

Open Research Online

The Open University's repository of research publications and other research outputs

Improving gender balance through a Combined STEM degree

Conference or Workshop Item

How to cite:

McPherson, Elaine; Clarke, Anactoria; Gallen, Anne-Marie; Keys, Mary and Wolf, Petra (2022). Improving gender balance through a Combined STEM degree. In: 15th Annual International Conference of Education, Research and Innovation, 7-9 Nov 2022, Seville, Spain.

For guidance on citations see [FAQs](#).

© [not recorded]



<https://creativecommons.org/licenses/by-nc-nd/4.0/>

Version: Accepted Manuscript

Copyright and Moral Rights for the articles on this site are retained by the individual authors and/or other copyright owners. For more information on Open Research Online's data [policy](#) on reuse of materials please consult the policies page.

oro.open.ac.uk

IMPROVING GENDER BALANCE THROUGH A COMBINED STEM DEGREE

E. McPherson, A. Clarke, A.M. Gallen, M. Keys, P. Wolf

(The Open University, UK)

Abstract

UK universities have struggled to recruit women to certain subjects within science, technology/computing, engineering and maths (STEM) despite best efforts to address this gender imbalance. In 2017, the Open University (a distance learning university) introduced a 'Combined STEM' degree 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 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 and single honours degrees who had recently entered the university via the STEM Access route or Stage 1 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.

Keywords: STEM, recruitment, qualification, choice, engineering, computing.

1 INTRODUCTION

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" [1]. 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 [1]. 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 [2].

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 [3]; lack of real-world scenarios to demonstrate relevance and a highly competitive environment [4]; lack of work/life balance, gender-bias /discrimination and high stress levels [5]. While early experiences and

encouragement by family and friends can lead to an increased propensity to enroll in a STEM degree [6], 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 [7]. 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 [8].

These imbalances are also apparent at the Open University which is a large distance learning university (more than 60, 000 students (full time equivalents)), the majority of whom study part-time, with nearly a quarter being STEM students). For example, in 2019 the intake into the first engineering module was 16% women and the intake into the first computing module was 27% women.

Since the creation of the Open University in 1969, students have been able to register on an 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 ‘Combined STEM’ degree 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.

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 total students on module (n) who were women	% of Combined STEM degree students on module (n) who were women
Mathematics entry module 1	31.3% (n=2010)	42% (n=63)
Mathematics entry module 2	32.9% (n=2018)	50% (n=96)
Engineering entry module	16.4% (n=1123)	33% (n=64)
Computing entry module	26.6% (n=2663)	42% (n=77)
Natural Sciences entry module	45.4% (n=1386)	46% (n=107)
Environment entry module	59.4% (n=1148)	67% (n=62)

Improvement in gender balance has been reported on joint/combined honours and interdisciplinary programmes at some institutions (e.g., [9], [10]), but is not something that had previously been noted

on the fully Open degree at the Open University. The reason for the increase in participation on joint and interdisciplinary degrees remains elusive in the literature. This study was carried out 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.

2 METHODOLOGY

2.1 Survey

As a starting point for the study, an anonymous survey was carried out amongst students studying the STEM Access module and entry modules at stage 1 within the Faculty of STEM. The students were registered on a range of qualifications including the Open degree and the Combined STEM degree. We wanted to identify what motivates students in their choices of qualification by asking them about the reasons for choosing their specific qualification and why that appealed to them more than other qualifications. The survey 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, the Open degree, as well as those on specific subject-based pathways.

Students on the Combined STEM degree were asked about which subjects they planned to include in the first 120 credits of their degree; with choices being 'All one subject (e.g., all maths, all computing, all engineering or all science modules)' 'More than one subject' and 'I am not sure yet'. Students who answered 'More than 1 subject' were then asked to list which subjects. We were interested in understanding whether these students were planning to use the flexibility within the qualification, e.g., by planning to include non-STEM subjects or study more than one STEM subject.

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. For example, students were asked 'Did you consider the Combined STEM degree?', which was followed (for 'Yes' responders) by open-queries such 'Why did you decide against studying the Combined STEM degree?' in an attempt to garner students' positive and negative thoughts and feelings about the Combined STEM qualification. The outputs from these free-text answers was then imported into NVivo for thematic analysis at a later stage.

Further open enquiries were made through more emotive survey questions such as 'Please tell us about anything else that attracted you to the qualification you are studying?' and 'Is there anything you don't like about the qualification you are studying?', before asking the students about other qualifications they had considered as well as their intentions to stay on that qualification or to change direction in future.

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 via the STEM Access route or STEM entry modules 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.

Each survey was terminated with an open entry question that allowed for respondents to add their thoughts and reflections on their qualification. There was then text information about the second stage of this project which involved further exploration around qualification choice, through one-to-one telephone or online semi-structured interviews. Students who were interested in participating further were invited to leave their email address to receive more detailed information.

2.2 Semi-structured interviews

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 semi-structured questions focused on *why* the student had chosen the qualification they were studying, and (if they were on the Combined STEM degree) why they did not choose a single honours

qualification. The interviewer then delved further, asking about whether choosing the Combined STEM degree was a positive choice for them and whether that had been their intention from the outset. Where appropriate the interviewer explored whether they chose the Combined STEM because they were unsure what they wanted to do or proactively *did not* want to study a specific route/module in a single honours degree. It was hoped these questions would allow the team to identify key drivers of qualification choice for these women.

Interviews were held between July and December 2021 using VOiP and recorded for transcription and later analysis. In total, nine women took part in interviews, which were planned to be approximately 30 minutes long. The women invited were taking different qualifications within STEM, with six women studying single honours degrees (Engineering, Computing, Natural Sciences, Mathematics, Chemistry) and three women from the Combined STEM degree. Transcripts were obtained and imported directly into NVivo for coding by theme/motivation. Open question responses from the three surveys were also imported and coded to identify emergent themes and motivations.

2.3 Participants

Across the three rounds of surveying, 383 survey responses were received including 256 (self-identified) women, 116 (self-identified) men and 11 students who chose not to identify as women or men. Of the 256 women, 30 were studying the Combined STEM degree (Table 2).

Table 2. Current qualification

Qualification	All respondents (n=383)	Women respondents (n=256)
Combined STEM degree	42	30
Mathematics degree	47	33
Natural Sciences degree	107	83
Engineering degree	60	28
Computing & IT degree	90	52
Open degree	27	22
Other/No qual	10	8

Amongst those women who chose single honours degrees, the majority (48.5%) were aged between 25 and 34. This differed from those women who had chosen the Combined STEM degree, the majority of whom fell across a younger age range, with 19.6% in the range 18-24 and a further 34.1% aged 25-34 (Table 3).

Table 3. Ages of respondents to the survey

Age (years)	All respondents	Women respondents	Women on the Combined STEM degree
18-24	79	53	10
25-34	156	109	9
35-44	86	55	8
45-54	39	26	2
55-64	21	12	1
65-74	2	1	0

Women on the Combined STEM degree were less likely to have a previous Higher Education or postgraduate qualification and hence likely to have less experience of studying at university level (Table 4).

Table 4. Highest previous educational qualification of survey respondents

Previous Education	All respondents	Women respondents	Women on the Combined STEM degree
Postgraduate	44	26	2
HE qualification	86	66	4
2 or more 'A' levels/highers or equivalent	119	82	10
Less than 2 'A' levels/highers or equivalent	54	35	5
No qualification	20	10	1
Unknown	15	10	1
Other	44	26	7

2.4 Analysis

Herman et al. [11] talk about the way in which joint honours degrees in computing and IT have seen a much larger growth amongst adult women than single honours before going on to look at the motivations of these women as they return to or change direction around careers. After reviewing this and other literature around women returners and combined STEM degrees, 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

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.

3 RESULTS

3.1 Survey results

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 5. 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 universities 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 Open University 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.

Of interest specifically to our university, 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 subjects and disciplines without a full single discipline commitment.

3.2 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 [12], [11].

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.

4 CONCLUSIONS

The Combined STEM degree offers a wide choice within STEM modules and the option for some non-STEM study. It offers students a doorway to a diverse set of STEM subjects, including those they may not have accessed through other routes. The proportion of women registering on the Combined STEM degree was higher than in single honours degrees for those STEM disciplines where the proportion of women is traditionally lowest (e.g. engineering, computing).

The most common motivations for qualification choice in the study were 'interest in the subject' and 'careers'. This held true across both the single honours qualifications and the Combined STEM degree. Women on the Combined STEM degree spoke about choosing the qualification after careful consideration, suggesting that this was a proactive choice. Survey and interview responses indicated that 'choice', 'flexibility' and 'the ability to study more than one subject' are valued by women entering STEM subjects and that these were strong motivators for women when choosing their Combined STEM degree. Furthermore, the chance to change course within the Combined STEM degree was valued both by students on the qualification and as a potential fall-back for students on other qualifications.

Herman et al. [11] note that joint honours degrees in computing and IT have seen more growth amongst women than single honours and it may be that some of the motivations recorded in this study around choice and broader interests, may also contribute to women choosing joint degrees.

Whilst one of the women studying engineering did indicate that she could identify with being an engineer, it may be that identifying specifically as an 'engineer' or as a 'computer scientist' is less common for women than men. Shapiro and Sax [7] suggested that women do not seem to see themselves in the image of the 'computer scientist', struggling with self-confidence and a sense of belonging, in spite of equal academic and mathematical abilities to men. Adding to this, the insight from Herman [8] concerning gender role normativity being a barrier for mature women entering STEM, it may be that the Combined STEM degree offers women the chance to express their interest in STEM subjects but without the need to label themselves as 'engineer' or 'computer scientist' and with the clear flexibility to change paths if their interests or goals change.

The implications of this study for other institutions are 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. As a STEM community, it may be useful to consider whether continuing to place emphasis on relatively narrow qualifications, such as single honours degrees, is inhibiting our ability to improve gender balance in some disciplines and whether broader and more flexible STEM qualifications may be a way to encourage women who identify with STEM, but not a specific discipline, into STEM education and ultimately STEM careers.

ACKNOWLEDGEMENTS

We would like to thank the Open University students who generously gave their time during the survey and interviews. Project funded by eSTEEem – The OU Centre for STEM Pedagogy. Project Reference 20F-EM-EEES-01.

REFERENCES

- [1] WISE. "2019 Workforce Statistics", 2019. Retrieved from <https://www.wisecampaign.org.uk/statistics/2019-workforce-statistics-one-million-women-in-stem-in-the->

uk/#:-:text=The%20government's%20data%20shows%20that,of%20the%20core%2DSTEM%20workforce.

- [2] STEM Women. "Women in STEM | Percentages of women in STEM statistics", 2021. Retrieved from <https://www.stemwomen.com/blog/2021/01/women-in-stem-percentages-of-women-in-stem-statistics%C2%A0>.
- [3] B. Hodgson, E. Sanlon and E. Whitelgg. "Barriers and constraints: women Physicists' perceptions of career progress." *Physics Education*, vol. 35, no. 4, pp. 454-459, 2000.
- [4] N.I. Abu-Lail, F.A. Phang, A.A. Kranov, K. Mohd-Yusof, R.G. Olsen, R.L. Williams and A.Z. Abidin. "Persistent gender inequity in US undergraduate engineering: Looking to Jordan and Malaysia for factors to their success in achieving gender parity". *ASEE Annual Conference & Exposition*, 2012. Retrieved from <https://peer.asee.org/21793>.
- [5] M.O. Conrad, A.R. Abdallah and L. Ross. "Why is Retaining Women in STEM Careers so Challenging? A Closer Look at Women's Insights and Experiences in STEM Fields". *ASEE Virtual Annual Conference Content Access*, 2021. Retrieved from <https://peer.asee.org/38060>.
- [6] K.G. Talley and A.M. Ortiz. "Women's interest development and motivations to persist as college students in STEM: a mixed methods analysis of views and voices from a Hispanic-Serving Institution". *International Journal of STEM Education*, vol. 4, no. 1, pp. 1-24, 2017.
- [7] C. Shapiro and L. Sax. "Major Selection and Persistence for Women in STEM". *New Directions for Institutional Research*, vol. 152, pp. 5-18, 2011.
- [8] C. Herman. "Returning to STEM: gendered factors affecting employability for mature women students". *Journal of Education and Work*, vol. 28, no.6, pp. 571-591, 2015.
- [9] J.S. Rossmann, K.L. Sanford and B. Cohen. "Asking 'why' instead of 'how'": Outcomes of an interdisciplinary Degree Program in Engineering Studies". *ASEE Virtual Annual Conference Content Access*, 2021. Retrieved from (Accessed 8th June 2022).
- [10] C.E. Brodley, B.J. Hescott, J. Biron, A. Rassing, M. Peiken, S. Maravetz and A. Mislove. "Broadening Participation in Computing via Ubiquitous Combined Majors (CS+ X)". *SIGCSE 2022: Proceedings of the 53rd ACM Technical Symposium on Computer Science Education* vol. 1, pp. 544-550, 2022. Retrieved from <https://dl.acm.org/doi/abs/10.1145/3478431.3499352>.
- [11] C. Herman, H. Donelan, J. Hughes, H. Jefferis and E. Thomas. "Gendered Choices Motivation and degree choices of Computing and IT students: a gendered analysis", 2019. Retrieved from <https://www.open.ac.uk/scholarship-and-innovation/esteem/projects/themes/other/gendered-choices-motivation-and-degree-choices-computing-and-it-students>.
- [12] C. Morris and S. Organ. "Changing direction: understanding and promoting mature female entry to undergraduate engineering programmes". *SEFI Annual Conference*, 2018.