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INDIVIDUAL ENQUIRY AND SCHOLARSHIP

"Scientists can be women" – A case study on perceptions of gender in science at a rural primary school in England

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Introduction

Science has been found to be a male dominated discipline and their success in this area is consistently exhibited (Miller *et al.*, 2018, p.1953). This may deter girls from considering jobs in science-related roles as they do not deem them gender appropriate professions, leading to disengagement from the discipline as a whole and so conforming to the negative gender stereotype (Davenport and Shimwell, 2019, p.29; Stenson, 2020, p.15). Thus, educational experiences can have major implications on future career choices, particularly in terms of girls entering science-based professions (Lumby and Coleman, 2016, p.7; Davenport and Shimwell, 2019, p.29). Therefore, the aim of this case study was to examine perceptions of gender in science from the viewpoint of both primary school teachers and Key Stage 2 children as well as to identify strategies to promote equality and challenge science-related gender stereotypes in primary science lessons. Semi-structured interviews and questionnaires were carried out in a rural primary school in England with the sample consisting of 2 primary school teachers and a range of Upper Key Stage 2 children.

Overall, the data suggested that science-related gender stereotypes are not currently perceived as a prevailing issue in the context of this study. The children's questionnaire responses proposed that most children enjoy learning science and that they do not hold views of scientists as being predominantly male or female. The interviews reinforced that engagement in science is not the result of gender, rather is due to the children as individuals. Outcomes of the research contribute to existing knowledge to suggest that tailoring learning to the individual children, alongside the use of role models and opportunities for group-based practical learning, are successful strategies for promoting equality and overcoming science-related gender stereotypes.

Review of the Literature

Perceptions of gender in science continues to be a key area of discussion in education (Mead and Métraux, 1957; Hoath,

2020, p.3). Such research has revealed student's predominant perception was that scientists were middle-aged white males wearing glasses and a white coat (Mead and Métraux, 1957, p.126). This has since become the most commonly acknowledged gender stereotypical image of a scientist (Finson, 2002, p.335) leading to narrow preconceptions about the attributes, characteristics or roles that should be obtained by men and women in society (Cusack, 2013, p.8; Stangor *et al.*, 2014, p.525). McLeod (2017) argues these are commonly negative perceptions resulting in the simplification of our social world due to social categorisation and prejudice attitudes.

The introduction of the Draw-a-Scientist Test (DAST) became the chosen method for many studies (Chambers, 1983, p.257; Finston, 2002, p.335) as an open-ended activity which assesses children's thoughts on what a scientist looks like. Chambers (1983) introduced the DAST when conducting similar research to Mead and Métraux (1957). His results reflected the same attitudes as those observed almost 30 years prior; only 0.6% of his sample of 4807 children aged 5–11 years drew a scientist as a woman, reinforcing the stereotype that scientists are typically viewed as male.

Contemporary research to that of Chambers (1983) continues being carried out in countries across the world (Samaras *et al.*, 2012; Miller *et al.*, 2018; Thompson *et al.*, 2019). These studies highlight a positive upward trend in the perception that women can be scientists, with such ideologies being more commonly reflected in the children's drawings or verbal discussions (Samaras *et al.*, 2012, p.1545; Miller *et al.*, 2018, p.1947; Thompson *et al.*, 2019, p.7). For example, compared to the 0.6% of participants that drew a woman as a scientist in 1983, research conducted in 2019 (n=210) found 24% of participants drew a female figure (Chambers, 1957, p.261; Thompson *et al.*, 2019, p.7). Nonetheless, this is still an imbalanced perception of the role of women in science and they remain underrepresented in science disciplines and in children's overall perceptions (Miller et al., 2018, p.1953).

The primary science National Curriculum (NC) at Key Stage 1 and Key Stage 2 highlights numerous influential figures within the non-statutory guidance throughout various topics (DfE, 2013; Spring, 2018, p.5). Whilst there is representation of female figures such as Mary Anning and Jane Goodall, the ratio of men to women is not of equal representation or a positive reflection of modern-day science (DfE, 2013, p.27; DfE, 2013, p.32; Sinclair and Strachan, 2016). It could be argued that this contravenes the Equality Act (2010) as education should not discriminate against children in accordance with any protected characteristics – including their gender (Equality Act, 2010). It must be remembered that these suggested influential figures are non-statutory and so giving teachers autonomy over which influential figures to use (DfE, 2013, p.12). Furthermore, consideration should be given to wider resources including textbooks (PISA, 2015, p.6). Males are three times more likely to be featured in primary science textbooks (Caldwell and Wilbraham, 2018, pp.1-9) whereas if images of women working in science occupations were increased then this would demonstrate to young girls that working in such disciplines is achievable and fulfilling (Caldwell and Wilbraham, 2018, p.1).

Teachers are fundamental in shaping the values and philosophies children develop, meaning they must uphold an inclusive approach to teaching and learning (Arthur *et al.*, 2006, p.433; DfE, 2011, pp.1-2) by challenging their own pedagogy, attitudes and ethos (Scantlebury, 2012, p.1; Kerkhoven *et al.*, 2016, p.1; Davenport, 2020, p.7). This notion of a role model is used widely in modern-day society and its meaning has taken on numerous iterations since it was established in the 1950s by sociologist Merton, who introduced it as the idea of an individual illustrating the required behaviours associated with taking on a specific role (Morgenroth et al., 2015, p.467). Every role model that children discover increases the number of possible selves they potentially internalise, due to each possible self being the result of immediate social experiences (Markus and Nurius, 1986, p.954). Research by Carsten-Connor and Danielson (2016) found that girls who initially held negative stereotypical ideas around women working in science changed such beliefs and developed new positive science-related possible selves after interactions with female scientists. Positive role models are believed to increase motivation, foster inspiration and accumulate resilience and self-efficacy (Lockwood, 2006, p.36; McIntyre et al., 2011, p.301; Morgenroth et al., 2015, p.465) suggesting their importance in the classroom.

The role of the teacher and their ability to change children's perceptions of themselves can be explored further using the notion of growth mindset established by Dweck who defined fixed mindsets as the belief that each of these traits are predetermined and cannot be changed; in comparison to growth mindsets which is the belief that they can be developed through effort, experience and practice (Dweck, 2014; Hildrew, 2018, p.2). Gender stereotypes promote the ideology that boys are naturally better at science than girls (Scantlebury, 2012, p.2), meaning girls with fixed mindsets may disengage from the subject due to believing they are not suited to such discourse because of their gender (Archer et al., 2013, p.187). However, a focus on fostering a growth mindset allows children to find inspiration in others' achievements and subsequently work harder to better their own performance (Hildrew, 2018, p.3) which has the potential to be applied to girls in primary science and beyond, thus highlighting the importance of this area of research.

Research Questions

- Do Key Stage 2 children perceive scientists as predominantly male or female?
- Do teachers still perceive gender stereotypes in science to be a prevailing issue in primary schools?
- What strategies do modern-day primary schools use to overcome gender stereotypes in the teaching of science?

Method

This case study (Hope, 2016, p.64) was a mixed-methods approach using interviews and questionnaires to gain a more holistic view through both qualitative and quantitative data (Denscombe, 2017). Data was collected from schoolteachers and Upper Key Stage 2 children in a rural primary school setting as a small-scale case study in the spring term of 2022. The school was selected for its active development of science curriculum provision and its prominence in curriculum intent. It must be noted that an exploratory sample size as part of this small-scale research enabled study of a specific context rather than an accurate cross-section of the population (Denscombe, 2017, p.34) and therefore wider generalisation may become negligible due to the small sample size and specific context (Erickson, 2020).

The research participants comprised of the science co-ordinator and the year 5/6 teacher. These were chosen through critical-case sampling (Cohen *et al.*, 2018, p.199; Cohen *at al.*, 2018,

p.307) as they held key positions and considerable knowledge relevant to assist in answering the research questions. The questions asked were open-ended and the interviews were semi- structured to enable the researcher to follow up ideas, further question particular responses and pursue alternative lines of discussion (Gillham, 2000b, p.41; Bell and Waters, 2018, p.210).

To gather data regarding the perception of a scientist from the view of KS2 children, a self-completion written questionnaire was given to the children in the year 5/6 class with individual participants accumulated through opportunity sampling (McLeod, 2019a). Quantitative, ordinal data was gathered through closed questions involving a Likert scale, which allowed for statistical analysis (Bandalos, 2010, p.972). Using Likert scales rather than semantic differential scales assists in creating consistent interpretations across participant answers as the scale levels have been explicitly labelled (Dillman et al., 2014, p.159). Qualitative data was collected through an open-ended question and a DAST to gain additional descriptive responses (Chambers, 1983, p.257; McLeod, 2018). DAST is successful when gaining an understanding of perceptions of a scientist from the viewpoint of children, suggesting it is high in construct validity (Markus and Lin, 2010, p.229). Ethical guidelines of both the British Educational Research Association (BERA) and the University of Northampton were upheld throughout the research process including the gaining of parental/guardian consent (Alderson and Morrow, 2011, p.102; BERA, 2018).

The qualitative interview raw data was systematically analysed and categorised (Price, 2009, pp.155-156) through open-coding. Correlations between both interviews were then established using axial coding (Simmons, 2018, pp.79–80). The quantitative data collected from the questionnaires was collated in tables format for comparison and qualitative DAST data was analysed and converted into quantitative data for analysis.

Findings and Analysis

RQ1 Do KS2 children perceive scientists as predominantly male or female?

The number of children that drew scientists as female were almost equal to the number of males drawn which is significantly different to the original DAST data collected by Chambers (1983) whereby only 0.6% of his sample drew women. Likewise, more contemporary research by Thompson et al., (2019) in which 23.8% of his sample drew female scientists also showed considerably more stereotypical views than those collected in this study. This suggests there has been significant improvements in reducing science-related gender stereotypes during recent years. The lack of gender stereotypes held by the sample children was reinforced by responses given in the questionnaire, such as when given the statement 'scientists can be women', 100% of the children responded strongly agree. Similarly, 100% of the children responded agree or strongly agree to 'scientists can be men' suggesting the positive improvement in promoting girls in science has not been to the detriment of boys, but rather shows developments in promoting equality. Overall, there was no predominant perception that scientists are male or female; the children mostly drew them as their own gender as seen in Figures 1, 2 and 3.

That said, the research highlighted that despite gender-related stereotypes becoming negligible, stereotypical interpretations of scientists, regardless of gender, remained prevalent. The most significant finding was the overriding ideology of scientists being individuals wearing lab coats and glasses or goggles, which appears to have remained consistent for over 50 years (Mead and Métraux, 1957, p.126). Overall, 14 of the 15 DAST responses suggested scientists wear lab coats and 10 of the 15 children made reference to them wearing glasses or goggles (see Figures 2 and 3). Only 1 child made no reference to any stereotypical characteristics suggesting, although in this context gender stereotypes have been overcome, the overall perception of scientists and their job role remains unchanged. This implies the children may have been primarily exposed to images and interactions with scientists that possess these features and therefore have developed these stereotypical views (Arendt and Northup, 2015).

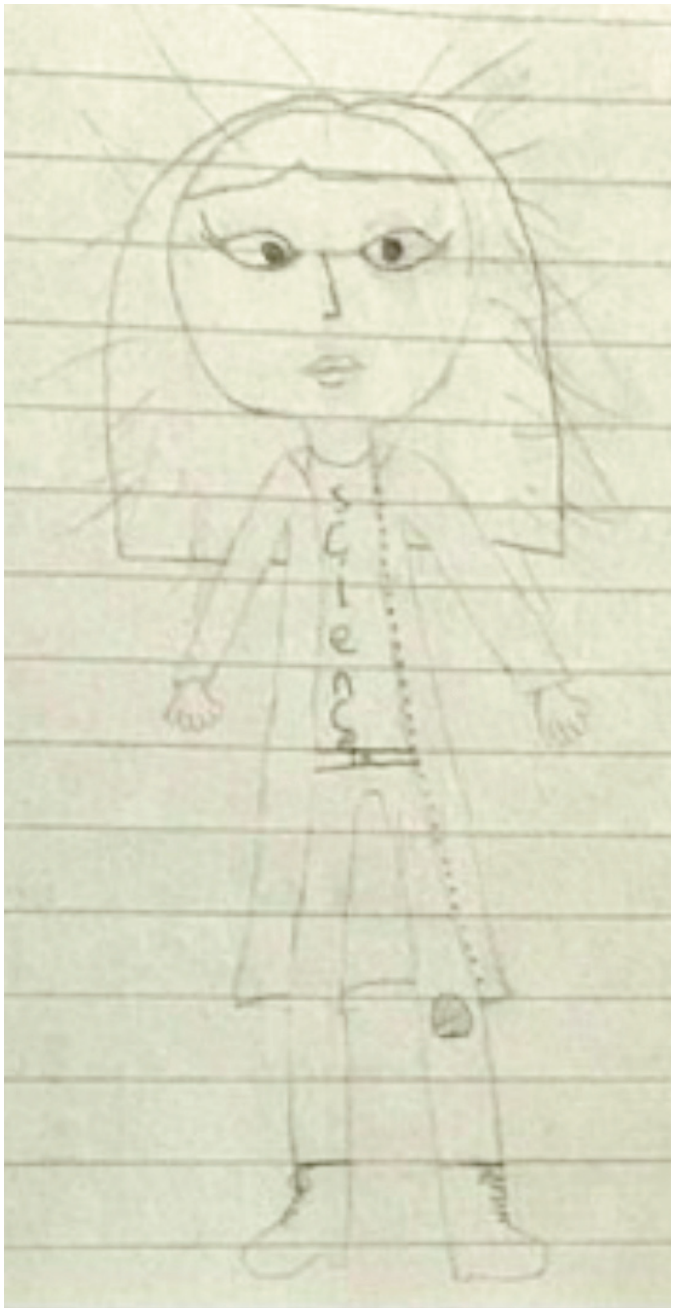

Figure 1: Image drawn by female Participant 'A'

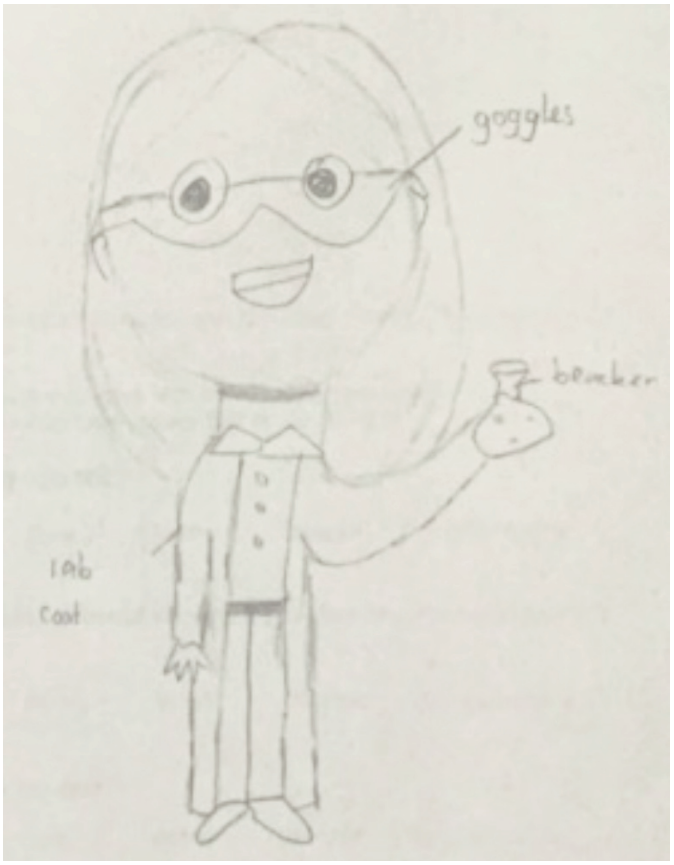

Figure 2: Image drawn by female Participant 'B'

Figure 3: Image drawn by male Participant 'C'

RQ2 Do teachers still perceive gender stereotypes in science to be a prevailing issue in modern-day primary schools?

For this research, it was important to gain an understanding of teachers' perceptions of gender differences in science as they have a fundamental role in shaping the attitudes and philosophies held by children (Arthur et al., 2006, p.433; DfE, 2011, pp.1-2). Teachers' perceptions of science-related gender stereotypes may present an explanation for the children's questionnaire responses (Scantlebury, 2012, p.1; Kerkhoven *et al.*, 2016, p.1).

The science co-ordinator and year 5/6 teacher participated in semi-structured interviews where they expressed similar opinions about the lack of science-related gender stereotypes they were currently experiencing, with one explaining "most children are highly engaged" and the other reinforcing this by explaining that engagement [in science] is good [from the girls] and they "have a positive attitude" towards the subject. These teacher perceptions were supported by the questionnaire data as 9 of the 11 children responded agree or strongly agree to "I like learning science". Furthermore, the year 5/6 teacher justified their opinion of experiencing a lack of science-related gender stereotypes by explaining that the school had a visit from a female scientist and "the children didn't make any comment that it was a woman in any surprise". Both interviewees explained "you have to be specific to a child, rather than a gender" and "it is more about them as an individual".

During the interviews, the opinion that "everybody can do whatever they want if they work hard" was expressed, suggesting a reason for the lack of gender-related stereotypes currently present. This is directly associated with Dweck's (2015) concept of growth mindset, which if promoted would enable the children to understand that they are able to achieve regardless of any stereotypical perceptions in society (Hildrew, 2018, p.3). Despite the concept not directly being referred to by the interviewees, the school promotes a growth mindset culture on their website and through their school values, implying this is something embedded within teaching and learning.

RQ3 What strategies do modern-day primary schools use to overcome gender stereotypes in the teaching of science?

To explore this question, approaches used by the school when teaching science were compared with the children's attitudes towards science and perceptions of scientists to critique their success.

Findings from this study support the notion that same-gender role models are significant in impacting attitudes, achievement and interest in subject areas and professions for both boys and girls (Carsten-Connor and Danielson, 2016). Throughout the interviews both individuals were expressive in their views about inclusion of "role models", "visitors" and "modelling" in the teaching of science. This alone does not signify the importance or impact these approaches possess, yet when accompanied by the questionnaire data whereby most children drew a scientist as their own gender and 9 of the 11 children responded agree or strongly agree to "I like learning science" it can be proposed that role models promote equality and enjoyment. The science co-ordinator advocated the internalisation of self when discussing role models by expressing that children should be able to "see themselves as

possible scientists" and understand that "science can come into many, many jobs". However, although the children present minimal gender-related stereotypes, most children responded neither agree nor disagree to "when I am older, I could choose a job that involves science if I wanted to" suggesting the possible selves they have accumulated may be limited due to their perception of science job roles remaining stereotypical (Mead and Métraux, 1957, p.136; Finson, 2002, p.335). This indicates the children may need exposure to larger varieties of science-related role models to change current perceptions of individuals wearing lab coats and glasses, because if aware that science is fundamental to a vast number of professions, their interest in working in jobs involving science may increase (McIntyre et al., 2011, p.301; Morgenroth et al., 2015).

The case-study school has adapted a topic-based curriculum design meaning learning is usually cross-curricular and science is embedded within the topic area. The data from this study advocates omitting National Curriculum (DfE, 2013) non-statutory guidance from the teaching of science; it was identified in the interviews as being hardly used with the year 5/6 teacher explaining that it was only used when most relevant. This approach could be argued as successful in promoting equality as the children in the study have not been exposed consistently to stereotypical white male scientists advocated in the non-statutory NC guidance (DfE, 2013).

The most consistent finding from the interviews was the promotion of ensuring learning is specifically tailored to the children. This was something not originally considered prior to conducting the research yet may have considerable impact on the positive non-gender stereotypical views presented by the children. Davies (2011) states successful teaching of science should comprise of an understanding of the needs and interests of the children, knowing their abilities and connecting with their lives. Advocating the same notion, the interviewees expressed that teaching should begin with "where their interests...confidence...ability is and develop these" and learning should be given a context to "make children conscious of the world around them". This suggests developing teaching of science on these foundations encourages gender to become extraneous as children are engaged in the learning as it is enjoyable and relevant to them as a cohort or individual (Cross and Bowden, 2009, p.7).

It is important to note the additional teaching strategies revealed throughout the interviews, which included "being practical", "group-based' learning including "mixed-aged groups" and "mixed-gender groups" and opportunities for "discussions". The significance of these approaches is that they engage children and demonstrate that anyone is able to participate, regardless of age, gender or ability (Loxley et al., 2014, p.4, p.54, p.60). This research suggests these strategies successfully assist in overcoming science-related gender stereotypes for these particular children.

Conclusion

The data has highlighted that the prevailing ideology that scientists are male is considerably less prominent in this primary school in comparison to previously acknowledged research (Mead and Métraux, 1957, p.126; Chambers, 1957, p.261; Miller *et al.*, 2018, p.1947; Thompson *et al.*, 2019, p.7). The children responded gender-neutrally in the questionnaire and the teacher's interviews reinforced that science-related gender stereotypes should not currently be regarded as an issue in this context. However, the data reinforced the stereotypical perception of the job role of scientists as being individuals in lab coats and glasses, the researcher believed it would be interesting to explore this further and examine the impact this ideology has on further education and career choices, as well as how it could be overcome in the future. Furthermore, this research has broadened understanding of the impact that prejudiced attitudes have on children's development of expectations of themselves and others (Culhane and Bazeley, 2019, p.11). Enjoyment and equality in science can be promoted by introducing role models, tailoring teaching and learning to individual children and providing opportunities for practical, group-based work.

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How prepared are Primary Pre-Service Teachers when teaching Physical Education? What impact do their prior experiences of PE have on their preparedness to teach the subject? Part Two

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Introduction

This article, the second of five, focuses on a research question from a Master's in Education thesis considering the impact of Primary Pre-Service Teachers' (PPSTs) prior experiences of physical education (PE) upon their preparedness to teach the subject after competing Initial Teacher Education (ITE). Making links with educational theories including Ecological Systems Theory, Emotional Intelligence, Growth Mindset and the Four Stages of Competence, this article explores who impacted PPSTs' early PE experiences and the factors underpinning