Chapter 14

Is Your Extra X Chromosome Holding You Back? An Insight into Female Education and Academic Careers in STEMM

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Additional information is available at the end of the chapter

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Abstract

This review discusses whether gender inequality still exists within medical, scientific and engineering academia, with regards to the career development of academic staff. In the 1970s it was suggested that women who are talented and educated with family responsibilities tend to come across problems of self-confidence and identity when attempting to enhance their professional careers, and although many are successful in doing so, others find it more challenging. By the 1990s, it was indicated that the main gender inequality mechanism in academia is the commonly known fact that women's career development in the academic hierarchy is slower than that of men. In the past 50 years, laws and attitudes of many societies, industries and countries, have changed to promote gender equality. What is the impact of these changes, does inequality still exist and what mechanisms exist to address these issues? This review looks in depth at the links between gender equality and continuing personal and professional development (CPPD), in which individuals at work are educated more about the workplace environment and their job roles and performance. The different types, requirements and success rates of CPPD within the scientific (especially medical) academic community is discussed with an emphasis on gender equality.

Keywords: continuing personal and professional development, gender, equality, education, STEMM

1. Introduction

This chapter sets out to understand how continuing personal and professional development (CPPD) can play a role in science, technology, engineering, mathematics and medicine

(STEMM) subjects in academia, especially in relation to career development and progression. For many years, females in STEMM subjects have been less likely to progress through the academic ranks. The first half of this chapter explores whether this has changed over the decades. It also explores the rationale, hypotheses and interventions put into place to try and achieve equality. The second half of the chapter then explores the possible interventions and concentrates particularly on CPPD as a form of pedagogy in relation to both males and females in academia. It also seeks to understand how CPPD can be beneficial and highlights areas that might be problematic and need further development. As far as possible, examples from differing countries are used, but frequently research from Europe and North America are referred to as they have generally undertaken more published studies and reports. Naturally, variations in CPPD exist worldwide; as do the types of CPPD available, career demands and even societal and cultural differences and expectations. Therefore it is difficult to capture all practices within all universities in each country. Literature searches were carried out using PubMed and Web of Science using the following key words: women/female; academic/academia; higher education; STEMM; pedagogy; equality; career progression; gender gap. In addition the same words were used to search the internet for articles relating to the media. Results from January 1960-August 2017 were included.

Throughout this chapter, a number of abbreviations are used depending on the research referenced. These include science, engineering and technology (SET), science, technology, engineering and mathematics (STEM), science, technology, engineering, mathematics and medicine (STEMM), continuing professional development (CPD) and continuing personal and professional development (CPPD). The abbreviation used in each instance reflects the abbreviation used in the reference, otherwise CPPD and STEMM are used.

2. Does gender inequality still exist in academia?

2.1. An insight into career progression

Despite changes to the law to promote gender equality in many countries, there is still evidence that suggests that gender inequality persists in academia. For example in a UK wide study encompassing all higher education providers and the National Health Service, only 29% of academics in science and engineering (SET) were female [1]. This variation differed between the traditional sciences with only 9% female academics in the physical sciences, 18% in mathematics and computing, 28% in engineering and rising to 33% in biological sciences [1]. Just 4 years later, in 2010, this figure had risen to 42% female academics in the SET subjects overall [2]. By 2016, across the STEMM subjects, male academics is were still dominating more senior positions (senior lecturer and above) and female academics were in higher percentages within the more junior positions (lecturer and positions leading up to lecturer). 46.5% of the women were graded higher than lecturer in comparison with men at 64.8% [3].

In the UK, between 1996 and 1997, only 6% of professors in the SET departments were female [4] and by 1999, 9.2% of professors in academia (as a whole) were female [5]. In 2006, an increase to 16% of professors in science were women was observed [1], but by 2010, this figure

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had decreased down to 14.5% [2]. In 2016, this number had increased with female professors in STEMM departments accounting for 32.3% of the positions available, despite nearly equal proportions of male and female respondents [3]. It is also interesting to note that female professorial levels in SET departments were lower than that for non-SET departments in 2010, in which the figure stood at 24%, which is still lower than expected as 50.7% of academics in those subjects are female, but higher than the 14.5% observed in SET subject areas [2]. The 32.3% for the UK was relatively high when compared to European figures, which averaged just 13% female professors in STEMM despite higher numbers of females in more junior positions [6].

An interesting exception was observed in medicine (and subjects aligned to medicine) in which there were more female academics and students than academics and students in 2006 [1], but a difference was still observed at the professorial level. Even with the increased number of women in medicine, in 2008, women made up only 11% of the professorial level clinical academics, despite with a 40% graduation rate over the last 20 years rising to a 60% medical school entrance rate of women in 2006 [7]. In 2008, one in five medical schools did not have a female professor and there were only two out of 33 British medical schools with a female dean [7, 8]. Nursing was also considered to be slightly different to the other STEMM subjects as differences between men and women were not frequently observed in all areas investigated [3].

These statistics were mirrored in other countries. In North America, there was evidence that one in three men and one in seven women worked in an SET occupation in academia [9] and women comprised only 8% of the medical school chairs and just eight of 125 U.S medical school deans were women in 2004 [10]. Women in Mexico, by the late 1990s, comprised only 2% of the higher positions in scientific fields, similarly, Austrian women dominated the lower levels or positions, however they only represent 1.5% of the directors of research units in natural sciences [11]. This evidence indicates that in general more men than women possess higher positions in academia within the scientific disciplines. This is not only the case for the countries in the examples given but is generally reflected in other countries too.

2.2. An insight into income inequalities

In addition to the differences observed in career progression, inequalities in salary still exist. A salary gap of 30% between female and male medical academics was observed in the UK in 2006 [1]. The researchers noted that this difference was particularly surprising as the educational requirements and career paths were often similar between the genders, and that only those with full/time continuous employment were included in the study and that this was also much larger than the 17% pay difference seen between men and women in the rest of the UK population (from non-academic careers). In 2010, the overall difference was 18.7% when looking across all higher education subjects [2]. When put into context, this equated to a median annual income of £28,839 for women and £35,469 for male academics. In addition, the proportion of male academic staff earning over £50,000 was 31.7%, over double that of the 15% of females earning above that salary [2]. By 2015, female academics were still receiving on average £6146 less than men [12]. Similar trends were observed in America with young female career researchers (mostly doctoral graduates) paid nearly a third less than their male counterparts [13] whilst female workers in general were paid 80% of the total that males were [14].

Differential salaries for men and women were also observed in North America. Studies have shown that men in SET occupations earn $8714 more than women in the same occupations and that in the non-SET occupations men earned $16,391 more than women [9]. Another study noted that a male physician with less than ten publications will earn approximately $96,214 in his first year; however, a woman who is similarly situated would earn $11,691 less [10]. Pay differences are common throughout the world. In 2015, data from 145 countries were assessed and none provided equality of pay for similar work between the genders, with the scale going from 0 to 1 with 1 being the highest score for equality between genders, the top ratio was 0.88 (Rwanda) and the lowest country stood at 0.34 which was Angola, but some countries did not provide data in this area [15, 16].

3. Assessing the rationale and reasons behind inequality

Women compared with men are largely in lower-paying and lower-status occupations in many countries and this results in fewer opportunities for progression. By contrast, the women that are being discussed in this chapter largely have the same qualifications and jobs as the men, therefore this cannot explain the wage and progression differences observed in the research shown above. In the 1980s, it was suggested that ″women fail to utilise fully their talents, capabilities and interests in career quests which is one of the main reasons why women's career behaviour differs from that of men″ [17]. Thinking has largely moved on since this statement was made; however, this section looks at whether aspects such as interest in STEMM, capabilities and behaviours are different in women to that of men and whether this impacts on their careers.

3.1. Teaching vs. research – balancing roles and esteem indicators

One theory as to the reduced career progression for women is that once they obtain higher positions (such as lectureships and beyond) they might spend more time teaching than doing research, resulting in fewer papers and grant successes; the latter two are often very important for career progression [18]. There have been differences observed between men and women in the amount and type of research activities undertaken. This is supported by various reports and studies. In the British academic system, women were more likely to hold 'teaching only' roles as opposed to 'research and teaching' roles in comparison with men (30.3% female teaching vs. 22.0% male teaching, 45.3% female research and teaching vs. 56.2% male research and teaching [2]. In 2017, a study throughout the UK showed that female academics still reported spending more hours on teaching and public-engagement tasks and less time on research than did their male colleagues; this was significantly different even after employment contract type, seniority and age were accounted for [19].

A woman's scientific research output (in terms of papers and patents produced) has been shown to vary depending on the country in which they work. Women scientists and engineers in India, for example, produce more 'outputs' than their male colleagues, whereas in Venezuela, male scientists have been found to produce more 'outputs' than female scientists [11]. Numerous studies have found that in general women are less likely to be awarded research grants, ranging from examples in the Netherlands [20], European Research Council [21], North America [22, 23]. The European Commission has shown that women in STEM academia are more likely to face inequality due to bias in most peer review situations ranging from grant and paper success through to curriculum vitae sifts and job interviews [24, 25]. In addition to this, it has been shown that frequently women are expected to obtain higher numbers of publications and grants in order to then achieve positions [26]; an even more difficult achievement, bearing in mind that the funding and publications are less likely to be given to women. Despite this back drop, some studies are starting to show that women in some areas are not facing bias at interview [27], so the environment could be changing.

Research has shown that journals ranging across the STEMM subjects based in the North America offer fewer opportunities for women to become reviewers and that women represent lower percentages of senior or first authorship. 26% of submitted papers have women as first authors, yet during the same period (2012–2015) only 20% of reviewers were women and male editors requested female reviewers 17% of the time in comparison to 22% requested by female editors [7, 28]. These figures were similar to the numbers observed when authors suggested reviewers. Male authors only suggested female reviewers 15% of the time in comparison to female authors who suggested women 21% of the time. On average men and women who were invited to review did not show differences in their responses (decline or accept). As men and women had similar review acceptance rates, women reviewed fewer papers in comparison with the number actually submitted by females. Women reported that they were less likely to be on influential panels, such as editorial boards of journals (32% female vs. 42% male), grant giving panels (21% female vs. 38% male) or become an editor (8% female vs. 20% male) [7, 22, 28, 29]. A number of similar studies for different journals and in different countries have shown similar trends. Journals are not the only place where male to female ratios have been suggested as problematic. From grant reviews through to promotions and job application situations, it has been suggested that with more men in senior positions, there might frequently be more men undertaking the peer review.

3.2. Lifestyle commitments and life balance

In the 1960s, women were not usually encouraged to pursue their professional career during the early years of child-rearing, mainly due to the concern of the effect of the decrease of their intellectual creativity [30]. 40 years later, one common explanation of continued gender inequality was the fact that women, more than men, hold the burdens of childcare and marriage and this is believed to be the best account for gender inequality [31]. In the 1990s, it was suggested that men tended to have lifestyle advantages over women and were often known to have greater resources, such as money and influential friends [32]. It has also been suggested that the belief that this is so, whether it's true or not, affects women's decisions, their careers and how they are treated [31]. One view that was used to explain gender inequality was that 'women tend to have less time, energy and commitment to invest in their careers and as a result are less scientifically valuable than men' and this is a popular explanation that relates to women's slow career advancements [33].

In the next decade, a study showed that the women in the study believed that having children could be detrimental to their career prospects and felt it was important to plan their pregnancies around their work timetables [34]. Women within the study group had adapted their personal lives to fit into their professional lives. From the 11 women in the study, one had chosen to have no children, six had babies in the month of May to avoid key teaching periods, two women waited until they became professors and two had children as students and postponed their careers. This study provides evidence that child-bearing does affect careers and mindsets of women greatly and that women are trying to avoid career disruption [34].

Conference attendance is also an important esteem indicator in academia and plays an important role in networking and research dissemination. It has been reported that part-time working, career breaks, balancing home and work life and a decreased attendance at international conferences could all have a detrimental effect on career progression [35]. This view is partially supported by evidence from the UK nationwide survey reporting that 54.2% of part-time academic staff were female [2], and it has to be recalled that women, on average, only make up to 29% of the academic population [1]. It has also been suggested that family responsibilities make female scientists in academia less geographically mobile than men and this factor might intensify gender inequalities in occupation and salary [36]. Interestingly, some studies did not indicate a detrimental effect in relation to having a family. In Israel for example it was found that child-raising did not have a negative impact on career progression for female professors in the natural sciences, and the rationale put forward was that these women produced more research papers than their male equivalents [11]. However, child-raising had a small effect on their abilities to travel abroad for international meetings and research opportunities, which is perceived as vital for scientists in small countries [11].

3.3. Confidence, behaviour and role models

Encouragement in career choices and progression is a key factor in inequality. Due to traditional societal beliefs regarding suitable roles for men and women, in the 1980s males generally received more encouragements for career pursuits and achievements than females [17]. In a survey of medical academics throughout the UK, women that responded were less likely to be encouraged towards promotion (38% female vs. 43% male) [7]. Women are also less likely to believe that gender equality exists when trying to gain a more senior position, with 47.3% of males believing there was equality and just 23% of females agreeing [3, 19].

By 2017, encouragement by management to achieve promotion was still lower in women than in men. In a UK study (43 universities, STEM based academics), 48.8% of women had been encouraged to apply for promotion whereas 59.7% of the men had been encouraged [19]. Outstanding women scientists might not engage in scientific careers simply because they do not have enough encouragement to do so, therefore they question whether they have what it takes to be successful or simply because they lack a female role model that could help them visualise themselves as faculty members [37]. Role models are themselves an important factor. In 1976 it was reported that more women than men were reporting a lack of a role model or mentoring, suggesting that an appropriate role model or mentor was either not available, or not offered to those women [38]. The lack of a mentor was studied in the 1970s (and most likely before then) and in investigating women in male dominated subjects, women mentored by men were thought to adapt their intellectual and personal integrations more than women who were mentored by other women [38]. Although this adaptation might assist women to 'fit into the system' better, it may not be the natural style of the woman involved, and long term this could have a detrimental effect on her attitude or wellbeing. A later study on mentors and role models for women showed that 50 of 558 women commented on the lack of female mentors [39]. Women with children within the study noticed that female mentors were often ones without family responsibilities or children, and therefore were not suitable role models when it came to combining family and careers [39]. In the present day, women are still more likely to not identify with an appropriate role model. In a survey of medical academics throughout the UK, women were more likely to report a lack of a role model (16% female vs. 4% male) or appropriate mentoring (29% female vs. 19% male) [7]. In 2017, female STEM academics reported that they had less access to appropriate role models than men but men did not indicate an advantage for themselves [19]. Therefore despite the number of studies throughout the decades highlighting that lack of role models was an issue, it appears that females may still not always have access to appropriate role models today.

Stereotypical characteristics of each gender might also play a part in gender inequality. The stereotypical masculine qualities are generally instrumental qualities, for example, competitiveness, dominance and assertiveness [17]. These qualities are usually related to success; however, the stereotypical feminine role is generally qualities that are related to emotion, for example, sensitivity, nurturing and innocence [17]. Stereotypes are problematic in the way that people are viewed, but there might also be real differences in the way that men and women behave. Confidence issues have also been suggested as potential barriers for women in academia. One view is that women might lack confidence when pushing for promotion whilst being seen as aggressive if they do push for promotion [40]. Bandura suggested that women who chose science and engineering tend to have strong beliefs in themselves and must possess the confidence in their ability to go against the social norms [41]. They must be confident that they can thrive when mentors and other supportive associates are lacking [42].

4. Understanding the potential roles of CPPD and the workplace in developing equality

The differences between the roles, opportunities and perceptions of success were explored in the first half of this chapter. These are essential as studies have shown that they are key factors in academic STEMM subjects in career progression and equality.

There are several reasons that contribute to the gender inequality in academia and it has been suggested that these reasons go as far back as elementary school where boys naturally had more interest in studying science than girls. The study on 6th grade students from the United States 42% of girls enjoyed science compared with 63% of boys [43]. It was suggested that this could be one explanation as to why there are fewer females entering the scientific departments, and therefore fewer females possess higher positions within the department [43]. However, by contrast, the numbers show that women are entering STEM subjects in increasing numbers. Whilst there were large disparities in bachelor's degree and PhD level attainments between the sexes up until the 1960s, for many disciplines these disparities were reduced and in many disciplines the numbers of females achieving bachelor's degrees and PhDs had outnumbered the males by the 1980s and 1990s [44]. Therefore with the exception of a few subject areas (computer science, engineering and physical science), the numbers of women entering STEMM subjects are either equal or higher than males. This indicates that retention of females within STEMM subjects is the leading factor in the reduced number of women in academia, and not that females are not entering into STEMM subjects at school, degree, PhD or post-doctoral level.

The types of roles, such as teaching versus research, and their outcomes and time allocated to these activities are important. As are life balance and the opportunities afforded to each academic. The 5000 person strong academic survey indicated that the following three factors were ranked the highest in relation to influencing academic careers: (i) being involved in well-regarded projects, (ii) successfully applying for grants and (iii) having substantive research output [3]. By contrast, the highest markers for a less successful career were stated as (i) having a heavy administrative load, (ii) having a heavy teaching load and (iii) taking a career break. This knowledge is essential as ultimately, during the promotions and employment processes, it is academics making the decisions based on their perceptions and requirements for the role. Understanding of both the statistics and current situations for female academics, understanding of male and female perspectives and reflections regarding promotion and working conditions have helped to signpost the types of interventions and training opportunities required. These include CPPD to empower and enable women to advance through their careers in a manner appropriate to their working and personal conditions and needs [45]. Health professionals are kept updated to meet the needs of the health service, the patients and their own professional development by continuing professional development. It involves continuous attainment of new skills, knowledge and approaches to assist in quality performance [46].

4.1. Exploring possible CPPD interventions and their success rates

In the UK, the Equality Challenge Unit published reports from 2004 to 2010 [2, 47] and the Higher Education Funding Council for England (HEFCE) also started an Equality Scheme in 2007 which is updated biannually [48], both with the aims of researching, highlighting and supporting good practice in higher education via women's networks, mentoring and career development. It would be unfair, however, to suggest that CPPD directives for women were not in place by 2004. A management development programme for women run by Strathclyde and Edinburgh Universities, which commenced in 1989, and reviewed female CPD initiatives run in the 1980s and 1990s describing that despite the work carried out, high satisfaction levels from participants and a high uptake of the courses, little perceptible change in the number of women at senior levels was observed [49]. One discussion point within the paper was that many women feel that single sex training is unfair to men and patronising to women, they also suggest that women might have less energy to pursue problems such as unequal pay due

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to a depressed economy and therefore failing women's networks [49]. In addition, it has been suggested that 'evaluation must look at the desired result rather than simply participant satisfaction or opinion of professional development experiences' [50], and this is certainly the case for CPD relating to women in academia, but is also more difficult to assess than participant satisfaction. The third suggestion is that women might prefer to side-step the issue of a male dominated career and opt for freelance or consultancy instead [49]. The 'Athena Project' was set up in the UK and similar other programmes are in place worldwide to try and promote good practice within the medical and scientific field, as so many of the inequalities discussed above had been observed throughout scientific subjects within universities [7]. These projects use many methods to try and establish whether inequalities exist (often not just between the genders but also in a number of other factors) and to encourage equal opportunities and to recognise good practice.

A major aspect to be taken into account when planning the intervention is the time allocated to CPPD. One study showed that academics (lecturer through to professor) spent an average of 50.4 hours working per week split down into teaching 17.8 hours, research 15.9 hours, administration 10.2 hours, external work 1.7 hours, other work 3 hours and only 1.8 hours on professional development [45]. This average time allocation must either be taken into consideration when planning CPD courses, or institutes have to provide and expect a larger time allocation, otherwise only participants willing to give their 'free' time can participate in longer courses. In addition, academics might be required to undertake several different types of CPD within this time allocation, for example with the Royal College, many health care professions and for veterinary professionals, formal CPPD in teaching, research and/or management is required [51]. Professional CPD schemes often require a particular number of credits or hours in order to complete the annual requirement, this in turn might impact on the part/time worker (as explored above, this effect is more likely to be a female [2]) as more time is devoted to CPD and less to writing papers or gaining grants which, as was previously reviewed, are perceived to be more important for career progression [18, 52].

The type of CPD is an important factor to consider. Riding and Agrell [53], suggested that learning preferences, such as the cognitive style, are mediated by gender. The link between gender and learning preferences has attracted attention and can be analysed by looking at approaches to studying. Some experiments concluded that there were no statistically significant differences between men and women and the types of learning orientations [54]. Conversely, others suggested from their studies that when it comes to information processing, men process more rapidly than women depending on the learning systems used [55]. Hence it is important when organising CPD, to use learning processes that appeal to both men and women [56]. It has also been suggested that the methods available are; (i) work based activities such as being a member of a team and resolving tasks, (ii) seminars, courses and conferences and (iii) self-directed learning [56].

However, it has been suggested that a lack of CPD is not the reason for women not progressing through the system. It has been reported that more women took up CPD opportunities than men, despite lower numbers of women in academia [57]. There is also the compounding difficulty that a large variety of CPD activities are available in many different subject areas and might range from half day courses through to qualifications such as the Postgraduate Certificate in Higher Education (PGCHE), masters' degree and even undertaking a further PhD in the area of education for example, whilst undertaking full time academic duties (in the STEMM areas) are now viable CPD options. This vast range makes assessing their impact (especially where people undertake a variety of these options), very difficult, especially on a long-term basis. This makes the statistics on the male:female ratios and income more important as long-term differences might indicate whether equality schemes, which usually emphasise CPD, have an effect or not. The types of CPPD offered to men and women might also have an impact on the roles that they take within the work place and on promotion. A recent study of 5000 academics from 43 British institutions showed that women reported that were more likely to be offered training in teaching than men, but less likely to be offered training in leadership, grant application skills, management, postgraduate supervision, project or finance management, equality and diversity and unconscious bias [3]. Women were also more likely to report more obstacles in undertaking CPPD than men. These included barriers such as time, obstructive management, cost, lack of eligibility, caring responsibilities and training not being relevant to position or offered within their institution [3].

An interesting, and somewhat aligned study on school teachers working towards or completing a Masters' degree in education showed that personal commitment, workplace culture and organisation of the course all had an impact on whether this predominantly female (83%) group completed their degree or not [58]. This directly feeds back into the fact that women were less likely to feel supported or mentored in the workplace than men [7]. An important feature that could potentially decrease gender inequality is that women scientists should acquire mentoring and in turn, be effective mentors. This could be achieved by CPD courses that focus on mentoring opportunities [4]. Research in Australia has shown that mentoring programmes can have beneficial effects for women including retention of staff, higher rates of promotion, grant and paper success [59, 60]. These results were mirrored in American institutions where females received mentoring but whole department educational sessions on gender bias were introduced. Improvements in pay equity, promotion and staff satisfaction were reported [39, 61, 62]. Flexibility was also more important to female academics than male academics [7], and it would appear that flexibility (on teaching, course duration and assignment deadlines) was highlighted as something that helped participants to complete the educational masters' course too [58].

The work and home life balance was highlighted as possibly affecting female academics more than males [35], and this was also supported by another study evaluating predominantly female attended CPD courses [63]. The latter study carried out a questionnaire survey on 45 students to measure the impact of CPD on their private lives as well as their professional lives. The results showed that the females' response was much more positive (69% yes definitely, 29% some and 0% no, not really) than males (50% said yes, definitely, 40% some and 10% no, not really) regarding the impact of their training on their practise [63]. This showed that CPD had a much larger effect on females in their professional lives than males. Conversely, only half of their participants responded that carrying out CPD had 'little or no effect on their family life, relationships with partners or relationships with others' and 47% felt that their stress levels had been negatively affected due to time commitment, time away from home and workload. Despite these more negative effects, 84% reported an increase in confidence [63]. A similar study looking at the PGCHE undertaken by university lecturers (and is increasingly a compulsory element for all new lecturers [64] as suggested by the Dearing Report [65] suggested that participants confidence levels were boosted [66] and that meeting people from throughout the university was also useful. Even this outcome might, in part, help towards the decreased confidence levels and potential reduction in networking abilities (from less attendance at international conferences) observed in previous studies [7, 35, 40].

5. Conclusions and future directions

This review chapter has drawn together research from many areas, both quantitative and qualitative to show that gender inequality is still an issue within scientific academia around the world. Large differences in pay, promotion, expectations, and requirements exist despite numerous laws and programmes being implemented, however it does appear small advances are being observed throughout academia, but at a slower rate in science, engineering and technology disciplines [5]. This chapter has also explored some possible reasons for, and solutions to, the gender inequality in STEMM – including CPD as a possible 'equality gap closing mechanism'. As with many CPD issues, understanding the links between effective and useful CPD and its effects on career progression are very difficult to determine.

Further research is needed in order to explore the effects of CPD methods and the relationship between learning styles and gender [56]. Ideally long-term studies need to be carried out to observe whether CPD, and indeed which type of CPD, is useful in assisting with career progression. This type of research teamed up with large-scale quantitative and qualitative research understanding (such as the HEFCE research discussed) will help to understand the needs of both academics and the institutions. The type of CPD offered is also important as individuals prefer modes of learning which suit the way they process information (due to different needs and wishes of the individuals involved). Some women have expressed that they do not like 'women only' programmes, whereas these programmes are attended by other women in universities throughout the UK.

Alongside CPD, a number of other factors might be influencing career progression including equality law, economics (CPD usually has a cost attributed to it), institutional aims and objectives, and indeed the wishes of the academics themselves. A key point to remember is that CPD can assist in redressing the gender imbalance, if appropriately designed courses are available to academics. Evidence has shown that CPD can increase confidence (a lack of which has been suggested as a reason for lack of progression among female academics [40]) and it is likely that CPD also affects many other important areas too. Within this context, it should also be important to reflect that CPD is not only essential for the academics involved, but also where research is a consideration there might be large areas of society affected in addition to the students that they teach, researchers within their group, their colleagues, school and ultimately their higher education institute.

Even though such listings of barriers exist that affect women's options and achievements, more research on systems by which social expectations and beliefs contribute to women's professional behaviour is required. It would not only increase the understanding of women's career development, but would also help in the design of systematic programs of intervention which are capable of increasing women's statuses within their professional careers [17]. Although this was stated in 1981, it is still largely true now.

In conclusion, gender inequality does not only originate in beliefs, self-confidence and values, but also in obstructions derived from the social cultures that educate scientists themselves. To reduce gender inequality in science, it is not only important to change women's attitudes and aspirations, but there is also a need for actions that would change the structural systems that are still in favour of the male scientists [67]. It is necessary to determine what it is about structural systems that make them well-suited to men's lives. So far, many university strategies have failed to assist in the combined roles of family life and work. Male-dominated leadership in academic institutions often fail to consider women-friendly policies and practises and women are expected to adjust to the norms which do not accommodate their differences [34]. On average only 28% of research performing organisations within the EU in 2015 had gender equality plans for example [6]. The more modern view is that in fact institutions should become more work-life balance and more understanding of the needs of their academics whether male or female. Changes in many societies mean that roles outside of the workplace are also changing. The differing roles expected from males and females undertaking the same job descriptions are also very complex and might put women at a disadvantage in relation to promotion and career advancement. Work towards recognising the differing roles and rewarding them appropriately, or giving the same opportunities for men and women need to be fostered by not only the universities but also grant funding agencies, journals and similar organisations that ultimately impact upon careers and esteem factors.

Looking across the decades, views have changed radically. An interesting progression is the awareness that there has been a gender gap in the STEMM subjects and that this needs to be rectified via a number of different routes. Both small and large scale studies are being carried out in differing countries to see where the differences lie. Transparency is being encouraged and in many cases equality is being rewarded or simply an expected part of processes such as academic roles, peer review, pay and when hiring staff.

CPPD plays an important role in addressing some of the challenges observed. Whether it is educational courses directed at both men and women such as equality training and management courses, or CPPD directed at women, getting the right balance of CPPD is essential. Undertaking too much or inappropriate CPPD in lieu of achieving grants and publications might inadvertently slow career advancement. By contrast, not being able to access appropriate CPPD might also deter progression. The ASSET report highlighted the need to make appropriate mentors, supportive and career progressive networks, and CPPD available for all staff [3]. Recent research suggested that female only programmes may in fact support stereotypes and care must be taken when developing programmes in STEM [68]. Pedagogical techniques, availability of training and education for academics and those in related roles are all essential in helping to close gender gaps across the board and in changing perceptions of STEMM academic roles.

Conflict of interest

The authors declare no conflicts of interest.

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