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# Females in computing: Understanding stereotypes through collaborative picturing

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ABSTRACT

This study investigates attitudes and perceived stereotypes that children have towards female computer scientists. Research was conducted within 2 high schools in Scotland across 7 workshops including 96 participants. Stereotype patterns and social expectations were identified giving insight into gendered world views. Data was derived through picturing. Collaborative picture drawing, as a means to investigate multiple opinions, is a powerful activity that has the capacity to break down barriers of education, language and culture. By use of content analysis on 24 workshop pictures three key areas were identified as significant when determining attitudes towards computing as a career choice for females; gender stereotypes, role models, and media influence. The conclusion determines there are stereotype misconceptions regarding physical appearance, personality type, and digital ability projected onto young females. These can influence their academic decisions resulting in poor uptake of computing science as a career choice. We determine that Computing Science is seen as a male gendered subject with females who select to work or study in this field having low self-worth, a sense of being different, a sense of being atypical, and a sense of being unattractive We further determine that positive role models and positive gender balanced media influences can broaden identities in computing.

## 1. Introduction

The purpose of this study is to investigate beliefs attitudes and perceived stereotypes that children have towards female computer scientists. Despite various interventions, over many decades, the discipline of computing science (CS) still appears to be unattractive to females. In this study we investigate the perceived stereotypes associated with females in CS from the viewpoint of adolescent boys and girls. This study is important in terms of problem appreciation from a specific group of stakeholders, namely adolescent children. Before we can make change to improve attractiveness and retentions figures for females in CS we have to understand what the problem is, why the problem exists, and who or what perpetuates the issues. In this study we ask adolescent children their views on females in computing and determine if there is a difference between boys and girls. Using visuals as a medium for knowledge discovery we seek to identify perceived physical appearance, perceived personality type, and perceived digital abilities that are associated with females in CS.

Females are seriously underrepresented in STEM subjects (Science, Technology, Engineering, and Mathematics). This is commonly known as the leaky pipeline describing the path and dropout rate from school to work of females in STEM. It is described as leaky due to the numbers of women who 'fall out of the pipeline' (Varma & Hahn, 2008) by dropping out of STEM fields at differing stages of their careers. Researchers have sought to find various issues within secondary school education that could contribute to the

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dwindling numbers of women. For example, Han (2016) highlighted that when asked about their future, male secondary school pupils expected to enter STEM subject based careers, whereas females expected to enter industries such as healthcare and life sciences. Shoffner (2015) suggests this is due to a decrease in self-esteem and a fear of failure in STEM subjects as a woman progresses through secondary school. Indeed, this view of a lack of confidence has been highlighted as a key issue by numerous researchers (Meelissen & Drent, 2008; Stoilescu & Egodawatte, 2010; Vekiri, 2013). Having a female teacher provides female students with a role model, and can help the retention along the pipeline (Beyer, 2014; Friend, 2015). Gendered messages can shape school pupils' opinions (Shapiro et al., 2015), and under-represent females within the field (Beyer, 2014; Friend, 2015; Herman, 2015). Classroom environments whereby stereotypical images and symbols are displayed can also be a deterrent, as it can lead to dissuasion and a general lack of belonging within the subject (Cheryan, Meltzoff, & Kim, 2011). The reason this is more pertinent to females, as suggested by Vitores and Gil-Juárez (2015) is due to the fact that these potentially harmful images and stereotypes seem to have a greater effect on females than males.

Many researchers have looked specifically at the STEM field of computing Science (CS) and the dearth of females. Lovegrove and Hall (1991) suggested that as children, boys tend to take a more hands on approach to technology, whereas girls tended to be cautious, and afraid to make mistakes in front of their peers. Ogan, Robinson, Ahuja, and Herring (2006) additionally stated that males tend to learn computing related skills independently, in the home, whereas females tended to learn in organisations such as schools, potentially leading to males receiving better grades if they are learning at a younger age (Denner, Werner, O'Connor, & Glassman, 2014). This perception of males performing better in computer science is a negative stereotype, despite the fact that the differences in performance are negligible (Beyer, 1999). Kermarrec (2014) recognised that school children are at the age where they are most likely to be influenced by stereotypes, and by the time they reach University, it is harder to change views that have been formed. Goode, Estrella, and Margolis (2006) suggested some reasons why and how high school female students are, or are not, drawn into the field of CS. The discovered that there were few learning opportunities existing at high school level, pre-set notions of relevance play a key role in influencing choice, and a limited and narrow presentation is purported on what CS is and what computer scientists do. Goode et al. further suggest that female students who do take CS have negative experiences in classroom settings, where greater male technology experience and female isolation are part of the cultural setting.

Papastergiou (2008) investigated Greek high school students' intentions and motivation towards and against pursuing studies in CS. She found that girls are less likely to pursue CS due to extrinsic reasons rather than personal interest. Extrinsic reasons were suggested to be lack of opportunities for early familiarization with computing in the home and scholastic environments involving teaching and encouragement. Meelissen and Drent (2008) state that there are non-academic factors which affect an individual's view on computing such as digital availability in the home, parental influence, the overall gender bias towards men in computing, and the general technical skills. Vekiri and Chronaki (2008) further this by suggesting any gender differences that may exist are through socialisations between an individual and their family and peers. Their studies, measuring perceived parental support, showed that boys tended to use computers more in their daily activities than girls that were questioned in a survey, despite equal accessibility to computers for both genders. However, they found primarily that parental encouragement is a greater influencer to their child's self-confidence than computer based activities (Ibid.).

Over the past few decades, various solutions to the ‘leaky pipeline’ have been suggested each with varying levels of success (Tech Partnership, 2016). Intervention programmes showcasing to secondary school girls the various different careers available to them have had “limited effects” in terms of its success (Lang, Fisher, Craig, & Forgasz, 2015). It has been highlighted that earlier intervention methods may be necessary to help improve numbers of women in CS and later representation (Klawe, Whitney, & Simard, 2009). Klawe et al. suggest that potentially, efforts at a secondary school level, may be too late to help improve the situation and encourage more girls into CS related subjects. However, Alvarado and Judson (2014) highlight the success of conferences with college students, helping them to decide whether or not to major in CS related subjects. Vitores and Gil-Juárez (2015) suggest the problem exists with the masculine culture that surrounds computing, education and work and that computing is a “chilly environment” where women need metaphoric “sweaters” to survive.

## 2. Stereotypes in computing

Stereotypes are a key detrimental gender issue that affects many women who wish to enter the field of CS. As with many other fields, the stereotypes pertaining to technology are integrally linked with much wider, cultural gender stereotypes (Perry & Cannon, 1968). Best et al. (1977) suggests that the archetypal stereotypes of men displayed a picture of one who was “ambitious, rational, and independent, as well as egotistical, coarse, and unemotional.” A woman is described as being “affectionate, sensitive, and sociable, as well as frivolous, high-strung, and submissive.” When these male stereotypes are compared to the characteristics relating to scientists, parallels can be identified. Namely, a scientist is often seen to be vastly independent from those around them, with a relatively low need for social interactions, and an element of emotional withdrawal (Rossi, 1965). This conflicts with the generic female stereotype, whereby it was identified that females tended to be sociable, and concerning (Best et al., 1977). However, despite the fact that these attitudes existed a generation ago, these gender stereotypes still play a large part in contemporary organisations and institutions today. Stereotypes identified by Best et al. (1977) are mirrored twenty years later by Chodorow (1998, pp. 41–49), who likewise describes men to be independent, unemotional, and rational. Current attitudes and stereotypes towards computing related courses are also similar to what they were half a century ago. A lack of social skills and a need to be independent is still a stereotype of a typical computer scientist in the contemporary environment (Cheryan, Plaut, Handron, & Hudson, 2013; Master, Cheryan, & Meltzoff, 2015; Wong, 2016). Due to these parallels, CS is still seen therefore, as a stereotypically male subject (Cheryan et al., 2013) as it clashes with what is to be perceived as the non-digital female gender role (Cheryan et al., 2011; Wong, 2016). Some researchers suggest the