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Research Article

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Decision-making factors of female A-level chemistry students when choosing to study a degree in chemistry

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Abstract: Gender issues, and specifically the lack of women in the physical sciences, has been a subject of intense debate for decades. The problem is so acute, that national initiatives have been developed to analyse and address the issues, with some success in STEM, particularly in higher education and also in industry. However, despite this progress, there is little understanding as to why women are less likely to study the chemical sciences in particular. In this research, a survey and interviews were used to find out why female A-level chemistry students choose, or do not choose, to study chemistry at higher education level. Two distinct phases were identified. Firstly, intelligence gathering to understand the location, content, entry requirements, and career options for potential course and institution combinations. Secondly, self-reflection to establish whether, knowing themselves, students feel as though they would be successful on a particular course at a particular institution. These findings align with research into gender imbalance in STEM and Higher Education more broadly, but go beyond this to broaden current debates with a focus on chemistry in particular.

Keywords: attitudes; culture and education; gender issues; misconceptions.

Introduction

The Global Gender Gap Report of the World Economic Forum (WEF) states that, on average, women are underrepresented in STEM fields (UNICEF, 2020; World Economic Forum, 2021). As of 2017, women accounted for just 35% of STEM students at Higher Education level (UNESCO, 2017). Recent reports from the Royal Society of Chemistry (RSC) highlight a particular problem within chemistry, with the gender gap permeating all career stages, from promotion to publishing (RSC, 2018a, 2018b, 2019).

Academic research has focused on women in science or STEM in general, or why women choose chemistry at (UK) High School level, GCSE or A-level (Boli et al., 1985; Levine & DiScenza, 2018; Ma, 1999; Oakes, 1990; Wilson & Boldizar, 1990). This study addresses the systemic gender imbalance in STEM by taking the issue to women, to identify the causal mechanisms influencing their decision on whether to progress their study of chemistry to undergraduate level. Through this approach the driving factors behind loss or retention of female chemistry students between A-level and Undergraduate-level can be better understood.

Intersectionality between socio-economic background and educational attainment is well documented in research (Britton et al., 2016; Crawford et al., 2016). However, socio-cultural factors are also influential at GCSE-level and earlier (Dilnot, 2016; Levine et al., 2015). Therefore, whilst it is recognised that differentials in attainment due to

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race and social background have a bearing on degree choice, these factors have already been triggered prior to A-level. STEM career choice is formulated during adolescence as it is difficult to transition to an STEM career after degree-level (Wang et al., 2013). Thus, this research focused on gender and chemistry degree choice.

Theoretical framework

The aim of this research was to identify factors that influence the take-up of a chemistry degree by female A-level students. In this study we have used realist evaluation to understand this phenomenon. Realist evaluation is theory-driven evaluation based on the principle of not just 'what works?' but 'what works, for whom and in what circumstances' (Pawson, 2002, p. 2), through a Context + Mechanism = Outcome configuration (Pawson & Tilley, 1997). An underlying theory (Mechanism) is trigged by Context to effect a change in behaviour (Outcome) (Pawson, 2002). This research aimed to identify the Mechanisms that, within the Context of an A-Level Chemistry course, influenced the Outcome of Chemistry as an Undergraduate course selection. With this aim in mind, the following research questions were identified:

(1) What mechanisms influence female A-level Chemistry students when deciding whether to take up a Chemistry degree at Higher Education level?
  a. What resources are used in making this decision?
(2) Do influential factors in whether to do a Chemistry at Higher Education level differ between male and female A-level students?
(3) How do the findings compare to existing research on the topic?

Methods

A mixed-method approach was used. A survey provided data to describe the literal and practical process of choosing an undergraduate degree and to demonstrate statistically significant differences between gender and decision-making factors. Additionally, interviews with female A-level students added depth to the analysis for a more 'close-up view' (Mason, 2006).

Survey and interview design

The survey and interviews were conducted concurrently. Findings from the interviews worked in combination and integration with findings from the survey to 'confirm, converge, and corroborate' each other (Towns, 2008). A literature review identified prior achievement (Bertrand, 2011; Sunny et al., 2017; Vincent-Ruz et al., 2018), enjoyment of the subject (DeWitt et al., 2019), self-perception and stigma (O'Brien & Crandall, 2003; Quinn & Spencer, 2001; Sunny et al., 2017), support networks (Archer et al., 2012; Levine et al., 2015; Miller-Friedmann et al., 2018), and future goals (Boatwright et al., 1992; Hayes, 1989; Maringe, 2006) as key factors for variation in men and women's take up of STEM subjects at university level. These factors were the themes for the survey questionnaire, which used a combination of closed questions with predetermined selection-box answers, open questions with free-text answers, and scale questions using a 1–5 point Likert scale. The interviews were similarly structured, using these themes to guide open questions.

Participants and setting

Heads of Chemistry at 19 Further Education Institutions (FEIs) in the Yorkshire region were contacted and nine agreed to participate. The online survey was distributed by chemistry teachers to A-level chemistry students, on each institution's online platform. Participants were aged 16–18 at the time of research and therefore able to consent, participation was voluntary, and the topic was not of a sensitive nature (University College London, 2018). The survey received 264 responses; 155 women, 72 men, 2 non-binary, 2 other, and 33 gender not specified. Due to the low number of non-binary/other responses these were excluded from gender analysis.

Four of the FEIs participating in the survey agreed to facilitate face-to-face interviews with women A-level chemistry students. These interviews contextualised the quantitative data with real stories (Watkins & Gioia, 2015), to give a deeper understanding of the decision-making process (Hurmerinta-Peltomäki & Nummela, 2006; Mason, 2006). The Qualitative interviews gave participants the platform to articulate their experience in their own words and provided a platform for the empowerment of a group identified as 'low confidence' (Bertrand, 2011; Hill et al., 2010; Lips, 1992). Interview participants self-selected with teachers' approval at participating Institutions. Whilst the risk of selection bias is acknowledged, the short time allocated for this research and safeguarding regulations within the FEIs necessitated cooperation for facilitation. Nine interviews were conducted at FEI's, four of which were chaperoned to comply with local safeguarding policies. As with the survey, participation was voluntary and prior informed consent was gained.

Data analysis

Data from the online survey was analysed using the Statistical Package for the Social Sciences (SPSS), and simple uni-variate analysis, to profile the sample. This was followed by multi-variate analysis to identify any statistically significant differences (where p = <0.05) between gender and other variables using Chi Squared significance testing. Transcriptions of the qualitative interviews were analysed using the software package NVivo. Inductive thematic analysis was used (Boyatzis, 1998), with two researchers analysing three interviews each and assigning sections of the transcriptions to codes. These codes were then cross-checked for consistency and formed the inductive coding frame used for all interviews. The research team held weekly meetings where the coding frame was discussed and adapted accordingly. Where quotes have been used, participants have been cited by number for anonymity.

Findings

Below we present an account of the most interesting and relevant features of the data that are aligned with our research aim. The questionnaire for the online survey has been included as supplementary information, along with a summary table of survey results.

Survey

The survey showed evidence of a relationship between the importance of female staff and gender. The number of female lecturers was ranked as 'very important' or 'moderately important' by a third of women respondents, compared to just 8% of men X^2 (2, N = 86) = 6.1, p = 0.048. The number of women in the department was ranked as 'very important' or 'moderately important' by 40% of women, compared to just 12% of men X^2 (2, N = 87) = 7.4, p = 0.024.

Over a quarter of women respondents (26%) did not believe that they would be accepted onto a chemistry course at degree level, compared to just a tenth of men X^2 (2, N = 226) = 8.4, p = 0.005.

Both genders reported grades as the primary reason for believing they would or would not be accepted onto a chemistry course, however women were more likely to qualify their achievements with *"I work hard"*, *"I enjoy chemistry"*, or *"I have extracurricular experience"* over and above *"I have good grades"* from men participants. Of participants that did not believe they would be accepted onto a chemistry course, women said *"I struggle with chemistry"* or *"I don't have the intellect"* and made generalised statements about their intelligence such as *"I'm really dumb"* or *"I'm a failure"*. Men were more straightforward, with direct acknowledgement that their grades were not high enough. This is supported by a smaller proportion of women respondents to the survey agreeing with the statement: 'chemistry courses are for people who do well at A-level chemistry' (72% women compared to 86% men) X^2 (2, N = 226) = 9.2, p = 0.01.

Survey findings support a gender difference in preference for coursework or exams, with 44% of women agreeing with the statement 'I prefer coursework to exams' and 46% of men disagreeing with the same statement X^2 (2, N = 226) = 11.7, p = 0.003. Similarly, there is a gender gap in the perception of mathematic ability, with 73% of women respondents agreeing with the statement 'I am good at maths', compared to 88% of men X^2 (2, N = 226) = 6.7, p = 0.035. This perception is linked to chemistry, with 91% of women agreeing that 'you need to be good at maths to do chemistry at University', compared to 79% of men X^2 (2, N = 226) = 7.0, p = 0.03. There was also evidence of a relationship between gender and perception of the difficulty of a chemistry degree, as 32% of women agreed that a chemistry degree would be too hard for them, compared to just 13% of men X^2 (2, N = 227) = 10.3, p = 0.006 (Figure 1). There was no evidence of a relationship between gender and interest in a career in chemistry X^2 (2, N = 226) = 0.382, p = 0.826.

Interviews

Open days and online sources, (cited by all nine participants), careers advisors and teachers (cited by four participants), and league tables (cited by three participants) were used by participants as sources of information about university institutions and courses (Figure 2). Open days were a valuable source, with all participants acknowledging the usefulness of taster sessions, equipment demonstrations, and meet and greets. Participants used open days to get a sense of whether the institution was 'for them' and whether they would be happy living and studying there, with participants commenting "I just liked the feel of it" (P2), "I really liked it there" (P3), and "[to] get a feel for the place" (P8).

The sources referenced by participants were used to gather information about course structure, reputation, entry requirements, and equality charter recognition. The course structure was the piece of information participants gathered the most detailed information about, with participants highlighting variation in modules, combinations of core and optional modules, and placement and study abroad opportunities as influential factors.

Participants drew attention to a number of reasons why women might not choose to continue studying chemistry after A-level (Figure 3). The most commonly cited reason was a general lack of information, including information about the style of a chemistry degree, the different course and module options available within chemistry, and a lack of knowledge about career opportunities.

> "I don't think you really get to experience university courses before you sign up for them, and so for me like I opted for my safe space" (P5)

> "I think because we didn't really have, we had people coming in for like medicine dentistry erm but not so much like solid chemistry or what chemistry can lead to" (P3).

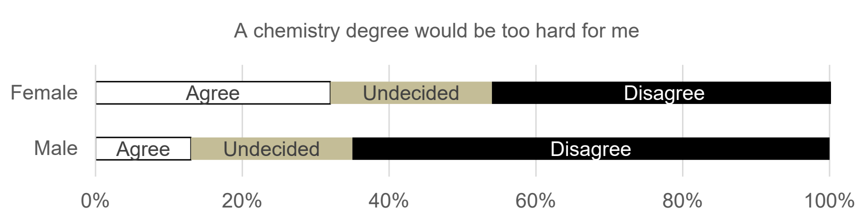

Figure 1: How far do you agree with the following statement: 'A chemistry degree would be too hard for me'.

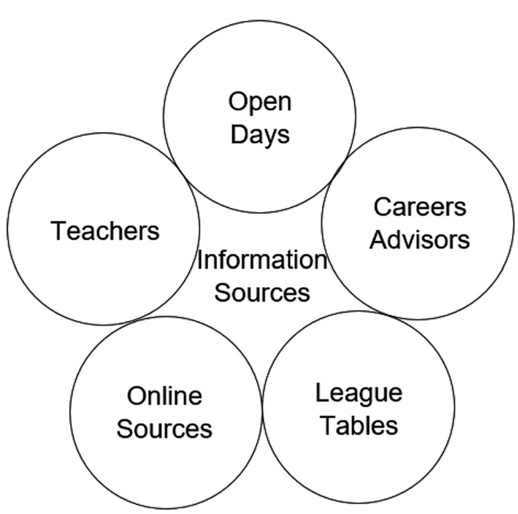

Figure 2: Sources of information about university institutions and their courses from interviews.

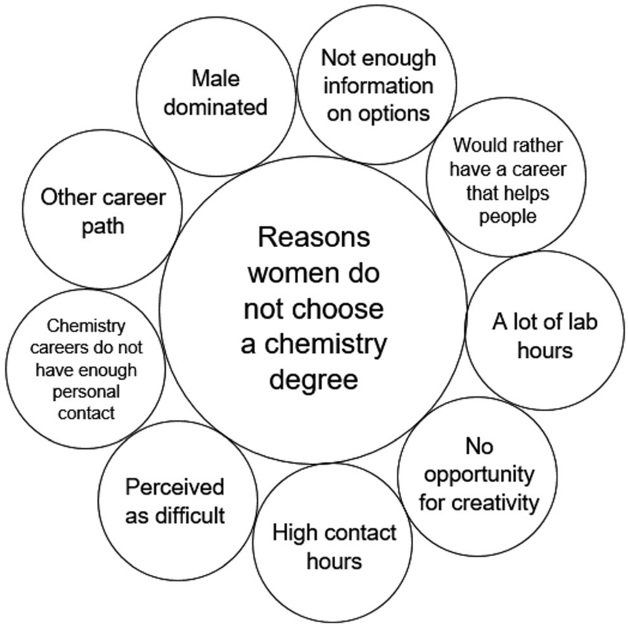

Figure 3: Reasons stated by interview participants as deterring women (including but not limited to themselves) from choosing a chemistry degree.

This was linked to an expressed desire for more engagement or awareness activities.

Stereotypes about chemistry (or STEM) careers were indirectly referenced, with participants claiming chemistry careers are not compatible with people wanting a lot of communication, personal contact, or a chance to use their creativity, and that chemistry careers comprise long, lab-based, working hours. Chemistry was also referred to as not "feminine" (P7) and perceived as "more for males" (P9), with one participant observing that, when the subject was particularly difficult, the men in the cohort were more likely to "get over it", whilst the women would reflect inwards with "what's wrong with me?" (P5).

Participants claimed that chemistry was often studied as a prerequisite for an adjacent career such as medicine, veterinary studies, or pharmacy. This supported the survey results, which showed that 94% of participants had a career in mind, with the most common being Doctor or Medicine.

Discussion

There was no significant gender difference in the level of interest in a career in chemistry. This supports previous research, which suggests that men and women are equally likely to be interested in chemistry and that other mechanisms are responsible for the male dominance seen in undergraduate chemistry programmes (Ayalon, 2003; Dickson, 2010; Hango, 2013; Lips, 1992).

The findings suggest that decisions about A-level courses are split into two factions: intelligence gathering and self-reflection. Intelligence gathering involves finding out the required grades, possible careers, etc., whilst self-reflection refers to whether potential applicants think they will succeed, knowing what they know about themselves. The data suggests little evidence of differentiation by gender at the intelligence gathering stage, but that women are more reflective and realistic, but value their skills and knowledge less, than men when it comes to self-reflection. Five key mechanisms influence this self-reflection stage: prior achievement, enjoyment of the subject, self-perception, support networks, and future goals.

Intelligence gathering

The number of institutions and courses available to prospective higher education applicants makes narrowing down the options complex (Maringe, 2006; Price et al., 2003). Findings from this research present a similar pattern of decision-making to that of product purchase (Price et al., 2003), which suggests several stages between recognising a need and making a final decision. Initially, the buyer recognises a need or a problem, followed by an information search, an evaluation of alternatives, and a purchase decision (Kotler & Armstrong, 2010). The attitude of others and situational factors can intervene in the decision-making journey (Price et al., 2003). Findings from this research align with this, identifying self-reflection as the point of intervention, contextualising the information from the intelligence gathering stage.

Potential applicants narrow their institution and course options by gathering information about key factors, including educational qualifications, geographical mobility and finances (Tackey & Aston, 1999). Participants predominantly used online sources to educate themselves on their options. Whilst many of these factors have no link to gender, course structure is identified as an influential and divisive factor (Bertrand, 2011; Levine et al., 2015; Ors et al., 2008; Sunny et al., 2017). High-pressure competitive settings such as exams are proposed to favour male participants, whilst female participants are more likely to reject an exam assessment format in favour of lower-pressure alternatives (such as coursework or essays) (Ors et al., 2008). Survey findings identified evidence of a relationship between the level of preference for coursework over exams and gender. If exams do favour men, the recent decrease in funding to STEM subjects at Secondary and Further Education level will increase this divide, as cost-effective exams and tests are favoured over hands-on experimental training (Levine et al., 2015). Levine et al. (2015) suggest that a hands-on approach to learning increases women's interest in pursuing STEM-related careers.

In contradiction to the literature, the survey data showed no evidence of a relationship between gender and the amount of practical work, the amount of maths, the number of exams, or the amount of coursework on a programme. This could be because the sample had chosen to study chemistry at A-level. As applied science subjects are traditionally assessed by exams, this pool of students may not be as averse to exams and maths (characteristic of an applied science A-level) as students who did not continue an applied science after GCSE.

Seeing women in STEM roles increases girls' confidence in their STEM ability (Hill et al., 2010) and conversely, absence of female role models perpetuates the stereotype that scientists are overwhelmingly male (Levine et al., 2015). Murray et al. (2019) demonstrated that women's participation in chemistry is inherently diminished in both the texts and images used in UK and Irish secondary school textbooks, suggesting that the invisibility of women in chemistry is indoctrinated from at least as early as secondary school level. It is well documented that female role models play an important part in shaping perceptions of what a chemistry career is, or can be, for a woman (Hill et al., 2010; Levine et al., 2015; Miller-Friedmann et al., 2018; Murray et al., 2019). This is supported by women survey participants placing importance on the number of female staff, and interview participants identifying female chemistry teachers as role models. However, increasing the number and visibility of female staff in chemistry education is difficult. In 2017, 44% of undergraduate chemistry students were women compared to 29% of non-professorial staff, and just 9% of professors (Royal Society of Chemistry, 2018a), suggesting that it is not just the visibility but the prevalence of women in high-level chemistry careers that needs to be addressed.

Interview participants suggested that outreach activities, aimed at providing information to A-level students about chemistry careers, were influential but missed the mark. Participants who had been aware of outreach activities noted a focus on chemical engineering, and a perception that this engagement was aimed at men on broader STEM programmes, rather than all chemistry students. This lack of engagement activities contributed to participants feeling uninformed about their career options.

> "We had people coming in for like medicine dentistry … but not so much like solid chemistry or what chemistry can lead to … we don't really get people coming in to talk to us about it" (P3)

As STEM career trajectories are relatively prescriptive, it is difficult to transition to an STEM career after Higher Education level, meaning that STEM career aspirations are necessarily formulated during secondary education (Wang et al., 2013). The importance of career aspiration was reinforced by all interview participants having a career in mind, indicating that degree choice is dictated in part by career opportunities.

Participants' lack of information about careers in chemistry was identified as contributing to the perception that chemistry careers are not people-facing. A lack of contact with people was repeatedly stated as a deterrent from a chemistry career and thus a valid reason for not choosing to study chemistry at Higher Education level.

> "I want to help people in, like, a more direct way" (P9)

> "for me it's essential to be able to talk to people and to work in a team with people and to have sort of a large amount of communication" (P5)

Research by Lips (1992) suggests that this preference for face-to-face contact is more prevalent in women than men, claiming that women place higher importance on people-related values. In-line with stereotypical perceptions of chemistry careers, which have traditionally been characterised as expecting long hours of work and a single-minded approach to career progression (Grunert & Bodner, 2011), women are more likely to perceive science careers as asocial (Bar-Haim & Wilkes, 1988; Lips, 1992; Matheson & Strickland, 1986). This Bourdieurian sense of the binary 'for them' or 'not for them' (Bourdieu, 1984) was also observed by DeWitt et al. (2019) who suggested that information and materials on a variety of career options leading from physics could be a path to increasing uptake. Findings from the interviews suggest that these results, and this strategy, could translate to A-level chemistry.

Following Intelligence Gathering, potential courses and institutions are then narrowed down in a process of self-reflection. Career aspirations, support networks, stigma, and prior achievement were identified as factors influencing participants' perceptions of the likelihood of individual success on a particular course or at a particular institution.

Self-reflection

Perception of ability to succeed is an important factor when choosing a degree programme (Wang et al., 2013). Once students have gathered information, findings suggest that they then progress to reflect on their personal experience to establish if, knowing what they know about themselves, they will be successful. The term 'successful' includes not only academic success by completion of the degree to an individually determined standard of success, but personal happiness as well. Throughout the survey, women were less likely to select the neutral option (point three on a five-point Likert scale) than men respondents. This suggests that women students are likely to have put more thought into these factors and are consequently more self-reflective. When asked to select level of agreement with the statement 'Entry requirements for chemistry courses are exceptionally high', 30% of women respondents selected the neutral option, compared to half of all men respondents. When asked to select level of agreement with the statement 'chemistry courses are for people who do well at A-level chemistry', just 7% of women respondents selected the neutral option, compared to 21% of men.

It is during this Self-Reflection stage that women and men present differently, with women valuing their skills, ability, and attainment more realistically than men. The following sections will consider this self-reflection stage with existing literature, breaking self-reflection down into five key mechanisms: prior achievement, enjoyment of the subject, self-perception, support networks, and future goals.

Prior achievement

Data from the survey suggests that women are more reflective when it comes to prior achievement, with 91% of women respondents agreeing that 'you need to be good at maths to do chemistry at University', compared to 79% of men respondents. Whilst prior achievement was universally cited as the most common reason for participants believing they would or would not be accepted onto a chemistry degree programme, women were more likely to place their prior achievement in context with other factors such as enjoyment or experience.

Despite little difference in performance levels between genders (Miller-Friedmann et al., 2018), prior research has identified mathematic ability as a greater physical and psychological barrier for women than men (Bertrand, 2011; Sunny et al., 2017; Vincent-Ruz et al., 2018). Survey results supported this, indicating that women place more weight on the mathematical component of chemistry in the chances of overall success on the course. Vincent-Ruz et al. (2018) found a link between maths performance and competency-belief in chemistry. This was more pronounced for women than men in both maths and science (Hand et al., 2017). Data from the survey supports this. When asked for level of agreement with the statement 'I am good at maths', 28% of women respondents did not agree with the statement, more than double the 12% of men ($p = 0.035$). However, a meta-analysis of the 2003 Trends in International Mathematics and Science Study and the Programme for International Student Assessment showed that, despite men reporting more positive math attitudes, there was little difference in achievement between genders (Else-Quest et al., 2010). Breda and Napp (2019) suggest that it is not a comparative underperformance in mathematics but rather an over-performance in reading that is responsible for the gender gap in subjects with a high maths content. As school-age women who perform well in maths achieve, on average, even higher performance in reading than their male counterparts, they are more likely to choose a reading-based subject to study at higher education level.

Mathematic ability, whilst an important factor, is not an overriding factor for the underrepresentation of women in STEM (Wang et al., 2013). Crawford et al. (2016) suggest that prior achievement is a potentially endogenous factor in determining exclusion from progression in certain subjects. This posits that students who do not believe they will go to university to study a specific subject may put less effort into studying (Crawford et al., 2016), and thus external factors influence course choice prior to achievement.

Enjoyment of the subject

There is evidence to suggest that interest and enjoyment are key factors driving subject choice (DeWitt et al., 2019). However, this research showed no evidence of a relationship between how much respondents enjoyed studying chemistry at A-level and gender, or perceived interest or enjoyment in a chemistry degree and gender. Despite this, in the free-text comments within the survey, women respondents cited their lack of enjoyment for the subject as a reason they would not be accepted onto a chemistry course at University level.

Self-perception and stigma

Sunny et al. (2017) suggest that the perceived risk of confirming negative stereotypes acts as a 'psychological burden that negatively impacts performance'. This is supported by O'Brien and Crandall (2003) and Quinn and Spencer (2001) who found that women underperformed in mathematics because of the enduring stereotype that women are less capable in mathematics. It is suggested that women systematically underperform in competitive environments relative to men due to gender differences in risk-aversion (Bertrand, 2011; Levine et al., 2015), which translate to an educational test environment. Sunny et al. (2017) extended this by suggesting that the testing situation alone was enough to trigger this underperformance. The survey data supports the theory that it is the test environment, rather than the subject matter, that triggers different gender outcomes, with 44% of women respondents showing a preference for coursework, compared to 46% of men respondents stating a preference for exams ($p = 0.003$). This could partially explain the gender gap in enrolments to Higher Education chemistry courses, as chemistry is a subject known for its linear learning style with 'no space for students to make social, economic or aesthetic arguments' (Andersson, 2017). This is supported by findings from the interviews, with one participant in particular stating that she would not choose a chemistry career because she wanted to use her 'creative side' (P3). Levine et al. (2015) suggest that young women have a self-perception that they lack the ability or aptitude to succeed in STEM disciplines. This research supports this, with evidence that women are more likely than men to believe that a chemistry degree would be too hard for them.

Support networks

Stereotypical notions of women's inferior ability compared to men are established, confirmed, and continually redefined through unconscious bias (Miller-Friedmann et al., 2018), causing confusion over the identity pairing of 'woman' and 'scientist' (Archer et al., 2012). Support networks comprising of teachers, parents, and other authority figures are integral to reinforcing or refuting these stereotypes (Levine et al., 2015), and influential in the success of women in chemistry (Miller-Friedmann et al., 2018). Parental opinion is identified as an influential factor, but one of limited significance (Boudarbat & Montmarquette, 2009; Price et al., 2003). Interview data supported this. Despite participants consistently claiming that they had not been influenced in their decisions: 'it's really my own decision' (P9), 'it was definitely my decision' (P8), 'I've had the freedom to make it by myself' (P6), participants followed these statements with discussion of parental involvement; 'my parents are open to me doing whatever' (P8), 'My parents are happy for me to, like, try and do that' (P9), 'I always sort of like consult my parents before I make any big decisions just to see if they agree' (P6), suggesting that parental involvement may be an important part of the decision-making process, despite having limited influence on the final decision.

Future goals

Decision-making about a university degree course is influenced by long-term future goals such as career and family aspirations (Boatwright et al., 1992; Hayes, 1989; Maringe, 2006). Better labour-market outcomes, and better paying jobs, are often credited as reasons for choosing an STEM degree, however this perceived reward is not a guarantee (Hango, 2013). This research supports that STEM careers are perceived as asocial (Bar-Haim & Wilkes, 1988; Lips, 1992; Matheson & Strickland, 1986). Grunert and Bodner (2011) take this further by suggesting that women are deterred from STEM careers at an early age, and thus less likely to take up chemistry careers, because of a perceived incompatibility with family life. This is not something that was indicated in this research. However, this issue permeates beyond STEM to socio-economic constructs of woman's role in the family as opposed to something intrinsic to chemistry.

Perceptions

Interview participants were asked why *they* thought young women studying A-level chemistry may not choose to study chemistry at university-level. The most common theme from these answers was that women are uninformed about their options to study chemistry further, including the range of courses available and the diversity of potential careers. This supports the theory that women are more reflective when choosing a degree. There was expression of a desire for more information through face-to-face contact at engagement activities. It was also put forward that many women may go into chemistry at A-level with a career path in mind and that, although a chemistry degree may not be part of that career pathway, chemistry would still be intrinsic e.g., medicine, dentistry, pharmacy. Stereotypes were also mentioned as perceived reasons as to why women do not progress from A-level chemistry to degree-level chemistry. In particular, the perception that chemistry is a hard subject and male dominated.

Conclusions

Women are in the minority at each stage of their chemistry careers. This becomes more prominent the higher up the ladder they climb. Existing literature, with support from findings from this research, suggests that increasing the number of women within chemistry, particularly beyond higher education level, is an ouroboros phenomenon, as more female chemists are needed in order to attract more female chemists. Looking at the point at which women commit to a chemistry career path, this research suggests that the decision whether to study chemistry at degree level is split into two distinct stages.

Intelligence gathering is a process of selection and rejection based on aspects of a course or institution such as location, entry requirements, and course structure. Self-reflection is a more nuanced process using an individual and internal measure of success to establish if, knowing what they know about themselves, students will be successful on a particular course at a particular institution. It is at this latter stage at which gender differences are most pronounced, with women giving lesser value to their skills and capabilities. These findings support previous research into gender differences in STEM education, and higher education decision making, by identifying prior achievement, enjoyment of the subject, stigma, support networks, and future goals as influential factors in choosing or rejecting chemistry as an undergraduate degree choice.

Despite findings indicating that underlying mechanisms such as support networks and future goals influence degree choice, when asked directly participants stated a lack of knowledge or awareness of the different paths available following chemistry at A-level as a deterrent for progressing with chemistry. Issues around the compatibility of an STEM career with family life were not raised by participants in either the survey or interviews. However, a chemistry career was perceived as an isolating endeavor, with a desire to work with people cited as a deterrent from a chemistry degree. This misconception links to a lack of awareness of the variety of available chemistry careers which, in turn, is linked to a lack of engagement activities and visibility of successful women in chemistry. Despite this, the majority of women in this study had at least a vague idea of the career or job sector they wanted to be heading towards. This indicates that, despite expressing a need for more information around career options, these women felt well enough informed in their career choice to plan steps forward.

Thinking forward, the findings from this research largely support the idea that previous strategies, aimed at increased engagement of women in the broad areas of STEM, would have impact if implemented with a chemistry focus. Increasing the visibility of female chemists to young women at the start of their science career is claimed to be the most effective method of dually addressing gender/career stereotypes and spreading awareness about the varied careers that stem from chemistry education. However, difficulties in achieving this are also responsible for the lack of implementation of these strategies thus far. Engagement activities are often positioned as additional to a standard workload and thus, if women become disproportionately responsible for delivering these activities, the perception of an exploitative workload becomes reality.

Research limitations/implications

There are no claims for generalisability of findings from this research on account of the small sample of participants for both the survey and interviews due to the short timescale of the research. However, the findings generally support existing literature about factors influencing women's' decision to choose or reject an STEM subject at degree level and extend this by narrowing the focus to chemistry in particular.

Supplementary Information

The following supplementary information is also provided: questionnaire, interview prompts, and summary table of Chi-Square Test results for quantitative data.

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