a single honours degree:

- "... I looked into the higher-level modules, there were one or two that I didn't want to do..." (Combined STEM degree)

and the ability to change subject/ emphasis without changing qualification should they encounter difficulties. Interestingly, one of the women on the engineering degree was thinking about transferring to the Combined STEM degree as being a possible 'fall-back', which suggests that although women students are willing to push themselves to study something they find challenging, they find it helpful to know they have an option to change path if needed:

- "...if I am not able to cope ... I can change it to a Combined STEM degree later on..."

There was some discussion related to levels of confidence:

- "I have never felt good enough if that makes sense or intelligent enough to study and obviously there are a lot of barriers when it comes to attending a brick [university], you know qualifications and time things…"

These echo previous findings that women, even if they already have a degree, may struggle with self-confidence when attempting to change career direction by starting a STEM qualification (Morris and Organ 2018, Herman et al 2019).
One student mentioned lack of confidence in their ability as a driver for choosing Combined STEM degree over a mathematics degree:

- "... a single honours maths degree … I was a little bit concerned simply about the level of difficulty"

However, students also noted the positive effect of study, despite their confidence being low before they started:

- "I do feel a sense of pride now, so yeah I am working part time, looking after kids and I am studying a degree…" (Combined STEM student)

Whilst there were lots of positive reasons given for choosing the Combined degree, some students also valued the perceived status of an accredited single honours degree:

- "I am also aware that I am female and wanting to work in an industry that has quite a male outlook so having that accreditation with a degree can help to sort of back me up if that makes sense." (Engineering degree student)

The negatives mentioned by students on the Combined STEM degree were around the difficulty in articulating the concept of a 'Combined STEM' degree to others:

- "People don't quite understand the 'STEM'..."
- "...it is usually older people… because it doesn't seem proper to have such a flexible way of doing things…they seem to understand it less"
- "People around my age will know immediately when I say STEM. When I said to my parents they were so confused."

One possible motivation for choosing the Combined STEM degree, the availability of credit transfer, did not come up in the survey or interviews, probably because the focus of this project was students on the entry modules who were less likely to have transferred credit from another institution. Interview comments also indicated students choosing a degree that fitted with their personal 'identity':

- "I am someone who likes to take like the broad view of things, … to see why things work… to ask why and for me the main drive of the degree…" (Engineering degree student)

Women who chose the Combined STEM degree commonly noted their interest in, and identification with, more than one STEM subject and it may be that students who actively choose to pursue the Combined STEM degree see this qualification as fitting with (and perhaps echoing/ solidifying) this broader identity.

Dissemination

Findings were shared at the ICERI 2022 conference and a paper submitted to the conference proceedings. The paper and outcomes of the study were shared with the Open Board of Studies as part of the 2022 QME process.
The project findings have also been shared at a STEM L1 Chair's meeting.
The outcomes will also go to the Access & Open and STEM Academic Committees and to each of the STEM Boards of Studies.
It is expected that findings will be presented at the 2023 eSTEeM conference and potentially other relevant conference/events.

Impact

Gender balance is an issue across the sector for specific STEM curriculum areas and many of the qualifications/schools within STEM are exploring ways to address this. This project makes the recommendation that placing more emphasis on aspects such as module/subject choice and flexibility during qualification design and in qualification descriptors may be useful in encouraging engagement of women in STEM subjects where they are traditionally underrepresented. We recommend that when OU STEM qualifications are designed or revised that level of module choice and flexibility is maximised. We further recommend that careful consideration is given to highlighting that flexibility in the qualification descriptions.

An additional recommendation from this project is that the Open Programme explore further with Marcomms how enquirers can be better informed about the full range of qualifications, including R28.

List of deliverables

Please provide a list of any deliverables that will be of value beyond the life of the project such as websites/wikis (URL), publications (pdf), papers (pdf), etc. Please reference papers and publications in full. Relevant files should be sent separately for inclusion on the eSTEeM website and Scholarship Exchange.

- R28 Combined STEM QME Review 2022
- ICERI paper: Improving gender balance through a Combined STEM degree - Open Research Online

Figures and tables

Figure 1. Combined STEM (R28) qualification structure from Open qualifications prospectus

Table 1. Data for student intake October 2019

Table 2. Percentage of students selecting responses to the survey question 'What attracted you to the qualification you are studying?'

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University approval processes

- *SRPP/SSPP – Approval from the Student Research Project Panel/Staff Survey Project Panel was obtained according to the Open University's code of practice and procedures before embarking on this project.* ***Application number 2020-064***
- *Ethical review – An ethical review was obtained according to the Open University's code of practice and procedures before embarking on this project. Reference number* ***HREC/3657/McPherson***
- *Data Protection Impact Assessment/Compliance Check – A Data Protection Impact Assessment/Compliance Check was obtained according to the Open University's code of practice and procedures before embarking on this project.* ***Data Protection registration number 28-04-32.***

Appendices

Appendix B – Interview questions/areas to explore
Appendix C – Extended literature review prepared by Petra Wolf

Appendix B – Interview questions

Aim of the interview:
To understand why the student has chosen the qualification they are on. And (if they are on R28) why they didn't choose a named qualification.
Was choosing R28 a positive choice for them? Did they choose this from the outset or have they chosen it because they either didn't know what they wanted to do or proactively didn't want to study a specific qualification/route/module in a named qualification?

Questions to explore to build a background on the student:

- Study to date
- Career path to date and what's happening in your career now (is this shaping your choice?)
- Personal/family situation
- Qual choice advice and support
- Articulation of the qualification

Possible questions to explore:

Study to date
Where are you in your OU journey? (which module are they on/what have they studied)?
Why have you chosen your qualification?
Has your qualification choice changed since you started studying? Why was this?

Career path to date and what's happening in your career now (is this shaping your choice?)
Is your current career shaping your study/qual choice?

Qual choice advice and support
How did you go about choosing a qualification?
What advice and support did you get in making your qualification choice (either OU or non-OU advice)?
Did you speak to other females about choosing a STEM qualification?
Do you feel you had full advice about poss options?
Did you advisor 'lead' you or help you choose?

Articulation of the qualification
How do you best explain your degree to someone?

Appendix C: Extended literature review prepared by Petra Wolf

Investigating the motivations of female students choosing an open versus named qualification

Contents

Introduction

This research has been initiated based on the observation that a greater proportion of female students are choosing to register on R28 (BSc (Honours) Combined STEM) instead of a named STEM qualification, particularly in disciplines where the general female to male student ratio is low (e.g., engineering). By understanding the reasons for the Combined STEM degree appearing to be able to attract a higher percentage of female students than the named STEM degrees, it is hoped that insights might be gained that could help improve gender balance further within STEM named qualifications.

Research questions:

Is there a link between participating in the STEM Access module and the choice of a named versus Open qualification?

Is a Combined STEM degree a more attractive pathway for women into subjects and professions where they have previously been under-represented?

Multiple bodies of knowledge are implicated in the research questions, therefore three areas in the literature were investigated that offer insights into current thinking regarding mature, female students and their engagement with STEM subjects.

- Women participation in STEM
- Mature students
- Combined degrees

Women and STEM

In 2019, one million women were reported to be working in STEM in the UK, making up "24% of the core-STEM workforce" (WISE, 2022). However, the numbers are not uniform across different sectors. While in engineering the number of women almost doubled from 5.8% in 2009 to 10.3% in 2019, in information technology there has only been a small increase from 15.7% in 2009 to 16.4% in 2019 (WISE, 2022). Even more worrying is the fact that the number of women working as science and engineering technicians and as IT technicians has dropped from 26.22% and 21.4% in 2018 to 24.5% and 20.7% in 2019 respectively (WISE, 2022). This difference in the numbers of women by discipline is also reflected in current student numbers through the UK. While in 2017/2018 overall 35% of core STEM subjects students were women, 39% of students in the physical sciences, 37% of students in mathematical sciences but only 19% of students in computer sciences and 19% of students in engineering and technology were women (STEM Women, 2021).

Educational choices and career have to be seen as interrelated spheres, especially in the case of female, mature students. Initial experiences of isolation and harassment of female STEM students at school and university have been found to influence perception of subsequent employment in STEM careers (Hodgson, Scanlon and Whitelegg, 2000). Furthermore, some of the criticisms of studying STEM subjects include lack of real-world scenarios to demonstrate relevance and a highly competitive environment (Abu-Lail et al., 2012), this then turns women away from pursuing a STEM career. A recent study finds that women are interested to work in STEM and feel they have an aptitude for it, but that a significant majority (91.1%) still reports "work/life balance (69.6%), gender-bias or other discrimination (56.3%) and high stress levels (50.9%)" (Conrad, Abdallah and Ross, 2021).

An interesting discovery during the literature review was the role that culture seems to play in women's participation in STEM. Developed nations have been found to have a higher degree of gender inequality, for example countries such as Sweden, Finland and Norway have a significant higher gender gap in relative strength in science than the United Arab Emirates, Jordan or Algeria (Saavedra-Acuna and Quezada-Espinoza 2021; OECD 2019; Abu-Lail et al., 2012). Equally, the percentage of women among STEM graduates is higher in Tunisia or Turkey than in Belgium or the Netherlands (OECD, 2019). The influence of culture even shows within country. For example, in Australia, male and female students from a non-English speaking background

were found to be more likely to choose STEM than their native English speaking counter parts (Justman and Mendez 2018).

A further contribution factor to women's participation in STEM is the role of gender.
While early experiences and encouragement by family and friends can lead to an increased propensity to enrol in a STEM degree (Talley and Ortiz, 2017), women do not seem to see themselves in the image of the 'computer scientist' and struggle with self-confidence and sense of belonging in spite of demonstrating equal academic and mathematical abilities to men (Shapiro and Sax, 2011). Moreover, in the case of mature STEM students seeking to return to employment after a career break, "gender role normativity, locality and mobility, and structural and institutional barriers" greatly influenced how mature, female STEM students fared in their attempt to re-enter the workforce (Herman 2015: 571). Adhering to gender norms that clearly locate the primary responsibility of caring work with the women, results in the partner's job being prioritised; the women's own employment then has to fit into temporal and spatial constraints that make it difficult to realise and maintain a STEM career. This deprioritisation of women's own progression therefore contradicts the assumption of a rational consumer that is at the heart of the UK government's Higher Education policies which assume that people make rational choices that are individualistic and solely focused on the self (Gonzales-Arnal and Kilkey, 2009).

Looking into the motivations for study of mature STEM students, women have been found to study to change direction while men study what they already are practising thus attempt to advance their existing career (Morris and Organ, 2018; Herman et al, 2019). A large number of women already have a degree when they start a STEM qualification, this could suggest that women struggle with self-confidence when attempting to change direction (Morris and Organ, 2018; Herman et al, 2019).
It could also indicate that, if women work in the sector that is closely related to their study, having this insider knowledge enables them to assess fit better and, while they are already qualified, they attempt to increase fit by adding another qualification that aligns more closely to the job.

A further important factor are role models and their influence on STEM (Gonzalez-Perez, Mateos de Cabo and Sainz, 2020; Shapiro and Sax, 2011). Role models have to be relevant and achievable, if they are too far removed from an individual's frame of reference then they might achieve the opposite effect. Additionally, role models can reframe the perception of STEM and working in STEM occupations as demonstrated by Abu-Lail et al.'s (2012) empirical research in which engineering students talk about the effects of role models and how they contribute to the students' believes that they too can be successful in forging a career.

Mature students

The idea of higher education as a public and private investment has long
been part of official political discourse and policy considerations (Davies and Williams, 2001). While return to education is perceived as valuable, mature students take a higher risk when re-entering education – these risks evolve around four areas: "risk of academic failure, economic and material risk, risk to personal relationships and risk to class identity" (Brine and Waller, 2007: 106). The risk of academic failure is exacerbated for mature students who have been unsuccessful in the traditional school system and often re-enter education through Access programs as a repeated failure also damages any hopes of bettering the student's circumstances. A return to education not only requires financial resources but also means that the student has to forego time normally spend with family and friends (Davies and Williams, 2001).
This means that the non-financial burden is not only carried by the student but also their immediate environment which requires those significant others to be willing to support this.

Mature students are motivated by a number of factors to return to education;
The factors allowed Osborne, Marks and Turner (2004:291) to establish six categories of mature learners: the delayed traditional student, the late starter, the single parent, the careerist, the escapee and the personal grower. A closer look however shows that the perceived disadvantages and benefits of HE education are not so different between the groups and reflect the risks identified by Brine and Waller (2007). All of them cite financial concerns such as future debt and increased childcare costs as detractors. Equally, a lack of self-confidence and time management problems are mentioned by all groups. On the plus side, the mature students expect to increase their chances of entering better employment with increased financial and career prospects as well as being better role models for their children.

Within the wider context of HE choices, a discussion of class and how it shapes the experience of HE study is rather rare (Reay et al., 2001). An examination of the gendered and classed experience of mature students clearly showed that men and women experience and talk about HE study from a gendered viewpoint (Tett, 2000). On one hand, female students' diversion from the housewife/mother identity can negatively influence the relationships with male partners (Brine and Waller, 2007; Baxter and Britton, 2001). Accounts of working-class male and female students of their study experience differed in their inclusion of domestic circumstances as part of their study experience, with men clearly separating the public and private sphere while women saw them integrally entwined (Tett, 2000).

Combined degrees

Interdisciplinary degree programs such as Lafayette College's Engineering studies program, which combines engineering with liberal arts curricula in order to emphasising the sociotechnical nature of engineering, have been found to be more diverse in regard to gender and ethnicity than traditional their single honours programs (Rossman, Sanford Cohen, 2021). Khoury College's 'CS+X' combined majors program reports that 39% of its students are women; this is considerably higher than the 21.5% seen in computing across the US (Brodley et al., 2022).
While these are impressive findings, the reason for the increase in participation remains elusive as both of the above papers merely report on the state of things but do not provide an analysis of the underlying reasons. Similarly, to the US joint and combined degrees seem to grow more popular in the UK. However, while there are some indications that a broader focus increases employability and transferable skills (Hodgson, 2011), the merit and value of combined degrees still needs to be further investigated (Pigden and Jegede, 2016). Subsequent research has highlighted some problems that might negatively impact combined degree students such as differences in learning and assessment between the subjects, dissimilar support levels by staff in the different discipline and a lack of belonging (Pigden and Jegede, 2020).

Theories used in the literature

Academic literature that explores the three topics above is quite descriptive and does not seek to explain the data reported with the help of specific theories. There are some exceptions such as Talley and Martinez Ortez (2017) and Gonzalez-Perez, Mateos de Cabo and Sainz, (2020) who draw on Eccles value-expectancy theory mainly looking at interest and self-concept. Other articles use a critique of rational choice theory such as Gonzales-Arnal and Kilkey, (2009) and Dashper et al. (2020) who argue that the omission of emotion from rational choice and a prioritisation of relationships leads to the failure of the government's HE policies.

Abu-Lail et al. (2012) applied Charles and Bradley's Gender-Essentialist and Self-Expressive Value Systems Framework to their analysis of gender inequity in the US. While "gender-essentialist refers to 'cultural beliefs in fundamental and innate gender differences'", "self-expressive value systems refer to the value systems frequently expressed in western economically developed countries as the expectation to pursue individual interests when making career choice" (Abu-Lail et al., 2012: 25.1036.5). In other words, Abu-Lail et al. (2012) are suggesting that in individualistic societies gender normativity trumps social policy and women are unlikely to violate gender norms in favour of taking up socially valuable employment.

Summary

In order to explore mature, female students' study-related decision-making, three areas of literature were reviewed.
The first area was women's participation in STEM. While the number of women in some STEM disciplines such as physical sciences and maths have almost reached the same levels as men, computer science and engineering still suffer from a shortage of female students and subsequent workers. Negative early experiences of STEM at school and university set the scene for women's reluctance to enter and remain in the STEM workforce. Culture and gender are contributing factors to the decision to engage with STEM; given that all these factors are outside HE's sphere of influence, one wonders how much a university can influence women's choices.

The second area was study choices of mature students. Mature students are exposed to four essential risks: "risk of academic failure, economic and material risk, risk to personal relationships and risk to class identity" (Brine

and Waller, 2007: 106). This means that a re-engagement with education is a fraught with insecurity and uncertainty and the slightest mishap can have significant consequences. In the light of this, studying a subject which leads potentially to work in an inflexible and hostile work environment, might not be in the student's best interests.

The final area was what is currently known about students and combined degrees. Research has shown that combined degrees have the potential to lead to better employment outcomes, the broader scope seems to appeal to women and minorities here in the UK and the US. This would indicate that universities should seek to eliminate the issues identified in the literature review in order to improve the experience and thus strengthen the combined degree pathways.

Based on the literature review, it could be considered that instead of attempting to attract a higher percentage of female students to named STEM degrees, resources should be used to strengthen and expand the combined degree pathways.

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