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Female university computing students' perceptions of technology careers: Interpretivist research to inform careers practice

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The representation of women in the technology sector, reported at 16.4% (Wise, 2020), necessitates investigation. How female university students' perceptions of careers in technology formed can help understanding of the causes of female underrepresentation and suggest possible practice by careers professionals to help redress this imbalance. This research utilised purposive sampling to identify four information-rich participants (Palinkas et al., 2013) for semi-structured interviews, followed by thematic analysis via coding (King & Horrocks, 2010). Societal influences on students' perceptions of technology careers, both prior to university and once employed in technology, emerged as significant factors.

Rationale for this study

News article headlines such as 'Ten years on, why are there still so few women in tech?' (Little, 2020) invite further exploration. My professional background in secondary school teaching meant I knew there had been a perceptible change in some female students' attitudes towards computing, in part due to the new computer science GCSE introduced from 2014 (Williams, 2020). Yet female representation in the technology sector remains low at 16.4% (WISE, 2020), particularly when compared to 46.8% across the UK workforce as a whole (World Bank, 2021). Further, attracting over $15 billion investment, average salaries of £53,318 (+4%) during 2020 and providing 10% of job vacancies during December 2020 (Tech Nation, 2020), the potential of the UK technology sector is arguably even more apparent with the advent of Covid19.

Computing / STEM university students are an important source of workers for the technology sector, though it should be noted that one third of roles within the field are non-tech roles (Tech Nation, 2020). Yet in 2019-2020 only 19.9% of UK university students in computing-related disciplines (HESA, 2021) and 35% of UK all STEM university students in 2017-18 (STEM Women, 2021) were women. The loss of females from technology and other STEM sectors is frequent enough to have been characterised as a 'leaky pipeline' (Grogan, 2018). This suggests the need to attract more female students from a range of disciplines into the technology sector and to retain those currently studying computing-related degrees.

Given my current work as a university careers consultant involves preparing students for their transition into the workplace, the underrepresentation of women in the UK technology sector raised questions in my mind as to why this is the case. What are the influences on female students' perceptions of careers in technology and how have these impacted their career decisions? This research focused on female Masters Computational Arts students' perceptions. Some had not previously studied a computing or STEM related degree, so their perceptions can help inform strategies to increase the representation of women in technology.

Significance of perceptions

Understanding female underrepresentation in technology careers requires comprehension of influences over female students' perceptual knowledge (O'Brien, 2020), or what they believe they know, about technology careers and how these perceptions effect career choices. Two main perspectives dominate existing literature. First, that UK societal attitudes and '…stereotypes about the type of people who usually fill technology roles put girls off from an early age' (McDonald, 2018). Secondly, that structural inequalities embedded within organisations cause female underrepresentation (the organisational culture approach, Wynn, 2019). These perspectives are actually interrelated given the perceived nature of working in technology organisations influences parents', teachers', and girls' perceptions, and subsequent views as to whether technology careers are desirable. Understanding students' perceptions, the way in which they have internally organised information received from a variety of sources (Epstein et al., 2018), can inform career management support for female computing university students.

Internally held perceptions of what constitutes a suitable career have long been the subject of career theories. Betz and Hackett's (1986) career self-efficacy theory implies female computing students need to believe they can succeed in a technology career before pursuing and persisting within that career. Indeed, imposter syndrome, or '…feelings of inadequacy that persist despite evident success' (Corkindale, 2008), has been identified as prevalent amongst university computing students and poses a threat to continuation: Rosenstein et al. (2020) found that 71% of female computing students suffer with imposter syndrome, compared to 52% of male students.

Recognising the importance of external influences, structural theorists raised the concept of 'horizons for action' (Hodkinson et al., 1996, as cited in Hodkinson et al., 2006): a student's perception of their future career identity is limited by the social situation from which they conceived their options. Further, Coogan and Chen (2007) highlighted the need for students to consider whether gender socialisation has influenced their career choices and perceptions. Certainly, consideration should be given to the idea that the shared habitus and gender socialisation of women through the 1950s to 1980s (Little, 2017), and resultant perceptions of computing, led to the decline of women in technology-related occupations and continue to influence societal views.

Many studies related to perceptions of technology careers look retrospectively, which is valuable for insights into why students have not engaged with the sector and possible actions to remedy this. Yet research considering computing students' expectations of technology careers is necessary if their transition into the world of work is to be supported effectively. Social cognitive career theory emphasises the role of perception, self-efficacy, and habitus in career choice and development (Lent et al., 2000). Their representation of the role of outcome expectations is compelling, that it is how an individual perceives a barrier (or support) that determines its influence on their career. The degree of underrepresentation of women in technology careers suggests a need to equip female computing students with techniques to overcome possible future challenges.

Career management support

Prior research into career management support for university computing students appears limited in extent. Vesisenaho et al. (2009) advocated group counselling with computing students, corroborating studies noting that although computing students are adept at self-directed learning (McCartney et al., 2016) they benefit greatly from peer discussions (Porter et al., 2011). Indeed, learning through conversation with others is a central concept within social constructivism. Commenting upon Vygotsky's concept of the zone of proximal development, Bassot (2011, p. 10) observed '…interactions with others enable the individual to achieve more than they could alone'. Other careers-related research has demonstrated the importance of mentorship for people in STEM disciplines (National Academies of Sciences, Engineering and Medicine, 2019) and supportive communities of practice (Gabbert & Meeker, 2002). So too, the pertinence of networking to develop mutually beneficial professional relationships (Forret & Dougherty, 2001, as cited in De Janasz & Forret, 2008).

A reflexive approach could tackle issues raised by gendered socialisation (Brooks & Forrest, 1994, cited by Bimrose, 2010). Indeed, Bassot (2016a,b) suggested that critical reflection and keeping a reflective journal would raise students' awareness of how they think, feel, act, of their assumptions and also of issues of power in relationships within organisations. Law et al. (2014) advocated cognitive behavioural therapy techniques to help clients experiencing anxiety over navigating an unpredictable and rapidly changing career landscape (see chaos theory of careers, Pryor & Bright, 2014). These include shared discussions about productive and unproductive worries, thought records, and cognitive exposure to concerns. Another approach, solution focused counselling, involves '…reframing the problem and presenting alternative possibilities, work[ing] towards developing achievable goals (in small, incremental steps) and then develop[ing] a workable action plan to meet the goals' (Reid, 2016, p. 89).

This research considered the appropriateness of different career management techniques through understanding of student perceptions. As such, perceptions can inform university-based careers professionals working to develop career management skills amongst female computing students aspiring to careers in technology.

Outline of research

How do female MA/MFA Computational Arts students in a university computing department in south-east England perceive careers in technology?

1. What do female students in a university computing department in south-east England think a career in technology involves?
2. What do female students in a university computing department in south-east England believe the benefits and challenges of careers in technology are?
3. How could understanding female students' perceptions of careers in technology inform careers professionals' practice?

This research focused on female MA/MFA Computational Arts students' perceptions of careers in technology. The ontological perspective that there are socially constructed multiple realities (Patton, 2002) suggests perceptions exist. Further, the idea that underlying structures impact people, without necessarily determining their actions, meant the adoption of both relativist and critical realist ontologies was appropriate. Multiple realities of technology career perceptions exist, the creation of which might be constrained by social structures influencing students' experiences. As such, an interpretivist epistemology was adopted throughout, that aimed to comprehend the students' understanding and experience of the social world (King & Horrocks, 2010). Interpretative phenomenological analysis (Smith & Osborn, 2008) was selected to provide a qualitative method of interpreting students' perceptions of careers in technology by looking for conceptual themes influencing them whilst also recognising the role of the researcher in this process. As such, careful practitioner reflexivity to ensure understanding of how social and cultural context influences practitioner beliefs, ideas, and assumptions (Fook, 2015) was integral to this research.

Semi-structured interviews (King & Horrocks, 2010) were utilised to investigate the perceptions of technology careers held by female MA/MFA Computational Arts students. Four students were identified via purposive sampling to ensure information-rich participants (Palinkas et al., 2013). One participant had never worked in technology before, one only had internship experience, and two had previously worked in technology roles. These interviews were conducted remotely via Microsoft Teams, adhering to appropriate ethical considerations.

Data analysis via transcription, noting paralinguistic features (King & Horrocks, 2010), was followed by the construction of biographical pen-portraits (Campbell et al., 2004) to facilitate the creation of a sense of character for each participant (using pseudonyms to preserve participant anonymity). Subsequent thematic analysis via coding (King & Horrocks, 2010) enabled identification of cross-case patterns amongst the students' perceptions of careers in technology. Given this qualitative study sought to inform future professional practice, as great a degree of generalisability from the findings as possible was required. The rigorous analysis undertaken indicated that higher level themes emerged from the students' responses and that the defined codes were applicable when tested via the referential adequacy process (Robert Wood Johnson Foundation, 2008). Findings from this thematic analysis form the focus of this article.

Emergent themes

Conceptions of technology careers change when students' experiences broaden.

- Evidence of relatively limited conceptions of careers in technology amongst some students, their families and some friends.

All students spoke at some length about a lack of understanding of what technology careers are amongst people outside the sector. Comments recorded included '…I know I'm having to explain what I do all the time.' When questioned about their conception of technology careers, most students hesitantly referred to its general function and then roles linked to their particular areas of interest.

- Proximal sociocultural factors are central to the formation of students' conceptions of technology careers.

Students linked whether their families had a background in technology to their knowledge of technology careers: '…if [young people] can't see what [technology] is, and if their parents haven't done it, then they definitely can't help [their child] pick this as a career.' Further, several participants viewed the lack of emphasis on STEM related careers at primary school as a limiting factor. All students highlighted the role of peer interactions in their perceptions, both positive and negative: one student commented 'I wouldn't go into game design because of… having heard about crap situations that friends have been in.' Of note, is the role played by one student's STEM undergraduate degree and another's interdisciplinary university studies in the United States, unexpectedly introducing them to the idea of a technology career.

- Varied distal sociocultural factors influence perceptions, particularly through interactions with the technology sector.

One student spoke of the enjoyment she derived from an internship in Greece. However, some technology sector experiences had raised concerns about the skills required, later allayed by an industry article highlighting that '…the skill set is not necessarily abstract mathematics.' Another student referenced the role of fictionalised media representations of technology companies in films and television.

Balancing personal well-being and professional opportunities are core attractions of careers in technology.

- Professional opportunities, in terms of career possibilities and work style.

Contrasting perceptions existed, with one (new to technology) student identifying a key benefit as being '…a clearer route of progression and room for development.' Meanwhile another student (with eleven years of experience in technology) stated 'I think tech is really not a linear path at all, which is exciting…I would be so bored to just stay on the same track.' The fusion of arts and technology was a central attraction and most participants viewed developing their technological skills as increasing their career flexibility.

- Personal well-being, particularly security and self-fulfilment.

All students identified the attraction of personal security, afforded by good remuneration and availability of jobs, as a key benefit. Self-fulfilment derived from intellectual challenge was frequently mentioned: 'I want to have a task that I have to engage with more, that's not easy.'

External and internal perceptions create challenges for careers in technology.

- Attitudes of other people.

Most participants identified other people's attitudes as a significant challenge. The need to prove themselves was commented upon: '…coming to [technology] slightly later and then having a background in the arts, sometimes people don't really take it seriously.' Another student recalled the challenge of convincing clients she had the technological knowledge and skills required, suggesting gender socialisation (Coogan & Chen, 2007) of her clients' attitudes. One student recalled another manager laughingly commenting 'Oh, who's this? Your girlfriend?' when she was introduced. The students were keen to emphasise that such gendered attitudes were only exhibited by a few (often older) male colleagues.

- Stereotypes of women.

Half the students characterised women as commonly found in less technical roles and men particularly dominating gaming. Stereotyping of women by some (older males) had created challenges, such as being told to get the coffee at the start of a meeting. One student mentioned the intersection of age and gender as impacting her salary negotiations.

- Underrepresentation of women.

All the students mentioned the challenge of female underrepresentation within the technology sector, whilst one highlighted the lack of female role models in senior positions. Further, the sense of usually being the only woman in a meeting was remarked upon a few times. One student said she was hoping to be hired because there were so few women in technology, illustrating the significance of individual perceptions of situations as challenges or opportunities (Lent et al., 2000).

- Identifying their niche within the technology sector, finding interesting work and managing workload.

Two students, with technology sector experience, raised concerns over finding interesting work in conjunction with their desire to avoid management roles, with one saying she was '…most interested in the creative elements'. The drive to learn and self-improve was a common characteristic of the students, but that proved a challenge in terms of time management. One student talked at length about the problems of burn-out and workload pressure.

Developing self-efficacy depends upon self-confidence.

- The importance of self-confidence and ignoring imposter syndrome feelings.

All students considered high levels of self-confidence and a belief that they will succeed in their technology careers important. One identified having the confidence to '…say what you think and have your voice heard…' as essential. Another was enthusiastic about finding a supportive community (as suggested by Gabbert & Meeker, 2002): 'I love being in a university situation, when you have people that support you and protect you.' All students indicated that they were trying to ignore imposter syndrome (Corkindale, 2008) feelings.

- The need to build self-confidence, in themselves and others.

The students' passion for mentoring indicated the value they all placed upon learning with other people, particularly female professionals. One student talked about the need for professionals that explain technical concepts without patronising, to build students' self-confidence.

Self-reflection and relationship building are key to career management.

- Developing career self-management through learning, understanding personal career values and understanding the technology sector.

The skill emphasised by all the students was their ability to learn. All the students showed evidence of self-reflection. One student described how reflection upon her life and career values made her realise she was unhappy in her previous (technology) job: 'I just dropped everything and quit my job…decided to go contracting…part-time and to do the MA, to then shift my career completely to something more artistic where I can really combine my love for digital and dance.' This reflects the emergence of boundaryless careers (Arthur, 2014) in technology.

- Network building, strong people skills and openness to opportunities.

All students were keenly aware of the need to build their professional network. One commented, particularly for creative careers, 'I think it's… important to extract yourself from your bubble and reach out to people who might have a different perspective.' They also talked about the importance of strong people and teamwork skills, of being able to '…talk to people, to try to understand what they're wanting and thinking and feeling, and the ability to build a team.' One student also mentioned the importance of being open to different opportunities, reflecting the idea of planned happenstance (Mitchell et al., 1999).

- Limited student understanding of sources of career management support.

Only one student said she understood the concept of career management skills, having recognised their importance whilst previously working in technology. When probed further, another student mentioned building confidence and another mentioned '…taking tests to figure out what your best career would be', suggesting the continued influence of trait and factor matching approaches to career choice (Barnes et al., 2011).

Implications for practice

The MA/MFA Computational Arts students' perceptions of careers in technology provide important insights, with implications for professionals working with university students as well as technology sector organisations and the government. The relatively limited conception of technology careers held by students suggests the need to broaden their sector knowledge of career possibilities (roles and fields of specialisation). Students can then pursue work that aligns with their career values (Gesthuizen et al., 2019) and preferred work style thus reducing the challenge of finding interesting work. Highlighting the personal security benefits identified by students (remuneration and job availability), supported by current labour market information, will also enable students to see advantages of careers in technology. Further, raising creative students' awareness of how their perspective and skill set enables them to compete in the labour market suggests an opportunity to attract more women to careers in technology, particularly if possibilities of combining computing degrees with other disciplines are promoted (as suggested by Funke et al., 2016).

Given some students recognised the role chance had played in their exposure to technology careers, discussing the idea of planned happenstance (Mitchell et al., 1999) is appropriate. Further, encouraging take up of internships and facilitating contact with female role models was highlighted as an important source of sector experience. Indeed, shared learning via mentoring (National Academies of Sciences, Engineering and Medicine, 2019), both being a mentor and getting one, as well as networking (Forret & Dougherty, 2001, as cited in De Janasz & Forret, 2008) was clearly valued by the students as a way of gaining personal support and encouragement.

Having self-confidence and thus career self-efficacy (Betz & Hackett, 1986) was viewed as essential by students. Careers professionals can help students develop self-advocacy techniques and their communication skills, whilst also normalising and helping students ignore imposter syndrome (Corkindale, 2008) feelings. This corroborates the view of social constructivists and Bassot's (2011) observation that people learn best in interaction with others, particularly if careers professionals help students reflect upon and assess the validity of informal proximal technology sector information. This highlights the need for careers professionals to develop students' critical reflection skills and promote the use of a reflective journal (Bassot, 2016a,b). Combining these approaches with strategies to develop teamwork skills and overcome challenges, such as time management, will help students cope with the pressure of technology careers. Further, solution focused careers counselling (Reid, 2016) and the cognitive behavioural therapy techniques suggested by Law et al. (2014) could be considered to help identify ways forward for students facing stereotypes of women in technology.

Conclusion

The idiographic nature of this research into the perceptions of technology careers held by female computing university students has also facilitated insights to the perceived views of women and technology held by others. The gender-based attitudes of some people working in technology, as experienced by these female students, suggests the need for further research comprising an independent review of technology sector organisational cultures and the experiences of women within. However, it is societal influences on perceptions that appear to dominate, suggesting the need for sector wide action to raise the profile of technology careers in schools, improve the wider public's understanding of technology careers and to challenge the underrepresentation of women within. Further, this research suggests the benefit of embedded, holistic programmes of career management skill development to prepare female university computing students for their careers in technology.

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